REPORT

Trinity Consultants
CANADA

Hope Bay Mine Fisheries Offsetting Plan

Operational Update

PREPARED FOR

Agnico Eagle Mines Limited
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DATE

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Hope Bay Mine Fisheries Offsetting Plan - Operational Update

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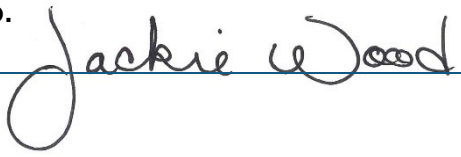

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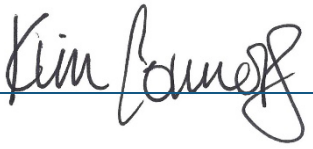

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ACRONYMS AND ABBREVIATIONS

AEMP – Aquatic Effects Monitoring Program
Agnico Eagle – Agnico Eagle Mines Limited.
CAD – Computed-Aided Design
CSP – Corrugated Steel Pipe
DFO – Fisheries and Oceans Canada
DO – Dissolved Oxygen
DQR – Data Quality Review
EOS – Iqaluktuutiaq Lake East Outflow System
FAA – *Fisheries Act* Authorization
FEIS – Final Environmental Impact Statement
GIS – Geographic Information System
GPS – Global Positioning System
HADD – Harmful Alteration, Disruption, or Destruction
HEP – Habitat Evaluation Procedure
HSI – Habitat Suitability Index
HT – Habitat Type
HU – Habitat Units
IEAC – Inuit Environmental Advisory Committee
IFC – Issued for Construction
IQ – Inuit Qaujimajatugangit
KIA – Kitikmeot Inuit Association
LRL – Laboratory Reporting Limit
the Mine – The Hope Bay Mine
Minnow – Minnow Environmental Inc.
NIRB – Nunavut Impact Review Board
NWB – Nunavut Water Board
PDA – Project Development Area
QA/QC – Quality Assurance / Quality Control
TCC – Trinity Consultants Canada
TIA – Tailings Impoundment Area
WSE – Water Surface Elevation

1 INTRODUCTION

1.1 Background

The Hope Bay Mine (the Mine) is a gold mine development owned by Agnico Eagle Mines Limited. (Agnico Eagle) in the Hope Bay Greenstone Belt area of the Queen Maud Gulf Lowlands in the West Kitikmeot region of mainland Nunavut (Figure 1.1). Cambridge Bay is the nearest community, located approximately 150 kilometers (km) northeast of the mine (Figure 1.1).

The mine area has been actively explored and developed since the late 1980s and is comprised of three known gold deposits at Doris, Madrid, and Boston. Doris was developed as Phase 1 of the Mine (Doris North; Figure 1.2) under a Nunavut Impact Review Board (NIRB) Project Certificate (No. 003) and Nunavut Water Board (NWB) Type A Water Licence (2AM-DOH1335) and began commercial production in 2017. In November 2018, Agnico Eagle received a Project Certificate (No. 009) from NIRB for Phase 2 of the Mine (Madrid North, Madrid South, and Boston; Figures 1.1 and 1.2) and in December 2018 received an amended Type A Water Licence (2AM-DOH1335) from NWB. In February 2022, Agnico Eagle suspended production activities at the Hope Bay Mine and entered into Care and Maintenance.

Based on exploration results and economic modelling, Agnico Eagle is planning to restart underground mining operations at Doris and Madrid.[1] The Hope Bay Mine Operational Update (the Operational Update) incorporates improvements and optimizations to the approved mine (i.e., under Project Certificates No.003 and No.009 and the Type A Water Licenses; TMAC 2017; Table 1.1). The Operational Update Project Development Area (PDA) has a total area of 229 ha and represents a 4.6% increase to the existing and permitted PDA under Project Certificates No. 003 and No. 009. This includes new infrastructure that will occur inside the existing and permitted PDA (69 ha of planned direct disturbance) and new infrastructure (143 ha of direct disturbance) that will occur outside of the existing PDA plus associated buffers (Figure 1.2). However, the Operational Update PDA remains within the overall amount of land already permitted by NIRB in 2017, included in the Nunavut Planning Commission's positive conformity determination, and licensed by NWB.

Planned development at Doris and Madrid under the Operational Update is shown in Table 1.1 and described in detail in the Operational Update Main Application Document (Agnico Eagle 2026). Additionally, to support operations, Agnico Eagle anticipates water needs of approximately 2,900,000 m^3/yr, a volume that exceeds the currently permitted volume under Agnico Eagle's existing water licences (2,076,800 m^3/yr). Three lakes located near the mine site,

[1] Exploration will continue at Boston, but development at Boston is not currently planned.

LEGEND

- Community
- 2025 Roberts Bay Jetty (24-HCAA-02389)
- Permitted Infrastructure
- Project Development Area

0 10 20 40
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 13N

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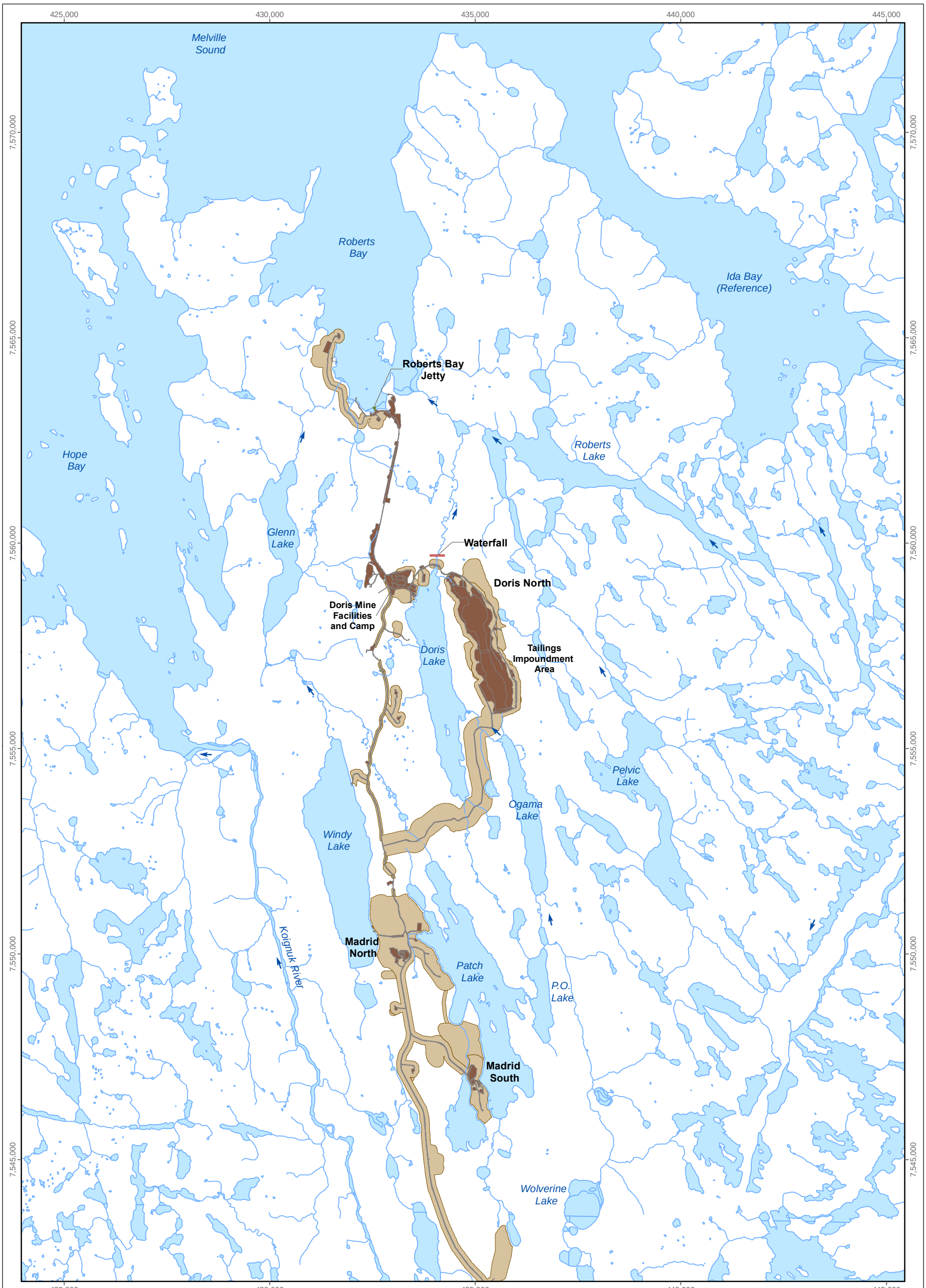
Location of the Hope Bay Mine

Date: January 2026
Project 257202.0052

minnow environmental inc.

Figure 1.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 257202.0052 - 2025 Freshwater FAA Permit Support\D - GIS\Freshwater FOP\25-52 Figure 1.1 Hope Bay Project Location.mxd



LEGEND

- Waterfall
- 2025 Roberts Bay Jetty (24-HCAA-02389)
- Permitted Infrastructure
- Project Development Area

Permitted Infrastructure and Project Development Area, Hope Bay Mine, 2025

0 1.25 2.5 5
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 13N

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Date: January 2026
Project: 257202.0052

minnow environmental inc.

Figure 1.2

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 257202.0052 - 2025 Freshwater FAA Permit Support\D - GIS\Freshwater FOP\25-52 Figure 1.2 Current and Permitted Infrastructure.mxd

Table 1.1: Hope Bay Mine Operational Update Scope Compared to Approved Mine

Activities	Project Certificate No. 003 (September 2016)	Project Certificate No. 009 (December 2017)	Operational Update
Operational Life of Mine	Doris: 6 yrs	Doris: 6 yrs Madrid North: 13 yrs Madrid South: 4 yrs Boston: 8 yrs	Doris and Madrid: 18 yrs Construction 2027-2028 Operations 2028-2042 Closure (3 yrs)
Waste Infrastructure and Management			
Processing Facilities	Doris Mill: 2,000 tpd	Addition of Doris Concentrator Handling Facility Madrid Concentrator: 1,200 tpd Boston Process Plant: 2,400 tpd	Doris Mill: Upgrade to 8,000 tpd
Tailings Management	Doris TIA - 2.5 Mt (Construction of North and South Dams)	Expansion of Doris TIA to 18 Mt; installation of tailings pipeline from Madrid North concentrator to Doris TIA; construction of waste rock pad, concentrator, and dry-stacked tailings management area at Boston	Phased transition from slurry to dry stacked/filtered tailings in Doris TIA
Underground Portals	Doris: Doris Portal	Madrid North: Madrid North Portal, Naartok East Portal (approved under Water Licence 2AM-DOH1335) Madrid South: Madrid South Portal Boston: Boston Portal	Madrid South: Relocated to Patch 7
Waste Rock Piles	Doris: 1 waste rock pile	Madrid North: 2 waste rock piles (Naartok East waste rock pile approved under Water Licence 2AM-DOH1335) Madrid South: 1 waste rock pile Boston: 1 waste rock pile	Waste rock piles at Doris, Madrid North, Madrid South
Overburden Stockpiles	Doris: 1 overburden stockpile	Boston: 1 overburden stockpile	Madrid North: Add 2 overburden stockpiles
Ore Stockpiles	Doris: 1 ore stockpile	Madrid North: 1 ore stockpiles Madrid South: 1 ore stockpile Boston: 1 waste rock pile	Madrid North: Add 1 ore stockpile Madrid South: Add 1 ore stockpile
Waste Management	Doris: Landfill, landfarm, and handling/temporary storage of hazardous waste, incinerator	Boston: landfarm and handling/temporary storage of hazardous waste, incinerator, waste transported to Doris or Roberts Bay for disposal	Doris: Increase capacity of Doris landfarm area
Water Infrastructure and Management			
Discharge to Roberts Bay	1 marine outfall (diffuser and piping) to Roberts Bay	-	Add second marine outfall diffuser to Roberts Bay within marine outfall corridor
Contact Water Ponds	Doris: 2 contact water ponds	Madrid North: 2 contact water ponds Madrid South: 1 contact water pond Boston: 2 contact water ponds	Doris: Add 1 contact water pond Madrid North: Add 2 contact water ponds Madrid South: Add 2 contact water ponds
Freshwater Withdrawal	Doris Lake: 480,000 m^3/yr	Doris Lake: 1,930,000 m^3/yr Windy Lake: 43,800 m^3/ yr Patch Lake: 60,000 m^3/yr TOTAL= 2,033,000 m^3/yr Boston: Aimaokatalok Lake (483,000 m^3/yr)	Doris Lake, Windy Lake, and Patch Lake Total freshwater withdrawals 2,900,000 m^3/yr
General Site Activities			
Marine Transport	1 charter, 1 tug, and five 1,500 series barges to Roberts Bay annually	4 cargo ships and 3 fuel tankers to Roberts Bay annually	12 cargo ships and 8 fuel tankers to Roberts Bay annually
Blasting	Doris: 700,000 Kg/yr	Madrid: 2,248,000 Kg/yr Boston: 1,685,000 Kg/yr	Doris, Madrid and Boston: Total 3,650,000 kg/yr
Quarries	Quarry 1, 2, 3, and 4	Quarry G, H, L, M, N, 0, P, Q,R,S,T,U, V,W, X,PJ,AA, AB, AE, AF, AH and Al (Quarry D approved under Water Licence 2AM-DOH1335)	Expand Quarry AF and Quarry Al
Camp and Associated Facilities	Doris camp: 280 people	Doris camp 400 people Boston camp: 300 people	Doris camp: 800 people Madrid camp: 250 people
All Weather Access Road and Traffic	Roberts Bay to Doris AWR: 300 fuel tanker trucks/yr	Doris to Madrid AWR: 9.5 m wide, 129 trucks/day (ore haulage)	Roberts Bay to Doris AWR: 430 fuel tanker trucks/yr. Fuel will be transferred to Doris by truck; however, a fuel line may be used in the future. Doris to Madrid AWR: 30 m wide, 160 trucks/day (ore haulage)
Diesel Generators	Doris: 8 x 1.2 MW	Madrid North: 3 x 1.2 MW Madrid South: 2 x 725 kW and 1 x 350 kW (standby) Boston: 8 x 1.2 MW and 1 x 725 kW (standby)	Doris: Add 7 x 5.6 MW Madrid North: Update to 3 x 1.8 MW
Wind Turbines	-	Doris: 2 wind turbines Madrid: 2 wind turbines Boston: 2 wind turbines	Doris and Madrid: Move two wind turbines from Boston
Infrastructure at Roberts Bay	Jetty and fuel storage (5 ML)	Off-loading fuel and cargo dock, road connecting cargo dock to facilities at Roberts Bay; permitted capacity 45 ML	Diesel: Add 33 ML of diesel fuel storage (total volume of 77 ML) Jet-A: Add 2 ML of Jet-A fuel storage (total volume of 2.5 ML)
Fuel Tank Farm	Doris: 7.5 ML tank farm	Madrid North: 4.5 ML tank farm Madrid South: 75,000 L tank farm Boston: 5 x 1.5 ML tank farm	Doris: Add 5 ML of diesel fuel storage (total volume of 12.5 ML) Madrid: Add 10 ML of diesel fuel storage (total volume of 14.5 ML)

Optimization of assessed scope activity

Notes: "yr" = year. "tpd" = tonnes per day. "Mt" = megatons. "TIA" = tailings impoundment area. "AWR" = all weather access road. "MW" = megawatt. "ML" = megaliters.

Doris Lake, Patch Lake, and Windy Lake, have been identified as potential water sources and Agnico Eagle has existing water licences associated with each waterbody (2AM-DOH1335 for Doris Lake and Windy Lake and 2BB-MAE1727 for Patch Lake). Agnico Eagle has optimized proposed freshwater withdrawals to minimize impacts to fish habitat in these lakes, however, water withdrawal and use from lakes is predicted to result in effects to freshwater fish and fish habitat in some streams in the vicinity of the Mine. Fish and fish habitat effects from water withdrawal and use were also predicted for lake and stream habitat under the Final Environmental Impact Statement (FEIS) for Phase 2 (TMAC 2017) and are expected to be reduced under the Operational Update for most locations assessed for the FEIS.

1.2 Regulatory Context

Based on the Operational Update scope of activities, a *Fisheries Act* Authorization (FAA) under section 34.4(2)(b) and 35(2)(b) of the federal *Fisheries Act* is required for the project to proceed. A FAA is required to undertake work that may result in the death of fish by means other than fishing[2] and/or harmful alteration, disruption, or destruction (HADD) of fish habitat[3]. The information requirements and documentation that must be submitted to apply for an authorization under paragraphs 34.4(2) or 35(2) of the *Fisheries Act* are set out in the *Authorizations Concerning Fish and Fish Habitat Protection Regulations* (SOR/2019-286) and include a requirement for proponents to submit an offsetting plan with their application.

Updates to water withdrawals associated with the Operational Update will also require modification of and/or amendments to the 2AM-DOH1335 water licence,[4] following the NWB established processes.

1.3 Offsetting Approach

In 2019, the *Fisheries Act* was amended to offer protection for all fish and fish habitat. As described in the policy entitled *Policy for Applying Measures to Offset Harmful Impacts to Fish and Fish Habitat* (the Policy; DFO 2025b), if there is likely to be adverse effects on fish and fish habitat, and if those adverse effects on fish and fish habitat are unavoidable, Fisheries and Oceans Canada (DFO) must consider if there are avoidance and/or mitigation measures that would eliminate or minimize those adverse effects and the proponent must develop a plan to offset any residual effects remaining after implementation of the avoidance and

[2] Subsection 34.4(1) of the *Fisheries Act* prohibits the carrying on of a work, undertaking, or activity, other than fishing, that results in the death of fish.

[3] Subsection 35(1) of the *Fisheries Act* prohibits the carrying on of a work, undertaking, or activity that results in the harmful alteration, disruption, or destruction of fish habitat.

[4] An amendment is not required for the 2BB-MAE1727 water licence for Patch Lake as water withdrawals from Patch Lake under the Operational Update will not exceed the amount approved under the existing licence.

mitigation measures. The avoidance and mitigation of effects to fish and fish habitat has been and will be an integral part of the design and engineering for development of the Mine, but as noted above, some alteration to and/or loss of fish habitat is anticipated. To obtain a FAA, Agnico Eagle is developing a habitat "offsetting plan" pursuant to the Policy (DFO 2025b) and the *Applicants Guide to Supporting the Authorizations Concerning Fish and Fish Habitat Protection Regulations* (Applicants Guide; DFO 2019) that will counterbalance unavoidable adverse residual effects to fish and fish habitat and improve the productivity of existing fish habitat. The offsetting plan will address habitat losses under Section 35 of the *Fisheries Act*.

To assess the potential loss of fish habitat relative to the planned habitat to be created through the offsetting plan, an assessment of equivalency is used to allow the current and post development fish productivity to be quantified. As a surrogate for fish productivity, a habitat units (HU) equivalency approach is employed. The approach uses a habitat evaluation procedure (HEP) to incorporate the habitat quality and quantity of pre- and post-development conditions such that the net change in productive fish capacity can be considered. The balance of habitat losses versus gains is considered together to provide for an overall assessment of change in fish productivity associated with the proposed undertaking. Furthermore, the offsetting plan considers abiotic and biotic features which have been incorporated to minimize lag times[5] and promote fish productivity.

Fish habitat losses associated with the Operational Update will occur in freshwater environments in the vicinity of the Mine whereas gains from offsetting are proposed to occur in the Iqaluktuuttiaq Lake East Outflow System (the EOS), near Cambridge Bay, NU (Figure 1.1). The offsetting approach for counterbalancing the anticipated fish habitat losses is to restore fish habitat in the EOS that has been degraded as a result of road development at Cambridge Bay as well as enhance existing fish habitat quality (Section 3.4; DFO 2025b).

A conceptual fisheries offsetting plan was developed for Phase 2 based on habitat losses predicted in the FEIS and was submitted to DFO in September 2022 (22-HCAA-02496; Minnow 2022). The offsetting plan presented herein has been updated based on planned activities and water withdrawal requirements to support the Operational Update. Water balance and hydraulic modelling to assess effects of water withdrawal and use for the Operational Update has been completed for some waterbodies and watercourses that will be affected by mine development and is currently underway for other waterbodies and watercourses. Where waterbody/watercourse specific modelling results are available, these have been used to update the predicted fish habitat losses. A qualitative comparison of anticipated fish habitat

[5] Lag times represent the time between the commissioning of new habitats and the ability of the habitat to be fully productive, as designed (Minns 2006).

losses associated with the Operational Update relative to the FEIS has been provided in Section 3.2. For most areas assessed for the FEIS, it is anticipated that habitat losses will be similar to or reduced under the Operational Update. Therefore, where water balance and/or hydraulic modelling results are not yet available to update watercourse specific losses, fish habitat losses predicted for the FEIS have been used. Fish habitat losses will be updated in the offsetting plan as the results of water balance and hydraulic modelling become available.

1.4 Engagement

Extensive Indigenous, public, and government consultation has been conducted in support of the Hope Bay Mine and specifically this offsetting plan. Indigenous peoples' perspectives have been considered throughout the development of the offsetting plan. As part of the NIRB review process for Project Certificate No. 009, public meetings and hearings were held during the scoping and guidelines creation phase and during review of the Draft Environmental Impact Statement and FEIS (TMAC 2016, 2017). Project Certificate No. 009 lists commitments that were confirmed by parties at the Phase 2 Hope Bay Belt Project Final Hearing including a commitment to the development of a fisheries offsetting plan in collaboration with DFO, the Kitikmeot Inuit Association (KIA), and the Hope Bay Inuit Environmental Advisory Committee (IEAC). These parties were included in engagement on the offsetting plan that was conducted from 2017 to 2023 with engagement to continue in 2026. Engagement for the Operational Update was conducted with NIRB, the KIA, and the IEAC in 2024 and 2025. A description of the engagement conducted to date is provided in Appendix A.

1.5 Objective

This offsetting plan is conceptual and provides a preliminary assessment of the residual death of fish and/or HADD of fish habitat as a surrogate for assessing changes in fish productivity that may result from further mine development and outlines conceptual offsetting measures to balance these changes. The objective of the conceptual offsetting plan is to demonstrate the feasibility of the proposed offsetting measures to be implemented and to support the conservation and protection of fish and fish habitat by counterbalancing the residual death of fish and/or HADD of fish habitat associated with the Operational Update.

The conceptual offsetting plan will be used to support an Application for Authorization under Paragraph 34.4(2)(b) and 35(2)(b) of the *Fisheries Act.* A final offsetting plan will be developed based on the conceptual plan and with feedback from DFO, the KIA, and the IEAC and will comply with the Policy (DFO 2025b) and the Applicants Guide (DFO 2019).

2 METHODS

2.1 Fish Species Considered in Assessment

2.1.1 Freshwater Environment

Fourteen fish species have been captured or observed in freshwater habitats in the vicinity of the Mine from 1993 to 2025 (TMAC 2017, Minnow 2026 in prep.). Ten species are predominately freshwater inhabitants or anadromous species including Arctic charr (*Salvelinus alpinus*), Arctic grayling (*Thymallus Arcticus*), burbot (*Lota lota*), broad whitefish (*Coregonus nasus*), cisco (*Coregonus artedi*), lake trout (*Salvelinus namaycush*), lake whitefish (*Coregonus clupeaformis)*, least cisco (*Coregonus sardinella*), ninespine stickleback (*Pungitius pungitius*), and slimy sculpin (*Cottus cognatus*; Table 2.1). Four species are predominately marine species which make occasional forays into freshwater including Arctic flounder (*Liopsetta glacialis*), fourhorn sculpin (*Myoxocephalus quadricornis*), Greenland cod (*Gadus ogac*), and starry flounder (*Platichthys stellatus*; Table 2.1; TMAC 2017).

Six species were considered in the assessment of lost and altered freshwater fish habitat associated with the Operational Update (Arctic charr, cisco, lake trout, lake whitefish, ninespine stickleback, and slimy sculpin; Appendix Tables B.1 and B.2). Burbot were excluded from the assessment because the species is rare in the Mine area (captured only in the Koignuk River) and is not present in areas of habitat loss or alteration (Section 3.2). Similarly, Arctic grayling are present in the Aimaokatalok watershed south of the Operational Update PDA (i.e., near Boston [Figure 1.1], which will not be developed as part of the Operational Update) but have not been documented in the areas of habitat loss or alteration associated with the Operational Update. Broad whitefish and least cisco were also excluded from the assessment due to a relative paucity of information to relate habitat associations with individual life history functions (i.e., spawning, nursery, foraging, and overwintering) in northern environments and freshwater niche overlap with related anadromous species (e.g., lake whitefish and cisco; Scott and Crossman 1973, Richardson et al. 2001). Predominately marine species were excluded from the assessment due to their minimal use of freshwater habitat.

The known fish community in Iqaluktuuttiaq includes Arctic charr, lake trout, lake whitefish, broad whitefish, least cisco, cisco, and ninespine stickleback (Grosbois et al. 2022). Of these species,

Table 2.1: Life History Description for Fish Species Documented in Freshwater Environments Near the Hope Bay Mine, 1993 to 2025

Species	Scientific Name	Primary Habitat-Depth Range	Spawning		Fry Emergence Timing	Nursery	Foraging	Overwintering
			Timing	Habitat Preference		Habitat Preference		
Arctic Charr (anadromous)	*Salvelinus alpinus*	Marine / Freshwater - benthopelagic	Sept - Oct[a]	Freshwater lakes[a]	April - July[b]	Freshwater lakes, rivers and streams[a]	Freshwater lakes and rivers; Marine nearshore coastal areas, benthopelagic[a]	Freshwater lakes
Arctic Flounder	*Liopsetta glacialis*	Marine - Demersal	Jan - June	Marine shallow coastal areas	15 days after spawning	Marine nearshore, shallow brackish	Marine nearshore and offshore	Marine
Arctic Grayling	*Thymallus arcticus*	Freshwater - benthopelagic	May - June	Freshwater rivers and streams; gravel or rocky substrate	13-18 days after spawning	Freshwater lakes, rivers, and streams	Freshwater lakes, rivers, and streams	Freshwater lakes; deep pools in large rivers
Broad Whitefish	*Coregonus nasus*	Marine Estuaries / Freshwater - benthopelagic	Aug - Oct	Freshwater rivers	April - May	Freshwater lakes, rivers, and streams	Freshwater lakes, rivers, and streams; brackish	Freshwater lakes
Burbot	*Lota lota*	Freshwater - demersal	Jan - Mar	Freshwater lakes, bays and shoals with sand or gravel substrate	Feb - Jan	Freshwater lakes, rivers, and streams	Freshwater lakes	Freshwater lakes
Cisco (anadromous)	*Coregonus artedi*	Marine Estuaries / Freshwater - benthopelagic	Sept - Oct[c]	Freshwater lakes and rivers[d]	May - June[c]	Freshwater lakes, rivers, and streams	Freshwater lakes, rivers, and streams; brackish	Freshwater lakes
Fourhorn Sculpin	*Myoxocephalus quadricornis*	Marine - Demersal	Mid-winter	Marine benthic, nearshore, gravel substrate	3 months after spawning	Marine or brackish, very shallow, nearshore	Marine nearshore; Freshwater rivers and streams; brackish	Marine
Greenland Cod	*Gadus ogac*	Marine - Demersal	Mar - Apr[e]	-	Apr - May	Marine or brackish[e]	Marine and brackish nearshore[f]	Marine
Lake Trout (anadromous)	*Salvelinus namaycush*	Marine Estuaries / Freshwater - benthopelagic	Sept - Nov[d]	Freshwater lakes	Mar - April[b]	Freshwater lakes	Freshwater lakes, rivers, and streams; brackish	Freshwater lakes
Lake Whitefish (anadromous)	*Coregonus clupeaformis*	Marine Estuaries / Freshwater - benthopelagic	Nov - Dec[b]	Freshwater rivers and lakes	April - May[b]	Freshwater lakes, rivers, and streams	Freshwater lakes, rivers, and streams; brackish[e]	Freshwater lakes
Least Cisco (anadromous)	*Coregonus sardinella*	Marine Estuaries / Freshwater - benthopelagic	Sept - Nov[e]	Freshwater, deep pools of rivers and lakes over sand and gravel substrates[b]	Spring[b]	Freshwater lakes, rivers, and streams; Marine nearshore, estuaries (move downstream to sea upon hatching)[b]	Freshwater lakes, rivers, and streams; Marine nearshore, estuaries[b]	Freshwater lakes, estuaries, brackish water
Ninespine Stickleback (anadromous)	*Pungitius pungitius*	Marine Estuaries / Freshwater - benthopelagic	June - July	Freshwater, nearshore areas in lakes, ponds, streams[e]	15 days after spawning	Freshwater lakes, rivers, and streams; brackish shallow, sheltered	Freshwater lakes, rivers, and streams; brackish shallow, sheltered	Freshwater, brackish
Slimy Sculpin	*Cottus cognatus*	Freshwater - demersal	June	Freshwater, nearshore areas with rocky substrate	30 days after spawning	Freshwater lakes, rivers, and streams	Freshwater lakes, rivers, and streams	Freshwater lakes
Starry Flounder	*Platichthys stellatus*	Marine - Demersal	June-July	Marine nearshore and shallow	5 days after spawning	Marine nearshore and shallow; estuaries and rivers	Brackish or marine shallow to mid-water, sand and mud substrate, low salinity	Marine

Note: Table modified from TMAC 2017. Demersal = bottom feeders. Pelagic = feed in open water. Benthopelagic = feed in open water and on bottom.
[a] DFO 2004.
[b] Scott and Crossman 1973.
[c] Gallaway et al. 1982.
[d] Hancock 2020.
[e] Froese and Pauly 2017.
[f] Mikhail and Welch 1989.

Arctic charr, *Coregonus sp.*,[6] and ninespine stickleback have been documented in the EOS (i.e., the proposed offsetting location) during recent baseline studies (ERM 2020, Minnow 2024). Four species were considered in the assessment of offsetting habitat gains: Arctic charr, cisco, lake whitefish, and ninespine stickleback; Appendix Tables B.1 and B.2). Lake trout were historically fished in the EOS (ERM 2019) but have not been captured during baseline studies conducted since 2019 (ERM 2020, Minnow 2024) and were therefore excluded from the assessment of offsetting habitat gains. Lake whitefish and cisco were included to represent *Coregonus sp.* based on niche overlap with, and the paucity of information for life stage specific habitat preferences for, broad whitefish and least cisco, as described above.

2.2 Habitat Evaluation Procedure (HEP)

Mine development will result in the harmful alteration of fish habitat, which has the potential to affect fish under Section 35 of the *Fisheries Act*, and therefore an accounting of habitat losses relative to the proposed habitat gains through implementation of offsetting measures is required.

A HEP was used to assess habitat losses and gains for the Operational Update. The HEP used was modified from the Fish Habitat Offsetting Plan for Agnico Eagle's Whale Tail Pit (Portt and Agnico Eagle 2018). This HEP approach was originally developed for the *2012 No Net Loss Assessment for the Meadowbank Mine* (Agnico Eagle 2012), was refined for work at other Agnico Eagle developments in Nunavut (e.g., Agnico Eagle 2015) and was reviewed by DFO (2016). Application of a HEP to the Operational Update involved modifications to the above referenced approaches to reflect the fish species and habitat types that are affected by mine development and present in proposed offsetting area, and incorporation of recent literature information on fish habitat preferences (e.g., Coad and Reist 2017, Hancock 2020) and the recommendations from DFO's *Review of HEP Input Parameters and Model Results for the Meadowbank Gold Mine Project* (DFO 2016).

The HEP approach implemented calculates HU by multiplying the spatial area of the habitat type affected (e.g., m^2) by the habitat quality for each of four life functions (i.e., spawning, nursery, foraging, overwintering) for each fish species included in the assessment, and by a series of weighting factors (i.e., species weight, life-function weight, access weight, and if applicable a habitat co-factor). This was calculated for all habitat that will be lost or altered as well as the habitat gained (created or enhanced) through offsetting. These HU were used to calculate the

[6] Field identification to the species level for the genus Coregonus (including cisco, lake whitefish, broad whitefish, and least cisco) is extremely difficult and unreliable in non-lethal surveys and thus was not attempted in the EOS baseline sampling programs.

expected net change in habitat attributed to the Operational Update. The following outlines the general approach used to calculate HU.

- **Habitat Quantity** – The quantity of lake or stream habitat calculated before and after development and offsetting as areal coverage (i.e., per m^2).
- **Habitat Quality** – The quality of lake or stream habitat was assessed for six fish species for the assessment of habitat lost and altered and four species for the assessment of habitat gains and four life functions. A habitat suitability score was assigned for each species and life function.
- **Habitat Units** – HU were calculated using the numeric quality of habitat multiplied by the quantity of habitat, weighted by species, life function, access, and a habitat co-factor (where applicable) before and after development and offsetting to assess the net change in habitat.

Both the quantity and quality of fish habitat for each identified life function of each species was incorporated into the HU assessment such that the resulting metric accounts for both quantity and quality of all habitat types lost or altered and gained and therefore is a reasonable substitute for the net change in productive capacity.

The HEP model used, originally described by Agnico Eagle (2012) and applied by Portt and Agnico Eagle (2018) is:

$$HU_{spp\ 1-n} = \sum_{HT\ 1-x} \left(\sum_{sp,nu,fo,ow} \left(HT_{1-x} \times HSI_{sp,nu,fo,ow} \right) \right) \times SPw \times LF_w \times ACw \times HBco$$

Where:

$HU_{spp\ 1\text{-}n}$ = habitat units for each fish species (spp 1-n)

$HT_{1\text{-}x}$ = area (m^2) of habitat types 1 through x

$HSI_{sp,nu,fo,ow}$ = habitat suitability index for each life function (spawning, nursery, foraging, overwintering)

SPw = species weight; 1/number of species with access to each habitat area

LFw = life function weight; 1/number of life functions (i.e., four)

ACw = access weight; 0 = no access; 1 = access

HBco = habitat co-factor[7]

The HSI (Habitat Suitability Index) is a numerical index that represents the capacity of a given habitat to support a selected fish species, and the area of available habitat is defined as the total surface area of all habitat types used by the selected species (US Fish and Wildlife Service 1981).

HSI Value = study area habitat conditions / optimum habitat conditions

HSI can have a minimum value of 0.0 and a maximum value of 1.0, representing unsuitable and optimal habitat, respectively. This can also be applied to word rankings where habitat can be rated by word descriptors such as “excellent”, “good”, “fair,” “poor”, or “nil”. The HSI values used for the habitat quality descriptors are outlined in Table 2.2.

Each species and life function were weighted equally in the application of the HEP, following the most recent available guidance from DFO (DFO 2016). The species weight was based on the number of species with an access factor of 1 for each habitat area and was calculated as 1/number of species. The life function weight was calculated as 0.25 for each of the four life functions assessed (i.e., spawning, nursery, foraging, overwintering). The species access weight was assigned as 0 (no access) or 1 (access) based on known or suspected fish and fish habitat distributions in specific waterbodies as described in baseline surveys from 1995 to 2025 (TMAC 2017, Minnow 2026 in prep.).

To account for proposed increases in hydrological connectivity for fish passage due to offsetting measures in freshwater channel habitat (Section 3.4), a habitat co-factor was applied. A habitat co-factor between 0 and 1 was applied to both baseline and post-offset habitats based on a combination of quantitative hydrological connectivity and qualitative evaluation of fish passage conditions under baseline and post-enhancement conditions. For example, hydrological connectivity under baseline conditions may have provided for fish passage/access to a habitat area in 25% of the open water season, while post-enhancement hydrological connectivity is predicted to allow for fish passage/access during 100% of the open water season. The duration of hydrological connectivity in stream channels with proposed enhancements was based on flow depth rather than velocity because the period of passage restriction was at low flow when water depth rather than velocity was the limiting factor. The duration of hydrological connectivity was determined for each fish species by adding target flow depths for passage to invert elevations in each stream channel, as surveyed in September 2021. The duration (days) where the measured water surface elevation in 2021 exceeded this value was then divided by the number of days in

[7] A habitat co-factor is applied to represent non-mapped changes to habitat quality that occur as a result of development or offsetting. Non-mapped changes in habitat quality can apply to hydrological, thermal, chemical, or biological components (Portt and Agnico Eagle 2018).

Table 2.2: HSI Word and Value Rankings According to Habitat Conditions

Word Ranking	HSI Value
Excellent	1.00
Good	0.75
Fair	0.50
Poor	0.25
Nil	0.00

Note: "HSI" = Habitat Suitability Index.

the overall hydrometric period of record in 2021 (days) to determine the percentage of the open water season where the habitat was passable by fish. The minimum flow depth for passage was conservatively set at 0.15 m for Arctic charr, cisco, and lake whitefish (Thompson 1972) and 0.01 m for ninespine stickleback. Where sufficient hydrometric monitoring data were unavailable to calculate the duration of hydrologic connectivity for passage, it was qualitatively evaluated based on available fish habitat evaluation data (ERM 2020). Because hydrological connectivity was based on limited available data (e.g., 2021 only)[8], fish habitat data including substrate composition, cover, and visual barriers identified during fish habitat surveys were also considered in the determination of habitat co-factors such that they reflected the combination of hydrological connectivity and other factors influence passage potential (e.g., predation risk, physical barriers, etc.).

2.2.1 Habitat Quantity

Freshwater habitats were quantified by delineating areas that represent "habitat types" (HTs) based on waterbody characteristics with lakes and streams combined being represented by twelve habitat types. Freshwater HTs 1 to 9 represent lake habitats and are based on a combination of depth (<2 m, 2 – 4 m, and > 4 m) and substrate characteristics (fines, mixed, and coarse; Table 2.3). These depth and substrate categories were selected based on their previous application representing similar species and habitats (i.e., freshwater waterbodies and streams in the Canadian Arctic region; Portt and Agnico Eagle 2018) and review by DFO (2016). Habitat depths and substrates were determined from information collected during baseline reconnaissance surveys including bathymetric (TMAC 2017, GeoProcess 2025) and littoral and sublittoral (except Imniagut Lake) habitat surveys (Rescan 2010b, 2011b, ERM 2014, 2020, Minnow 2024). Bathymetric surveys used hydroacoustic methods to map bottom depth (TMAC 2017, GeoProcess 2025). Littoral habitat surveys separated the littoral zone into habitat units of similar substrate composition described by the relative percent surface area of different substrate types including fines (<2 mm), gravel (2 to 64 mm), cobble (64 to 256 mm), boulder (256 to 4,000 mm), and bedrock (>4,000 mm; ERM 2014, 2020, Minnow 2024). These categories are further reduced to support the association between life function and habitat preference. The substrate categories used in the HEP model include fines (<2 mm), mixed (mostly sand/gravel with some cobble or occasional boulder; 2 to 256 mm) and coarse (>64 mm). Hydroacoustic methods were used to determine sublittoral habitat through substrate classification (Rescan 2011a, ERM 2020). Sublittoral substrate in Imniagut Lake was

[8] Additional hydrometric data collected in the EOS in 2022 and 2023 was not incorporated in the calculation of habitat co-factors based on identified gaps in the data (GeoProcess 2025). Habitat co-factors will be verified through additional data collection to support development of engineering designs for offsetting measures.

Table 2.3: Description of Freshwater Lake Habitat Types Used in the HEP Model

Habitat Type	Depth (m)	Substrate[a]
1	< 2	Fines
2	< 2	Mixed
3	< 2	Coarse
4	2 - 4	Fines
5	2 - 4	Mixed
6	2 - 4	Coarse
7	> 4	Fines
8	> 4	Mixed
9	> 4	Coarse

Note: "HEP" = Habitat Evaluation Procedure.

[a] Fines = sand, mud, clay, and silt; < 2 mm particle size. Mixed = sand/gravel with some cobble or occasional boulder; 2 to 256 mm particle size. Coarse = cobble and boulder; > 64 mm particle size.

assumed to be 100% fines below the 1 m depth contour based on aerial imagery and known habitat types in other small Arctic lakes.

Freshwater HTs 10 to 12 represent stream habitats and are based on channel width, water depth, substrate composition, habitat unit distribution (i.e., riffle, glide, flat, and pool), and permanence (i.e., continuously or intermittently flowing during the open-water season; Table 2.4). Stream habitats were characterized at high (i.e., freshet) and low (i.e., base) flows during the open-water season in 2017 (ERM 2017c) and the three stream HTs reflect three main types of streams identified in the Mine area during these baseline reconnaissance surveys (Table 2.4). HT 10 represents small, intermittent streams[9] with fine substrates. These streams were generally characterized by wetted widths of less than 1 m and wetted depths of less than 0.5 m at high flow with 90 to 100% fine substrates. They were comprised of mostly glide and flat habitats with very few small pools and abundant vegetative cover. Dry channel sections were observed during the low flow survey in 2017. HT 11 represents large streams with wetted widths of less than 10 m and wetted depths of less than 1.5 m at high flow and mixed substrate composition (i.e., fines, gravel, cobble, boulder). Glides and riffles comprise the majority of fish habitat and abundant cover of multiple types was present. Fish habitat conditions varied widely between high and low flow but dry channel barriers to fish passage were rarely present at low flow. HT 12 represents large streams (i.e., rivers) with wetted widths up to 30 m and wetted depths up to 2 m at high flow and mixed substrate composition (i.e., fines, gravel, cobble boulder). A glide-pool/riffle-pool habitat unit pattern was often present, and pools were large and deep enough to provide cover for large-bodied fish. Water depth and flow were maintained in these streams such that barriers to fish passage at low flows were not observed.

To calculate habitat quantity, the spatial area of each habitat type affected by mine development was calculated using both Geographic Information System (GIS) and reconnaissance data collected in baseline surveys. Stream channel widths and lengths were determined based on stream measurements during reconnaissance surveys (ERM 2017c, Minnow 2026 in prep.). Similarly, the spatial area of each habitat type to be created or enhanced was also calculated either in ArcGIS or Computer-Aided Design (CAD) after conceptual design drawings. Proposed waterbody or watercourse habitat sizes resulting from offsetting measures will be re-confirmed based on Issued for Construction (IFC) drawings in subsequent versions of the offsetting plan.

[9] Streams that have flowing water during certain times of the year, when snowmelt or groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from precipitation is a supplemental source of water for stream flow.

Table 2.4: Description of Freshwater Stream Habitat Types Used in the HEP Model

Habitat Type	Wetted Width (m)		Wetted Depth (m)		Habitat Types [a]	Substrates [b]	Cover	Barriers	Flow
	High Flow	Low Flow	High Flow	Low Flow					
10	< 1	< 1	< 0.5	≤ 0.2	Glides and flats, with occasional small pools.	> 90% fines.	Abundant cover. Exclusively overhanging and instream vegetation in the form of riparian grasses and shrubs.	At high flow, occasional overland flow barriers. At low flow, common dry channel and overland flow barriers.	Often intermittent with no fish habitat under low flow conditions. Habitat types reflect low discharge. Mean annual discharge estimated to be 0.001 - 0.02 m^3/s.
11	< 10	< 10 m	0.1 - 1.5	0 - 1.5	Glides, riffles, and some pools. Pools are small and generally the least common habitat type.	Mixed substrates (fines, gravel, cobble, boulder).	Abundant mixed cover types including instream vegetation, overhanging vegetation, deep pool, boulder, and undercut banks.	At high flow, occasional boulder garden, drop, or gradient barriers. At low flow same as high flow but with rare dry channel or subsurface flow barriers as well.	Large variation in habitat under high and low flow conditions. Mean annual discharge estimated to be 0.001 - 0.5 m^3/s .
12	≤ 30	≤ 20	0.2 - 2	0.2 - 1.5	Glides, riffles, and pools with a more consistent glide-pool/riffle-pool pattern. Pools are large and deep enough to provide cover and foraging habitat for large-bodied fish.	Mixed substrates (fines, gravel, cobble, boulder and bedrock).	Instream vegetation provides moderate cover for small fish along margins of most habitat units. Moderate boulder (glides and riffles) and deep pool (pools) cover present.	At high flow and low flow, occasional drop or gradient barriers may be present.	Flows maintained throughout open water season. Mean annual discharge estimated to be 0.05 - 2.5 m^3/s.

Notes: "HEP" = Habitat Evaluation Procedure.

[a] Riffle = turbulent, fast-flowing water usually shallow in water depth with gravel or cobble substrates that project above the water surface; Glide = flowing, non-turbulent water with relatively flat bottom in cross-section; Flat = still, often stagnant water with substrates usually covered in silt or organic matter; Pool = relatively deep, slow flowing with a concave longitudinal streambed profile and a surface gradient near 0%.

[b] Particle sizes for substrates defined as fines = < 2 mm, gravel = 2 to 64 mm, cobble = 64 to 256 mm, boulder = 256 to 4,000 mm, and bedrock = consolidated rock.

2.2.2 Habitat Quality

Habitat quality (i.e., HSI) is estimated as the degree of association between each habitat type and each life function of the selected fish species. Based on literature, baseline fish and fish habitat studies, previous HSI models (Portt and Agnico Eagle 2018), and local conditions in the Mine area, an HSI value was applied to each habitat type that will be lost, altered, created, or enhanced for each fish species and life function selected for inclusion in the assessment (Appendix Tables D.1 to D.14). The life functions considered included spawning, nursery (young-of-the-year), foraging (adult and juvenile), and overwintering (all life stages). The quality of habitat associated with the proposed offsetting plan was based on the characteristics of the habitat to be created (i.e., substrate, depth, flow, access) relative to the HSI scores established for each species and life function (Appendix Tables D.11 D.14).

The HSI were developed using habitat associations found in key literature sources and existing Arctic habitat suitability models (e.g., Richardson et al. 2001, Evans et al. 2002, Agnico Eagle 2012, Larocque et al. 2014, ERM 2017c, and Hancock 2020; Appendix Tables B.1 and B.2). Each habitat type (i.e., HT 1 to 12) was evaluated relative to the needs of each species/life function to estimate a suitability score between 0 (not utilized/nil) and 1 (excellent; Table 2.2). The HSI represents the relative quality of each habitat type to the species during each phase of their life cycle. Habitat characteristics associated with each species and life function are provided for freshwater fish species included in the assessment (Appendix Table B.2) and formed the basis for numerical ranking of habitat quality. The HSIs were assigned using the most recent and comprehensive information for each species and habitat category. In many cases, delineation of general life function and habitat associations relied on a limited number of literature sources with few specific to Arctic environments (Appendix Table B.2). Where information for a particular species, life function, or habitat type was not available, a precautionary approach was taken, and justification was provided based on supporting literature (Appendix Table B.2).

Although the approach does not assume that habitat use is equivalent to habitat preference, fish distribution and abundance was occasionally taken into consideration in the development of HSI. For example, where there was little or no literature support for a specific habitat association, but local information (i.e., fish distribution and capture data) demonstrated presence of a species in a habitat type, this was considered and HSI values were assigned accordingly. Further, only in cases with high certainty that a species would be absent from a habitat type was a “nil” value assigned. This approach was conservative as it assigned value to a species/life function if the target species was suspected to use the habitat, even if potentially present in very low abundance. This approach also acknowledged that species may have access to all habitats

despite not necessarily being confirmed in all accessible areas during baseline studies (TMAC 2017).

Information on overwintering habitat associations for freshwater species in the Arctic is very limited (e.g., Richardson et al. 2001, Evans et al. 2002, Moller et al. 2018). In the development of HSIs for overwintering, all substrates were valued equally, but greater water depths were assumed to have a higher value for all species (Appendix Tables B.1 and B.2). This does not account for generally greater value of complex substrate to small and juvenile fishes (DFO 2016) but has been previously applied in HEP models in the Arctic (e.g., Portt and Agnico Eagle 2018). In lakes, overwintering is assumed to occur below 3 m depth for all species due to the duration and thickness of ice formation on lakes in the Mine area which excludes fish from areas with shallower water depths (Agnico Eagle 2012, ERM 2017c, Minnow 2024). Watercourses in the Mine area generally freeze to the bottom in winter, (except for occasional deep pools (e.g., pools in the Koignuk River; TMAC 2017). Given their sizes and depths, streams with habitat loss, alteration, creation, or enhancement associated with mine development have been assigned "nil" values for overwintering for all species and life functions. The only exception is for ninespine stickleback where a value of "fair" is assigned to HT 12 (large stream with mixed substrate) to account for the possibility of deep (>3 m) pools providing overwintering habitat.

2.2.3 Calculation of Habitat Units Lost and Gained

HU lost and gained were calculated using the HEP model such that the HU for each species and life function were determined for each habitat type in both mine-affected (loss/alteration) and offsetting (gain) habitats (Appendix Tables D.1 to D.14). Existing habitat in areas where offsetting measures are proposed was accounted for as altered habitat where the total existing habitat was accounted for in the loss/alteration calculation and the total enhanced habitat was accounted in the gain calculation (Appendix Tables D.7 to D.14). Total HU represented the sum of all species and life-stage specific HU affected by the Mine or offsetting measures (i.e., loss/alteration) and the sum of all species and life-stage specific HU enhanced or created (i.e., gain).

Habitat within each area affected by mine development or offsetting measures is described briefly (detailed descriptions are presented in Rescan [2010a, 2010b, 2011a, and 2011b], ERM [2014, 2017b, 2017c, and 2020], TMAC [2017], and Minnow [2024, 2026 in prep.]), focusing on the habitat requirements for each life function of the fish species known or suspected to be present. Discussion is focused on habitat losses and gains separately.

2.3 Lag Times and Uncertainty

Lag times, the period between the construction of habitat and its ability to functionally support a fishery, and uncertainty in whether offsetting measures will be effective in meeting established performance metrics have been considered in the habitat offsetting plan (Minns 2006, DFO 2025b). Measures to reduce lags times and uncertainty have been described, as well as the expected outcome of each measure incorporated.

2.4 Quantifying Net Change

The change in HU for each species and life function was summarized for lake and stream habitat. The quantified change in HU was considered a measure of expected change to fish productivity. The net change in HU was also considered with respect to other factors which may influence fish productivity, including habitat connectivity.

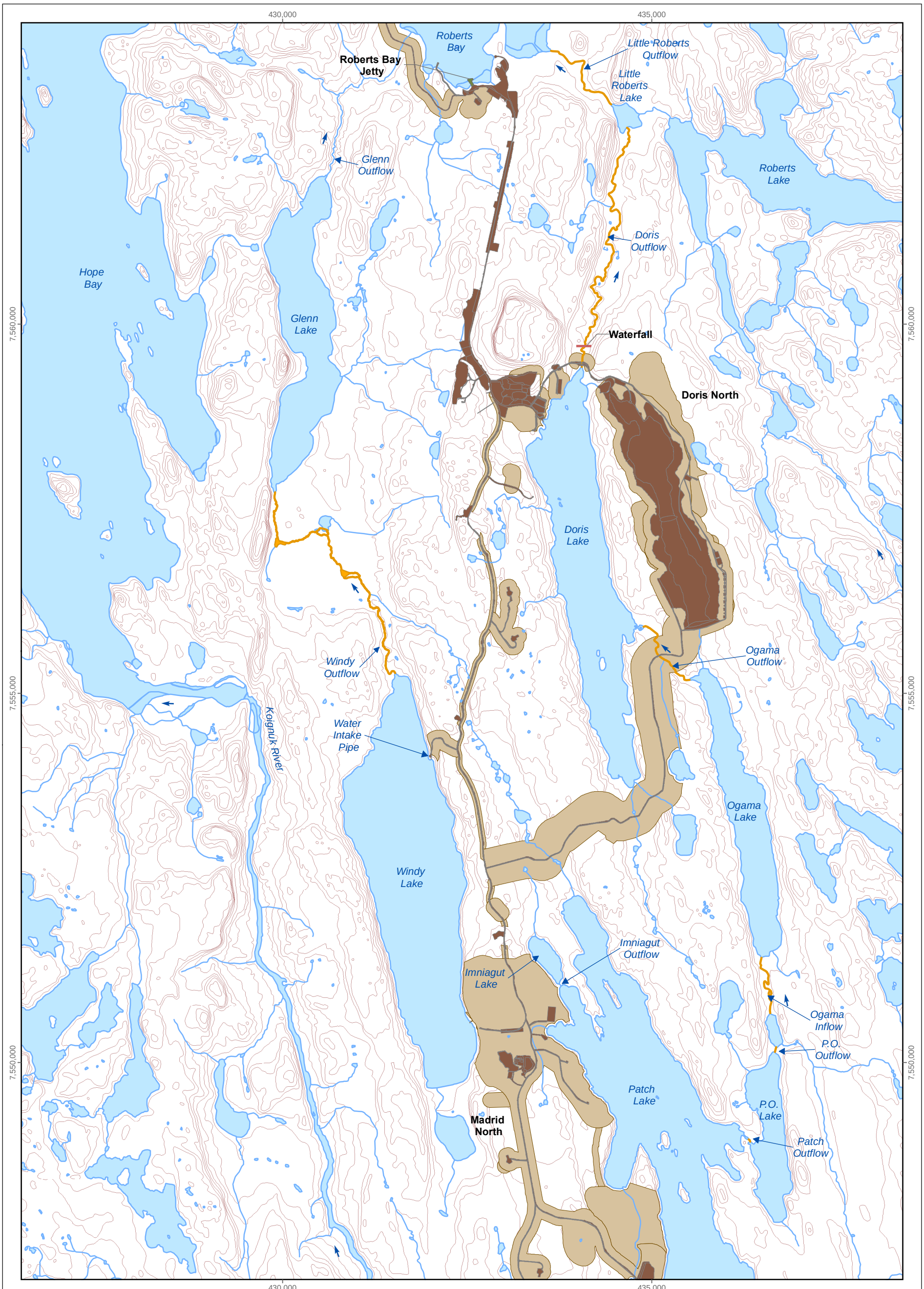
Alterations to fish habitat associated with offsetting measures are considered enhancements as they are proposed to result in net gains in the quantity and/or quality of fish habitat. To calculate the overall net gain from the enhancements, both the baseline (i.e., existing) habitat and the proposed post-enhancement habitat were included in habitat accounting using the HEP approach. Therefore, the total HU (i.e., quantity and quality) of fish habitat under baseline conditions have been calculated and represent the amount of habitat altered while the total HU of fish habitat post-enhancement will represent the amount of habitat gained. The net HU will represent the balance of offsetting achieved.

3 PREDICTED EFFECTS ON FISH HABITAT AND PROPOSED OFFSETTING

3.1 Overview

Mine development is anticipated to result in fish habitat losses in seven streams due to predicted changes in surface hydrology from water withdrawal and use (Figure 3.1). Effects on fish habitat from water withdrawal and use have been/will be characterized using results from a water balance model that incorporates effects from domestic and industrial water use and drawdown during construction and development of underground mines and from waterbody specific hydraulic models (e.g., Appendix E). The majority of effects to fish habitat from water withdrawal and use are in the Doris watershed where reductions in discharge are predicted in the streams connecting multiple waterbodies (i.e., Patch, P.O., Ogama, Doris, and Little Roberts outflows and Ogama Inflow; Figure 3.1). Reduction in discharge resulting in effects to fish habitat is also predicted for the Windy Outflow in the Windy watershed (Figure 3.1). Watercourse specific hydraulic modelling for the Operational Update has been completed for Doris and Windy Outflows and is currently underway for Patch Outflow, Ogama Inflow and Outflow, and Little Roberts Outflow. Water balance modelling for Imniagut Lake is also underway and will be used to determine potential for impacts to Imniagut Outflow. In most cases, fish habitat effects are anticipated to be similar to or smaller for the Operational Update compared to the FEIS. Therefore, where updated water balance and/or hydraulic modelling results are outstanding, estimates of fish habitat losses from the FEIS have been used as a surrogate to provide a preliminary indication of overall fish habitat losses. This includes Imniagut Outflow, although no impacts are expected to this watercourse based on substantially reduced drawdown in Imniagut Lake relative to the FEIS (Table 3.1). Fish habitat losses will be updated as the water balance and watercourse specific hydraulic modelling results become available and are validated with DFO throughout the *Fisheries Act* Authorization review process.

Offsetting measures proposed for habitat losses were selected based on input from relevant stakeholders including the KIA and the IEAC. Fish habitat enhancements are proposed in the EOS, an outflow system from Iqaluktuuttiaq (formerly Grenier Lake) near Cambridge Bay, NU, that will result in the alteration of habitat in multiple small waterbodies and their connecting streams (Figure 3.2, Figure 3.3a, b, c). However, these alterations are predicted to result in overall habitat gains by increasing fish access to habitat, including critical overwintering habitat, and by increasing the overall area and quality of habitat available.



LEGEND

- Waterfall
- Stream Habitat Loss or Alteration Area
- 2025 Roberts Bay Jetty (24-HCAA-02389)
- Permitted Infrastructure
- Project Development Area
- Contour (10m interval)

Fish Habitat Loss or Alteration Areas from Water Withdrawal and Use, Hope Bay Mine Operational Update

0 0.75 1.5 3
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 13N
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Date: January 2026
Project: 257202.0052

minnow environmental inc.

Figure 3.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 257202.0052 - 2025 Freshwater FAA Permit Support\D - GIS\Freshwater FOP\25-52 Figure 3.1 Fish Habitat Loss or Alteration Areas from Water Withdrawal and Use.mxd

Table 3.1: Summary and Rationale for Differences in Residual Effects Requiring Offsetting for the Hope Bay Mine Operational Update Compared to the FEIS

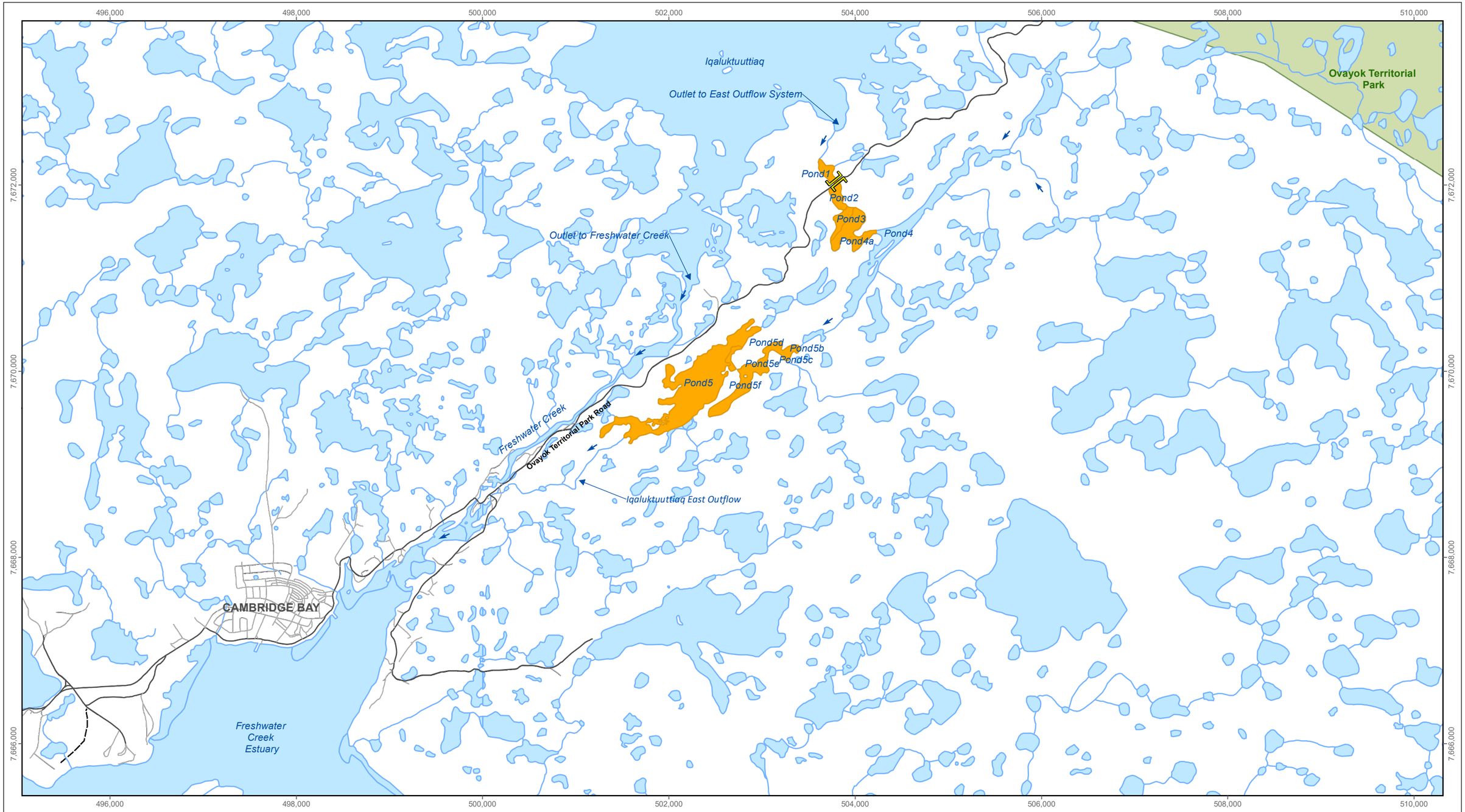
Impact	Watershed	Location	FEIS Predicted HADD Requiring Offsetting		Operational Update Predicted HADD Compared to FEIS	Rationale
			Area (m^2)	HU[a,b]		
Water Use and Withdrawal	Doris and Roberts	Imniagut Lake	150,043	54,987	None	Predicted drawdown from underground mine development is substantially lower (maximum of approx. 220 m^3/yr) compared to the FEIS (maximum of approx. 21,000 m^3/yr) and anticipated to be below FEIS effect thresholds for reduction in under-ice lake volume and water surface elevation, to be confirmed through updated water balance modelling results
		Imniagut Outflow	120	19	None	Predicted drawdown from Imniagut Lake is substantially lower compared to the FEIS. To be confirmed based on updated water balance modelling results for Imniagut Lake
		Patch Outflow	72	21	Decrease	Predicted reduction in mean annual discharge is lower under the Operational Update (8.1%) than the FEIS (23.8%)
		P.O. Outflow	17	5	Decrease	Based on reduction in predicted effects to Patch Lake and Patch Outflow which are located upstream
		Ogama Inflow	341	99	Decrease	
		Ogama Outflow	195	57	Decrease	
		Doris Outflow	1,045	308	Increase	Increased water withdrawal from Doris Lake relative to FEIS
		Little Roberts Outflow	330	97	Increase	Increased water withdrawal from Doris Lake relative to FEIS
	Aimaokatalok	Stickleback Outflow	66	22	None	Development of the Boston site is not included in the Operational Update
	Windy	Windy Lake Outflow	0	-	Increase	Increased water withdrawal from Windy Lake
Intake and Discharge Pipelines	Windy	Windy Lake	94	40	None	Habitat at intake location is not limiting in the littoral zone of the lake and important spawning habitat is not present at the intake location. DFO did not indicate that authorization was required for the intake based on review of RFR.
	Aimaokatalok	Aimaokatalok Lake	2,743[c]	1,310[c]	None	Development of the Boston site is not included in the Operational Update
Watercourse Crossings	Doris and Roberts	Roberts Bay Inflow	3	24	None	Road crossings already constructed or approved for construction under LOAs issued by DFO; no offsetting required
		Patch Inflow	5	1	None	
		Doris Inflow	8	1	None	
	Aimaokatalok	Stickleback Outflow	18	45	None	Development of the Boston site is not included in the Operational Update
		Aimaokatalok Inflow	133	34	None	
		Aimaokatalok Inflow	101	3	None	

Note: "HU" = habitat units. "yr" = year. "FEIS" = Final Environmental Impact Statement. "LOA" = letter of advice. "DFO" = Fisheries and Oceans Canada. "RFR" = Request for Review. "HEP" = habitat evaluation procedure.

[a] Habitat units were calculated using the Habitat Evaluation Procedure during development of the conceptual fisheries offsetting plan for the Madrid-Boston Project that was submitted to DFO in September 2022 (Minnow 2022).

[b] Habitat units presented are for all species and life functions considered in the HEP assessment for each impact and location.

[c] Area and HU for Aimaokatalok Lake is for intake and discharge combined.



LEGEND

- Ovayok Territorial Park Road Crossing Culvert
- Section 35 Authorization

0 0.5 1 2
km

Projection: North American Datum 1983 UTM Zone 13N

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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada.

N W E S

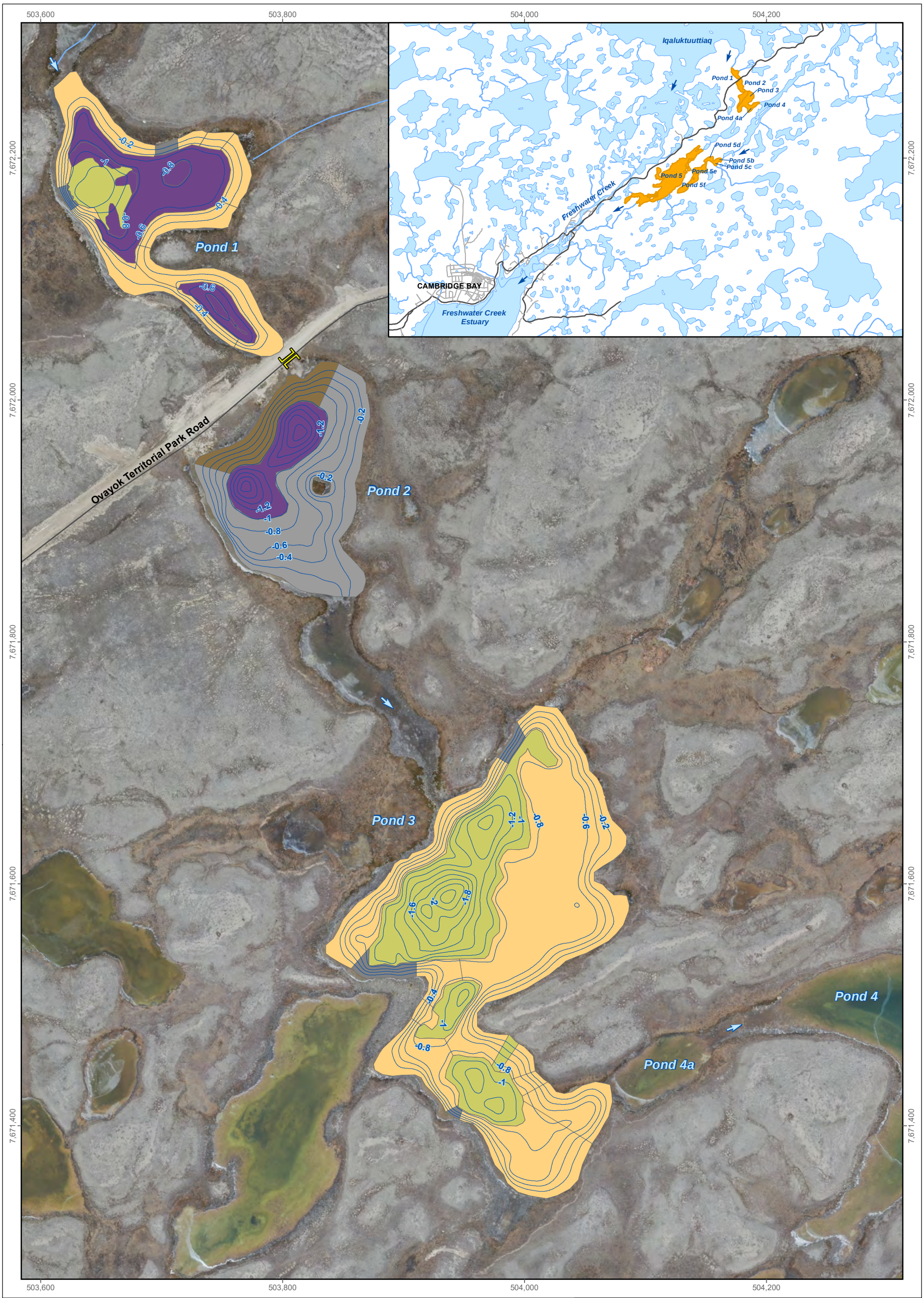
Overview of Fish Habitat Loss or Alteration, Hope Bay Mine Operational Update Offsetting Measures

Date: November 2025
Project 257202.0052

minnow environmental inc.

Figure 3.2

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 257202.0052 - 2025 Freshwater FAA Permit Support\D - GIS\Freshwater FOP\25-52 Figure 3.2 Overview of Fish Habitat Loss or Alteration.mxd



LEGEND

Subittoral Substrate
- Fines
- Large Rock

Littoral Substrate
- Boulder
- Cobble
- Fines
- Gravel

- Bathymetry (.2 m interval)
- Ovayok Territorial Park Road Crossing Culvert
- Section 35 Authorization

Fish Habitat Alteration Areas Associated with Habitat Offsetting, Hope Bay Mine Operational Update, 2025

0 50 100 200
Meters

Projection: North American Datum 1983 UTM Zone 13N

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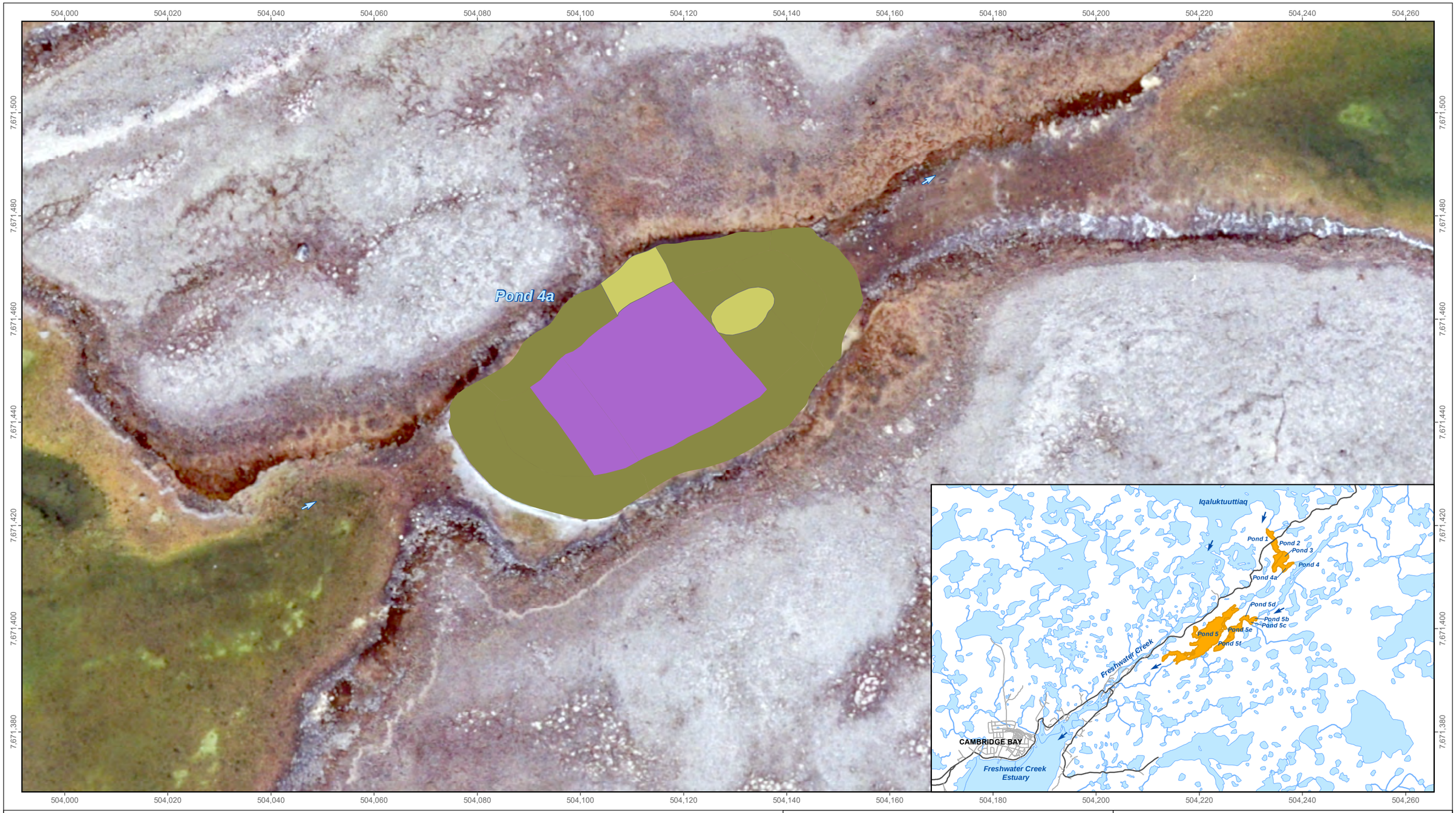
Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada. Base imagery on main map collected in September 2021.

Date: November 2025
Project 257202.0052

minnow environmental inc.

Figure 3.3a

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 257202.0052 - 2025 Freshwater FAA Permit Support\D - GIS\Freshwater FOP\25-52 Figure 3.3a Fish Habitat Alteration Areas Associated with Habitat Offsetting.mxd



LEGEND

Littoral Substrate

- Coarse
- Fines
- Mixed

- Section 35 Authorization

0 10 20 40
Meters

N
W E
S

Projection: North American Datum 1983 UTM Zone 13W

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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada. Base imagery on main map for East Outflow System collected in September 2021.

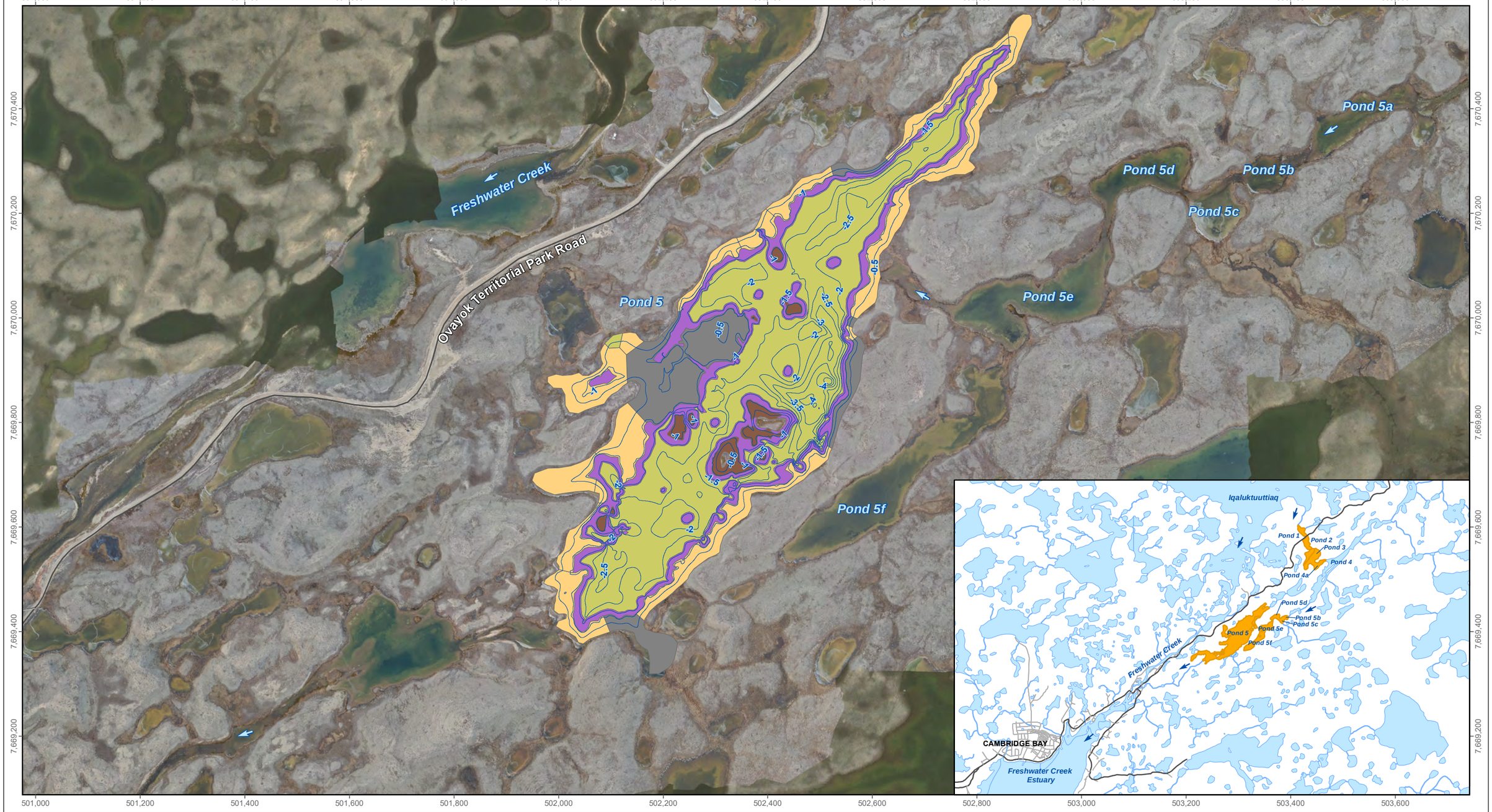
Fish Habitat Alteration Areas Associated with Habitat Offsetting, Hope Bay Mine Operational Update, 2025

Date: November 2025
Project 257202.0052

minnow environmental inc.

Figure 3.3b

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 257202.0052 - 2025 Freshwater FAA Permit Support\D - GIS\Freshwater FOP\25-52 Figure 3.3b Fish Habitat Alteration Areas Associated with Habitat Offsetting.mxd



LEGEND

Littoral Substrate
- Boulder
- Cobble
- Fines

Sublittoral Substrate
- Fines
- Large Rock
- Mixed

- Bathymetry (.5 m interval)
- Section 35 Authorization

0 125 250 500
Meters

N
W E
S

Projection: North American Datum 1983 UTM Zone 13N

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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada. Base imagery on main map for East Outflow System collected in September 2021.

Fish Habitat Alteration Areas Associated with Habitat Offsetting, Hope Bay Mine Operational Update, 2025

Date: November 2025
Project 257202.0052

minnow environmental inc.

Figure 3.3c

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 257202.0052 - 2025 Freshwater FAA Permit Support\D - GIS\Freshwater FOP\25-52 Figure 3.3c Fish Habitat Alteration Areas Associated with Habitat Offsetting.mxd

A qualitative comparison of effects for the Operational Update relative to the FEIS is provided in Section 3.2 whereas expected fish habitat losses for the Operational Update and habitat gains associated with offsetting are described in Sections 3.3 and 3.4, respectively.

3.2 Operational Update and FEIS Effects Comparison

A detailed effects assessment for freshwater fish and fish habitat was conducted as part of the FEIS (TMAC 2017) and characterized the following residual effects (Table 3.1):

- alteration of 268 m^2 (108 HU)[10] of stream fish habitat in the Doris and Aimaokatalok watersheds associated with construction of six road crossings (i.e., bridge or culvert installations) for development of all-weather access roads;
- alteration of 2,837 m^2 (1,350 HU) of fish habitat in Windy and Aimaokatalok lakes associated with construction of infrastructure to support two freshwater intake pipes (one each in Windy Lake and Aimaokatalok Lake) and one discharge pipe (Aimaokatalok Lake);
- complete loss of fish habitat in Imniagut Lake (150,043 m^2; 54,987 HU) from water withdrawal and use (i.e., drawdown through talik during construction and development of underground mines); and
- loss of 2,186 m^2 (628 HU) of fish habitat in eight connecting stream channels in the Doris and Aimaokatalok watersheds associated with water withdrawal and use.

In most cases, residual effects to fish and fish habitat are expected to be similar to or reduced under the Operational Update compared to the FEIS (Table 3.1). Predicted drawdown from Imniagut Lake under the Operational Update is substantially reduced compared to the FEIS (Table 3.1; Appendix F; TMAC 2017) such that changes in lake volume and surface elevation are anticipated to be below the thresholds used in the FEIS to identify a potential effect as follows (DFO 2010):

- Where a modelled mine-affected reduction in average annual lake volume and maximum monthly under-ice lake volume was within 10% of average annual baseline volume, the change was considered to be within the range of natural variation (i.e., mine effects on fish were considered negligible) and no further assessment of effects was conducted.
- Where a modelled mine-affected annual reduction in under-ice lake surface elevation differed from the baseline maximum annual reduction by less than 10 cm, the area of

[10] Habitat units were calculated using the Habitat Evaluation Procedure during development of the conceptual fisheries offsetting plan for the Madrid-Boston Project that was submitted to DFO in September 2022 (Minnow 2022).

unusable fish habitat under the ice was considered to be within the natural range of water level change and no further assessment was conducted.

Predicted drawdown under the Operational Update is also low or negligible for other waterbodies (i.e., Wolverine Lake, Ogama Lake, P.O. Lake; Appendix F) and is anticipated to be below the FEIS effect thresholds but will be verified based on the results of updated water balance modelling.

For waterbodies subject to direct water withdrawals (Doris Lake, Patch Lake, Windy Lake), water withdrawals from Patch Lake and Windy Lake for the Operational Update result in a maximum reduction in under-ice lake volume of 1.8% and 0.2% relative to baseline, respectively, and an increase in interannual water elevation reduction of 1.2 cm and 2.8 cm, respectively, relative to baseline (Appendix E), which is below the FEIS effect thresholds. For Doris Lake, the maximum reduction in under-ice lake volume is 9.1% which is below the effect threshold but the modelled interannual change in water elevation relative to baseline exceeds 10 cm (45.4 cm; Appendix E) and requires further assessment with respect to potential effects on fish and fish and fish habitat.

Detailed information on the distribution of spawning habitats for lake trout, lake whitefish, and cisco in Doris Lake was collected in 2015 for the FEIS (ERM 2016). The known presence and locations of high value spawning habitats were surveyed and mapped and compared with the areas of potential habitat loss due to water withdrawal. All habitats shallower than 1.84 m were considered unsuitable for spawning as this is the minimum depth of baseline ice penetration for Doris Lake. All habitats between 1.84 and 2.74 m depth were categorized as unsuitable or of low quality for spawning as they were within the baseline range of ice thickness and interannual change in water elevation (Appendix E). Between 2.74 m and 4 m, high quality habitat for lake trout and lake whitefish spawning was identified in five of 47 habitat units surveyed in Doris Lake and high-quality habitat for cisco spawning was identified in seven of 47 habitat units (ERM 2016). Further, deep-water transect surveys identified extensive good-quality spawning habitats for lake trout and lake whitefish at depths of up to 10 m. Under extreme water level variation and ice thickness conditions, lake surface elevation reductions up to 3.14 m modelled during the FEIS were predicted to be unlikely to result in adverse effects on spawning in Doris Lake because high value spawning habitats were not limited to the shallowest 3.14 m (ERM 2016). Results from current modelling for the Operational Update predict an isolated lake depth under extreme ice conditions of 2.83 m which is less than the 3.14 m considered in the FEIS and therefore is unlikely to cause adverse effects on spawning in Doris Lake (Appendix E).

For streams, mine-related effects in the FEIS were characterized as follows:

- A variation in streamflow of 10% from baseline conditions was initially used to identify waterbodies that may be affected by reduced streamflows, allowing "least risk" watercourses to be screened out.

The "higher risk" watercourses (i.e., changes in streamflow exceeding 10%) were then further assessed by:

- Using a minimum flow threshold of 30% of the mean annual discharge to determine periods of highest risk for fish and potential effects on habitat use; and
- Calculating the area of potential fish habitat loss using information from baseline fish habitat assessments (ERM 2016, 2017b, Minnow 2026 in prep.) and hydraulic models (Appendix E; ERM 2016, 2017a).

Predicted reduction in mean annual discharge in Patch Outflow is lower under the Operational Update (8.1%; monthly streamflow reductions ranging from 4.6% to 11.9%) compared to the FEIS (23.8%) and is anticipated to lower fish habitat losses in Patch Outflow (Table 3.1). Accordingly, fish habitat losses are also anticipated to lower downstream of Patch Lake/Outflow, in P.O. Outflow, Ogama Inflow, and Ogama Outflow (Table 3.1). Fish habitat losses are not expected for Imniagut Outflow given impacts from drawdown on Imniagut Lake are substantially lower under the Operational Update, however losses for Imniagut Outflow have been conservatively included in the current habitat accounting pending confirmation via the updated water balance modelling for Imniagut Lake (Table 3.1). For Doris and Windy outflows, fish and fish habitat effects are higher under the Operational Update relative to the FEIS based on increased water withdrawal from Doris Lake and Windy Lake, respectively. Similarly, increased water withdrawal from Doris Lake is anticipated to result in increased effects to Little Roberts Outflow (Table 3.1). In addition to loss of wetted habitat area, results of hydraulic modelling predict a delay in the spring open water season in Doris Creek by approximately one month under the Operational Update that has been considered in the assessment of fish habitat losses (Section 3.3.2; Appendix E). A potential delay in the open water season will also be assessed for Little Roberts Outflow based on the results of hydraulic modelling, when available, and fish habitat losses will be included to account for any delay that may impact fish. No fish habitat losses will occur in Stickleback Outflow as development at Boston is not included in the Operational Update (i.e., water will not be withdrawn from Aimaokatalok Lake; Table 3.1).

Habitat loss and alteration associated with the construction of infrastructure to support freshwater intake and discharge pipes has not been included in the assessment of habitat losses for the Operational Update (Table 3.1). For Aimaokatalok Lake, the intake and discharge pipeline proposed in the FEIS is no longer planned as development at Boston is not included in the Operational Update. For Windy Lake, the overall footprint of the intake pipeline below the

highwater mark will be small and it is expected that most effects can be minimized through implementation of relevant mitigation measures (see Section 4). With respect to direct habitat losses (i.e., habitat directly overprinted by the intake infrastructure) baseline surveys indicate that habitat present at the intake location (30% fines, 30% cobble, and 20% bedrock; Rescan 2010b) is not limiting in the littoral zone of Windy Lake and that potentially important lake trout spawning habitats were identified on the west side of the lake, opposite the intake location, but not at the proposed intake location (Table 3.1). In their review of the Request for Review for the Madrid-Boston Project (2022), DFO did not indicate the requirement for offsetting associated with construction of intake and discharge pipes (Appendix G).

Water crossings associated with the Operational Update have already been constructed or are approved for construction under Letters of Advice (LOA) issued by DFO (24-HCAA-02544 for the Madrid-TIA Road and 24-HCAA-02329 for the Patch Lake Gravel Track). If any additional road crossings are required at fish-bearing streams to support mine development, a Request for Review will be prepared and submitted to DFO.

3.3 Operational Update Habitat Lost and Altered

3.3.1 Introduction

Mine development activities will withdraw and use water from lakes and streams in the Mine area from construction through to reclamation (Agnico Eagle 2025). For the FEIS, a water balance model that incorporated water withdrawal for domestic and industrial uses and drawdown from construction and development of the underground mines was used to estimate hydraulic conditions in lakes and streams under mine affected conditions and compare the results to simulated average baseline conditions. DFO guidance (DFO 2010, 2013) was then used in determining if changes in lake volume, lake surface elevation, and/or streamflow would result in effects on fish and fish habitat, as described in Section 3.2. Where effects on fish and fish habitat were predicted, water balance model outputs, waterbody specific hydraulic models, and baseline fish habitat information are used to quantify fish habitat loss/alteration (ERM 2017d, TMAC 2017, Minnow 2022). The same approach will be followed to estimate fish habitat losses for the Operational Update. Watercourse specific hydraulic modelling for the Operational Update has been completed for Doris and Windy outflows and has been used to update the fish habitat losses for these watercourses whereas hydraulic modelling is currently underway for Patch Outflow, Ogama Inflow and Outflow, and Little Roberts Outflow. Additionally, water balance modelling for Imniagut Lake is underway and will be used to confirm the expectation that Imniagut Outflow will not be impacted. Fish habitat losses will be updated as the water balance and/or watercourse specific hydraulic modelling results become available; in the interim, estimates of fish habitat

losses from the FEIS have been used for Imniagut Outflow, Patch Outflow, P.O. Outflow,[11] Ogama Inflow and Outflow, and Little Roberts Outflow as a surrogate, providing a preliminary indication of overall fish habitat losses.

Because the amount of fish habitat loss/alteration due to water withdrawal and use is based on water balance model outputs, there is the potential that some of the predicted effects may not occur or may not occur to the extent predicted. Monthly water balance model monitoring is a requirement of the Hope Bay Mine's Water Licence (No. 2AM-DOH1335) and model assessments, including re-calibration, are conducted annually. To date, the water balance model presented in the FEIS has, after calibration updates, demonstrated that predicted hydrology data and mine water flows are a good fit with measured data and annual monitoring as part of the Aquatic Effects Monitoring Program has not detected mine related effects on water levels or ice thickness in evaluated lakes (ERM 2022, 2024, 2025).[12] This indicates that prediction of fish habitat loss/alteration using water balance model outputs is appropriate. On-going water balance model monitoring results will be used to validate habitat accounting presented in this offsetting plan as needed as mine development progresses (see Section 4.5).

3.3.2 Lotic Water Use

Stream habitat loss/alteration may occur as a result of water withdrawal and use in seven streams located in the Doris watershed (Imniagut, Patch, P.O., Ogama, Doris, and Little Roberts outflows and Ogama Inflow) and Windy Outflow in the Windy watershed (Figure 3.1, Appendix E).

Imniagut Outflow connects Imniagut and Patch lakes and is a small (wetted width = 4.0 m; wetted depth <0.5 m at high flow) ephemeral stream with fine substrates (HT 10; Table 3.2; ERM 2017c). The channel is poorly defined and braided, flowing though a heavily vegetated area (ERM 2014). During the baseline assessment, instream cover was dominated by overhanging vegetation with some instream vegetation present. The riparian canopy, consisting of shrubs, covered 80% of the stream (ERM 2017c). Ninespine stickleback was the only fish species observed in the outflow (Table 3.3; ERM 2014, 2017c) which provides excellent spawning, nursery, and foraging habitat for this species (Appendix Tables B.1 and D.5) as well as a seasonal connection to Patch Lake (i.e., during high flow). Predicted drawdown from Imniagut Lake under the Operational Update is substantially reduced compared to the FEIS and effects to fish and fish habitat in the lake and outflow are no longer anticipated, however fish habitat losses for Imniagut Outflow have been

[11] There is no hydraulic model for P.O. Outflow, however, lost/altered habitat for this stream in the FEIS was estimated based on the relationship between mine-affected streamflow reduction from baseline and glide habitat loss in Patch Outflow (nearest upstream channel).

[12] Only Doris Lake was assessed for mine-related effects to fish habitat in 2024 due to absence of under ice water level data for other lakes. No mine-related effects were detected for Doris Lake in 2024.

Table 3.2: Summary of Predicted Lost or Altered Fish Habitat from Modelled Effects on Streamflow Resulting from Water Withdrawal and Use, Hope Bay Mine Operational Update

Watershed		Windy				Doris																	
Waterbody		Windy Outflow				Imniagut Outflow [e]	Patch Outflow[f]		P.O. Outflow [e,f]	Ogama Inflow[f]				Ogama Outflow[f]			Doris Outflow				Little Roberts Outflow[f]			
Fish Habitat	Habitat Unit	Glide	Pool	Riffle	Flat	Glide	Glide	Pool	Glide	Glide	Pool	Riffle	Cascade	Glide	Pool	Riffle	Glide	Pool	Riffle	Cascade	Glide	Pool	Riffle	
	Stream Length (m)	2,965	582	465	293	30	97	58	39	639	239	104	16	688	433	155	3,691	440	103	235	747	320	243	
	Mean Wetted Width (+ 1SE)	4.4 ± 0.5	5.5 ± 0.4	1.8 ± 0.2	13.6 ± 2.1	4.0	6.7	20.0	10.3	4.9 ± 0.5	12.2 ± 2.8	2.6 ± 0.2	3.0	5.4 ± 0.5	14.1 ± 2.0	5.2 ± 0.6	4.8 ± 0.5	9.7 ± 0.5	3.9 ± 1.8	5.4 ± 1.1	11.9 ± 1.1	22.3 ± 6.6	9.6 ± 1.8	
	Total Area (m^2)	19,148	3,582	1,010	4,915	120	650	1,160	402	3,231	4,084	273	48	4,153	8,543	855	19,569	4,171	396	1,388	9,542	7,108	2,482	
	Habitat Type[a]	HT 12				HT 10	HT 12		HT 11	HT 12				HT 12			HT 12				HT 12			Total
Change in Monthly Streamflow >10%[b]		Yes				Yes	Yes		Yes	Yes				Yes			Yes				Yes			
Period of Monthly Streamflow < 30% of MAD		No				Yes	No		No	No				No			Yes				No			
Maximum Reduction in Hope Bay Project-Affected September Streamflow [c]	Streamflow (m^3/s)	0.083				-	0.144		0.105	0.306				0.273			0.309				1.05			
	% Reduction from Baseline	6.1				-	6.0		15.6	6.0				6.9			27.8				20.3			
Habitat Lost or Altered per Habitat Morphology (m^2)[d,g]		1,431	249.9	56.2	380.5	120.0	19.6	52.0	16.7	258.3	47.7	33.6	1.4	97.1	59.2	38.9	1,120				218.2	93.4	18.6	
Habitat Lost or Altered from Reduction in the Duration of Flows[h]		-				-	-		-	-				-			4,371				-			
Total Habitat Lost or Altered[i]	m^2	**2,118**				**120**	**72.0**		**17.0**	**341**				**195**			**5,491**				**330**			**8,684**
	HU	**743**				**18.8**	**21.0**		**4.61**	**99.5**				**56.9**			**1,592**				**97.2**			**2,633**

Notes: "SE" = standard error of the mean. "MAD" = mean annual discharge. "HT" = habitat type. "HU" = habitat unit. "-" = data not available.

[a] Habitat type as defined in Habitat Evaluation Procedure (see Table 2.5).

[b] Change in project-affected monthly streamflow compared to baseline monthly streamflow.

[c] Maximum reduction of simulated September Hope Bay Project-affected streamflow compared to simulated baseline streamflow during the life of the Madrid-Boston Project (i.e., Years 1 to 22).

[d] Estimated habitat lost and altered was calculated as reduction in channel top width estimated from hydraulic modeling multiplied by channel length (ERM 2017d).

[e] No hydraulic model; Lost/altered habitat estimated based on relationship between Project-affected streamflow reduction from baseline and glide habitat loss in Patch Outflow (nearest upstream channel).

[f] Estimated habitat losses from the FEIS; habitat losses will be updated as results for watercourse specific hydraulic models becomes available.

[g] For Doris Outflow, the predicted reduction in wetted area across all habitat types for September is provided; habitat loss for each habitat type will be provided once the results are available based on hydraulic modelling.

[h] Reduction in the duration of flows will be assessed for Windy Outflow, Patch Outflow, Ogama Inflow and Outflow, and Little Roberts Outflow based on the results of modelling and habitat losses will be included, if required.

[i] Sum of habitat lost or altered per habitat morphology and habitat lost or altered from reduction in the duration of flows.

Table 3.3: Fish Species Distribution in Freshwater Habitats with Project Effects or Offsetting Measures

Watershed	Waterbody Type	Waterbody Name	UTM (NAD 83)		Known Fish Community[a]	Project Effect or Offsetting Measure
			Easting	Northing		
Windy	Watercourse	Windy Lake Outflow	431511	7555285	LKTR, NSSB	Water withdrawal and use
Doris	Watercourse	Imniagut Outflow	433757	7551046	NSSB	Water withdrawal and use
	Watercourse	Patch Outflow	436374	7548748	LKTR, CISC sp.[b]	Water withdrawal and use
	Watercourse	P.O. Outflow	436641	7550178	NSSB	Water withdrawal and use
	Watercourse	Ogama Inflow	436585	7550895	NSSB, LKTR, LKWH, CISC	Water withdrawal and use
	Watercourse	Ogama Outflow	435059	7555575	NSSB, LKTR, LKWH, CISC	Water withdrawal and use
	Watercourse	Doris Outflow	434067	7559440	NSSB, ARCH, LKTR, LKWH, CISC	Water withdrawal and use
	Watercourse	Little Roberts Outflow	433800	7563622	NSSB, ARCH, CISC, LKTR, LKWH, LSCS, BRWH, ARFL, FHSC	Water withdrawal and use
Iqaluktuuttiaq	Waterbody	Ponds 1, 2, 3, 4a, 4, 5b, 5c, 5d, 5e, 5f, 5	503980[c]	7670817[c]	ARCH, CORE sp.[b], NSSB, LKTR[d]	Freshwater offsetting measures

Notes: LKTR = lake trout. LKWH = lake whitefish. CISC = cisco. NSSB = ninespine stickleback. CISC sp. = cisco or least cisco. ARCH = arctic charr. LSCS = least cisco. BRWH = broad whitefish. ARFL = arctic flounder. FHSC = fourhorn sculpin. CORE sp. = cisco or least cisco or lake whitefish or broad whitefish.

[a] Based on fish community data collected between 1993 and 2017 (TMAC 2017), 2019 (ERM 2020), 2022 and 2023 (Minnow 2024), and 2025 (Minnow in prep). Access by additional species was considered in the Habitat Evaluation Procedure based on fish distribution in the watershed (e.g., species presence in upstream or downstream waterbodies that could reasonably have access to the stream).

[b] Individuals were not identified to the species level.

[c] Location approximated to represent multiple waterbodies.

[d] Species presence not confirmed by sampling but based on habitat characterization, confirmed species presence in upstream or downstream waterbodies, and/or Inuit Qaujimajatugangit.

included pending confirmation of no impacts via the updated water balance model results for Imniagut Lake. In the interim, fish habitat losses for Imniagut Outflow have been estimated as the entire stream channel (i.e., 100% reduction in streamflow) resulting in a loss of 120 m^2 or 19 HU (Table 3.2).

P.O. Outflow is characterized as a large stream with a wetted width of 10.3 m and wetted depths of less than 1.5 m at high flow and a mixed substrate composition (HT 11; Table 3.2; ERM 2017c). Dry channel sections (i.e., fish barriers) during low flow were rarely present (ERM 2017c). Ninespine stickleback was the only species observed in P.O. Outflow (Table 3.3) which provides fair nursery and foraging habitat for this species (Appendix Tables B.1 and D.5). The total area of HT 11 predicted to be lost or altered in P.O. Outflow for the FEIS was 17 m^2 or 5 HU (Table 3.2). A watercourse specific hydraulic model was not developed for P.O. Outflow during the FEIS; lost/altered habitat for this stream in the FEIS was estimated based on the relationship between mine-affected streamflow reduction from baseline and glide habitat loss in Patch Outflow (the nearest upstream stream channel). Estimated fish habitat losses for P.O. Outflow will be updated once hydraulic modelling results are available for Patch Outflow.

Patch Outflow, Ogama Inflow and Outflow, Doris Outflow, Little Roberts Outflow, and Windy Outflow were characterized as rivers with wetted widths up to 30 m and water depth up to 2 m at high flows and a mixed substrate composition (HT 12; Table 3.2; ERM 2017c, Minnow 2026 in prep.). During low flow, and very rarely during high flows, occasional drops or gradient fish barriers were observed in some HT 12 rivers. With respect to documented fish communities, lake trout were observed in all HT 12 rivers, whereas cisco, ninespine stickleback, and lake whitefish were observed in most HT 12 rivers (Table 3.3). Arctic charr were only observed in Doris and Little Roberts Outflow. Additional fish species were also captured in Little Roberts Outflow that were not caught in the other HT 12 rivers including least cisco, broad whitefish, Arctic flounder, and fourhorn sculpin (Table 3.3). Slimy sculpin were not captured during baseline studies in HT 12 rivers but may reasonably be present based on distribution within the watersheds. HT 12 provides poor nursery and good foraging habitat for Arctic charr, fair nursery and poor foraging habitat for lake trout and cisco, and fair nursery and foraging habitat for lake whitefish and ninespine stickleback (Appendix Tables B.1, D.1, D.2, D.3, D.5, and D.6). HT 12 provides excellent spawning habitat for slimy sculpin (Appendix Tables B.1 and D.4). Overwintering habitat is not present in HT 12 for most species, except for ninespine stickleback for which it is rated as fair (Appendix Tables B.1 and D.1 to D.6). The total area of HT 12 predicted to be lost or altered due to water use is 8,547 m^2 (72 m^2 in Patch Outflow, 341 m^2 in Ogama Inflow, 195 m^2 in Ogama Outflow, 5,491 m^2 in Doris Outflow, 330 m^2 in Little Roberts Outflow, and 2,118 m^2 in Windy Outflow) or 2,609 HU (21 HU in Patch Outflow, 99 HU in Ogama Inflow, 57 HU and Ogama Outflow, 1,592 HU in Doris Outflow, 97 HU in Little Roberts Outflow, and

743 HU in Windy Outflow; Table 3.2). Estimated fish habitat losses for Patch Outflow, Ogama Inflow and Outflow, and Little Roberts Outflow are from the FEIS and will be updated once updated hydraulic modelling results become available for these areas.

In addition to loss of wetted area, results of hydraulic modelling predict a delay in the spring open water season in Doris Creek by approximately one month (from May 14 to June 13) representing a 20% reduction in the open water period (Appendix E). This was not considered in the FEIS, but this change may have implications for the timing of fish movement into Doris Creek and fish use in the lower and middle portions of Doris Creek (Appendix E).[13] The predicted delay in the timing of open water has been included in the assessment of habitat lost and altered as 20% of the total HU representing existing, accessible fish habitat in Doris Creek (i.e., in lower and middle Doris Creek, downstream of the impassable waterfall; Figure 3.1). The total area of habitat lost or altered due to a reduced duration in the open water season is 4,371 m^2 or 1,262 HU (Table 3.2, Appendix Tables D.1 to D.6). A potential delay in the open water season will also be assessed for Little Roberts Outflow based on the results of hydraulic modelling, when available, and fish habitat losses will be included for any delay that may impact fish.

3.3.3 Habitat Offsetting in Iqaluktuuttiaq East Outflow System

Proposed offsetting measures for mine development under the Operational Update will result in the alteration of existing freshwater fish habitat in the EOS (Figure 3.2, Table 3.4) which is accounted for as part of habitat alteration. From Iqaluktuuttiaq, water moves through a series of small waterbodies in the EOS towards an outlet in the Freshwater Creek Estuary near Cambridge Bay. These small waterbodies have been named as numbered “Ponds” from upstream to downstream within the EOS (Figures 3.2, 3.3a, b, c, Appendix H). Within the EOS, water flows from Pond 1 (the first pond downstream of Iqaluktuuttiaq) into Pond 2 through eight culverts which direct water under the main access road to Ovayok Territorial Park. Due to the flat terrain and surficial permafrost, there are multiple outflow points from each pond which creates a complex hydrological system influenced by water levels and pond shape (e.g., depth and slope).

Alteration to fish habitat in the EOS associated with offsetting measures will result from changes in hydrological connectivity between the ponds and, in some cases, changes in pond water levels due to channel modifications up/downstream of the ponds (Appendix C). These changes are considered overall enhancements as they are proposed to result in net gains in the quantity and/or quality of fish habitat (Section 3.4.2).

[13] Access to upper Doris Creek and Doris Lake is restricted by an impassable waterfall at the upstream extent of middle Doris Creek (ERM 2015).

Table 3.4: Summary of Freshwater Habitat Altered for Habitat Offsets, Hope Bay Mine Operational Update

Waterbody	UTM		Pond Size (m^2)	Maximum Depth (m)	Substrate (%)			Fish Community[a]	Habitat Type[b]	Duration of Hydrological Connectivity to Downstream Waterbody (% Open Water Season)[c]		Baseline Habitat Co-Factor		Habitat Altered	
	Easting	Northing			Fines	Mixed	Coarse			ARCH, CISC, LKWH	NSSB	ARCH, CISC, LKWH	NSSB	m^2	HU
Pond 1	503669	7672172	29,081	< 2	9	7	84	ARCH, CISC, LKWH, NSSB	HT 1 - 3	*25*	*100*	0.25	0.50	29,081	3,046
Pond 2	503798	7671900	23,249	2	0	15	84	ARCH, CISC, LKWH, NSSB	HT 2 - 3	25	32	0.25	0.30	23,249	2,106
Pond 3	503932	7671614	58,382	< 4	31	5	64	ARCH, CISC, LKWH, NSSB	HT 1 - 4	47	100	0.50	0.75	58,382	11,184
Pond 4a	504187	7671491	3,129	< 2	7	28	65	ARCH, CISC, LKWH, NSSB	HT 1 - 3	47	100	0.50	0.75	3,129	612
Pond 5b-5f	503034	7670129	98,638	> 4	3	40	57	ARCH, CISC, LKWH, NSSB	HT 1 - 5, 7	*25*	*75*	0.25	0.50	98,638	10,677
Pond 5	502280	7670077	352,800	> 4	36	24	40	ARCH, CISC, LKWH, NSSB	HT 1 - 5, 7	-	-	1.00	1.00	352,800	122,426
													Total	**565,279**	**150,051**

Notes: "ARCH" = arctic charr. "CISC" = cisco. "LKWH" = lake whitefish. "NSSB" = ninespine stickleback. "HT" = habitat type. "HU" = habitat unit. "-" = not applicable.

[a] Fish species indicated are either confirmed or predicted based on fish community data collected in 2019, 2022, and 2023 (ERM 2020, Minnow 2024).

[b] Habitat type as defined in Habitat Evaluation Procedure (see Table 2.4).

[c] Measured from hydrometric data or estimated from fish habitat evaluations. Estimated values are in italics. Based on minimum required flow depths for fish passage of 0.15 m for Arctic char and 0.01 m for ninespine stickleback (see Section 2.2).

Pond 1 has a total area of 29,081 m^2 with a maximum depth of less than 2 m and therefore provides no overwintering habitat for fish (i.e., Figure 3.3a, Table 3.4; ERM 2020, Minnow 2024). Pond 1 is dominated by coarse substrates (approximately 84%) with small portions of fines and mixed substrates (9% and 7% respectively; Table 3.4; ERM 2020). Pond 1 is intermittently connected to Iqaluktuuttiaq upstream and Pond 2 downstream (Table 3.4). The duration of Pond 1's connection to Iqaluktuuttiaq in 2021 was estimated at approximately two weeks in duration (late June to July 13 to 17; Appendix C). Pond 1 includes HT 1, 2, and 3 and provides poor nursery and foraging habitat for Arctic charr, fair to good spawning habitat and poor to excellent nursery and foraging habitat for cisco, fair spawning habitat and poor to excellent nursery and foraging habitat for lake whitefish, and fair to excellent spawning habitat and poor to excellent nursery and foraging habitat for ninespine stickleback (Appendix Tables B.1 and D.7 to D.10). The estimated alteration due to improved connectivity to Pond 2 (see Section 3.4.2.3) has been assumed to be the entire existing area of Pond 1 (29,081 m^2 or 3,046 HU; Table 3.4, Appendix Tables D.7 to D.10).

Pond 2 has a total area of 23,249 m^2 with a maximum depth of 2 m and therefore provides no overwintering habitat for fish (Figure 3.3a, Table 3.4; ERM 2020, Minnow 2024). Pond 2 is dominated by coarse substrates (approximately 84%) with a smaller portion of mixed substrate (15%; Table 3.4; ERM 2020). Pond 2 is intermittently connected to Pond 1 and Pond 3 (Table 3.4). The water level in Pond 2 is predicted to decrease by up to 0.15 m due to downstream connecting channel enhancements (Section 3.4.2.3). Pond 2 includes HT 2 and 3 and provides poor nursery and foraging habitat for Arctic charr, good spawning habitat and poor to excellent nursery and foraging habitat for cisco, fair spawning habitat and good to excellent nursery and foraging habitat for lake whitefish, and fair spawning habitat and poor to good nursery and foraging habitat for ninespine stickleback (Appendix Tables B.1 and D.7 to D.10). The estimated maximum loss of fish habitat due to a reduction in water level of 0.15 m in Pond 2 is 1,436 m^2 and alteration due to improved connectivity to Pond 3 has been assumed for the remaining area (21,813 m^2). Therefore, the combined loss or alteration area of Pond 2 is equivalent to the entire waterbody (23,249 m^2 or 2,106 HU; Table 3.4; Appendix Tables D.7 to D.10).

The proposed connection channel enhancements (Section 3.4.2.3) will not result in measurable impacts to fish or fish habitat in Ponds 3 or 4a (Figure 3.3a,b). However, the existing conditions of Pond 3 and Pond 4a are described here to account for alteration due to improved connectivity to Pond 4 and allow for calculation of habitat gains.

Pond 3 has a total area of 58,382 m^2 with a maximum depth of 2.4 m and therefore provides no overwintering habitat for fish (Figure 3.3a, Table 3.4; ERM 2020, Minnow 2024).

Substrate composition in Pond 3 is comprised of coarse, fine, and mixed substrates (64%, 31%, and 5%, respectively; Table 3.4; ERM 2020). It is intermittently connected to Pond 2 but maintains a shallow wetted connection (<15 cm water depth) to Pond 4a throughout the open water season (Appendix C). Pond 3 includes HT 1 to 4 and provides poor foraging and nursery habitat for Arctic charr, fair to good spawning habitat and poor to excellent nursery and foraging habitat for cisco, fair spawning habitat and poor to excellent nursery and foraging habitat for lake whitefish, and good to excellent spawning habitat and poor to excellent nursery and foraging habitat for ninespine stickleback (Appendix Tables B.1 and D.7 to D.10). Alteration due to improved connectivity to Pond 4a (Section 3.4.2.3) has been assumed for the entire area of Pond 3 (58,382 m^2 or 11,184 HU; Table 3.4, Appendix Tables D.7 to D.10).

Pond 4a is a total area of 3,129 m^2 with a maximum depth of less than 2 m and therefore provides no overwintering habitat for fish (Figure 3.3b, Table 3.4; ERM 2020, Minnow 2024). Substrate in Pond 4a is comprised of coarse, mixed, and fine substrates (65%, 28%, and 7%, respectively; Table 3.4; Minnow 2024). It is connected to Pond 3 and 4 throughout the open water season. Pond 4a includes HT 1 to 3 and provides poor nursery and foraging habitat for Arctic charr, fair to good spawning habitat and poor to excellent nursery and foraging habitat for cisco, fair spawning habitat and poor to excellent nursery and foraging habitat for lake whitefish, and fair to excellent spawning habitat and poor to excellent nursery and foraging habitat for ninespine stickleback (Appendix Tables B.1 and D.7 to D.10). Alteration due to improved connectivity to Pond 4 (Section 3.4.2.3) has been assumed for the entire area of Pond 4a (3,129 m^2 or 612 HU; Table 3.4; Appendix Tables D.7 to D.10).

The proposed offsetting enhancements at the outlet of Pond 5 will result in indirect enhancements in Ponds 5b to 5f. No habitat losses are anticipated in Ponds 5b to 5f; however, the existing conditions are described here to account for alteration due to enhancements and allow for calculation of habitat gains.

Ponds 5b to 5f collectively cover an area of 98,638 m^2. Bathymetry has not been completed for these ponds with the exception of Pond 5b which has a maximum depth of 1.1 m (GeoProcess 2025), although some areas are predicted to have a water depth greater than 4 m. Substrates in these ponds is comprised of coarse, fine, and mixed substrates at percentages of 57%, 40%, and 3%, on average, respectively (Table 3.4; Minnow 2024). These waterbodies, which are conservatively assumed to include HT 1 to 5 and HT 7, may provide some overwintering habitat for all three salmonid species and primarily poor to fair nursery and foraging habitat for Arctic charr, poor to good spawning habitat and poor to excellent nursery and foraging habitat for cisco, fair spawning habitat and poor to excellent nursery and foraging habitat for lake whitefish, and good overwintering habitat, fair to excellent spawning habitat, and poor to excellent

nursery and foraging habitat for ninespine stickleback (Appendix Tables B.1 and D.7 to D.10). Habitat alteration in Ponds 5b to 5f will occur as a result of the installation of a riffle structure downstream of Pond 5 that will backwater upstream habitats as far upstream as Pond 5b (Section 3.4.2.4; Figure 3.3c). This will increase the total area of the backwatered ponds but will also change the relative amounts of each HT due to changes in the depth of existing habitat areas (Appendix C). Backwatering will also result in alteration associated with improved connectivity to Pond 5. Therefore, alteration has been assumed for the entire area of Ponds 5b to 5f (98,638 m^2 or 10,677 HU; Table 3.4; Appendix Tables D.7 to D.10).

Pond 5 has a total area of 352,800 m^2 with a maximum depth of approximately 4.8 m (Figure 3.3c, Table 3.4; ERM 2020). The substrate is dominated by coarse material in shallow areas (34% at < 2 m), and by fines in deeper areas (29% at 2 – 4 m) for total coverage of 36% fines, 24% mixed, and 40% coarse substrates (Table 3.4; ERM 2020). Pond 5 includes HT 1 to 5 and 7 and provides limited fair spawning habitat and primarily poor to fair nursery and foraging habitat for Arctic charr, fair to good spawning habitat and poor to excellent nursery and foraging habitat for cisco, fair spawning habitat and poor to excellent nursery and foraging habitat for lake whitefish, and fair to excellent spawning, nursery, and foraging habitat for ninespine stickleback (Appendix Tables B.1 and D.7 to D.10). Finally, a limited quantity of good to excellent overwintering habitat for all four species is available (Appendix Tables B.1 and D.7 to D.10). Habitat alteration in Pond 5 will occur as a result of the installation of a riffle structure immediately downstream that will backwater Pond 5 and increase its area and depth (Section 3.4.2.4). The proportion of habitat types in Pond 5 will be altered due to the increase in water level and depth and alteration has been assumed for the entire area of Pond 5 (352,800 m^2 or 122,426 HU; Table 3.4; Appendix Tables D.7 to D.10).

3.3.4 Summary of Lost and Altered Fish Habitat

The development of the Mine will result in the loss of stream habitat due to water withdrawal and use (e.g., reduced flow and in some instances a reduction in the duration of the open water season for Doris Outflow). The total area of stream habitat to be lost or altered due to water withdrawal and use is 8,684 m^2 (Table 3.5, Appendix Tables D.1 to D.6). Habitat alteration will also occur at proposed offsetting sites and has been accounted for in HEP assessment. The total area of habitat that will be altered due to offsetting measures is 565,279 m^2 (Table 3.5, Appendix Tables D.7 to D.10). The total HU predicted to be lost or altered from water withdrawal and use is equal to 2,633 HU (Table 3.2, Appendix Tables D.1 to D.6) while the total HU predicted to be altered through offsetting implementation is 150,051 HU (Table 3.4, Appendix Tables D.7 to D.10).

Table 3.5: Summary of Habitat Lost or Altered, Hope Bay Mine Operational Update

HADD Type	Habitat Type	Location	Area (m^2)	HU						
				Arctic Char	Lake Trout	Cisco	Slimy Sculpin	Lake Whitefish	Ninespine Stickleback	Total
Habitat Loss or Alteration - Project Water Withdrawal and Use	Watercourse	Imniagut Outflow	120	0	1	0	1	1	15	19
		Patch Outflow	72	0	2	2	9	3	5	21
		P.O. Outflow	17	0	1	1	2	1	1	5
		Ogama Inflow	341	0	11	11	43	14	21	99
		Ogama Outflow	195	0	6	6	24	8	12	57
		Doris Outflow	5,491	241	145	145	579	193	289	1,592
		Little Roberts Outflow	330	15	9	9	35	12	18	97
		Windy Lake Outflow	2,118	113	68	68	270	90	135	743
	Water Withdrawal and Use Total		**8,684**	**368**	**242**	**241**	**964**	**322**	**496**	**2,633**
Habitat Alteration - Offsetting	Waterbody	Pond 1	29,081	227	-	840	-	853	1,125	3,046
		Pond 2	23,249	182	-	699	-	740	485	2,106
		Pond 3	58,382	929	-	2,917	-	2,846	4,492	11,184
		Pond 4a	3,129	49	-	173	-	192	198	612
		Pond 5b to 5f	98,638	883	-	2,712	-	2,785	4,296	10,677
		Pond 5	352,800	14,499	-	35,925	-	36,261	35,742	122,426
	Alteration from Offsetting Total		**565,279**	**16,769**	**0**	**43,267**	**0**	**43,677**	**46,338**	**150,051**
Project Total			**573,963**	**17,137**	**242**	**43,508**	**964**	**43,999**	**46,834**	**152,683**

Notes: "HADD" = harmful, alteration, disruption, or destruction of fish habitat. "HU" = habitat unit."-" = not applicable.

3.4 Proposed Fish Habitat

3.4.1 Introduction

Offsetting measures for the Operational Update were identified during the Phase 2 environmental assessment through a multi-year process that included:

1. Identifying candidate sites from multiple sources including desktop and high-level field assessments, and engagement with local Inuit Qaujimajatugangit (IQ) holders and researchers.
2. Incorporation of local knowledge and IQ from multiple sources including workshops and meetings with the IEAC, the KIA, and DFO (Appendix A).
3. Consideration of local and regional fisheries management objectives including DFO integrated fisheries management plans and local fisheries management priorities (Appendix H).
4. Results of field reconnaissance surveys at candidate sites (Appendix H).

The offsetting measures that were selected through this process will result in the creation and enhancement of, and improved access to, waterbody habitat and seasonal stream habitat in the EOS (Figure 3.4). Specifically, the offsetting measures include:

- enhancement or remediation of a fish passage impediment at eight culverts at the EOS crossing along the main access road to Ovayok Territorial Park;
- connector channel modifications at the inlet of Pond 3 and the outlets of Pond 3 and 4a in the EOS; and
- the creation of a riffle at the outlet of Pond 5 in the EOS resulting in habitat creation and improved connectivity through backwatering.

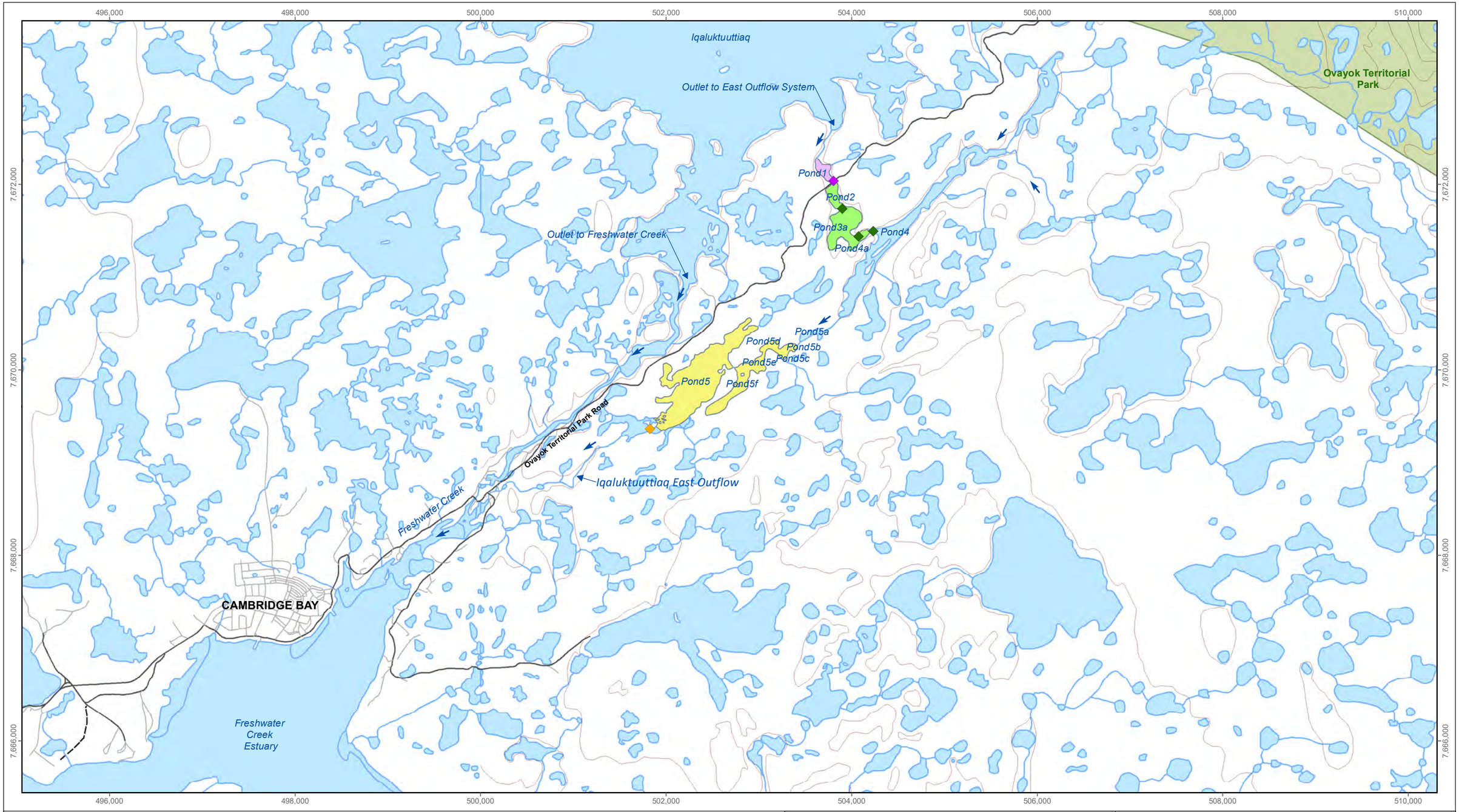
Additional measures to prevent erosion and establish food web components (e.g., planting of macrophytes and/or riparian vegetation) are discussed in the reduction of lag times (Section 4.6).

The offsetting habitat measures have been incorporated into the HEP as habitat gains to offset the habitat losses and alterations described in Section 3.3. A description of the fish habitat quality and quantity associated with each of these created and enhanced fish habitats is provided below.

3.4.2 Iqaluktuuttiaq East Outflow System

3.4.2.1 Background and Design Considerations

The EOS flows south from Iqaluktuuttiaq to the Freshwater Creek Estuary located in the Dease Strait (Figure 3.4). The EOS has a length of approximately 8 km and is comprised of



LEGEND

Offsetting Measures
- Channel Enhancement
- Crossing Remediation
- Riffle Structure

Area of Enhancement from Offsetting Measures
- Channel Enhancement
- Crossing Remedition
- Riffle Structure

Contour (10m interval)

0 0.5 1 2 km

Projection: North American Datum 1983 UTM Zone 13N

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N W E S

Iqaluktuuttiaq East Outflow System Offsetting Measures, Hope Bay Mine Operational Update

Date: November 2025
Project 257202.0052

minnow environmental inc.

Figure 3.4

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 257202.0052 - 2025 Freshwater FAA Permit Support\D - GIS\Freshwater FOP\25-52 Figure 3.4 Iqaluktuuttiaq East Outflow System Offsetting Measures, Operational Update .mxd

multiple small waterbodies connected by intermittent stream habitat. Iqaluktuuttiaq has an area of approximately 34,000,000 m^2 and a fish community including Arctic charr, lake trout, lake whitefish, cisco, least cisco, broad whitefish, and ninespine stickleback (Grosbois et al. 2022). Fish from Iqaluktuuttiaq, particularly Arctic charr, *Coregonus sp.*,[14] ninespine stickleback, and potentially lake trout, access the EOS (ERM 2018, 2020, Minnow 2024). The EOS is one of two outflow systems between Iqaluktuuttiaq and the Freshwater Creek Estuary. The other outflow, Freshwater Creek (Figure 3.4), is located to the northwest and supports an important Arctic charr subsistence fishery for fishers from Cambridge Bay (DFO 2004).

A road from Cambridge Bay to Ovayok Territorial Park runs parallel to, and between, Freshwater Creek and the EOS (Figure 3.4), then crosses the EOS near its outflow from Iqaluktuuttiaq. At the crossing, eight culverts are present that are perched under various flow conditions (ERM 2019, 2020, Minnow 2024). The EOS was identified as a candidate offsetting option by participants at a Fisheries Offsetting Workshop in Cambridge Bay in June 2018 when the culvert crossing was raised as an issue for fish passage (ERM 2019; Appendix A). In response to frequent road washout events, culverts were installed across the width of the channel to accommodate seasonal high flows. The culverts create an impediment to both upstream and downstream fish passage during a majority of the open water period of each year (ERM 2020, Minnow 2024). At the 2018 Fisheries Offsetting Workshop, water levels in the EOS were also noted by local IQ holders to be lower in recent years than they had observed historically (Appendix A).

Field investigations in 2018, 2019, and 2021 to 2023 found that fish migration at multiple stream channel locations in the EOS became compromised in mid- to late-July and frequently remain that way until freshet of the following year (Appendix C; ERM 2019, 2020, Minnow 2024). Flow and water level conditions at the culverts indicate that at high flows (typically during freshet) the culverts are a potential velocity barrier to upstream migration (ERM 2020), while at lower flows, all but one of the culverts are perched (Photos 3.1 to 3.4; Appendix C). Without passable stream channel connections, and with the culverts acting as a barrier to fish passage, fish habitats in waterbodies along the EOS become disconnected from each other between upstream Iqaluktuuttiaq and the downstream marine environment.

Fish community surveys in the EOS in 2019, 2022, and 2023 captured ninespine stickleback and *Coregonus spp.* in both stream and waterbody habitats and Arctic charr in waterbodies only

[14] Field identification to the species level for the genus Coregonus is extremely difficult and unreliable in non-lethal surveys and thus was not attempted in the EOS baseline sampling programs. The term *Coregonus spp.* has been used to represent the four Coregonus species that have been documented in Iqaluktuuttiaq (i.e., cisco, least cisco, lake whitefish, and broad whitefish).

Photo 3.1: Culverts at the EOS Crossing Upstream (Top) and Downstream (Bottom) of the Culverts in September 2021

Note: Culverts are numbered sequentially from 1 to 8 facing downstream. EOS – Iqaluktuutiaq Lake East Outflow System.

Photo 3.2: Culverts at the EOS Crossing Upstream (Top) and Downstream (Bottom) of the Culverts in September 2022

Note: EOS – Iqaluktuutiaq Lake East Outflow System.

Photo 3.3: Culverts at the EOS Crossing Downstream of the Culverts in August 2023

Note: EOS – Iqaluktuutiaq Lake East Outflow System.

Photo 3.4: Culvert 1 at the EOS Crossing Upstream (Top) and Downstream (Bottom) of the Culverts in August 2023

Note: EOS – Iqaluktuutiaq Lake East Outflow System.

(ERM 2020, Minnow 2024). According to IQ, Arctic charr and lake trout were historically fished in the EOS (Appendix A; ERM 2019). The depth and habitat characteristics of the waterbodies (see Section 3.3.3) suggest that they provide habitat for ninespine stickleback and *Coregonus spp*. (represented by cisco and lake whitefish) migration, spawning, nursery, and foraging, and Arctic charr migration, nursery, and foraging (Appendix Table B.1 and B.2). Some maturing or mature Arctic charr were captured in Ponds 4 and 5 in 2019. Limited fair spawning habitat may be present in Ponds 4 and 5 based on the habitat types present (HT 1 to 5 and 7; Appendix Table D.11) although no spawning habitat for Arctic charr was specifically identified during the survey in 2019 (ERM 2020). In a limited number of locations, maximum depth is sufficient to provide overwintering habitat for fish (i.e., water depth >3 m). Under-ice *in situ* water quality profiles measured in April 2024 showed that Ponds 1, 2, and 3 (maximum depths less than 2.4 m; ERM 2020) provide no or marginal overwintering habitat based on ice extending to the substrate in most cases, or, in the very limited areas with shallow water under the ice, concentrations of dissolved oxygen (DO) indicating hypoxic or near hypoxic conditions (Minnow 2024). Under-ice conditions in Pond 4 and Pond 5 suggested overwintering habitat for fish was present, but was limited in area and, in some cases, had marginal water quality (Minnow 2024). Under-ice surveys have not been conducted in Ponds 5b to 5f but some areas are predicted to have a water depth greater than 4 m, therefore limited overwintering habitat may also be present in these waterbodies.

Habitat assessments completed in the EOS indicate that there is a period during high flows where stream habitats in the EOS provide fair quality habitat for Arctic charr, *Coregonus spp*., and ninespine stickleback migration, nursery, and foraging but that habitat quality declines rapidly with declining flows, particularly for large-bodied species (Appendix Tables B.1 and B.2; Evans et al. 2002, ERM 2020, Minnow 2024). In general, when stream channel connections dry up, fish in the EOS may lose access to the deeper waterbodies, Iqaluktuuttiaq, and/or the marine environment, and populations may not survive over winter or likely have limited overwintering success.

Enhancements to migratory and overwintering habitats in the EOS are proposed as offsetting measures for increasing fish habitat and fisheries productivity. Improved habitat connectivity could extend the period over which fish can access suitable overwintering habitat and improve their overwintering success. Enhancement to the amount and quality of overwintering habitat could also improve survival, allowing more fish to use habitats in the waterbodies for this critical life function. Given the number of locations along the channel where migratory potential is or may be compromised, enhancements in the EOS are not anticipated to result in unimpeded migration between the marine environment and Iqaluktuuttiaq during the entire open water season. Instead, the intent of enhancements is to extend the period over which migration is possible,

improve migration success for specific life stages of fish (e.g., juvenile fish moving to overwintering habitats in the late summer/fall), and/or improve nursery, foraging, and overwintering conditions for fish that use stream/waterbody habitats in the system. Additionally, IQ indicates that water levels in the EOS have declined over time (Appendix A), and a general trend of decreasing water levels in Arctic watersheds due to climate change has been identified (Smith et al. 2005). The enhancements proposed are also expected to increase the long-term resilience of fish habitat quality in the EOS given potential future climate change effects.

The proposed offsetting habitats in the EOS were developed to accommodate key design considerations (Appendix C) which include:

- the region's complex surface flow through a series of short, shallow channels among waterbodies;
- channels that range in cross-sectional size (10 to 20 m) but often lack bank definition or sustain flushing flows;
- maintenance of freshet flows throughout the EOS and Freshwater Creek;
- continuous and deep permafrost and lack of groundwater flow;
- limited change in elevation among Ponds 2 to 6 (mean slope 0.05%);
- avoiding modification to the Iqaluktuuttiaq outlet since this could potentially impact summer flows in Freshwater Creek;
- measures that are resilient to predicted climate induced changes in the hydrological regime (e.g., a flashier system that rises and falls more quickly in response to runoff or precipitation events);
- minimize reductions to existing water levels in waterbodies;
- minimize impacts to surrounding areas; and
- maximize available habitat potential, matching or enhancing the existing habitat conditions.

Sections 3.4.2.2. to 3.4.2.4 provide details for each of the proposed offsetting measures in the EOS.

3.4.2.2 Culvert Remediation

Eight culverts control the outflow of Pond 1 to Pond 2 (and subsequently the entire downstream area of the EOS) during high flows and may act as a velocity barrier preventing upstream fish

movement between Ponds 1 and 2 through the culverts (ERM 2020). During low flows in 2021, 2022, and 2023, a single culvert (Culvert 1) remained flowing, but fish movement both up and downstream between Ponds 1 and 2 was limited by the depth of flow through the culvert and access to the culvert inlet and outlet (Photos 3.1 to 3.4). In 2021, the water depth in Culvert 1 receded to between approximately 5 cm (upstream end) and 17 cm (downstream end) by late July, likely limiting passage for larger Arctic charr (Thompson 1972). Although, based on hydrometric data, Culvert 1 remained wetted during the 2021 open water season, an accumulation of fill from road construction and repairs over time on both sides of the road created physical impediments for all fish attempting to access the culverts as water levels receded in Ponds 1 and 2 (Appendix C). In August 2023, Culvert 1 was wetted at the downstream end (but shallow) and was perched at the upstream end, completely restricting fish passage (Photo 3.4). In 2021, Pond 1 also became disconnected from Iqaluktuuttiaq relatively early in the open water season by a substantial dry channel barrier (i.e., between July 13 and 17) that was also documented during baseline surveys in fall of 2022 and 2023 (Photos 3.5 and 3.6). Therefore, while Pond 1 continued to act as fish habitat, limited access to upstream and downstream habitats and a lack of overwintering habitat meant that fish that remained in Pond 1 as water level receded likely perished over winter and did not contribute to ongoing productivity in the EOS system. Given downstream passage potential based on hydrometric and fish habitat information, the HEP habitat co-factor for Pond 1 under existing conditions was conservatively applied as 0.25 for Arctic charr, cisco, and lake whitefish, and 0.5 for ninespine stickleback (Table 3.4, Appendix Tables D.11 to D.14).

Several options were explored for enhancement/remediation of the crossing (Appendix C). The objective of the offsetting measure proposed and accounted for in this conceptual offsetting plan will offer improved fish access and migration potential directly between Pond 1 and 2 and indirectly throughout the EOS with the least potential risk of influencing summer flow in Freshwater Creek. For this offsetting measure, the existing road crossing structures (i.e., culverts) will be maintained in place and a shallow connecting channel will be constructed from Pond 1 to the inlet of Culvert 1 (Appendix C). Pond 2 will be enhanced by increasing the depth downstream of Culverts 1 and 2 through excavation of existing excess road fill material. This will improve connectivity between the outlets of the culverts and the deepest portion of Pond 2, increasing the water level at the upstream end of Pond 2 and improving connectivity between the ponds during low flows. Because this option will not alter the culvert dimensions, invert elevations, or conveyance capacity, there is no anticipated change in fish passage potential through the culverts during high flow conditions (e.g., potential velocity barriers), no anticipated change in water level in Pond 1 or Pond 2, and no anticipated effects on the distribution of flow between the EOS and Freshwater Creek.

Photo 3.5: Low Flow and Dry Channel Sections in the Iqaluktuuttiaq Outflow (Facing Upstream Towards Iqaluktuuttiaq) in September 2022 (Top) and August 2023 (Bottom)

Note: EOS – Iqaluktuutiaq Lake East Outflow System.

Photo 3.6: Dry Channel Section in the Iqaluktuuttiaq Outflow (Facing Downstream Towards Pond 1) in August 2023

Note: EOS – Iqaluktuutiaq Lake East Outflow System.

This offsetting measure, in combination with other measures downstream in the EOS described below will result in improved potential for fish using Pond 1 to access downstream overwintering habitats over a longer period of the open water season. Therefore, the habitat co-factor for Pond 1 post-enhancement has been conservatively applied as 0.5 for Arctic charr, cisco, and lake whitefish, and 0.75 for ninespine stickleback (Table 3.6; Appendix Tables D.11 to D.14). The resulting increase in HU will be 2,483 (3,046 HU altered from existing conditions and 5,529 HU gained under post-enhancement conditions; Tables 3.4 and 3.6, Appendix Tables D.7 to D.14).

During engagement with the IEAC, KIA, and DFO (August 3 and 4 and September 21, 2022; Appendix A), potential options for offsetting at the crossing location were discussed. Rightsholders from the IEAC expressed their interest in an approach where the culverts are modified or replaced based on the potential for the system to more closely resemble its historical condition, prior to the installation of the existing road and culverts (Appendix A). Options for remediating the crossing were further discussed during engagement with IEAC, KIA, and DFO on August 9, 2023, including options to replace the existing culverts with larger embedded culverts, arched culverts, or a clear span bridge structure (Appendix A).

Based on this feedback, the options to enhance/remediate the crossing by replacing some or all of the existing culverts with larger corrugated steel pipe (CSP) culverts at new elevations or replacing the culverts with a clear span bridge received some additional exploration (Appendix C). The design for replacing the existing culverts with larger CSP culverts would have the objectives of increasing the duration of connectivity between Ponds 1 and 2 at low flows and reducing the potential of velocity barriers to upstream migration through the culverts at high flows. Modifying culvert invert elevations could reduce the water level in Pond 1, however the invert elevations would be designed to balance impacts to the Pond 1 water level while improving connectivity for downstream fish migration. Ideally, the upstream invert would be lowered to provide backwater within the culvert(s) from Pond 2. Thus, the low flow water level of Pond 1 would decrease by only approximately 0.20 m (equalizing with Pond 2; Appendix C). Replacing the culverts with a clear span bridge would also reduce the potential of velocity barriers to upstream migration during freshet and would reduce the risk of the road overtopping during freshet but would reduce water levels in Pond 1 (Appendix C).

Any option for culvert modification or replacement is likely to change the conveyance capacity at the crossing which may impact the distribution of flows between the EOS and Freshwater Creek during the high flow period before Pond 1 becomes disconnected from Iqaluktuuttiaq. While this change is expected to be minor, potential impacts to Freshwater Creek require additional assessment and consideration. Therefore, an assessment of feasibility, including a hydrological

Table 3.6: Summary of Freshwater Habitat Gained through Offsets, Hope Bay Mine Operational Update

Waterbody	Enhancement	Offsetting Benefit	Post-Enhancement Habitat Co-Factor		Habitat Enhancement Area (m^2)	Habitat Gain (HU)
			ARCH, CISC, LKWH	NSSB		
Pond 1	Crossing remediation	Access to habitat	0.50	0.75	29,081	5,529
Pond 2	Downstream channel connection	Access to habitat	0.75	0.75	21,813	5,706
Pond 3	Downstream channel connection	Access to habitat	1.00	1.00	58,382	19,373
Pond 4a	Downstream channel connection	Access to habitat	1.00	1.00	3,129	1,093
Pond 5b - 5f	Downstream riffle structure	Increase in habitat area and quality, access to habitat	1.00	1.00	122,137	42,245
Pond 5	Downstream riffle structure	Increase in habitat area and quality	1.00	1.00	401,500	142,066
					636,042	**216,011**

Notes: "ARCH" = arctic charr. "CISC" = cisco. "LKWH" = lake whitefish. "NSSB" = ninespine stickleback. "HU" = habitat unit. "-" = not applicable.

assessment of the distribution of flow between the EOS and Freshwater Creek is proposed for 2026. Land tenure and long term maintenance of the access road and crossing also need to be considered for any option to modify or replace the culverts.[15]

If an option to modify/replace the culverts is deemed feasible and is supported by the IEAC and KIA and pursued as the preferred offsetting measure, habitat accounting will be updated to reflect this approach.

3.4.2.3 Connecting Channel Enhancements

Under existing conditions, Ponds 2 and 3 became disconnected on July 30 in 2021 and the water depth in channel connections between Ponds 3, 4a, and 4 were generally < 15 cm starting in late-July 2021; Figure 3.3a,b, Appendix C). Water depth in connecting channels upstream of Pond 4 was also extremely shallow and/or sections of the channels were dry during baseline surveys conducted in September 2022 and August 2023 (e.g., Photo 3.7). These conditions prevented or impeded fish passage from the upstream ponds into Pond 4 as water levels in the EOS receded. The maximum depths of Ponds 2, 3, and 4a, measured in 2019 and 2021 were <3 m (Figure 3.3a) and under-ice *in situ* water quality profiles collected in April 2024 showed that Ponds 2 and 3 provide no or only marginal overwintering habitat based on ice extending to the substrate in most cases, or, in the very limited areas with shallow water under ice, concentrations of DO indicating hypoxic or near hypoxic conditions (Minnow 2024). Downstream, Pond 4 is a large waterbody with a maximum measured depth of 4.7 m (Figure 3.5; ERM 2020). The substrate in Pond 4 is dominated by coarse and mixed substrates at depths <2 m (approximately 50% and 30% of total area, respectively) with fine substrates present at all depths (20% of total area; Figure 3.5; ERM 2020). Pond 4 includes HT 1 to 5 and HT 7 and provides good to excellent overwintering habitat for Arctic charr, cisco, lake whitefish, and ninespine stickleback and fair to excellent spawning habitat for ninespine stickleback. It also provides poor to excellent nursery and foraging habitat for all four species (Appendix Tables B.1).

As with Pond 1, Ponds 2, 3, and 4a provided fish habitat throughout the 2021, 2022, and 2023 open water season but with limited access to upstream and downstream habitats and a lack of overwintering habitat. If fish remain in these ponds as water levels recede, their potential for overwintering success is extremely low and therefore they would not contribute to ongoing productivity in the EOS system. Given downstream passage potential based on hydrometric and

[15] Trinity Consultant Canada's (TCC's; formerly Minnow Environmental Inc. [Minnow]) understanding is that the land along the road is a mix of tenure and ownership that includes Inuit Owned Land (administered by the Kitikmeot Inuit Association) and Commissioner's Land (unpatented Crown land administered by the Government of Nunavut Department of Community and Government Services within a municipal boundary) and that the portion of the Ovayok road where the culverts are located is on Commissioner's Land (Appendix A).

Photo 3.7: Dry Channel Sections in the Connecting Channel Between Pond 2 and 3 in September 2022 (Top) and August 2023 (Bottom)

Note: EOS – Iqaluktuutiaq Lake East Outflow System.

504,000 504,500 505,000

7,672,500 7,672,000 7,671,500 7,671,000

Ovayok Territorial Park Road

Pond 2

Pond 3

Pond 4

Pond 4a

-0.5 -1 -1.5 -2 -2.5 -3 -4

LEGEND

Littoral Substrate
- Bedrock
- Boulder
- Cobble
- Fines
- Gravel

Sublittoral Substrate
- Fines
- Large Rock
- Mixed

Pond 4 Bathymetry (.5 m interval)

Pond 4 Bathymetry and Substrate Characteristics, Hope Bay Mine Operational Update

0 100 200 400
Meters

N W E S

Projection: North American Datum 1983 UTM Zone 13N

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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada. Base imagery on main map for East Outflow System collected in September 2021.

Date: November 2025
Project 257202.0052

minnow environmental inc.

Figure 3.5

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 257202.0052 - 2025 Freshwater FAA Permit Support\D - GIS\Freshwater FOP\25-52 Figure 3.5 Pond 4 Bathymetry and Substrate Characteristics.mxd

fish habitat information, the HEP habitat co-factor for Pond 2 under existing conditions was 0.25 for Arctic charr, cisco, and lake whitefish, and 0.3 for ninespine stickleback (Table 3.4, Appendix Tables D.7 to D.10). The HEP habitat co-factors for Ponds 3 and 4a under existing conditions were 0.5 for Arctic charr, cisco, and lake whitefish, and 0.75 for ninespine stickleback (Table 3.4 Appendix Tables D.7 to D.10).

Channel modifications at three locations are proposed to increase habitat connectivity between waterbodies and enhance seasonal channel habitat availability and migration potential (Figure 3.4; Appendix C). The inlet to Pond 3, the outlet of Pond 3, and the outlet of Pond 4a will be modified to provide 1 m bottom width with 2:1 side slopes that would maintain a water depth during the open water season of approximately 0.3 m. The connecting channel modifications would enhance the connection between Ponds 2, 3, 4a, and 4 during low flow conditions such that fish that use habitats in the upstream ponds would have increased access to overwintering habitat in Pond 4. Therefore, the HEP habitat co-factor for Pond 2 post-enhancement is predicted to be 0.75 for Arctic charr, cisco, lake whitefish, and ninespine stickleback (Table 3.6; Appendix Tables D.11 to D.14). The HEP habitat co-factor for Ponds 3 and 4a under post-enhancement conditions is predicted to be 1 for Arctic charr, cisco, lake whitefish, and ninespine stickleback (Appendix Tables D.11 to D.14). This will result in a total increase of 12,270 HU across the three waterbodies (2,106 HU, 11,184 HU, and 612 HU altered from existing conditions and 5,706 HU, 19,373 HU, and 1,093 HU gained under post-enhancement conditions in Ponds 2, 3, and 4a, respectively; Tables 3.4 and 3.6, Appendix Tables D.7 to D.14).

3.4.2.4 Pond 5 Outlet Riffle Structure

Pond 5 provides limited fair spawning habitat and primarily poor to fair nursery and foraging habitat for Arctic charr, fair to good spawning habitat and poor to excellent nursery and foraging habitat for cisco, fair spawning habitat and poor to excellent nursery and foraging habitat for lake whitefish, and fair to excellent spawning, nursery, and foraging habitat for ninespine stickleback, and good to excellent overwintering habitat for all four species (see Section 3.3.3; Appendix Tables B.1 and D.11 to D.14). Habitat within Pond 5 is limiting outside of regional lakes in the surrounding area and therefore very valuable to fish species that use the EOS. Under existing conditions, Ponds 5b to 5f are connected to Pond 5 through a series of shallow channels (i.e., generally <15 cm when surveyed in September 2019, 2021, and 2022 [Figure 3.3c; ERM 2020, Minnow 2024]). The conditions in these channel connections likely prevent or impede fish passage into Pond 5 as water levels in the EOS recede. The maximum depth of Pond 5b is 1.1 m (GeoProcess 2025) but the maximum depth of Ponds 5c to 5f have not been directly measured. Substrates in these ponds were comprised predominantly of coarse and fine substrates (Section 3.3.3). Although some overwintering habitat is anticipated to be present,

it is predicted to be limited to the larger, downstream Ponds 5e and 5f (Figure 3.3c). Given the estimated habitat conditions and downstream passage potential based on hydrometric and fish habitat information, the HEP habitat co-factor for Ponds 5b to 5f under existing conditions was 0.25 for Arctic charr, cisco, and lake whitefish, and 0.5 for ninespine stickleback (Table 3.4, Appendix Tables D.7 to D.10).

The creation of a riffle structure is proposed near the outlet of Pond 5 and will increase the water level within Pond 5 while improving connectivity among upstream Ponds 5b to 5f (Figure 3.4, Appendix C). The riffle will be placed within an existing connector channel with a minimal crest height of 0.5 m to maintain the existing reach-wide morphology. The riffle will facilitate backwater conditions in Pond 5 such that the waterbody water surface elevation (WSE), and therefore the depth, would increase by 0.5 m. Based on WSE measured in September 2021 the WSE would increase from 9.19 masl to 9.6 masl and would result in an increased area of deeper overwintering habitat (i.e., the total area of habitats in the 2 – 4 m and >4 m depth ranges would increase from 55,100 m^2 to 139,400 m^2; Appendix Tables D.7 to D.14). The total area of Pond 5 would increase from 352,800 m^2 to 401,500 m^2. Furthermore, Ponds 5b to 5f and their connecting channels would also experience an increase in WSE, and therefore depth, of between 0.1 and 0.5 m which would sustain a connection to Pond 5, with channel depths greater than 15 cm throughout the open water season (Appendix C). The HEP habitat co-factor for Ponds 5b to 5f under post-enhancement conditions is predicted to be 1 for Arctic charr, cisco, lake whitefish, and ninespine stickleback (Table 3.6; Appendix Tables D.11 to D.14). Non-mapped changes in connectivity or productivity are not anticipated for Pond 5, therefore the HEP habitat co-factor under both pre- and post-enhancement conditions will be 1 for all four species (Tables 3.4 and 3.6). Overall, the creation of the riffle structure near the outlet of Pond 5 will result in a total increase of 51,208 HU in Ponds 5b to 5f and Pond 5 collectively (10,677 and 122,426 HU altered from existing conditions and 42,245 and 142,066 HU gained under post-enhancement conditions in Ponds 5b to 5f and Pond 5, respectively; Tables 3.4 and 3.6, Appendix Tables D.7 to D.14).

3.4.3 Summary of Proposed Habitat in the Offsetting Plan

Freshwater fish habitat will be enhanced or created in the EOS through crossing remediation, channel enhancements, and the construction of a riffle structure to backwater an existing waterbody (Pond 5) and upstream waterbodies and stream habitat (Figure 3.4, Tables 3.6 and 3.7). The total area of freshwater habitat that will be enhanced or created is 636,042 m^2 and the total HU predicted to gained through the offsetting measures is 216,011 HU (Tables 3.6 and 3.7; Appendix Tables D.11 to D.14).

Table 3.7: Summary of Habitat Gained from Offsetting, Hope Bay Mine Operational Update

Waterbody	Area (m^2)	HU				
		Arctic Charr	Cisco	Lake Whitefish	Ninespine Stickleback	Total
Pond 1	29,081	454	1,680	1,707	1,688	5,529
Pond 2	21,813	511	1,963	2,086	1,146	5,706
Pond 3	58,382	1,858	5,834	5,692	5,989	19,373
Pond 4a	3,129	98	347	384	264	1,093
Pond 5b-5f	122,137	4,380	13,428	13,785	10,652	42,245
Pond 5	401,500	21,354	43,040	39,144	38,527	142,066
Total	**636,042**	**28,656**	**66,292**	**62,798**	**58,266**	**216,011**

Notes: "HU" = habitat unit."-" = not applicable.

3.5 Predicted Net Change in Habitat/Fish Productivity

The predicted loss of fish habitat associated with the Operational Update and alteration associated with proposed offsetting measures (Section 3.3) were assessed relative to the planned habitat to be created or enhanced through offsetting measures (Section 3.4) such that the net change in productive fish capacity could be considered. HU were used as a surrogate for fish productivity. As described in Section 2, HU were considered for six representative resident freshwater species for habitat (four of which are present at the offsetting locations) for four life functions (e.g., spawning, nursery, foraging, and overwintering). The results of this assessment were tabulated for each species before and after Project development and offsetting implementation (Appendix Tables D.1 to D.14). The overall results of the assessment (i.e., summary of habitat accounting) are summarized by species in Table 3.8.

This approach provides a quantitative method for the assessment of habitat change and suggests that the offsetting measures will result in positive habitat balance of 63,328 HU and an offsetting gain:loss ratio of 216,011 HU:152,683 HU or 1.41:1 (Table 3.9). Although this is slightly lower than the offsetting ratio of 1.6:1 that has been used for recent projects at other Agnico Eagle sites, it is considered adequate to account for lag times and uncertainty associated with the proposed offsetting measures for the following reasons:

- the offsetting measures proposed in the EOS can be used by fish as soon as construction and commissioning is completed, thereby minimizing or eliminating lag times (see Section 4.6);
- uncertainty associated with the culvert remediation and connecting channel enhancements offsetting measures is low as the former represents a common category of fish habitat restoration project that is likely to benefit fish in the EOS given the current condition of the crossing and the latter measure has been implemented previously for development at Hope Bay via the Doris North No Net Loss Plan and was shown to be effective (Minnow 2023); and
- habitat losses associated with alteration of existing EOS habitat due to implementation of offsetting measures are based on habitat that has already been degraded (i.e., by development of the Ovayok Road at Cambridge Bay) and do not represent alterations to pristine fish habitat.

Increased water withdrawal and use from Doris Lake relative to the FEIS is anticipated to result in increased effects on fish and fish habitat in Doris Outflow and Little Roberts Outflow. Hydraulic modelling for Little Roberts Outflow is currently underway and predicted fish habitat losses for this area will be updated once model results become available. Given that effects to

Table 3.8: Summary of Habitat Accounting, Hope Bay Mine Operational Update

Project Effect	Habitat Type	Waterbody or Watercourse Name	Area (m^2)	HU						
				Arctic Charr	Lake Trout	Cisco	Slimy Sculpin	Lake Whitefish	Ninespine Stickleback	Total
Habitat Loss or Alteration - Project Water Withdrawal and Use	**Watercourse**	Imniagut Outflow	120	0	-1	0	-1	-1	-15	-19
		Patch Outflow	72	0	-2	-2	-9	-3	-5	-21
		P.O. Outflow	17	0	-1	-1	-2	-1	-1	-5
		Ogama Inflow	341	0	-11	-11	-43	-14	-21	-99
		Ogama Outflow	195	0	-6	-6	-24	-8	-12	-57
		Doris Outflow	5,491	-241	-145	-145	-579	-193	-289	-1,592
		Little Roberts Outflow	330	-15	-9	-9	-35	-12	-18	-97
		Windy Outflow	2,118	-113	-68	-68	-270	-90	-135	-743
	Total		**8,684**	**-368**	**-242**	**-241**	**-964**	**-322**	**-496**	**-2,633**
Habitat Alteration - Offsetting	**Waterbody**	Pond 1	29,081	-227	-	-840	-	-853	-1,125	-3,046
		Pond 2	23,249	-182	-	-699	-	-740	-485	-2,106
		Pond 3	58,382	-929	-	-2,917	-	-2,846	-4,492	-11,184
		Pond 4a	3,129	-49	-	-173	-	-192	-198	-612
		Pond 5b-5f	98,638	-883	-	-2,712	-	-2,785	-4,296	-10,677
		Pond 5	352,800	-14,499	-	-35,925	-	-36,261	-35,742	-122,426
	Total		**565,279**	**-16,769**	**0**	**-43,267**	**0**	**-43,677**	**-46,338**	**-150,051**
Habitat Gain - Offsetting	**Waterbody**	Pond 1	29,081	454	-	1,680	-	1,707	1,688	5,529
		Pond 2	21,813	511	-	1,963	-	2,086	1,146	5,706
		Pond 3	58,382	1,858	-	5,834	-	5,692	5,989	19,373
		Pond 4a	3,129	98	-	347	-	384	264	1,093
		Pond 5b-5f	122,137	4,380	-	13,428	-	13,785	10,652	42,245
		Pond 5	401,500	21,354	-	43,040	-	39,144	38,527	142,066
	Total		**636,042**	**28,656**	**0**	**66,292**	**0**	**62,798**	**58,266**	**216,011**
NET TOTAL			**-**	**11,519**	**-242**	**22,784**	**-964**	**18,799**	**11,432**	**63,328**

Notes: "HU" = habitat unit. "-" = not applicable.

Table 3.9: Net Balance of Habitat Units and Gain:Loss Offsetting Ratio from Project Development and Offsetting Measures

Habitat Type	Habitat Loss or Alteration - Project (HU)	Habitat Alteration - Offsetting (HU)	Habitat Gain - Offsetting (HU)	Net Balance (HU)	Offsetting Gain: Loss Ratio
Waterbody	0	-150,051	216,011	65,960	-
Watercourse	-2,633	0	0	-2,633	-
Total	**-2,633**	**-150,051**	**216,011**	**0**	**-**
	-152,683		**216,011**	**63,328**	**1.41 : 1**

Notes: "HU" = habitat unit. "-" = not applicable.

Little Roberts Outflow are expected to be larger under the Operational Update, the current estimated fish habitat losses (which are based on FEIS anticipated effects where modelling results are outstanding) are likely underestimated. However, it is anticipated that, based on the HEP approach described herein, effects to Little Roberts Outflow would be lower than for Doris Outflow, as was the case for the FEIS. As a conservative assessment, even if fish habitat losses for Little Roberts Outflow were similar to Doris Outflow (1,592 HU), this would still result in a positive habitat balance (61,833 HU) and an offsetting gain:loss ratio of 216,011 HU:154,178 HU or 1.40:1.

A riffle/boulder garden feature separating lower and upper Little Roberts Outflow reaches has potential to impede fish passage during low flow conditions (ERM 2015); passage conditions through the boulder garden under predicted water withdrawal and use for the Operational Update will be considered in the updated effects assessment for Little Roberts Outflow once the hydraulic modelling results become available. If water withdrawal has potential to impact fish passage at this feature, measures may be developed/implemented to mitigate the effect. For example, migration channels were constructed to improve fish passage through a boulder garden in the Roberts Lake Outflow as part of the Doris North No Net Loss Plan and monitoring from 2013 to 2022 showed that the constructed channels increased migration success for Arctic charr by approximately 64%, on average, over the monitoring period (Minnow 2023). Similar mitigation could be explored for impacts to fish passage, if any, at the Little Roberts Outflow boulder garden from mine related water withdrawals.

4 AVOIDANCE AND MITIGATION MEASURES

4.1 Overview of Undertaking

Mine development under the Operational Update will include the construction and operation of underground mines (Doris and Madrid), the expansion of the TIA, as well as the expansion or construction of several other pieces of infrastructure (e.g., mine camp, processing facility, water treatment use and treatment infrastructure, and all-weather access roads; TMAC 2017, Agnico Eagle 2025). Some development activities will require construction in or near watercourses and/or waterbodies. Effects assessments for freshwater fish and fish habitat were completed as part of the FEIS and included comprehensive application of measures to avoid or mitigate impacts on freshwater habitats. These measures were reviewed by regulators (including DFO) and stakeholders as part of the FEIS review process prior to receipt of the Project Certificate and are detailed in Chapters 5 and 10 of Volume 6 of the FEIS (TMAC 2017). The proposed changes to the Mine under the Operational Update do not include any new type of work or activity beyond those already permitted under Project Certificate No. 003 and No. 009, therefore the proposed measures to avoid or mitigate impacts to freshwater habitats in the FEIS are considered adequate to avoid or mitigate impacts associated with the Operational Update.

The avoidance and mitigation measures presented herein are for development activities in or near water (i.e., road crossing upgrades, construction of the water intake in Windy Lake, and water withdrawal and use) as well as for construction and commissioning of proposed freshwater offsetting measures. All other avoidance and mitigation measures detailed in the effects assessments in the FEIS (TMAC 2017) will also be applied as appropriate.

4.2 Construction Timing

Mine development is proposed to occur in four phases: construction, operations, closure, post-closure (Agnico Eagle 2025) although some activities (e.g., upgrades to all-weather access roads which have been constructed and/or approved for construction under LOAs from DFO; File Nos. 24-HCAA-02544 and 24-HCAA-02329) have been/will be completed as part of early works. Activities with potential to result in effects on fish and fish habitat are anticipated in the construction, operation, and post-closure phases of the Operational Update. The specific timing of implementation of these activities is currently not confirmed but may be initiated as early as 2027. These components include:

- Water use infrastructure: The installation of an intake pipe in Windy Lake will be completed within a single open-water season, though all installations may not occur in the same year.

- Water use and withdrawal: Domestic and industrial water use will occur throughout the life of the Mine and is predicted to affect eight watercourses. Effects from water withdrawal and use are predicted to occur at different intensities over the life of the Mine, the timing of which is tied to the development and operation of underground mines. However, peak water usage is anticipated to begin in 2031.

Offsetting habitat in the EOS is proposed to be constructed and commissioned as soon as feasible to reduce lag times and may be initiated as early as 2027, pending receipt of an FAA.

- Freshwater Offset Construction: Construction and commissioning of offsetting habitat will begin as soon as approvals are received and is expected to occur over the course of one ice-covered and open-water cycle. If feasible, enhancements in the EOS will occur during frozen conditions with some additional work potentially occurring during the low flow period (fall). Vegetation plantings in newly created or enhanced habitat will be undertaken during the open-water season following construction. Commissioning of some of the habitat offsets may require one additional ice-covered and open-water cycle to allow for backwatered areas to fill under high-flow conditions.

Additional construction timing constraints and mitigation measures for the protection of fish and fish habitat include:

- the duration of in-water work will be minimized to the extent possible;
- freshwater habitat in-water works will conform with the Nunavut Restricted Activity Timing Windows for the Protection for Fish and Fish Habitat (DFO 2013b); and
- where feasible, construction in and near freshwater watercourses (e.g., watercourse crossings and offsetting enhancement measures) will be undertaken when streams are isolated from flows such as under dry conditions (if low flow conditions allow) or frozen to the substrates.

4.3 Fish Salvages/Relocation

Fish salvages may be undertaken, as required, to capture and safely remove and relocate any fish present in areas that will be affected by construction activities (e.g., road crossing upgrades at fish bearing streams). Although construction in fish bearing streams will be targeted during periods when construction areas are isolated from flows (and therefore from access by fish), in some cases, fish salvage prior to dewatering or site isolation may be required. Fish salvage events are not planned for works associated with the installation of the intake pipe in Windy Lake as fish will not be confined to the work area and will be able to move away from the construction. Silt curtains will be deployed surrounding the in-water work area as needed but will be equipped

with fish egress areas. Fish salvage is also not required in stream habitat as a result of water withdrawal and use as predicted effects will result in a reduction in habitat availability but general habitat function for the species and life stages present will be maintained.

Should a fish salvage be required in any waterbody or watercourse associated with mine development activities or offsetting measures described in this offsetting plan, a fish salvage plan will be developed that outlines the approach and timing, and incorporates standard techniques and best practices (e.g., Tyson et al. 2011).

4.4 Standards and Codes of Practice and Monitoring

Standards and codes of practice have been outlined by DFO to comply with the fish and fish habitat protection provisions of the *Fisheries Act* by incorporating measures to avoid causing the death of fish, and harmful alteration, disruption, or destruction of fish habitat in any work, undertaking, or activity near water (DFO 2024b, 2025a). While carrying out any activities near water construction contractors will be expected to consider all standards and codes of practice outlined by DFO (2024b) and they are to be incorporated into construction plans, such as: measures to protect fish (e.g., limiting duration of in-water works, and maintaining adequate depth and flow), measures to protect fish passage, riparian zone protection, aquatic habitat protection, erosion and sediment control measures, design, installation, and maintenance of end-of-pipe fish screens (i.e., to avoid fish entrainment or impingement; DFO 2024a), and measures to avoid the introduction of deleterious substances into fish habitat, and developing a response plan(s).

In addition to DFO's standards and codes of practice, the construction contractor will be required to coordinate all monitoring with a qualified environmental professional. The monitoring objective is to protect fish communities from the negative impacts derived from construction activities through monitoring of water quality, maintaining sediment and erosion control measures and fish impingement and entrainment control measures are operational, and monitoring of noise. Briefly, water quality monitoring will occur throughout the construction period in active areas that may impact nearby fish bearing waterbodies (e.g., within the Windy Lake water intake construction area). Daily turbidity monitoring will be required along with triggers for investigation of cause, work stoppage, and requirements for further mitigation. All sediment and erosion control and mitigation measures will be monitored regularly as well as any bypass pumping and fish barriers installed for the construction work.

Should any exceedance of established thresholds, or any documentation of mitigation measures not functioning properly (i.e., silt plume) be identified, the qualified environmental professional will be called upon to review the monitoring records and suggest next steps for mitigation and continued construction.

The construction monitoring program can be provided to DFO for review if requested and will include details about implementation of the standards of codes of practice and monitoring scope.

4.5 Monitoring to Verify Habitat Accounting

To verify that all habitat was adequately accounted for in the HEP of the offsetting plan, additional baseline monitoring information will be collected, where necessary, to confirm HSI variables assigned to areas of habitat alteration or loss. This monitoring may occur through dedicated baseline monitoring study (e.g., EOS), or though ongoing monitoring programs (i.e., Aquatic Effects Monitoring Program [AEMP]). Data collected will then be used to confirm HSI, access factors, and habitat co-factors assigned for different life functions of the freshwater fish species included in the HEP.

Fish and fish habitat monitoring required for verification of habitat accounting may include:

- quantification of bathymetric contours in Pond 4a and Ponds 5c-5f of the EOS (bathymetry for Pond 5b was collected during the hydrometric baseline survey in 2023 [GeoProcess 2025]);
- under-ice water quality (i.e., DO and temperature) in Ponds 1, 2, 3, 4 and 5 to supplement baseline data collected in April 2024;
- hydrometric monitoring for waterbodies and connecting channels in the EOS to supplement baseline studies completed in 2021, 2022, and 2023; and
- ongoing implementation of an AEMP that monitors water levels, ice thickness, and stream flows in watersheds with predicted effects from the Mine and monthly water balance model monitoring that are anticipated to be a requirement of the amended Water Licence No. 2AM-DOH1335.

Results of AEMP monitoring and water balance model assessment, including recalibration, will be used to compare the predicted effects of water use (e.g., reduced water level) against *in situ* observations and verify if effects have occurred to the extent predicted. For all other fish and fish habitat variables, existing information from comprehensive baseline studies (TMAC 2017, Minnow 2024, Minnow 2026 in prep.) is considered adequate for habitat accounting purposes in the HEP. Results from verification monitoring will be included in the final offsetting plan and/or post-construction offset monitoring reports, as required (Section 5).

4.6 Reduction of Lag Times and Uncertainty

Lag times represent the time between the commissioning of new habitats and the ability of the habitat to be fully productive as designed (Minns 2006). Lag times have the potential to affect the productivity of the system through limiting the ability of fish to fully utilize constructed habitats for

their various life functions. Lag times associated with the offsetting plan are anticipated to be minimal in the freshwater environment; the habitat enhancements in the EOS will provide improved connectivity and increased availability of overwintering habitat as soon as construction and commissioning is completed. Monitoring of other habitat enhancements associated with fisheries offsetting in Arctic and sub-Arctic freshwater environments, suggests that fish use of these habitats occurs as soon as they become accessible (ERM 2015, Minnow 2022). Habitat improvements in the EOS will be prioritized to occur as soon as is feasible with the potential for offsetting habitat to be commissioned prior to some mine related effects occurring.

Riparian and aquatic vegetation provide habitat and food for many different types of organisms such as zooplankton, benthic invertebrates, and fish. Vegetation provides cover from predators, shade from sun and spawning substrate for certain species of fish (e.g., ninespine stickleback). Plants also improve water quality by stabilizing substrates or preventing erosion (caused by wind or run off). Therefore, it is important to start the plant community within enhanced habitats as soon as possible to establish a productive, successful plant community, which will provide habitat and a food base for fish. Aquatic plant transplants may be considered to reestablish riparian and aquatic vegetation in areas that are disturbed during the construction of connecting channel enhancements in the EOS. Small plugs of tundra may be harvested from areas that will be flooded by backwatering in Ponds 5b-5f and Pond 5 and transplanted in disturbed areas. This method of revegetation has proven to be effective in stream habitats in the sub-Arctic region (ERM 2015).

The proposed offsetting measures are expected to provide a surplus of habitat gains to account for uncertainty (i.e., offsetting gain:loss ratio of 1.41:1). As described in Section 3.5, uncertainty associated with the culvert remediation and connecting channel enhancements offsetting measures is expected to be low as the former represents a common category of fish habitat restoration project that is likely to benefit fish in the EOS given the current condition of the crossing and the latter measure has been implemented previously for development at Hope Bay via the Doris North No Net Loss Plan and was shown to be effective in improving fish passage conditions (Minnow 2023).

5 EFFECTIVENESS MONITORING

5.1 Overview

A monitoring program is proposed to assess the success of the proposed offsetting plan (Table 5.1). The program will assess habitat structure and function and fish species diversity and abundance in the EOS following freshwater habitat enhancements with the objective of documenting the post-commissioning habitat relative to the design specifications and requirements of target species (i.e., Arctic charr, cisco, lake whitefish, and ninespine stickleback in the EOS). Success of offsetting habitats over time will be evaluated by comparing measurements of key habitat characteristics (e.g., water depth, percent cover, etc.) to the designed habitat quality rating for spawning, nursery, foraging, and overwintering of target species in the proposed offsetting habitat (Appendix Tables D.11 to D.14). Collection of habitat data will enable comparison of built HUs to the original HU predicted for the proposed offsetting habitat and will confirm that the habitat meets requirements for the intended species use. Other success criteria will include fish species diversity and relative abundance in the EOS.

Triggers have been developed to initiate mitigation measures and will focus on design compared to as built habitat area and function (e.g., improved migration potential and increase in overwintering habitat) and fish use in the EOS compared to baseline information. In the event that monitoring demonstrates that the offsetting measures are not functioning as intended, mitigation actions will be taken, and the habitat will be repaired, adjusted, or augmented to function properly. It is expected that monitoring will document the establishment and succession of habitats over the first few years following commissioning. The subsequent sections briefly describe the various components of the monitoring program as well as the scope and planned frequency of monitoring that will be included. It is anticipated that the proposed monitoring program will be refined with the development of final offsetting designs. A final effectiveness monitoring plan will be submitted with the final offsetting plan.

5.2 Monitoring Objectives

The objective of the effectiveness monitoring program will be to document the function and stability of the post-construction habitat relative to the design and requirements of the intended life functions of target species in the EOS. The monitoring program will document the post-construction habitat relative to the design, the requirements of the intended target species, and baseline conditions in the EOS (Appendix C; ERM 2019, 2020, Minnow 2024). Components that will be monitored include fish habitat (including stability and function of habitat structures and water quality and quantity) and fish utilization as described below.

Table 5.1: Summary of Effectiveness Monitoring for Offsetting Measures in the Iqaluktuuttiaq East Outflow System

Component	Endpoints	Objective	Location	Scope	Timing and Frequency Within Monitoring Year	Monitoring Frequency (Years Post-Construction)
Habitat	Structure	To document as-built design and determine whether key habitat structures[a] are performing as designed from an engineering perspective.	Key habitat structures[a] assessed in-situ where constructed.	Visual inspection of constructed habitat, size, form, and function.	Once at low flow (fall)	Conducted in the first year post-construction and then in years 2, 5, and 10.
	Function	To document whether habitat characteristics are suitable to support migration potential and the intended life functions of the target species.	Key monitoring locations to be determined in the field.	Visual characterization, measurement, and documentation according to standard methods[b]. Focused on identifying general habitat types and significant physical or biological features including water depth, littoral and sublittoral substrate material, aquatic and riparian vegetation and other features. In all areas, photo documentation from consistent vantage points and directions. *In situ* water quality evaluation in overwintering offsetting areas. Hydrometric monitoring to document water depth and flow in enhanced waterbody and watercourse habitats.	Visual characterization, measurement, and documentation: once at low flow (fall) In-situ water quality: once at low flow (fall) during fish usage and community surveys and once under-ice (March or April) or using data loggers Hydrometric monitoring: continuous during open-water period	
Fish	Use	To evaluate use of as-built fish habitat by target species.	Key locations within the offsetting habitat (e.g., around habitat structures, in habitats with enhanced access).	Assessed by a variety of standardized fishing techniques (e.g., electrofishing, minnow trapping, and short-set gill netting). Document where fish are captured and what habitat they are using through all components of the monitoring program. Fish aging based on length frequency distributions and/or non-lethal collection of aging structures will be used to determine life stages of target species using the enhanced habitat (connection channels, enhanced connection channels, and overwintering areas).	Once at low flow (fall)	Conducted in the first year post-construction and then in years 2, 5, and 10.
	Community	To evaluate fish species diversity and relative abundance in the EOS	Key locations within Pond 1, 2, 3, 4a, and 5.	Assessed by a variety of standardized fishing techniques (e.g., gill nets, electrofishing, and minnow trapping). Identify fish species captured and document where fish are captured in the EOS through all components of the monitoring program.	Once at low flow (fall)	

Note: "EOS" = East Outflow System.

[a] Key habitat structures include connecting channels, connecting channel enhancements, and riffle structure in the EOS.

[b] Methods to follow baseline fish and fish habitat collection methods used to determine pre-enhancement habitat quality (ERM 2019, 2020, Minnow 2024).

5.3 Habitat Structures and Features

Generally, created or enhanced habitat structures and features in the EOS will be monitored for size, form, and function (e.g., providing adequate depth and flow to operate as a connecting channel or depth to act as overwintering habitat) and compared to the habitat design specifications to ensure that they are functioning as designed (Table 5.1). The habitat quantity and quality will be documented and augmented with photographs for key structures and/or habitats. More specifically, physical and biological features such as depth, littoral and sublittoral substrate material, aquatic and riparian vegetation, etc. will be documented according to standard methods similar to those used in previous baseline studies (ERM 2019, 2020, Minnow 2024). Ice thickness and water depth will also be monitored concurrently with under-ice water quality in each monitoring year (see Section 5.4). Key structures within the EOS offsetting habitat will also be documented (i.e., Global Positioning System [GPS] coordinates recorded, and photographs taken) and inspected to ensure they are stable and performing as designed from an engineering perspective. These key structures include culvert remediation channels in Ponds 1 and 2, connecting channel enhancements to the inlet to Pond 3, the outlet of Pond 3, and the outlet of Pond 4a, habitat created by backwatering in Ponds 5b-5f and Pond 5, and the constructed riffle structure at the outlet of Pond 5 (Figure 3.4).

Data collected from the assessment of habitat structures and features will be compared to the habitat designs to confirm the analysis of altered habitat and offsetting habitat (Section 3.4). Fish habitat characterization measures will be summarized (e.g., mean and standard deviation, maximum, minimum) for any numerical parameters (e.g., water depth) for each area within each year of monitoring. Habitat variables will then be compared relative to designed habitat quality ratings for spawning, nursery, foraging, and overwintering of target species in the offsetting habitat (Appendix Tables D.11 to D.14). Success criteria triggers have been developed and focus on the area of habitat created in the EOS, the quality of overwintering habitat created/enhanced, and fish passage conditions (Table 5.2). Monitoring of habitat structures and features will occur once at low flow (fall) in years 1, 2, 5, and 10 post-construction to account for annual variability in water levels and flows within the EOS (Table 5.1).

5.4 Water Quality and Quantity

Water quality and quantity (water level and flow) are characteristics that define suitable fish habitat. No routine water quality monitoring is currently undertaken in the EOS by Agnico Eagle as it is a relatively pristine system with no anticipated future impacts from development. *In situ* water quality monitoring will be conducted by collecting point measurements at fish sampling locations during fall fish community surveys and by collecting temperature and dissolved oxygen profiles in enhanced EOS waterbodies (i.e., Ponds 1, 2, 3, 4a, 4, 5b-5f, and 5; Figure 3.4)

Table 5.2: Response Triggers Associated with Monitoring of Offsetting Measures in the Iqaluktuuttiaq East Outflow System

Category	Assessment	Rationale	Endpoint	Response Trigger	Timeline	Action
Habitat	Area	Habitat was constructed as designed. Area constructed is similar or equal to area designed.	Area (m^2)	Total area created is less than proposed by >10%.	Following the first year of assessment (i.e., first year post-construction) and years 2, 5, and 10.	Evaluate all aspects of the assessment in the second post-construction monitoring event, if there is a deficit of habitat compared to the predicted value and it is confirmed in the third post-construction monitoring event, trigger habitat modification or contingency habitat.
	Quality	Overwintering habitat provides adequate depth and water quality to sustain species that is within the range of natural variation among regional waterbodies of similar size/depth that provide overwintering habitat for fish	Depth (m) and DO (mg/L)	Under-ice water depth and DO trigger ranges TBD[a]	Following the first year of assessment (i.e., first year post-construction) and years 2, 5, and 10.	Evaluate all aspects of the assessment in the second post-construction monitoring event, if there is a deficit of habitat quality compared to the predicted value and it is confirmed in the third post-construction monitoring event, trigger habitat modification and contingency habitat.
	Fish Passage	Water levels and flow are suitable to allow migration/passage.	Fish passage for arctic charr, cisco, lake whitefish, ninespine stickleback	Fish passage potential is not confirmed.	Following three years (in year 5) of assessment.	Modify monitoring or conduct studies necessary to assess fish passage.
				Fish passage conditions are not adequate for arctic charr and/or ninespine stickleback at the threshold durations predicted at key locations.	Following three years of assessment, triggers are consistently not achieved.	Modify culvert remediation efforts or connecting channel enhancements to achieve adequate passage conditions (water depth / flow) or trigger habitat modification or contingency habitat.
Fish	Diversity or Usage	Fish usage of enhanced habitat areas has increased compared to baseline	Richness or CPUE	Number of taxa documented in the EOS during monitoring events < 3[b] or No increase in total CPUE compared to baseline at enhanced habitat areas	Following the first year of assessment (i.e., first year post-construction) and years 2, 5, and 10.	Evaluate all aspects of the assessment in the second post-construction monitoring event, if there is a deficit of fish diversity or usage compared to the predicted value and it is confirmed in the third post-construction monitoring event, trigger habitat modification or contingency habitat.

Note: "DO" = dissolved oxygen. "CPUE" = catch-per-unit-effort. "TBD" = to be determined.

[a] Appropriate trigger ranges will be established prior to submission of the final offsetting plan in collaboration with DFO

b Fish community sampling conducted in the EOS in 2019, 2022, and 2023 indicated the presence of arctic charr, Coregonus spp., and ninespine stickleback. Coregonus spp. potentially includes at least four species that have been documented in Iqaluktuuttiaq Lake (cisco, least cisco, lake whitefish, and broad whitefish; Grosbois et al. 2022), however field identification to the species level for Coregonus spp. is extremely difficult and unreliable in non-lethal surveys. Therefore, species of the genus Coregonus will be considered as one species for the purpose of effectiveness monitoring for species diversity and usage.

once at low flow (fall) and once under-ice (March or April) in each monitoring year or by using data loggers to characterize temperature and dissolved oxygen conditions (Table 5.1). Water quality monitoring will occur in years 1, 2, 5, and 10 post-construction (Table 5.1).

Water quality results, in combination with ice thickness and under-ice water depth, will be used to evaluate the quantity and quality of overwintering habitat in enhanced habitats (Table 5.1). Overwintering success will be evaluated based on fish presence in the fall prior to ice formation (see Section 5.5) and suitable water quality conditions to support aquatic life in the fall and under-ice (Tables 5.1 and 5.2). A success criteria trigger will be developed for depth and water quality in overwintering habitat (Table 5.2). Appropriate response triggers for under ice water depth and/or DO will be established for the target species (i.e., Arctic charr, cisco, lake whitefish, and ninespine stickleback) prior to submission of the final offsetting plan, in collaboration with DFO. Response triggers will likely be based on the natural range of under-ice depth and DO conditions in similarly sized waterbodies in the region where overwintering habitat for fish is known to be present (TMAC 2017) as well as baseline under-ice water depth and DO data collected in the EOS in April 2024 (Minnow 2024) and literature information on aquatic life (i.e., CCME 1999) and species-specific tolerances.

Water quantity will be monitored through the use of a hydrometric monitoring network in the EOS that includes continuous monitoring of water levels and point flow measurements during the open-water period. Hydrometric monitoring will be implemented according to similar methods as used in baseline surveys completed in 2021, 2022, and 2023 to support offset design (Appendix C; GeoProcess 2025). Hydrometric monitoring will be continuous throughout the open-water season in the first-year post-construction and following that monitoring will occur in years 2, 5, and 10 (Table 5.1). Equipment will be deployed as early as possible following ice-out in each monitoring year and removed as close as possible to freeze up. Flow measurements and topographic and bathymetric surveys may be completed on an as needed basis to supplement water quantity data from hydrometric monitoring stations.

Water quantity monitoring will be used to evaluate migration potential for fish in the remediated culvert area in Ponds 1 and 2, in channel connection enhancements in Ponds 3, and 4a, and in channel connections enhanced by backwatering in Ponds 5b-5f by providing information for evaluation of adequate depths and flows in these habitats for passage by Arctic charr, cisco, lake whitefish, and ninespine stickleback over the open-water season (Figure 3.4 and Table 5.2). Water level monitoring in waterbodies will also be used to support evaluation of the area and depth of created and enhanced habitat in Ponds 5b-f and Pond 5 (Figure 3.4 and Table 5.2). Success criteria triggers have been developed and focus on the area of habitat created in the

EOS, the quality of overwintering habitat created/enhanced, and fish passage conditions (Table 5.2).

5.5 Fish Utilization, Community, and Abundance

The objective of fish community structure and species diversity monitoring will be to demonstrate fish usage (i.e., by the species and life functions targeted in the design; Arctic charr, cisco, lake whitefish, and ninespine stickleback). Specifically, species richness and target species presence will be assessed in Pond 1, 2, 4, and 5 in the EOS. Fish community structure, abundance, and health (i.e., condition) in the ponds will be monitored once at low flow (fall) in post-construction monitoring years (i.e., year 1, 2, 5, and 10). Monitoring data will be compared to baseline fish community and fish use data collected in the EOS offsetting areas in 2019 (ERM 2020) and in 2022 and 2023 (Minnow 2024).

Standardized, non-destructive fish collection methods including short-set gill nets, hoop nets, and minnow traps will be used to evaluate fish use, and fish community diversity and structure within the ponds with minimal mortality to fish populations (Table 5.1). All fish captured will be identified to species, enumerated, and sampled (measured for weight and length, and non-lethal aging structures may be collected) prior to release at their capture location. For each collection method, supporting information including sampling effort, GPS coordinates, *in situ* water quality, and habitat descriptions will be recorded. The habitat descriptions will include observations of shoreline and littoral substrate characteristics in the vicinity of sampling, riparian vegetation (if present), macrophytes (if present), as well as any potential confounding influences or other observations deemed relevant to interpretation of the fish survey data.

The proposed monitoring will demonstrate whether the fish populations are using the habitat for the intended life functions (see Section 3.4). Monitoring will also determine whether relative abundance and richness of target species in the EOS is consistent or increasing over time (e.g., if increased habitat connectivity is supporting an increased number of fish or diversity of fish species in the EOS). Species richness will be used to evaluate fish species diversity in the EOS ponds and will be compared to baseline data and across years post-construction. Summary statistics (sample size, mean, standard deviation, minimum and maximum value) will be calculated separately by year. The success criteria triggers will focus on relative abundance and diversity in enhanced areas compared to baseline (i.e., pre-construction data collected in potential offsetting areas since 2019; Table 5.2).

5.6 Reporting and Scheduling

Monitoring of the functionality of the created habitat and use by fish in the EOS will be completed in the first year post-construction and then in years 2, 5, and 10 and will be summarized for each

year in an offset monitoring report. Monitoring to verify habitat accounting (Section 4.5) will also be included in the first and relevant subsequent offset monitoring reports. Reports will be prepared for each field monitoring program for submission to DFO by May 30 following field data collection.

6 CONTINGENCY MEASURES

In the unlikely event that the designed offsetting habitat does not function as intended (as demonstrated through monitoring; Section 5) to successfully offset the fish habitat alteration and loss described in Section 3.3, the first step will be to undertake mitigation measures through which the offsetting habitat will be repaired, adjusted, or augmented to function properly. Should mitigation measures fall short in reaching the anticipated outcomes for the offsetting habitat, alternative offsetting candidates may be explored to account for any habitat shortfall of the primary offsetting measures. Since 2018, engagement with DFO and relevant stakeholders (Appendix A) and reconnaissance and baseline field programs (Appendix C and H; GeoProcess 2025) have identified and investigated multiple candidate offsetting options. Enhancement in the EOS was identified as the freshwater offsetting candidate with the most potential to meet offsetting requirements under DFO's offsetting Policy (DFO 2025b) and stakeholder goals (ERM 2020) and is the primary freshwater offsetting measure proposed in this offsetting plan. However, potential fish passage enhancement for anadromous Arctic charr and lake trout in the Tahilugyuak Outflow was identified as a secondary candidate with the potential to meet these criteria (ERM 2020).

Tahilugyuak is a lake with an area of approximately 22 km^2, located approximately 25 km northeast of the Mine (Figure 6.1). Tahilugyuak Outflow flows northeast to the marine environment in Elu Inlet (Figure 6.1). Baseline fish habitat assessments were undertaken at Tahilugyuak Outflow in 2018 and identified locations where migratory potential between the lake and the marine environment for anadromous fish was compromised (ERM 2019). The objectives and potential implementation methods for an offsetting project at Tahilugyuak Outflow were proposed by ERM (2020) and would include enhancement of migration potential for Arctic charr and lake trout between the marine environment (Elu Inlet) and spawning and overwintering habitat in Tahilugyuak. This may be achieved through the construction of migration channels in areas where water depth is insufficient for fish passage or where boulder garden habitat features block passage under certain flow conditions (ERM 2020). This approach has been successfully employed at the Roberts Lake Outflow as part of implementation of a No Net Loss Plan for the Doris North Mine at the Hope Bay Mine (Minnow 2022). Fish and fish habitat benefits anticipated from migratory enhancements in Tahilugyuak Outflow rely on the assumption that constraints on access to the marine environment are a limiting factor to fish productivity in the system. Although further baseline investigations are required to confirm feasibility, sufficient investment has been made to date to consider migratory enhancements in Tahilugyuak Outflow a suitable contingency offsetting measure for mine development under the Operational Update.

445,000

450,000

7,585,000

7,580,000

7,575,000

Elu Inlet

Elu Inlet

Tahilugyuak Outflow

T-Pond

Tahilugyuak

Melville Sound

Hope Bay

Elu Inlet

Tahilugyuak

Tahilugyuak Outflow

Doris North

Madrid North

Madrid South

0 2.5 5 10
km

LEGEND

- Contingency Offsetting Option
- Permitted Infrastructure
- Phase 2 Project Development Area
- Operational Update Project Development Area
- Contour (10m interval)

Tahilugyuak Outflow Contingency Offsetting Option, Hope Bay Mine Operational Update

0 0.5 1 2
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 13N

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Date: November 2025
Project: 257202.0052

minnow environmental inc.

Figure 6.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 257202.0052 - 2025 Freshwater FAA Permit Support\D - GIS\Freshwater FOP\25-52 Figure 6.1 Tahilugyuak Outflow.mxd

Tahilugyuak Outflow is currently the primary contingency measure for the offsetting plan for modifications to the marine jetty at Roberts Bay (FAA No. 24-HCAA-02389). However, it is anticipated that habitat gains associated with implementing the proposed enhancements in Tahilugyuak Outflow would be sufficient to provide adequate contingency for both the marine and freshwater offsetting plans. As stated above, multiple candidate offsetting locations have been investigated since 2018 (ERM 2019, 2020) that could potentially be advanced as additional or alternative contingency, if required.

As an alternative to the development of additional habitat offsetting measures, complementary measures may be applied if the initial commissioning of the EOS offsetting habitat and any subsequent mitigation measures fall short of reaching the anticipated outcomes for the offsetting habitat. Complementary measures equivalent to up to 10% of the required offsetting measures could be applied as contingency in this scenario. Contingency complementary measures could include Agnico Eagle funding for research that informs the management and conservation of fish populations in Arctic environments in collaboration with Polar Knowledge Canada, researchers at the Canadian High Arctic Research Station in Cambridge Bay, Nunavut, and/or members of the ArcticNet multidisciplinary research network.

Additional or alternative contingency measures and/or complementary measures contingency measures would be developed through discussions with DFO, the IEAC, and KIA, and included in the final offsetting plan.

7 COSTS

The costs associated with implementation of offsetting measures for the Hope Bay Mine Operational Update, including the costs for monitoring and reporting, will be provided in the final version of the offsetting plan. The cost of construction will be based on quotes and known construction costs for development projects of similar scale at the Hope Bay Mine and in Cambridge Bay, NU. Monitoring costs will be assumed based on the ten-year monitoring plan described in Table 5.1.

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APPENDIX A
ENGAGEMENT

APPENDIX A FISHERIES OFFSETTING ENGAGEMENT RECORD

A1 INTRODUCTION 1

A2 AGREEMENTS WITH INDIGENOUS PEOPLES.....2

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APPENDIX A-1 CONSULTATION MATERIALS, PRESENTATIONS, AND MEETING NOTES

A1 INTRODUCTION

Agnico Eagle Mines Limited (Agnico Eagle) carries out public consultation and engagement to support the Hope Bay Mine (the Mine) planning and design, evaluation through regulatory assessment processes, and continuous improvement of community involvement throughout the mining cycle. As part of this ongoing consultation and engagement, activities have been undertaken to specifically engage, establish a dialogue, generate feedback, and report on progress related to the development of a fisheries offsetting plan for planned mine development. This appendix describes Agnico Eagle's agreements with Indigenous Peoples and general approach to community involvement and how these have supported engagement activities during the development of the offsetting plan. Engagement timing, participation, and results are summarized.

A2 AGREEMENTS WITH INDIGENOUS PEOPLES

Agnico Eagle and the Kitikmeot Inuit Association (KIA) have a comprehensive Framework Agreement for land access compensation and an Inuit Impact and Benefit Agreement (IIBA). The IIBA addresses Inuit interests in the areas of employment, contracting, and training in relation to the Mine as a whole, through its entire lifespan. Under the IIBA, an Inuit Environmental Advisory Committee (IEAC) has been established with Agnico Eagle which allows for the local community to have input directly to Agnico Eagle on environmental concerns.

According to the IIBA (in place from previous owner TMAC Resources Inc.; KIA 2016), the IEAC is tasked with:

- Reviewing Project information related to wildlife and the environment.
- Providing input to Agnico Eagle and KIA about potential environmental impacts or concerns.
- Providing advice on how to reduce or prevent environment impacts or concerns.
- Listening to community concerns about environmental and wildlife issues related to the Project.
- Attempting to resolve community concerns about environmental and wildlife issues related to the Project.

The IEAC consists of seven Kitikmeot Inuit who have environmental and/or traditional knowledge of the Project area. The committee members are appointed by the Implementation Committee for three-year terms. An Agnico Eagle senior staff person with environment or community responsibilities chairs the IEAC. A KIA staff person sits on the IEAC to support other committee members. The KIA staff person does not participate in making formal recommendations to either KIA or Agnico Eagle.

The IEAC meetings are held at least twice a year in the Kitikmeot region (typically in Cambridge Bay, NU). Additional meetings are sometimes held where agreed upon by the KIA and Agnico Eagle. Agnico Eagle also arranges an annual site visit to the Mine for the IEAC.

A3 IDENTIFICATION OF STAKEHOLDERS AND APPROACH TO COMMUNITY INVOLVEMENT

Agnico Eagle has a Community Involvement Plan (CIP; in place from previous owner TMAC Resources Inc.; TMAC 2016) that provides a basis for involving the public in the Mine, beginning with the Doris Project and applicable to future development at Hope Bay. The plan describes the policy framework, approach, process, resources, and activities that Agnico Eagle has adopted in relation to community involvement. The CIP acknowledges and does not seek to duplicate the Hope Bay Inuit Impact Benefit Agreement (IIBA).

The CIP defines what is meant by the public and stakeholders and further outlines:

- methods, practices, and procedures for identifying stakeholders;
- methods, practices, and procedures for engaging stakeholders, including the public and impacted communities, that foster dialogue and provide venues for addressing stakeholder concerns;
- methods, practices, and procedures that provide for stakeholders to respond to Agnico Eagle plans and activities including means by which Agnico Eagle can measure the effectiveness of engagement; and
- methods, practices, and procedures that Agnico Eagle undertakes to report on engagement activities and the results derived from these engagements. This includes how stakeholder contributions have influenced the design and implementation of management and monitoring plans, procedures to disseminate monitoring results and information on socio-economic, cultural, and environmental conditions, and procedures for community-based monitoring of social, cultural, and ecological conditions to determine if, when, and how the Project contributes to community sustainable development.

Public consultation and engagement occur on a regular basis to provide updates on Mine progress, initiatives, and future work plans. The CIP provides for involvement activities that will be carried out to share information on any unforeseen changes to the Mine (e.g., temporary closure or production slow downs).

The CIP identifies communities involved in the Project as Kugaaruk, Taloyoak, Gjoa Haven, Cambridge Bay, Umingmaktok, Kingaok, and Kugluktuk, comprising the Kitikmeot region of Nunavut.

A4 ENGAGEMENT ACTIVITIES RELATED TO THE FISHEREIS OFFSETTING PLAN

Engagement activities specifically related to fisheries offsetting for potential effects on fish and fish habitat associated with Phase 2 (which has been optimized in the Operational Update) have been undertaken since 2017. Table A.1 summarizes the dates, participants, and topics of these engagement activities. Engagement materials, presentations, and meeting summaries from engagement activities have been listed in Section A5 and can be provided upon request. Engagement for the Operational Update is summarized in Table A.2.

A5 ENGAGEMENT MATERIALS REFERENCES

ERM (ERM Consultants Canada Ltd.). 2017. Summary of November 15, 2017 Meeting with DFO: Freshwater and Marine Environment Baseline and Offsetting for Madrid-Boston. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd. December 2017.

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Table A.1: Summary of Engagement Activities Related to Fisheries Offsetting

Year	Date	Participants	Topic	Reference or Supporting Information
2017	November 15	DFO – Angie McLellan TMAC – Oliver Curran, Alex Buchan ERM – Genevieve Morinville, Kathryn Kuchapski, Greg Sharam KIA – John Roesch KIA Consultant – Heather Bears	Freshwater and Marine Environment Baseline and Offsetting for Madrid-Boston	ERM 2017
2018	June 26 and 27	DFO – Angie McLellan TMAC – Oliver Curran, Alex Buchan ERM – Genevieve Morinville, Nicole Bishop KIA – John Roesch IEAC – Jason Akoluk, George Angohiatok, Mary Avalak, David Epilon, George Hakongak, Jimmy Haniliak, Clarence Kaiyogana, Joseph Tikhak Sr.	Fisheries Offsetting Workshop for the Hope Bay Project to identify offsetting measures and candidates.	ERM 2019a
2019	April 30 and May 1	DFO – Angie McLellan, Daniel Coombs TMAC – Oliver Curran, Alex Buchan ERM – Kathryn Kuchapski, Nicole Bishop KIA – John Roesch IEAC – Peter Kapolak, George Angohiatok, David Epilon, George Hakongak, Jimmy Haniliak, Joseph Tikhak Sr.	Fisheries Offsetting Workshop for the Hope Bay Project to provide background information on fisheries offsetting, further discuss offsetting measures and candidates.	ERM 2019b
2019	June 10	EHTO Secretary Manager	Securing EHTO guide and field assistant to support Freshwater Creek/Grenier East Outflow hydrology and fisheries studies.	-
2019	December 4	TMAC – Oliver Curran, Alex Buchan ERM – Nicole Bishop, Kent Gustavson, Nicola Lower KIA – John Roesch IEAC – Peter Kapolak, Jimmy Haniliak, Joseph Tikhak Sr., Clarence Kaiyogana, George Hakongak, George Angohiatok	Results from the 2019 fisheries offsetting field program with respect to three candidate offsetting options: Grenier Lake System, Tahilugyuak, and marine shoals.	ERM 2020a
2020	October 29	TMAC – Oliver Curran, Alex Buchan, Ikey Evalik ERM – Nicole Bishop, Greg Sharam KIA – John Roesch, Natalie Griller IEAC – Peter Kapolak, Jimmy Haniliak, Clarence Kaiyogana, George Hakongak, George Angohiatok	Existing, new, and future caribou monitoring programs. A reminder of the Fisheries Offsetting Program	ERM 2020b
2021	March 25 and 26	DFO – Daniel Coombs, Nicholas Wasilik Agnico Eagle – Oliver Curran, Alex Buchan, Ikey Evalik Minnow – Amy Wiebe, Kevin Martens ERM – Greg Sharam, Nicole Bishop KIA – Natalie Griller IEAC – George Angohiatok, Jimmy Haniliak, George Hakongak, Clarence Kaiyogana, Lawrence Otokiak	Fisheries Offsetting background including discussion of the ongoing Roberts Lake Fish Enhancement Monitoring Program. Background on Madrid-Boston Offsetting to date and group discussion.	ERM 2021 Meeting Presentation Materials
2021	June 2	Agnico Eagle – Oliver Curran, Alex Buchan Minnow – Amy Wiebe, Kim Connors POLAR - Ann Balasubramaniam, Donald McLennan, Johann Wagner Université du Québec à Chicoutimi – Milla Rautio University of Waterloo – Michael Power Other – Samantha McBeth DFO – Les Harris	Proposed Grenier Lake System Offsetting Project and potential synergies with Polar Knowledge research	Meeting Agenda and Presentation Materials
2021	June 24	EHTO Board and Staff	Annual Wildlife Research Permitting recommendation request and annual notice of Freshwater Creek/Grenier East Outflow hydrology and fisheries studies.	-
2021	December 1	DFO – Daniel Coombs, Nicholas Wasilik Agnico Eagle – Oliver Curran, Alex Buchan, Nancy Duquet Harvey, Ikey Evalik, Heather Murphy Minnow – Amy Wiebe, Kathryn Kuchapski ERM – Greg Sharam, Nicole Bishop KIA – Natalie Griller, John Roesch IEAC – George Angohiatok, Jimmy Haniliak, George Hakongak, Clarence Kaiyogana, Peter Kapolak, Randy Klengenberg, Lawrence Otokiak	Fisheries Offsetting background including presentation of results from the 2021 Roberts Lake Fish Enhancement Monitoring Program. Presentation of Madrid-Boston Offsetting options, baseline data collections in 2021, and group discussion.	Minnow 2021
2021	December 1	EHTO Board and Staff	Follow-up meeting on marine mine effluent discharge into Roberts Bay and potential independent monitoring. Summary for 2021 Freshwater Creek/Grenier East Outflow hydrology and fisheries fieldwork.	-
2022	March 31	EHTO Board and Staff	Annual Wildlife Research Permitting recommendation request and annual notice of Freshwater Creek/Grenier East Outflow hydrology studies in support of Fisheries Offsetting planning.	-
2022	Aug 3 to 5	DFO – Jose Audet-LeCouffe, Chris Shapka Agnico Eagle – Nancy Duquet Harvey, Sandra Eyegetok Minnow – Kim Connors ERM – Hannah Visty, Nicole Bishop KIA – John Roesch IEAC – George Angohiatok, Jimmy Haniliak, Clarence Kaiyogana, Peter Kapolak, Randy Klengenberg, Lawrence Otokiak	Presentation of draft contents of Conceptual Offsetting Plan for Madrid-Boston, and group discussion. Tour of Roberts Lake Outflow, operational fish fence, and remote monitoring system.	ERM 2022
2022	Sept 21	Agnico Eagle – Alex Buchan, Sandra Eyegetok Minnow – Kim Connors, Jacquelyn Wood GeoProcess - Ben Plumb IEAC – George Angohiatok, Clarence Kaiyogana, Peter Kapolak	Site visit to the Iqaluktuuttiaw East Outflow Ovayok road crossing and discussion of proposed crossing enhancements from the Conceptual Offsetting Plan	Meeting Minutes
2023	March 23 and 24	DFO – Jose Audet-LeCouffe, Chris Shapka Agnico Eagle – Nancy Duquet Harvey, Guy Dufour, Alex Buchan Minnow – Jacquelyn Wood GeoProcess - Ben Plumb ERM – Danielle Willmon, Hannah Visty KIA – Skye Lacroix IEAC – Jimmy Haniliak, Peter Kapolak	Presentations and group discussion for Hope Bay general update, wildlife mitigation and monitoring, Roberts Lake Outflow monitoring, and Madrid-Boston Conceptual Offsetting Plan updates. Site visit to Hope Bay.	Meeting Summary Report and Presentation Material
2023	April	DFO – Jose Audet-LeCouffe, Chris Shapka Agnico Eagle - Nancy Duquet Harvey Minnow - Kim Connors, Jacquelyn Wood	Virtual meeting to discuss details of HADD included in the Request for Review submitted to DFO (i.e., drawdown in Imniagut Lake, discharge to Aimaokatalok Lake, and road crossings)	-

Notes: "-" = not applicable, DFO = Fisheries and Oceans Canada, TMAC = TMAC Resources Inc. , Agnico = Agnico Eagle Mines Ltd., ERM = ERM Consultants Canada Ltd. , KIA = Kitikmeot Inuit Association, IEAC = Inuit Environmental Advisory Committee, Minnow = Minnow Environmental Inc., POLAR = Polar Knowledge Canada, EHTO = Ekaluktutiak Hunters and Trappers Organization

Table A.1: Summary of Engagement Activities Related to Fisheries Offsetting

Year	Date	Participants	Topic	Reference or Supporting Information
2023	August 9	DFO – Jose Audet-LeCouffe, Chris Shapka	Presentations and group discussion for Hope Bay general update, drill site remediation program, wildlife monitoring program, caribou ID workshop, and Madrid-Boston Conceptual Offsetting Plan update. Site visit to Iqaluktuuttiaq East Outflow and proposed offsetting locations	Meeting Summary Report and Presentation Material
		Agnico Eagle – Guy Dufour, Jonny Toft, Sandra Eyegetok		
		Minnow – Jacquelyn Wood		
		GeoProcess - Ben Plumb		
		ERM – Hannah Visty, Alice Merondun		
		KIA – Skye Lacroix		
		IEAC – George Angohiatok, Clarence Kaiyogana, Lawrence Otokiak		

Notes: "-" = not applicable, DFO = Fisheries and Oceans Canada, TMAC = TMAC Resources Inc. , Agnico Eagle = Agnico Eagle Mines Limited, ERM = ERM Consultants Canada Ltd. , KIA = Kitikmeot Inuit Association, IEAC = Inuit Environmental Advisory Committee, Minnow = Minnow Environmental Inc., POLAR = Polar Knowledge Canada, EHTO = Ekaluktutiak Hunters and Trappers Organization

Table A.2: Summary of Engagement Activities Related to Hope Bay Mine Plan Operational Update

Year	Date	Participants	Topic
2024	July 3-4	IEAC, KIA, and Agnico Eagle	Presented key highlights of what a potential re-start of the mine could look like if favorable economic return can be attained
	October 11	IEAC, KIA, and Agnico Eagle	Discussed updated information for a potential re-start of the mine
	November 13-14	KIA and Agnico Eagle	Meeting in Kugluktuk to discuss the Operational Update application and agreement for meeting in 2025 for technical discussion on next steps
	December 16	NIRB and Agnico Eagle	Presented overview of the Operational Update Discussed intent to engage with NIRB on the file
2025	February 25-26	KIA, Agnico Eagle, and consultants of both parties	Presented overview of the Operational Update Presented technical aspects of application in response to information requests received from KIA. Technical areas included air quality, water quality, surface hydrology, groundwater, terrestrial, and shipping Actions were established following the conclusion of the meeting for additional work to complete
	April 8	NIRB and Agnico Eagle	Discussed intent to engage with NIRB on the file
	Late April to early June	KIA and Agnico Eagle	Various meetings with KIA consultants to work through information requests received in February and actions established from February 25-26, 2025 workshop
	June 9-10	IEAC, KIA, Agnico Eagle	On-site IEAC meeting Presented overview of scope of activities of Operational Update Presented earlier shipping window, as presented in Operational Update
	June 18-19	KIA, Agnico Eagle, and consultants of both parties	Presented conclusions of actions as were established in February and through the various meetings held between April and June Based on the outcomes of meetings and work with KIA, revisions to some studies were updated, as presented in the Operational Update documents

Notes: "IEAC" = Inuit Environmental Advisory Committee. "KIA" = Kitikmeot Inuit Association. "Agnico Eagle" = Agnico Eagle Mines Limited. "NIRB" = Nunavut Impact Review Board.

APPENDIX B
HABITAT SUITABILITY

Table B.1: Habitat Suitability for Freshwater Fish Species in Lake and Stream Habitat, Hope Bay Mine Operational Update

Habitat Type	Depth	Substrate	Arctic Charr				Lake Trout				Cisco			
			SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	<2 m	Fines	0	0.25	0.25	0	0	0.25	0	0	0.5	0	0.25	0
2	<2 m	Mixed	0	0.25	0.25	0	0	0.5	0	0	0.75	0.5	0.25	0
3	<2 m	Coarse	0	0.25	0.25	0	0	1	0	0	0.75	1	0.25	0
4	2-4 m	Fines	0	0.25	0.5	0.75	0	0.5	0.5	0.75	0.5	0.25	0.5	0.75
5	2-4 m	Mixed	0.5	0.75	0.5	0.75	0.5	0.75	0.75	0.75	1	0.25	0.5	0.75
6	2-4 m	Coarse	1	1	1	0.75	1	1	1	0.75	1	0.75	0.5	0.75
7	>4 m	Fines	0	0.25	0.5	1	0	0.25	0.5	1	0.25	0	1	1
8	>4 m	Mixed	0.25	0.75	0.75	1	0.5	1	0.75	1	0.75	0	1	1
9	>4 m	Coarse	0.5	1	1	1	1	1	1	1	0.5	0	1	1
10	small stream	Fines	0	0.25	0	0	0	0.25	0	0	0	0	0	0
11	large stream	Mixed	0	0.5	0.5	0	0	0.5	0.25	0	0	0.5	0.25	0
12	river	Mixed	0	0.5	0.75	0	0	0.5	0.25	0	0	0.5	0.25	0
Habitat Type	**Depth**	**Substrate**	**Slimy Sculpin**				**Ninespine Stickleback**				**Lake Whitefish**			
			SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	<2 m	Fines	0.5	0	0.25	0	1	1	1	0	0	0.25	0.25	0
2	<2 m	Mixed	0.75	0.75	0.75	0	0.5	0.5	0.75	0	0.5	1	0.75	0
3	<2 m	Coarse	1	1	1	0	0	0.25	0.75	0	0.5	0.75	0.75	0
4	2-4 m	Fines	0	0	0.25	0.75	0	0	0.5	0.75	0	0	0.5	0.75
5	2-4 m	Mixed	0.25	0.25	0.75	0.75	0	0	0.25	0.75	0.75	0.5	0.75	0.75
6	2-4 m	Coarse	0.25	0.25	1	0.75	0	0	0.25	0.75	0.75	0.25	0.75	0.75
7	>4 m	Fines	0	0	0.25	1	0	0	0	1	0	0	0.75	1
8	>4 m	Mixed	0	0	0.75	1	0	0	0	1	1	0	1	1
9	>4 m	Coarse	0	0	1	1	0	0	0	1	1	0	1	1
10	small stream	Fines	0	0	0.25	0	1	1	1	0	0	0.25	0	0
11	large stream	Mixed	1	1	1	0	0	0.5	0.5	0	0	0.5	0.5	0
12	river	Mixed	1	1	1	0	0	0.5	0.5	0.5	0	0.5	0.5	0

Notes: "SP" = Spawning. "NU" = Nursery. "FO" = Foraging. "OW" = Overwintering. Habitat Suitability Index Values: 0 = habitat not utilized, 0.25 = Poor, 0.5 = Fair, 0.75 = Good, 1 = Excellent. Habitat Type 10 = Less than 1 m wetted width during high flow, < 0.5 m depth during high flow, with 90- 100% fines. Predominantly glides and flats with some pools and abundant cover. Typically ephemeral. Habitat Type 11 = Large streams and small rivers with wetted width < 10m, sustained depth of 0 - 1.5 m and mixed substrates (fines, gravel, cobble, boulder). Predominantly glides and riffles with few pools. Abundant cover and undercut banks. Occasional high flow barriers or dry sections. Habitat Type 12 = Rivers with wetted width < 30m, sustained depth of 0.2 - 2 m and mixed substrates (fines, gravel, cobble, boulder). Consistent glide-pool/riffle-pool pattern. Pools are large and deep. Moderate amount of cover along margins and in pools. Flow is unlikely to be a barrier to fish movement.

Table B.2: Habitat Suitability Index (HSI) Ranking Justification for Freshwater Fish Species, Hope Bay Mine Operational Update

Arctic Charr	Life Function							
Habitat Type	Spawning[a]		Nursery		Foraging		Overwintering	
	Rank	Rationale	Rank	Rationale	Rank	Rationale	Rank	Rationale
1	Nil	Not utilized	Poor	Limited use of shallow habitats (<5 m) due to abundance of predators and infrequent or no association with fines/muds[h]	Poor	Juveniles infrequently found in shallow nearshore areas of lakes and adults utilize pelagic habitat at all depths[h]	Nil	Not utilized
2	Nil	While mixed substrates are used less frequently for spawning[f,h]; habitats < 2m are frequently frozen during spawning period[j]	Poor	Limited use of shallow habitats (<5 m) due to abundance of predators[h]	Poor	Juveniles infrequently found in shallow nearshore areas of lakes and adults utilize pelagic habitat at all depths[h]	Nil	Not utilized
3	Nil	While optimal spawning occurs over coarse substrate[f, h]; habitats < 2m are frequently frozen during spawning period[j]	Poor	Limited use of shallow habitats (<5 m) due to abundance of predators[h]	Poor	Juveniles infrequently found in shallow nearshore areas of lakes and adults utilize pelagic habitat at all depths[h]	Nil	Not utilized
4	Nil	Not utilized	Poor	Infrequent or no association with fines/mud[h]	Fair	No specific mention of fine substrate use near optimum depth for juveniles or adults.	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
5	Fair	Where nearshore areas do not freeze below ~1.5 m, mixed substrates are used less frequently for spawning[f,h]	Good	YOY found at > 5 m depth to avoid predators and moderately associated with mixed substrate (but less so with gravel/sand)[f,h]	Fair	No specific mention of mixed substrate use near optimum depth for juveniles or adults.	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
6	Excellent	Where nearshore areas do not freeze below ~1.5 m, optimal spawning occurs over coarse substrate[f,h]	Excellent	YOY found at > 5 m depth to avoid predators and associated with boulder, cobble, rubble cover[f, h]	Excellent	Juvenile foraging typically at > 5 m depth over gravel and cobble/boulder substrate[f, h]. Adults migrate to marine habitats to feed in the summer,	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
7	Nil	Not utilized	Poor	Infrequent or no association with fines/mud[h]	Fair	No specific mention of fine substrate use near optimum depth for juveniles or adults.	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
8	Poor	Spawning not likely to occur at > 4 m depth[f]	Good	YOY found at > 5 m depth to avoid predators and moderately associated with mixed substrate (but less so with gravel/sand)[f, h]	Good	Juvenile foraging typically at > 5 m depth over gravel and cobble/boulder substrate[f, h]. Adults migrate to marine habitats to feed in the summer, or use pelagic area of lake.	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
9	Fair	Spawning not likely to occur at > 4 m depth[f], but has been observed[h]	Excellent	YOY found at > 5 m depth to avoid predators and associated with boulder, cobble, rubble cover[f, h]	Excellent	Juvenile foraging typically at > 5 m depth over gravel and cobble/boulder substrate[f, h]. Adults migrate to marine habitats to feed in the summer, or use pelagic area of lake.	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
10	Nil	Not utilized	Poor	YOY have been observed in the study area using stream habitats[i] and generally in the north[e]. No known association with mud/fines.	Nil	Not utilized	Nil	Small streams freeze to the substrate in winter and all species have been assigned a HSI value of 0.
11	Nil	Not utilized	Fair	YOY have been observed in the study area[i] using stream habitats and generally in the north[e]. Substrate association in streams is unknown.	Fair	Primarily used as migration corridor to and from marine summer foraging habitats and overwintering habitat in lakes[i]	Nil	Large streams with pools < 2 m will freeze to the substrate and will not provide overwintering habitat for any species.
12	Nil	Not utilized	Fair	YOY have been observed in the study area using stream habitats[i] and generally in the north[e]. Substrate association in streams is unknown but in lakes strong association with coarse substrate[h]	Good	Primarily used as migration corridor to and from marine summer foraging habitats and overwintering habitat in lakes[i]	Nil	Few pools > 2 m depth which are not sufficient for most fish species to overwinter.

Notes: Habitat Suitability Index Values: 0 = habitat not utilized, 0.25 =Poor, 0.5 = Fair, 0.75 = Good, 1 = Excellent.

[a] Assuming that lakes freeze in winter between 0 - 1.5 m depth, but that some habitat is available for fall/winter species to spawn from 1.5 to 2 m.

[b] Hancock 2020 reported that YOY lake trout associated only with 10+ m depth, but it seems as though this is an interpretation error based on figures presented in the MSc manuscript. Therefore, depth associations different from Richardson et al. are not included.

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[f] Hancock 2020

[g] Larocque et al. 2014

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[i] TMAC 2017

[j] Appendix E

Table B.2: Habitat Suitability Index (HSI) Ranking Justification for Freshwater Fish Species, Hope Bay Mine Operational Update

Lake Trout	Life Function							
Habitat Type	Spawning		Nursery		Foraging		Overwintering	
	Rank	Rationale	Rank	Rationale	Rank	Rationale	Rank	Rationale
1	Nil	Not utilized - Typically spawn in areas free of silt, sand, and detritus[h]	Poor	Infrequently associated with fines in shallow habitat[h]	Nil	Not utilized[f]	Nil	Not utilized
2	Nil	While mixed substrates are used less frequently for spawning[f,h]; habitats < 2m are frequently frozen during spawning period[j]	Fair	Marginal use of mixed substrates in shallow habitat[h]	Nil	Not utilized[f]	Nil	Not utilized
3	Nil	While optimal spawning occurs over coarse substrate[f,h]; habitats < 2m are frequently frozen during spawning period[j]	Excellent	YOY associated with nearshore areas with coarse cover substrate[h,b]	Nil	Not utilized[f]	Nil	Not utilized
4	Nil	Typically spawn in areas free of silt, sand, and detritus[h]	Fair	Marginal use of fine substrates in moderate depth habitat[h]	Fair	Marginal use of fine substrates at moderate depth[h,i]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
5	Fair	Spawning occurs in 1-6 m, infrequently over mixed substrate[f,h]	Good	Associated with use of mixed moderate depth habitat[h]	Good	Associated with use of mixed moderate depth habitat[h,i]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
6	Excellent	Optimal spawning occurs from 1-6 m associated with steep drop-offs over coarse substrate[f,h]	Excellent	High association with coarse substrate at moderate depth[h]	Excellent	High association with coarse substrate at moderate depth[h,i]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
7	Nil	Not utilized - Typically spawn in areas free of silt, sand, and detritus[h]	Poor	Infrequent use of fine substrates at depth[h]	Fair	Marginal use of fine substrates at moderate depth[f,h]	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
8	Fair	Spawning occurs infrequently at > 4 m over mixed substrate[h]	Excellent	High association with mixed substrate at moderate (> 10m) depth[f,h]	Good	Associated with use of mixed moderate depth habitat[f,h]	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
9	Excellent	Optimal spawning occurs > 4 m over coarse substrate[h]	Excellent	High association with coarse substrate at moderate (> 10 m) depth[f,h]	Excellent	High association with mixed substrate at moderate depth[f,h]	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
10	Nil	Not utilized	Poor	Lake trout infrequently utilize small streams and rivers with fines for rearing habitat in the study area[i]	Nil	Not utilized[i]	Nil	Not utilized
11	Nil	Not utilized	Fair	Lake trout utilize large streams and rivers with mixed substrate for rearing habitat in the study area[i]. Quality matched to 0 - 2 m mixed lake habitat.	Poor	Lake trout infrequently utilize large streams and rivers with mixed substrate for foraging in the study area[i]	Nil	Not utilized
12	Nil	Not utilized	Fair	Lake trout utilize large streams and rivers with coarse substrate for rearing habitat in the study area[i]. Quality matched to 0 - 2 m mixed lake habitat.	Poor	Lake trout infrequently utilize large streams and rivers with mixed substrate for foraging in the study area[i]	Nil	Not utilized

Notes: Habitat Suitability Index Values: 0 = habitat not utilized, 0.25 =Poor, 0.5 = Fair, 0.75 = Good, 1 = Excellent.

[a] Assuming that lakes freeze in winter between 0 - 1.5 m depth, but that some habitat is available for fall/winter species to spawn from 1.5 to 2 m.

[b] Hancock 2020 reported that YOY lake trout associated only with 10+ m depth, but it seems as though this is an interpretation error based on figures presented in the MSc manuscript. Therefore, depth associations different from Richardson et al. are not included.

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Table B.2: Habitat Suitability Index (HSI) Ranking Justification for Freshwater Fish Species, Hope Bay Mine Operational Update

Cisco	Life Function							
Habitat Type	Spawning		Nursery		Foraging		Overwintering	
	Rank	Rationale	Rank	Rationale	Rank	Rationale	Rank	Rationale
1	Fair	Where nearshore areas do not freeze below 1.5 m, marginal spawning habitat occurs in < 2 m over fine substrate[h,i]	Nil	Not utilized[h]	Poor	Infrequent association with shallow, pelagic habitats[f]	Nil	Not utilized
2	Good	Spawning associated with gravel / mixed substrate where nearshore areas do not freeze below 1.5 m[h,i]	Fair	Limited YOY use of nearshore, shallow, mixed substrate habitat[h]	Poor	Infrequent association with shallow, pelagic habitats[f]	Nil	Not utilized
3	Good	Spawning associated with use of coarse substrate for spawning in 1.5 - 2 m depth of lakes[h,i]	Excellent	YOY associated with use of nearshore, shallow coarse substrate[h]	Poor	Infrequent association with shallow, pelagic habitats[f]	Nil	Not utilized
4	Fair	Marginal use of fine substrate for spawning in moderate depth of lakes[h,i]	Poor	Limited use of offshore area, no known YOY association with fine substrate[h]	Fair	No habitat associations with substrate known for juvenile or adult cisco; however, they are found in moderate water depth in study area[i]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
5	Excellent	High association of spawning over mixed substrate at moderate depth[h,i]	Poor	Limited YOY use of offshore area, mixed substrate habitat[h]	Fair	No habitat associations with substrate known for juvenile or adult cisco; however, they are found in moderate water depth in study area[i]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
6	Excellent	Spawning associated with coarse substrate at moderate depth[h,i]	Good	Limited YOY use of moderate depth habitat but high association with coarse substrate is known[h]	Fair	No habitat associations with substrate known for juvenile or adult cisco; however, they are found in moderate water depth in study area[i]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
7	Poor	Infrequent use of fine substrate for spawning at > 5 m depth of lakes[h,i]	Nil	Not utilized[h]	Excellent	No habitat associations with substrate known for juvenile or adult cisco; however, they are found in increasing abundance with increasing depth in the north	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
8	Good	Spawning associated with gravel / mixed substrate at > 5 m depth of lakes[h] but this depth is not often used in the project area[i]	Nil	Not utilized[h]	Excellent	No habitat associations with substrate known for juvenile or adult cisco; however, they are found in increasing abundance with increasing depth in the north and study area specifically[f, i]	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
9	Fair	Marginal use of coarse substrate for spawning at substrate at > 5 m depth of lakes[h] but this depth is not often used in the project area[i]	Nil	Not utilized[h]	Excellent	No habitat associations with substrate known for juvenile or adult cisco; however, they are found in increasing abundance with increasing depth in the north and study area specifically[f,i]	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
10	Nil	Not utilized	Nil	Not utilized	Nil	Not utilized	Nil	Not utilized
11	Nil	Not utilized	Fair	Observed in vegetated outflow habitat in the study area suggesting habitat provides nursery function[i]	Poor	Cisco infrequently utilize large streams and rivers with mixed substrate for foraging in the study area[i]	Nil	Not utilized
12	Nil	Not utilized	Fair	Observed in vegetated outflow habitat in the study area suggesting habitat provides nursery function[i]	Poor	Cisco infrequently utilize large streams and rivers with mixed substrate for foraging in the study area[i]	Nil	Not utilized

Notes: Habitat Suitability Index Values: 0 = habitat not utilized, 0.25 =Poor, 0.5 = Fair, 0.75 = Good, 1 = Excellent.

[a] Assuming that lakes freeze in winter between 0 - 1.5 m depth, but that some habitat is available for fall/winter species to spawn from 1.5 to 2 m.

[b] Hancock 2020 reported that YOY lake trout associated only with 10+ m depth, but it seems as though this is an interpretation error based on figures presented in the MSc manuscript. Therefore, depth associations different from Richardson et al. are not included.

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Table B.2: Habitat Suitability Index (HSI) Ranking Justification for Freshwater Fish Species, Hope Bay Mine Operational Update

Slimy Sculpin	Life Function							
Habitat Type	Spawning		Nursery		Foraging		Overwintering	
	Rank	Rationale	Rank	Rationale	Rank	Rationale	Rank	Rationale
1	Fair	Spawning associated with all substrate types, but less so with fines/muds[h]. High association with spawning < 1.5 m[f]	Nil	Not utilized	Poor	Limited use of fines/mud substrate in lake habitat by adults[h]	Nil	Not utilized
2	Good	Spawning associated with mixed substrates[h] in shallow lakes and streams < 1.5 m[f,i]	Good	YOY nursery habitat associated with mixed substrates[h] in shallow lakes and streams between 0.5 - 1.5 m[f,i]	Good	Foraging habitat associated with mixed substrates[h] at all depths[f,i]	Nil	Not utilized
3	Excellent	Spawning highly associated with coarse substrates[h] in shallow lakes and streams < 1.5 m[f,i]	Excellent	YOY nursery habitat highly associated with coarse substrates[h] in shallow lakes and streams between 0.5 - 1.5 m[f,i]	Excellent	Foraging habitat highly associated with coarse substrates[h] at all depths[f,i]	Nil	Not utilized
4	Nil	Not utilized	Nil	Not utilized	Poor	Limited use of fines/mud substrate in lake habitat by adults[h]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
5	Poor	Limited to no spawning associated with depths > 2 m[f]	Poor	Limited to no nursery habitat associated with depths > 2 m[f]	Good	Foraging habitat associated with mixed substrates[h] at all depths[f,i]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
6	Poor	Limited to no spawning associated with depths > 2 m[f]	Poor	Limited to no nursery habitat associated with depths > 2 m[f]	Excellent	Foraging habitat highly associated with coarse substrates[h] at all depths[f,i]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
7	Nil	Not utilized	Nil	Not utilized	Poor	Limited use of fines/mud substrate in lake habitat by adults[h]	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
8	Nil	Not utilized	Nil	Not utilized	Good	Foraging habitat associated with mixed substrates[h] at all depths[f,i]	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
9	Nil	Not utilized	Nil	Not utilized	Excellent	Foraging habitat highly associated with coarse substrates[h] at all depths[f,i]	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
10	Nil	Not utilized	Nil	Not utilized	Poor	Limited use of fines/mud substrate in shallow (0.5 - 1.5 m)[f], stream and river habitat by adults[h]	Nil	Not utilized
11	Excellent	Spawning highly associated with mixed / coarse substrates[e] in shallow rivers and streams < 1.5 m[f,i]	Excellent	YOY nursery habitat highly associated with mixed substrates[e] in shallow rivers and streams between 0.5 - 1.5 m[f,i]	Excellent	Foraging habitat highly associated with mixed substrates[e] in shallow lakes and streams between 0.5 - 1.5 m[f,i]	Nil	Not utilized
12	Excellent	Spawning highly associated with mixed / coarse substrates[e] in shallow rivers and streams < 1.5 m[f,i]	Excellent	YOY nursery habitat highly associated with coarse substrates[e] in shallow rivers and streams between 0.5 - 1.5 m[f,i]	Excellent	Foraging habitat highly associated with coarse substrates[e] in shallow lakes and streams between 0.5 - 1.5 m[f,i]	Nil	Not utilized

Notes: Habitat Suitability Index Values: 0 = habitat not utilized, 0.25 =Poor, 0.5 = Fair, 0.75 = Good, 1 = Excellent.

[a] Assuming that lakes freeze in winter between 0 - 1.5 m depth, but that some habitat is available for fall/winter species to spawn from 1.5 to 2 m.

[b] Hancock 2020 reported that YOY lake trout associated only with 10+ m depth, but it seems as though this is an interpretation error based on figures presented in the MSc manuscript. Therefore, depth associations different from Richardson et al. are not included.

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[h] Richardson et al. 2001

[i] TMAC 2017

[j] Appendix E

Table B.2: Habitat Suitability Index (HSI) Ranking Justification for Freshwater Fish Species, Hope Bay Mine Operational Update

Ninespine Stickleback	Life Function							
Habitat Type	Spawning		Nursery		Foraging		Overwintering	
	Rank	Rationale	Rank	Rationale	Rank	Rationale	Rank	Rationale
1	Excellent	Spawning highly associated with organics, fines, and mud substrate, with vegetation if present, in shallow areas[h,i]	Excellent	Nursery habitat highly associated with organics, fines, and mud substrate, with vegetation if present, in shallow areas[h,i]	Excellent	Rearing habitat highly associated with organics, fines, and mud substrate, with vegetation if present, in shallow areas[h,i]	Nil	Not utilized
2	Fair	Spawning habitat marginally associated with mixed substrate in shallow areas[h,i]	Fair	Nursery habitat marginally associated with mixed substrate in shallow areas[h,i]	Good	Foraging habitat associated with mixed substrates in shallow areas up to 1.5 m depth[h,i]	Nil	Not utilized
3	Nil	Not utilized	Poor	Limited nursery habitat associated with corase substrate in shallow areas[h,i]	Good	Foraging habitat associated with coarse substrates in shallow areas up to 1.5 m depth[h,i]	Nil	Not utilized
4	Nil	Not utilized	Nil	Not utilized	Fair	Rearing habitat highly associated with organics, fines, and mud substrate, but limited association at depths > 1.5 m[f]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
5	Nil	Not utilized	Nil	Not utilized	Poor	Limited association between foraging and mixed substrate as depths > 1.5 m[f]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
6	Nil	Not utilized	Nil	Not utilized	Poor	Limited association between foraging and coarse substrate as depths > 1.5 m[f]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
7	Nil	Not utilized	Nil	Not utilized	Nil	Not utilized	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
8	Nil	Not utilized	Nil	Not utilized	Nil	Not utilized	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
9	Nil	Not utilized	Nil	Not utilized	Nil	Not utilized	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
10	Excellent	Spawning highly associated with organics, fines, and mud substrate, with vegetation if present, in shallow areas[e]	Excellent	Nursery habitat highly associated with organics, fines, and mud substrate, with vegetation if present, in shallow areas[e]	Excellent	Rearing habitat highly associated with organics, fines, and mud substrate, with vegetation if present, in shallow areas[e]	Nil	Not utilized
11	Nil	Not utilized	Fair	No association between ninespine stickleback nursery habitat and mixed sediments in streams[e]	Fair	No association between ninespine stickleback foraging habitat and mixed sediments in streams[e]	Nil	Not utilized
12	Nil	Not utilized	Fair	No association between ninespine stickleback nursery habitat and mixed sediments in rivers[e]	Fair	No association between ninespine stickleback foraging habitat and mixed sediments in rivers[e]	Fair	Few pools > 2 m depth that may provide limited overwintering habitat for this species.

Notes: Habitat Suitability Index Values: 0 = habitat not utilized, 0.25 =Poor, 0.5 = Fair, 0.75 = Good, 1 = Excellent.

[a] Assuming that lakes freeze in winter between 0 - 1.5 m depth, but that some habitat is available for fall/winter species to spawn from 1.5 to 2 m.

[b] Hancock 2020 reported that YOY lake trout associated only with 10+ m depth, but it seems as though this is an interpretation error based on figures presented in the MSc manuscript. Therefore, depth associations different from Richardson et al. are not included.

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Table B.2: Habitat Suitability Index (HSI) Ranking Justification for Freshwater Fish Species, Hope Bay Mine Operational Update

Lake Whitefish	Life Function							
Habitat Type	Spawning		Nursery		Foraging		Overwintering	
	Rank	Rationale	Rank	Rationale	Rank	Rationale	Rank	Rationale
1	Nil	Not utilized	Poor	YOY have limited association with fines/muds in shallow habitats[h]	Poor	Adults show no substrate preference and limited use of very shallow areas[f,i]	Nil	Not utilized
2	Fair	Spawning associated with gravel / coarse substrate where nearshore areas do not freeze below 1.5 m[h,i]	Excellent	YOY highly associated with < 1 m depth over mixed substrates with boulders/cobble[f,h]	Good	Juvenile foraging associated with boulders, cobble, sand, and gravel. Highest abundance of juvenile/adult in < 5 m depth in Doris Lake[i]	Nil	Not utilized
3	Fair	Spawning associated with gravel / coarse substrate where nearshore areas do not freeze below 1.5 m[i]	Good	YOY associated with < 1 m depth over hard, boulders/cobble substrate[f,h]	Good	Juvenile foraging associated with boulders, cobble, sand, and gravel. Highest abundance of juvenile/adult in < 5 m depth in Doris Lake[i]	Nil	Not utilized
4	Nil	Not utilized	Nil	not utilized (YOY's not associated with fines/mud[h])	Fair	Adults show no substrate preference and use of moderate depths, whereas juveniles avoid fines/muds during foraging[h,i]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
5	Good	Spawning associated with gravel / coarse substrate < 5 m in depth[h,i]	Fair	Marginal use of depths > 1 m over mixed substrate[f]	Good	Juvenile foraging associated with boulders, cobble, sand, and gravel. Highest abundance of juvenile/adult in < 5 m depth in Doris Lake[i]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
6	Good	Spawning associated with gravel / coarse substrate < 5 m in depth[h,i]	Poor	Limited use of depths > 1 m over coarse substrate[f,h]	Good	Juvenile foraging associated with boulders, cobble, sand, and gravel. Highest abundance of juvenile/adult in < 5 m depth in Doris Lake[i]	Good	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
7	Nil	Not utilized	Nil	Not utilized	Good	High association of adult / juvenile lake whitefish with depths > 10 m[f] Adults show no substrate preferences while juveniles are associated with boulders, cobble,	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
8	Excellent	Spawning highly associated with gravel/coarse substrate from 5 - 8 m depth[f]	Nil	Not utilized	Excellent	High association of adult / juvenile lake whitefish with depths > 10 m[f]. Adults show no substrate preferences while juveniles are associated with boulders, cobble, sand and gravel[h]	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
9	Excellent	Spawning highly associated with gravel/coarse substrate from 5 - 8 m depth[f]	Nil	Not utilized	Excellent	High association of adult / juvenile lake whitefish with depths > 10 m[f]. Adults show no substrate preferences while juveniles are associated with boulders, cobble, sand and gravel[h]	Excellent	Overwintering habitat for all species occurs below 3 m due to ice formation[c,d]
10	Nil	Not utilized	Poor	No information on use of streams with fines as nursery habitat[e]	Nil	not utilized	Nil	Not utilized
11	Nil	Not utilized	Fair	Marginal use of stream/river outflows in study area for rearing[i]	Fair	Marginal use of stream/river outflows in study area by adults / juveniles[i]	Nil	Not utilized
12	Nil	Not utilized	Fair	Marginal use of stream/river outflows in study area for rearing[i]	Fair	Marginal use of stream/river outflows in study area by adults / juveniles[i]	Nil	Not utilized

Notes: Habitat Suitability Index Values: 0 = habitat not utilized, 0.25 =Poor, 0.5 = Fair, 0.75 = Good, 1 = Excellent.

[a] Assuming that lakes freeze in winter between 0 - 1.5 m depth, but that some habitat is available for fall/winter species to spawn from 1.5 to 2 m.

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[i] TMAC 2017

[j] Appendix E

APPENDIX C
CONCEPTUAL DESIGN PLAN

Hope Bay Fisheries Offsetting: Conceptual Options Evaluation

FINAL REPORT

Prepared for

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GeoProcess RESEARCH ASSOCIATES

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1. Introduction

Agnico Eagle Mines Limited (Agnico) operates a gold mine known as the Hope Bay Project in the West Kitkmeot region of mainland Nunuvat (Map 1). Planned activities at this location (Madrid-Boston Project) will result in impacts to fish and fish habitat. As such, Agnico is investigating potential options for a Fisheries Offsetting Plan as required by Fisheries and Oceans Canada (DFO). GeoProcess Research Associates (GRA) was contracted by Minnow Environmental (Minnow) to support Agnico in the hydrotechnical evaluation of offsetting options. This report summarizes the conceptual design and supporting hydraulics and hydrology for offsetting options for freshwater fish.

1.1. Project Purpose

The purpose of this project is to evaluate the hydrotechnical feasibility of the proposed offsetting options to increase the productivity of Ninespine Stickleback, Arctic Char, and potentially, Lake Trout. GRA's role is to assess the feasibility of different habitat offsetting options and to evaluate their associated impacts to local hydrology and hydraulics. The purpose of these works is not solely to increase the spatial availability of fish habitat, but to also increase connectivity within the system.

1.2. Project Location and Setting

The offsetting options evaluated in this assessment are focused on Victoria Island in the Kitkmeot region of Nunavut, approximately 7.7 km northeast of the hamlet of Cambridge Bay (Map 1). There are populations of Arctic Char, Lake Trout, Lake Whitefish, Least Cisco and Ninespine Stickleback in the region (Grosbois et al. 2022). The project area is located in the Northern Arctic ecozone and the Amundsen Gulf Lowlands Ecoregion (Marshall et al., 1999). The landscape is characterized by a nearly continuous cover of dwarf tundra vegetation and gentle slopes covered with drumlinoid ridges (Marshall et al., 1999). These ridges result in the formation of low depressions were water ponds. The hydrography is characterized by the cascade of these ponds which "fill and spill" and drain towards Cambridge Bay and the Dease Strait. The region is characterized by deep and continuous permafrost which limits groundwater movement. The surficial geology is classified as a thin till veneer consisting of an approximate 1 m thick layer of poorly sorted subglacial deposits (GSC, 2016).

The area of focus is on the East Outflow System (EOS) which is an outlet for Iqaluktuuttiaq (formerly known as Grenier Lake) that flows through a series of ponds, as shown in Map 2 and Map 3. Ponds have been numbered by GRA (see Map 3) for clarity. The EOS outlets Iqaluktuuttiaq and flows southwest into Pond 1 where it then discharges into Pond 2 through a series of 8 culverts under the main access road to Ovayok Territorial Park. From here it cascades southwest for approximately 8 km, through the pond network and into Cambridge Bay (Arctic Ocean). The relatively flat terrain results in multiple spill points for each pond, creating complex and dynamic flow patterns that are governed by water levels and pond shapes.

2. 2021 Field Program

2.1. July Field Visit

A field investigation was undertaken between July 1 and 8, 2021 to install instrumentation as part of a new hydrometric program. This included a series of water level sensors throughout the EOS and in Iqaluktuuttiaq to characterize the system's dynamic "fill and spill" flow regime throughout the open-water season of 2021. The hydrometric program was initiated approximately one to two weeks after ice-out, when water levels were starting to recede from the freshet peak. Six water level sensors were installed, along with two barometric sensors (locations shown on Map 3). Each water level station consisted of a Hobo U20 pressure transducer affixed to a heavy portable weight, steel cable, and float. The sensors were set to record temperatures and stage at 15-minute intervals. Discharge measurements were conducted at four of the sites (GR-01, GR-03, GR-05, GR-06) with two high flow measurements taken at each site during the field visit. The remaining two sites (GR-02, GR-04) were not used for measuring discharge due to inadequate hydraulic controls and/or safety concerns. A network of 3 benchmarks was established for a local assumed datum near each gauging station by tagging and anchoring a concrete screw into nearby boulders. The assumed datum was established using differential levelling for the entire network.

2.2. September Field Visit

Subsequent fieldwork was undertaken in September to extend the hydrometric program for lower flows and to complete a survey and assessment of the EOS to inform the feasibility assessment of habitat enhancement measures within the system. This program was executed between September 18-20, 2021 and included GeoProcess, Minnow, and Agnico staff. All water level sensors were retrieved during this field visit to prevent damage by ice. At the time of the field visit, ice was just starting to form on the smaller ponds. Additional discharge measurements were made at three stations (GR-03, GR-05, GR-06) under low flow conditions. The outlet of Iqaluktuuttiaq was completely dry during the field visit, and the sensor (G-01) was found to be above the current lake level, due to water levels dropping significantly since the commissioning of the sensor in July. Another sensor (G-02) was found out of the water near a favourite fishing area upstream of the culverts. It is speculated that it was removed accidentally by local residents.

Concurrent with the hydrometric survey was a fluvial geomorphic assessment to characterize the features within the EOS. This assessment included a visual assessment of the entire EOS, with a focus on the short connector channels between the ponds. These connections were surveyed using a base and rover global navigation satellite system (GNSS) with enabled real-time kinematic (RTK) corrections (+/- 0.04 m error). During the visit, several of the benchmarks established in July were surveyed with the GNSS to convert the local datum to the datum consistent with the additional topographic data. Additionally, an aerial survey was completed on September 20, 2021 using a small UAV (DJI Mavic 2) to obtain a high-resolution orthoimage and Digital Surface Model (DSM).

2.3. Data Processing

2.3.1. Hydrometric Data Record

As no benchmarks were available at the time of the survey (to localize to a previously established datum), the initial GNSS setup was used as the reference datum. All data were corrected to common points surveyed each day to account for potential elevation errors resulting from multiple base station locations. The upstream and downstream culvert inverts and obverts were surveyed and can also be used as benchmarks to transform between datums in the future (if required).

All water level data were compensated for atmospheric pressure and then calibrated to the site visits using direct water level measurements (by survey level) from referenced benchmarks. Sensor values and field observations were imported into time series software for analysis and interpretation. Stage data was collected from July 2 to September 19 and is of very good quality overall. A few days of averaging was applied at G-01 to smooth out large waves due to a wind event. G-02 had a few periods of missing data and was interpolated based on falling trends to reconnect the dataset.

A stage-discharge curve was developed for the four sites that collected manual discharge measurements by plotting each flow measurement against the corresponding water level for the same time and duration. A time series flow record was produced by running the water levels collected through the curve model. Figure 1 shows an example of a rating curve that was developed for G-06. The curves that were developed are considered preliminary because, while they have measurement calibrations at the high and low-end sections, important mid-range flows are required for stronger correlation and confidence in the curve models. It should be noted that the G-01 model is not yet a valid rating curve and still needs a low flow measurement, in addition to a mid-range measurement. Until additional data can be collected and a valid curve plotted, this model was estimated using two high flow measurements and the zero-flow elevation determined from a cross-sectional field survey at the hydraulic control for the lake.

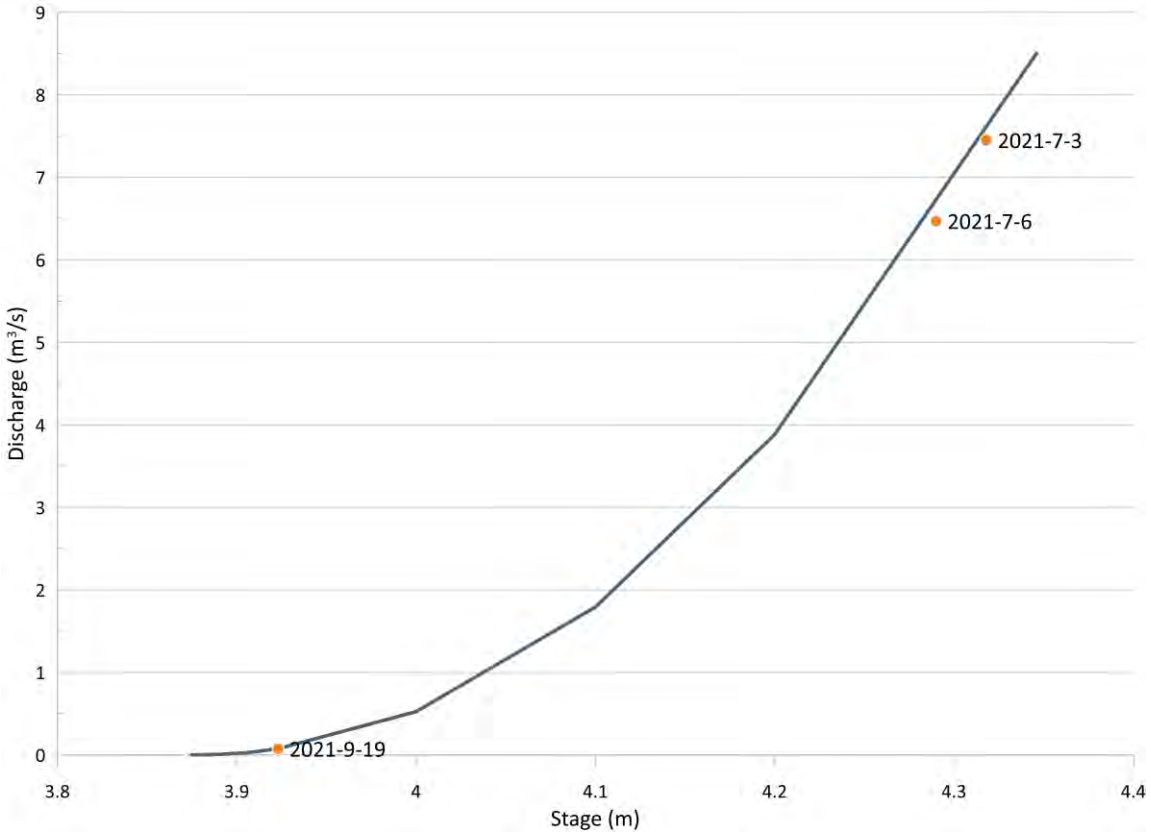

Figure 1: Rating curve developed for the G-06 hydrometric gauge. Orange points show field measurements used to develop the curve.

The discharge data is sound for the first season of data collection. However, additional curve development is recommended to refine the models across a broader range of flows. Some manual interpretation was required for the discharge readings in early July at G-01, due to backwater at the culverts and there being no discharge data once the stage dropped below the hydraulic control for the lake.

2.3.2. Aerial Imagery

A total of 951 photos from the UAV, covering an area of 28.6 km^2, were processed using an open source photogrammetry toolkit with a resulting average ground sampling distance of 0.2 m. Five ground control points were surveyed with the GNSS to increase the vertical resolution of the DSM, with a resulting vertical RMS error of 0.22 m. Given the sparse vegetation and lack of structures in the area, DSM filtering to remove vegetation or buildings was not required.

3. Existing Conditions Assessment

3.1. Channel Morphology

Map 4 illustrates the main flow path and longitudinal profile of the EOS. There are two distinct morphologies within the EOS, with the transition between each occurring at the outlet of Pond 6 (~6400 m). The upstream reach (EOS-1) is characterized by a series of small ponds connected by short, shallow channels. These short channels range in cross-sectional size and lack bank definition; instead they transition gently to the adjacent higher terrain. The system generally lacks geomorphic indicators relating to channel adjustment, suggesting that these features remain relatively stable in the present flow regime. Downstream of Pond 6 (EOS-2), the gradient increases and the flow path follows a more confined channel having a 550 m long run at a slope of 1%. Localized bank erosion was observed throughout this run, suggesting that this reach has sufficient energy to erode the till banks or that ice scarring is contributing to the observed bank erosion. At the end of this run, there is a small pond that transitions to another well-defined channel, in this case having a bedrock outcrop creating a sharp vertical inflection in the streambed. Downstream of this bedrock outcrop, the gradient decreases and there is evidence of deposition within the channel until the EOS outlets into the Freshwater Creek estuary. This conceptual study focuses on EOS-1, thus the downstream reaches are not further characterized.

Within EOS-1, the geomorphic conditions indicate that the connection channels do not have sufficient stream power to frequently mobilize the bed sediment. This stability is attributed to the shallow reach slope and to the influence of the bounding ponds that, during the freshet, reduce erosive forces by creating backwater within these connector channels. The average slope between Pond 2 (downstream of the culverts) and the outlet of Pond 6 is 0.05%, but it is noted that most of the elevation is lost through the connector channels, with these channel slopes ranging between 0.1% to 0.3%. The active width of the connector channels varies between approximately 10 m to 20 m.

3.2. 2021 Hydrometrics

Figure 2 shows the stage time series at each of the hydrometric gauges (locations shown on Map 3). The gauges captured the receding limb of the spring freshet, after which water levels remained fairly constant until early September when rain increased water levels slightly. The EOS discharge ranged from approximately 8 m^3/s in early July to less than 0.01 m^3/s by the end of August, based on the estimates from GR-06. Figure 2 indicates that, during the highest periods of flow in 2021, the culvert is controlling the inflow of water from Iqaluktuuttiaq into the EOS (based on the measured water levels at GR-01 and GR-02). Between approximately July 13 and 17, the hydraulic control changes from being the culvert to the connection between Iqaluktuuttiaq and Pond 1, indicated by the divergence in water levels at GR-01 and GR-02.

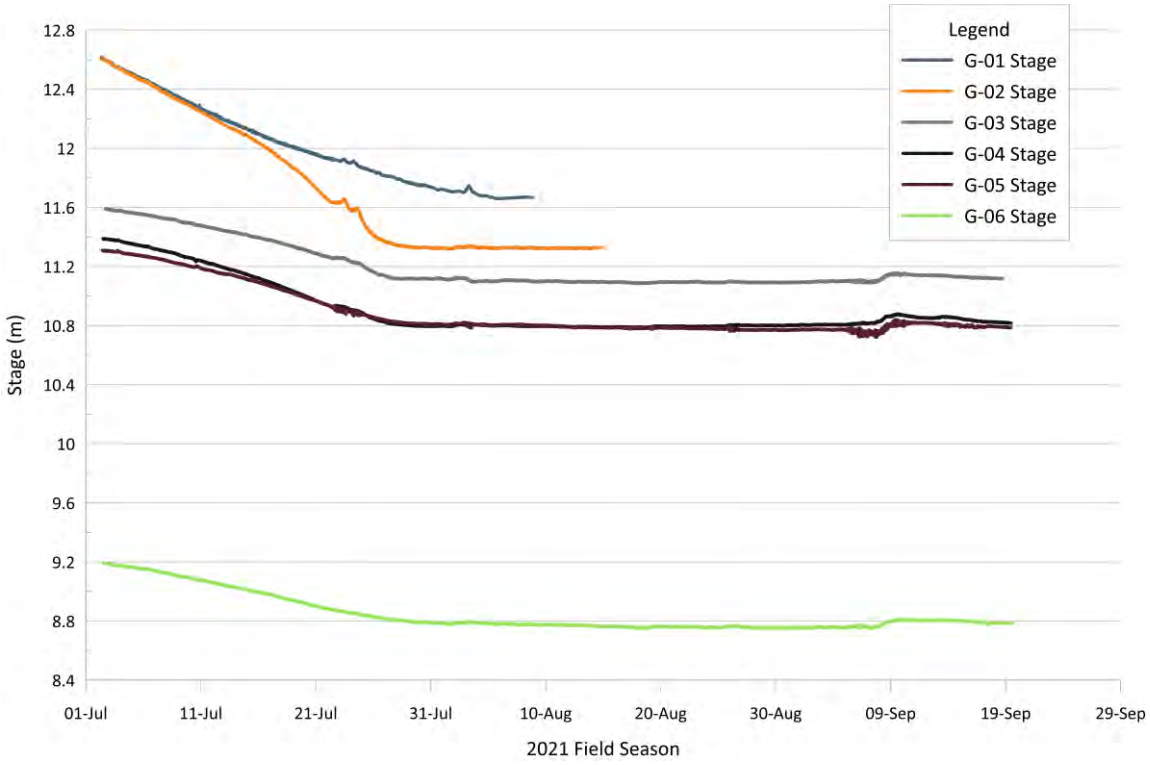

Figure 2: Timeseries of measured stage values at the six hydrometric stations installed by GRA for the 2021 field season. Gauge locations shown in Map 3.

3.3. Hydroclimatic Regime

3.3.1. Current Regime

There is a Water Survey of Canada hydrometric gauge on Freshwater Creek (10TF001), located near the Iqaluktuuttiaq outlet to the west of the study area (Map 2). The gauge has a data record spanning 1971-2021. The hydrologic regime at this gauge is likely representative of the conditions at the study site and is, therefore, presented here as a hydrologic surrogate for this study. Figure 3 shows the mean discharge for each day of the year for the available period of record with the ribbon showing the maximum and minimum recorded discharge on that day.

The hydrologic regime is bell-shaped and dominated by a single peak that occurs in late June or early July and is the result of the spring freshet. After the peak, the hydrograph recedes through the summer and into the winter. A flow duration analysis indicates that, at the WSC gauge, the channel is dry for 40% of the year, with dry periods typically occurring between October and May. Based on an examination of the flow record it is likely that during the winter the creek freezes completely to the bottom, except in the deepest pools. Using the WSC "backwater" flag (a quality control parameter) as an indication of ice presence, freeze-up typically occurs in late September but has occurred as early as the beginning of September and as late as mid-October. Breakup typically occurs in late June but has occurred as early as mid-June and as late as mid-July.

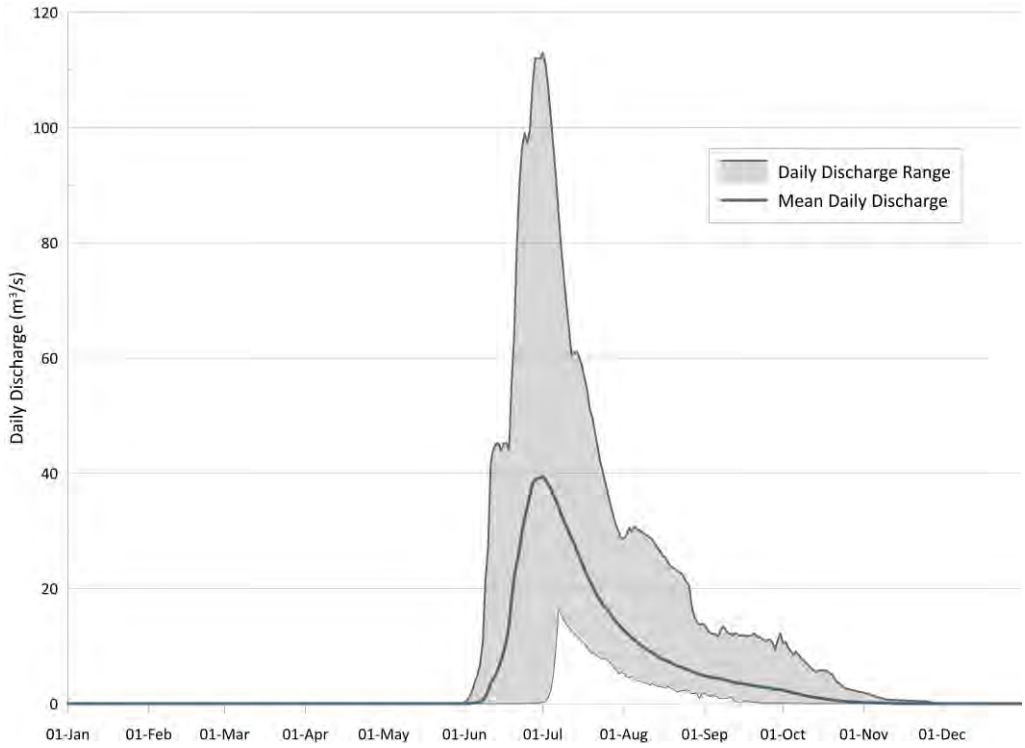

Figure 3: Mean daily discharge at Freshwater Creek from 1971-2021; maximum and minimum recorded value for each day of the year shown with the grey ribbon.

The EOS has more flow cascades and inline ponds than Freshwater Creek, therefore, storage effects in the study area are likely more pronounced than for the WSC gauged hydrologic regime. When comparing the data at G-06 to the WSC gauge (Figure 4) the magnitudes are significantly less in the EOS, but the recession timing and shape are similar. The flow duration (based on one season of record at G-06) also indicates that the channel is effectively dry (discharge < 0.05 m^3/s) for 40% of the open water season, which is different from Freshwater Creek, which has a more continuous flow regime for the same period.

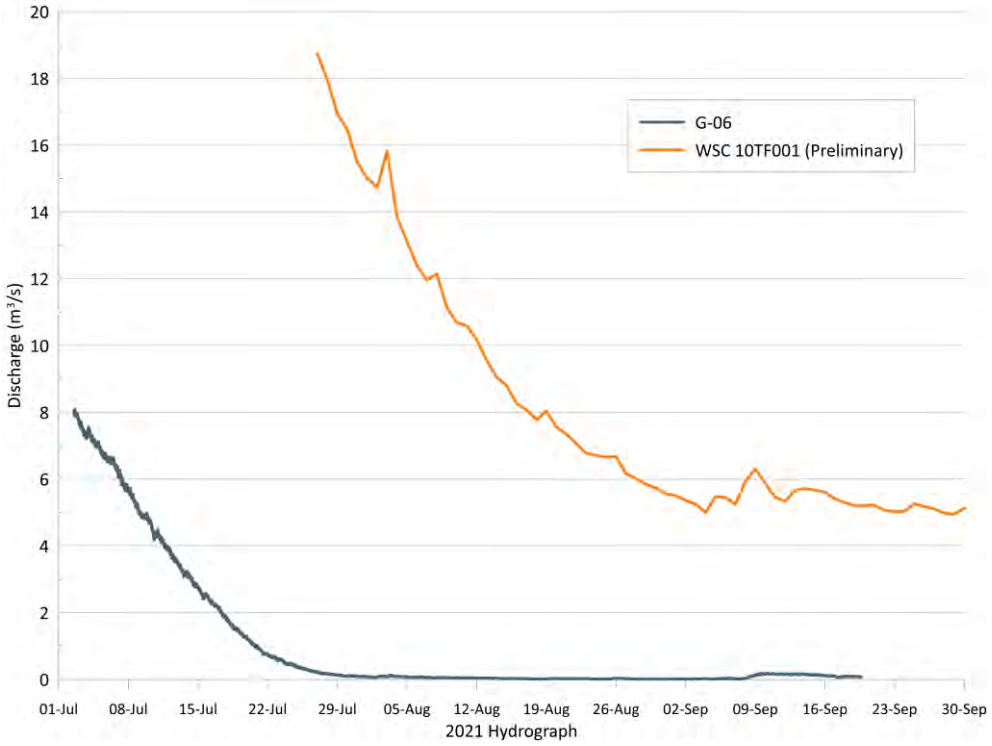

Figure 4: Comparison hydrographs between G-06 and the WSC gauge 10TF001.

3.3.2. Hydroclimatic Trends

There is a series of Environment Canada (EC) climate gauges operated in Cambridge Bay that have a collective record from 1929-2021. EC publishes long-term climate normals for their stations, with the last published period from 1981-2010. GRA used the available climate data to create a climate normal for 1991-2020. A comparison between the two climate normal datasets shows that the temperature normals have been relatively stable but there has been a shift in the precipitation regime. Table 1 summarizes the precipitation data for the different periods of analysis. It should be noted that the GRA values are not in compliance with the World Meterological Organization (WMO) standards for climate normal as additional data processing to screen for significant gaps is required.

Table 1: Climate normals at Cambridge Bay.

Month	EC Climate Normal 1981-2010			Calculated Climate Normal 1991-2020[1]		
	Total Precipitation (mm)	Rainfall (mm)	Snowfall (cm)	Total Precipitation (mm)	Rainfall (mm)	Snowfall (cm)
January	5.8	0.0	6.7	5.4	0.0	5.9
February	4.9	0.0	5.9	4.4	0.0	5.0
March	7.1	0.0	8.4	6.7	0.0	7.6
April	5.7	0.0	6.9	6.0	0.0	7.1
May	7.0	1.0	7.2	6.5	1.1	6.2
June	13.6	10.0	3.8	15.7	12.9	2.9
July	24.1	23.9	0.1	26.8	26.7	0.1
August	25.7	23.9	1.8	23.6	22.3	1.4
September	19.1	12.7	6.8	17.2	12.2	5.2
October	14.7	0.6	15.9	13.8	0.7	14.9
November	8.0	0.0	9.8	8.6	0.1	10.0
December	6.1	0.0	6.8	6.1	0.0	6.6
Annual Total	141.7	72.1	80.2	140.8	75.9	73.0

1. Calculated climate normals are not in compliance with the WMO standards

While the total amount of mean annual precipitation is consistent (141.7 mm compared to 140.7 mm) there was a shift in timing and type of precipitation. In the 1981-2010 climate normal more precipitation fell as snow (80.2 mm) than rain (72.1 mm) with peak precipitation occurring as rain in August. In the 1991-2020 climate normal more precipitation fell as rain (75.9 mm) compared to snow (73.0 mm) and the peak precipitation now occurs as rain in July. Figure 5 shows a comparison of mean total precipitation between the two periods.

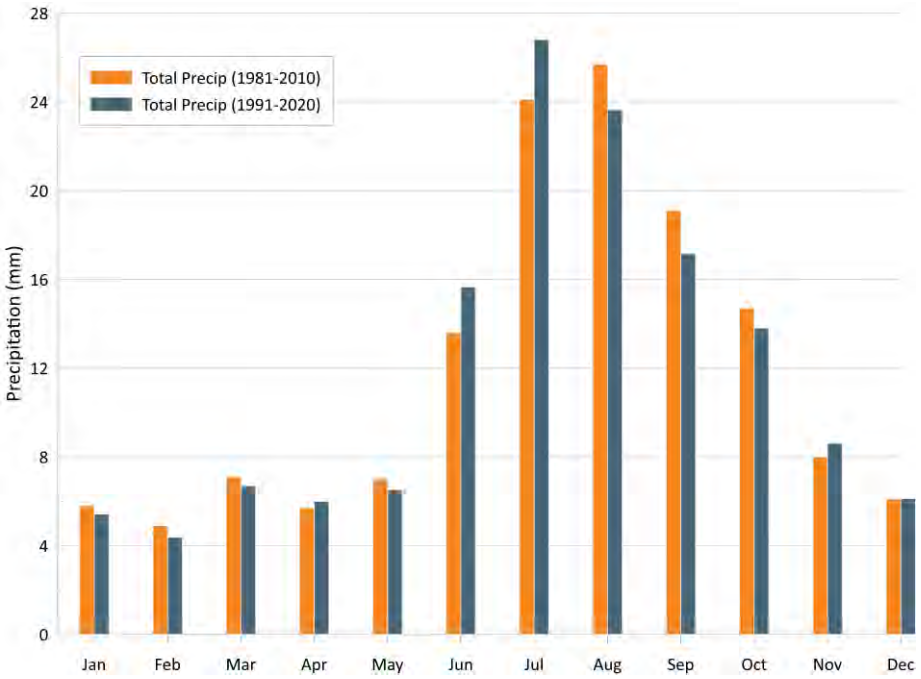

Figure 5: Comparison of mean total precipitation between the two periods at Cambridge Bay.

The significance of this shift is that peak precipitation can now occur at the same time as the spring freshet which could result in larger, more extreme, peaks. For example, the July 2, 2011 peak flow on Freshwater Creek is the largest on record (116 m^3/s) and there was 30 mm of rain in the 5 days leading up to the peak flow, which is almost half of the total mean annual rainfall. This suggests that the freshet peak was likely supplemented with a rain driven peak and possibly a rain-on-snow driven peak. While rain-on-snow events are not fully understood, previous studies have indicated that they can result in higher peaks due to the synchronization between precipitation and rapid snowmelt driven by rain events (Dingman 2015). This rain driven rapid snowmelt can also result in a sharper summer recession as less snowmelt is available later in the season. This could be compounded by the fact that more precipitation is falling as rain as opposed to snow, as the smaller snowpack will deplete sooner. The shift of peak precipitation from August to July compounds this sharper summer recession in the annual hydrograph further. A sharper summer recession could potentially increase the likelihood of fish becoming stranded within the various ponds of the EOS. Further complicating matters is the proportionally high evapotranspiration (ET) rates of the region which limit excess water availability. The mean annual ET is between 100 and 200 mm per year (Statistics Canada, 2017) which is significant in comparison to the mean annual precipitation of 140 mm per year. How this ET regime could change and the impacts to the overall system are unclear.

3.3.3. Project Implications

A shift in climate will result in a shift in the hydrologic regime of the system. It is likely that peak flows will be larger and occur earlier in the season leading to a harsher summer recession. This potential shift from a more gentle attenuated hydrologic response to a flashier one will have impacts to fish and fish habitat. The climate trends suggest that the potential for fish stranding in the EOS may increase due to the hydrologic shift. As such. physical enhancements implemented in the EOS should be resilient enough to function with increased peak flows while counteracting the potential quicker transition to low flows.

4. Hydraulic Analysis

To aid in the evaluation of the relative impacts of the proposed offsetting options a 2-dimensional HEC-RAS model was developed for the existing conditions, as well as the proposed conditions. This section presents the model development methodology and the existing conditions results.

4.1. Model Terrain

Bathymetry data (contours) for five ponds (Ponds 1, 2, 3, 4, and 5) in the EOS (ERM, 2020) were incorporated into the EOS's overall DSM. This combined DSM surface was then brought into HEC-RAS and the channel thalweg (based on survey data) was "burned" into the surface so the hydraulic controls and flow paths could be captured in the model. Manning's roughness values were determined using a landcover analysis tool that processed the orthometric photos in GIS to determine specific landcover types. The determined landcover and associated Manning's roughness values (based on Chow, 1959) are summarized in Table 2 . Map 5 shows the final landcover classification.

Table 2: Adopted Manning's roughess values.

Landcover Classification	Adopted Manning's Roughness Values
Open Water/Littoral Zone	0.035
Road	0.04
Tundra	0.045

The road crossing of the EOS and its eight corrugated metal culverts were included in the model's terrain development, using the GRA surveyed elevations. A manning's roughness of 0.02 was adopted for the culverts based on standard values for corrugated metal pipes (Chow 1959).

4.2. Mesh Generation

A 10m x 10m square mesh was generated for the 2D model domain. This mesh was refined in the channel, which was delineated using the orthoimagery to identify approximate bank lines. The refined mesh had a resolution of 2.5 m x 2.5 m and was blended into the larger mesh. One section of the channel at the downstream portion (where the channel naturally steepens) required a coarser mesh for model stability due to the rapid change in velocities. This mesh was set to 15 m x 15 m. Banklines outside of the refinement region and the centerline of the assumed thalweg were entered as breaklines to better align the mesh with the flow direction and wet areas. The refinement regions, breaklines, and model domain are shown in Map 6.

4.3. Boundary and Initial Conditions

The model was run under unsteady flow conditions. Due to the large amount of storage in the basin a "hotstart" run was completed first to fill the storage within the model domain. This hotstart file had a normal downstream boundary condition with the friction slope set to the average channel slope in the reach and a constant flow hydrograph as the upstream boundary condition. The flow for the hotstart was set to 5.5 m^3/s which is the mean average discharge in Freshwater Creek. The model was then run using the observation stage at G-01 from 2021-07-02 to 2021-08-05 as G-01 became dry on August 5th.

4.4. Existing Conditions Results

To evaluate the model's performance, the modelled water surface elevation (WSE) was compared to the observed water surface collected at the six hydrometric gauges by extracting the WSE time series at the model cell that was nearest to the gauge. Figure 6, Figure 7, and Figure 8 show sample comparisons at G-03, G-04 and G-06, respectively. In general, the high WSEs during the recession from freshet are well represented. However, as water levels continue to recede the modelled WSE begins to diverge from the observed WSE. At G-02, G-04, and G-05 the model overestimates the WSE by approximately 20 cm. At G-06 there is a much better simulation with a maximum difference of approximately 10 cm. At G-01 there is a near-perfect match for the entire simulation period due to its proximity to the upstream boundary. The gauge at G-03 is immediately downstream of the culverts and the WSE is underestimated for most of the simulation, indicating that the local culvert hydraulics were not fully captured in the model. However, the model was built for conceptual purposes and fully capturing the complicated hydraulics of a multi-tiered culvert system was beyond the scope of this iteration of the model.

While the model did not represent lower flows as well as the overall storage dynamic (between the ponds), and despite not being calibrated, as a hydraulic analysis tool for informing concept-level offsetting habitat

options it is satisfactory for evaluating relative changes between the existing conditions and conceptual design that are proposed in Section 5. Further model refinement and calibration will be required at a detailed design stage.

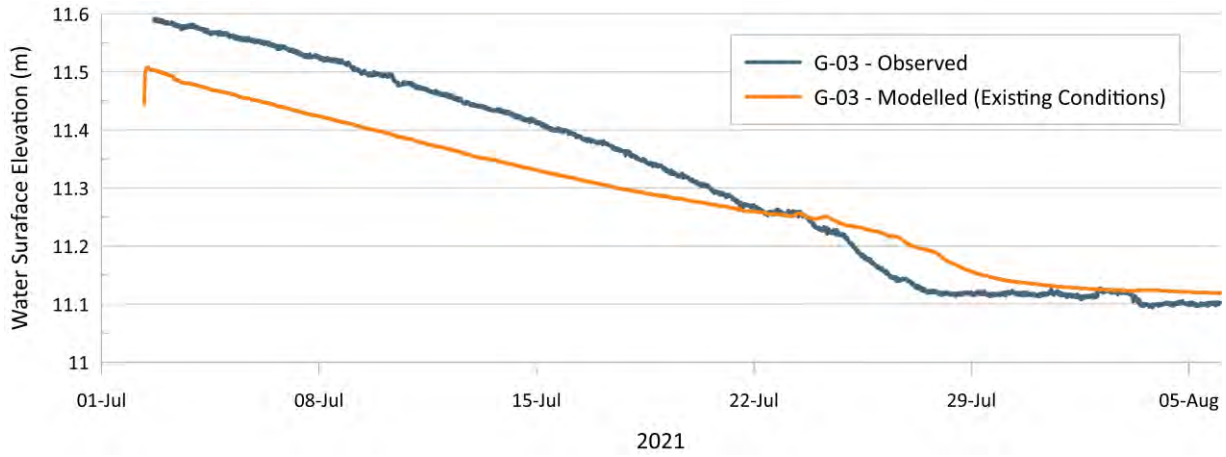

Figure 6: Comparison of observed and simulated WSE at G-03

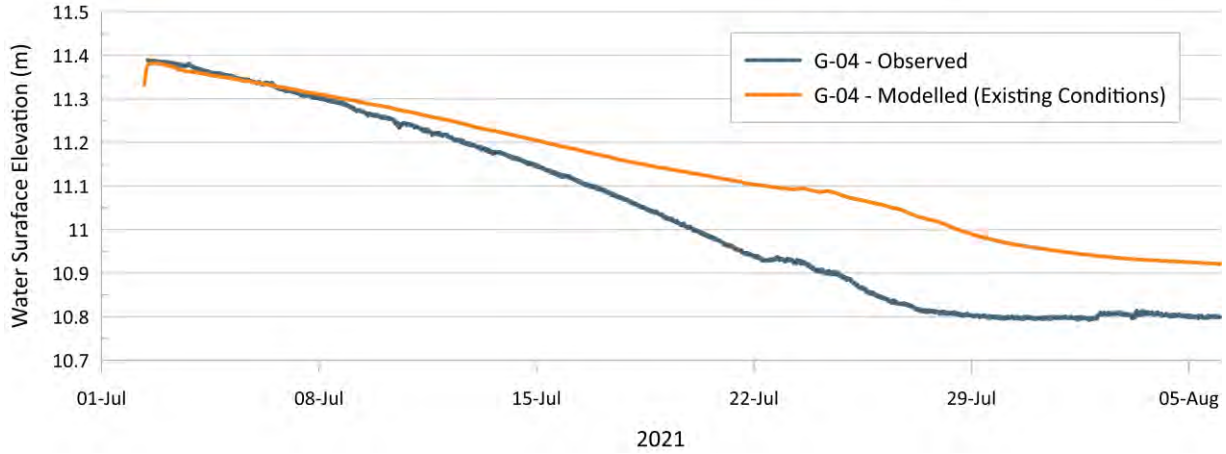

Figure 7: Comparison of observed and simulated WSE at G-04

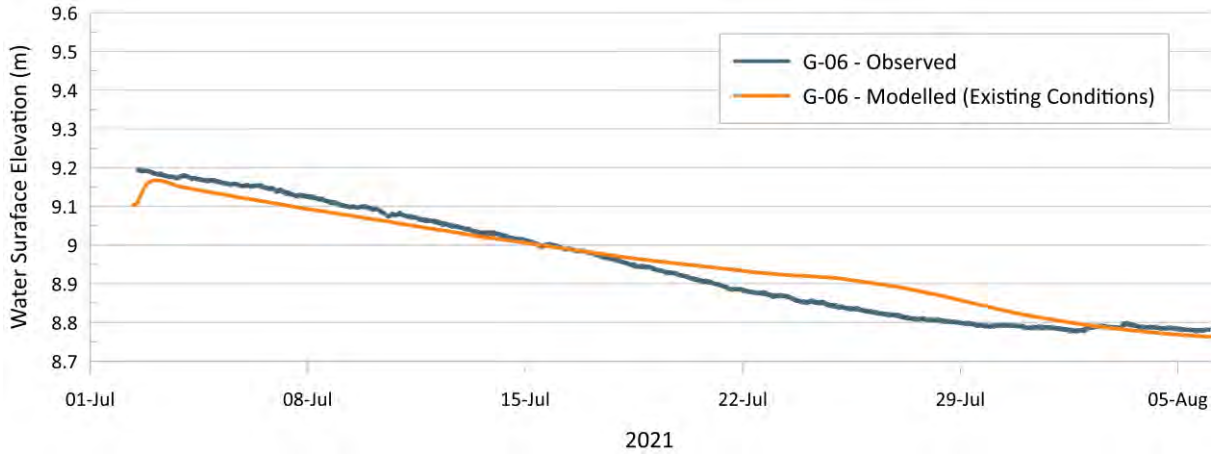

Figure 8: Comparison of observed and simulated WSE at G-06

4.5. Model Limitations and Areas for Improvement

While the model satisfactorily predicted pond water levels for this conceptual assessment, limitations and future improvements have been identified for future project phases. The model did not consider the local hydraulics associated with the culverts. Should modifications to the culverts (discussed further in Section 5) be selected as a preferred option, it is recommended that a smaller scale model be developed. Other important processes that will affect water availability for fish habitat that are not captured in the model include evapotranspiration, direct precipitation, runoff from contributing areas other than Iqaluktuuttiaq, and shallow subsurface connections (taliks). It is unclear to what degree the absence of these processes impacts the model's prediction of the WSE in the system and if including them would improve performance for a model intended for evaluation of detailed designs. As the model typically over-predicts the water in the system, representing evaporation could result in improved model performance for more detailed analysis phases.

Recommended areas for improvement for future iterations of the model include:

- Explicitly including evaporation and precipitation inputs in the model for long-term simulations (greater than a week)
- Calibrating the model roughnesses
- Improved representation of the local culvert hydraulics, whether done internally in HEC-RAS or externally.

5. Conceptual Offsetting Habitat Options: Connectivity and Passage Enhancements

Several conceptual fish habitat enhancements were considered, with the objective of facilitating passage and improving connectivity within the upstream portion of the EOS (EOS-1). Options in this regard are described below and were evaluated at the conceptual level for feasibility and considerations for the next design stages.

Several constraints were identified in scoping the enhancement options:

- No modification of the Iqaluktuuttiaq outlet (at the upstream end of the EOS) since this could potentially impact summer flows in Freshwater Creek.
- The enhancements should minimize reductions to existing pond water levels where possible.
- The enhancements should minimize impacts to the surrounding areas where possible.

5.1. Enhancement Options

5.1.1. Culvert Modifications at Road Crossing

The culverts were previously identified as a potential barrier to fish migration (ERM, 2019). At high flows (typically during the freshet) the culverts are a potential velocity barrier, while at lower flows most of the culverts are perched. The existing culverts have been assessed based on the measured water levels from the 2021 hydrometric field campaign and considerations are discussed below.

5.1.2. Connector Channel Enhancements

The objective of the connector channel enhancements is to modify the channel's width:depth ratio at strategic locations to improve connectivity between the deeper ponds (those providing over-wintering habitat). It is anticipated this will primarily be achieved by excavating smaller passage channels within the wider existing channel. The feasibility assessment focused on the connection between Ponds 2 and 4. A conceptual plan (Appendix A) has been prepared to illustrate the general configuration of these enhancements.

5.1.3. Downstream Riffle

This study assessed the feasibility of constructing a riffle within the downstream portion of EOS-1 to increase the water level in Pond 5. This included an assessment of the optimal location and configuration for this riffle, based on the predicted increase to the Pond 5 water levels and depths. A conceptual plan illustrating the general arrangement of the riffle has been prepared (Appendix A).

5.2. Culvert Modifications at Road Crossing

The existing culvert inlet and outlet elevations (illustrated in Figure 9) were surveyed in September 2021. They were then compared to the measured water surface elevations from the hydrometric program (Figure 10). This evaluation further corroborated that the culverts are controlling the flow into the EOS during higher flows, with different culverts becoming perched as the water levels recede (based on the invert elevations).

By the end of July, only two culverts (1 and 2) were active and controlling the elevation of Pond 1. After the freshet, Culvert 1 is the only one that is not perched at the outlet.

Three options were considered for improving fish passage here, and are discussed in Table 5 below. Several considerations will need to be evaluated prior to the selection of a preferred option, as follows:

- Improving connectivity by lowering the upstream culvert invert will reduce the Pond 1 water level. Ideally, the upstream invert should be lowered to provide backwater within the culvert from Pond 2. Thus, the low flow water level of Pond 1 would reduce by approximately 20 cm (equalizing with the water level in Pond 2). The trade-off between this reduction in habitat and improved connectivity will need to be assessed.
- Changing the conveyance capacity at the crossing may impact the distribution of flows between the EOS and Freshwater Creek during the higher flows. While this change is expected to be minor, potential impacts to Freshwater Creek should be assessed.
- The benefits of improving migration from the EOS to Iqaluktuuttiaq would only be realized for a short period during higher freshet flow until the lake and Pond 1 have receded and the connection between them dries up. This occurred between approximately July 13-17 for the 2021 period of record. The benefits and trade-offs between providing upstream passage through the crossing should be assessed.

Table 3: Crossing enhancement options and considerations.

Option	Description	Benefits	Trade-Offs
Maintain the Existing Crossing and Modify Upstream/Downstream Ponds	A shallow connector channel would be constructed from Pond 1 to the inlet of Culvert 1. Pond 2 would be enhanced by increasing the depth downstream of Culverts 1 and 2 to improve connectivity between the culverts and the deepest portion of Pond 2.	Least costly. Minimizes disturbance to surrounding area. Provides improved connectivity for downstream migration between Pond 1 and 2 during low flow periods. Maintains existing water levels of Pond 1.	Does not address potential velocity barriers to upstream migration during freshet.
Clear Span Bridge	Replace culvert crossing with a clear span bridge similar to the crossing at the downstream of the EOS.	Would reduce the potential of a velocity barrier to upstream migration during freshet. Would reduce risk of road overtopping during freshet.	Most costly. Would reduce Pond 1 water level. Would require additional engineering assessment for hydraulic and constructability feasibility. Greatest design and construction complexity of the crossing options.
Replacing Culverts	The existing crossing can be modified by replacing some or all of the culverts with larger CSPs at new elevations to improve connectivity.	Less expensive than a clear span bridge. May reduce potential of velocity barrier to upstream migration. Inverts can be designed to balance impacts to Pond 1 water levels while improving connectivity for downstream migration.	May result in reductions to Pond 1 water level. Would require additional engineering assessment for hydraulic and constructability feasibility.

Figure 9: Photos of the upstream (top) and downstream (bottom) face of the culverts (September 18, 2021). Culverts have been numbered sequentially from 1 to 8 facing downstream.

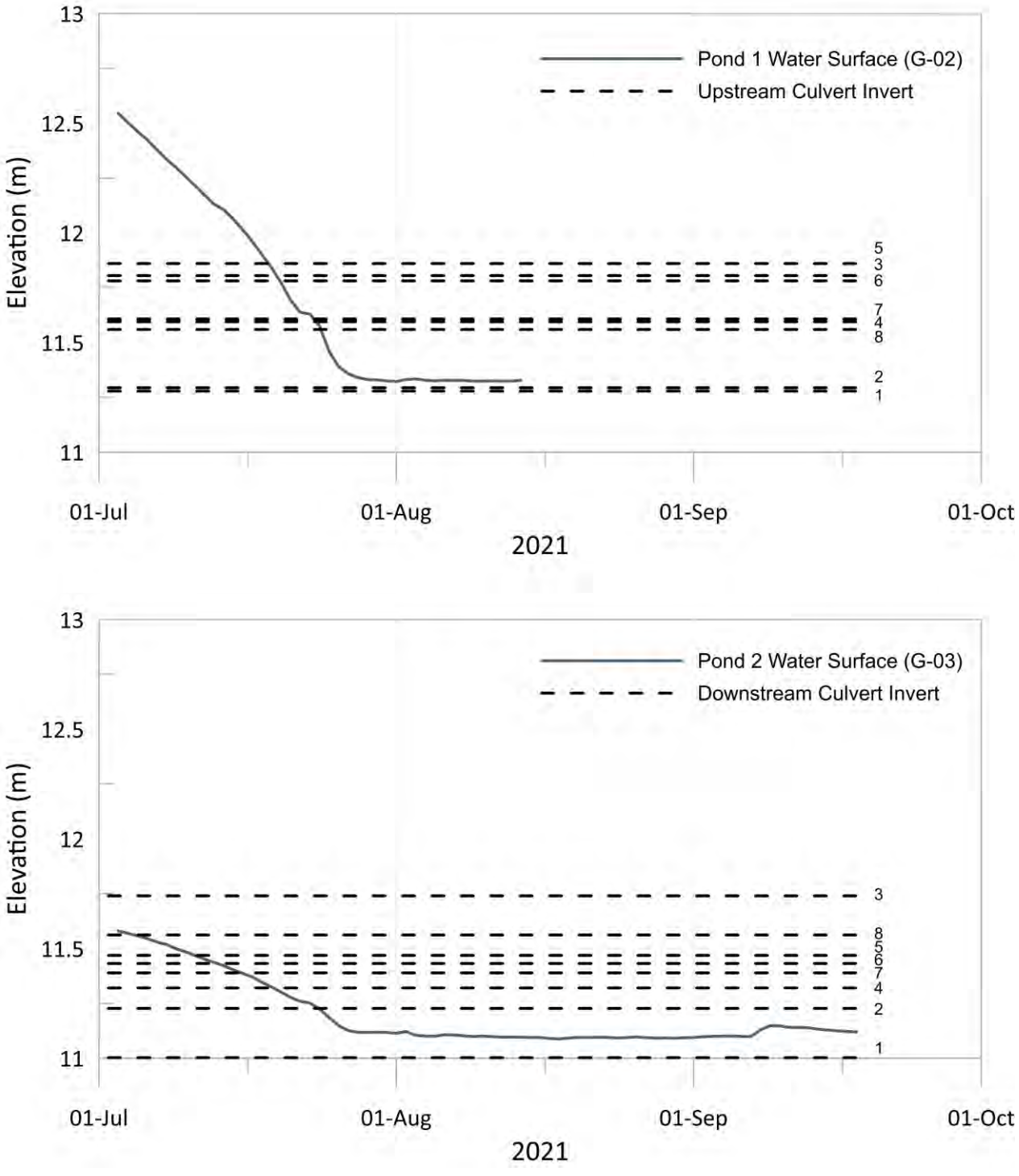

Figure 10: Upstream (top) and downstream (bottom) water levels with surveyed culvert inverts for reference. G-02 record ends on 2021-08-14.

5.3. Connector Channel Modifications

To evaluate the relative changes between the existing conditions and the enhancement of the connector channels, the HEC-RAS model was used to simulate a potential configuration of the enhancements. Three channel modifications were added to the model, with one each at the inlet to Pond 3, the outlet of Pond 3 and the outlet of Pond 4a (Map 3). The modelled channel modification had a 1.0 m bottom width and 2:1 side slopes. To simulate the increased roughness of the rock used to construct the channels, the Manning's roughness values in the modified channel areas was increased to 0.04. The longitudinal slope was blended into the existing terrain and maintained a depth of approximately 0.3 m. The presented slope is conceptual and will be refined during the detailed design phase. The existing and modified channel profiles are shown in Figure 11 along with the resulting WSE profiles at the model simulation time of 05-Aug-2021 17:15.

Figure 12, Figure 13, and Figure 14 shows simulated impacts of the proposed channel modifications on the modelled WSE at the gauged locations. The biggest impact is observed at G-03 (Pond 2) where the water level was decreased by as much as 15 cm. The water levels at G-04 were increased slightly and the levels at G-06, G-02, and G-01 were unaffected. Under existing conditions, Pond 2 and Pond 3 became disconnected on 2021-07-30 but this connection was maintained under the proposed conditions. The connections between Pond 3 and Pond 4a and Pond 4 were maintained through the simulation period, corroborating the measured water elevations during the September 2021 fieldwork. Although the water surfaces were similar within these ponds, the connector channels still had shallow flow depths (<10-20 cm). The field measurements and modelling suggest that the outlet to Pond 4 is the primary hydraulic control for Ponds 3, 4a and 4. As such, there are expected to be minimal impacts to upstream water levels if connection channels are modified to improve passage. This design option can allow for longer periods of fish passage further upstream, but there will be potential water depth decreases in some of the ponds (i.e. the connection between Pond 2 and Pond 3).

The hydraulic modelling investigation corroborates field observations that improved channel connections between Ponds 3, 4a and 4 are feasible, with minimal impacts to upstream water levels predicted. It also demonstrates the feasibility of improving passage between Pond 2 and Pond 3, however, the upstream (Pond 2) water level may decrease as a result. Opportunities to minimize the impact to Pond 2 will be explored during the next design phases.

The modelling investigation can also be extended to Ponds 5a-e during the next project phase (if required). Based on the measured water levels, it is anticipated that a similar channel modification approach could be implemented to connect, at a minimum, Ponds 5b-e to Pond 5. This option could be explored as an alternative or contingency to the downstream riffle option (discussed in Section 5.4). It is not recommended to modify the connection between Pond 4 and Pond 5a due to the importance of the Pond 4 outlet in controlling upstream pond levels.

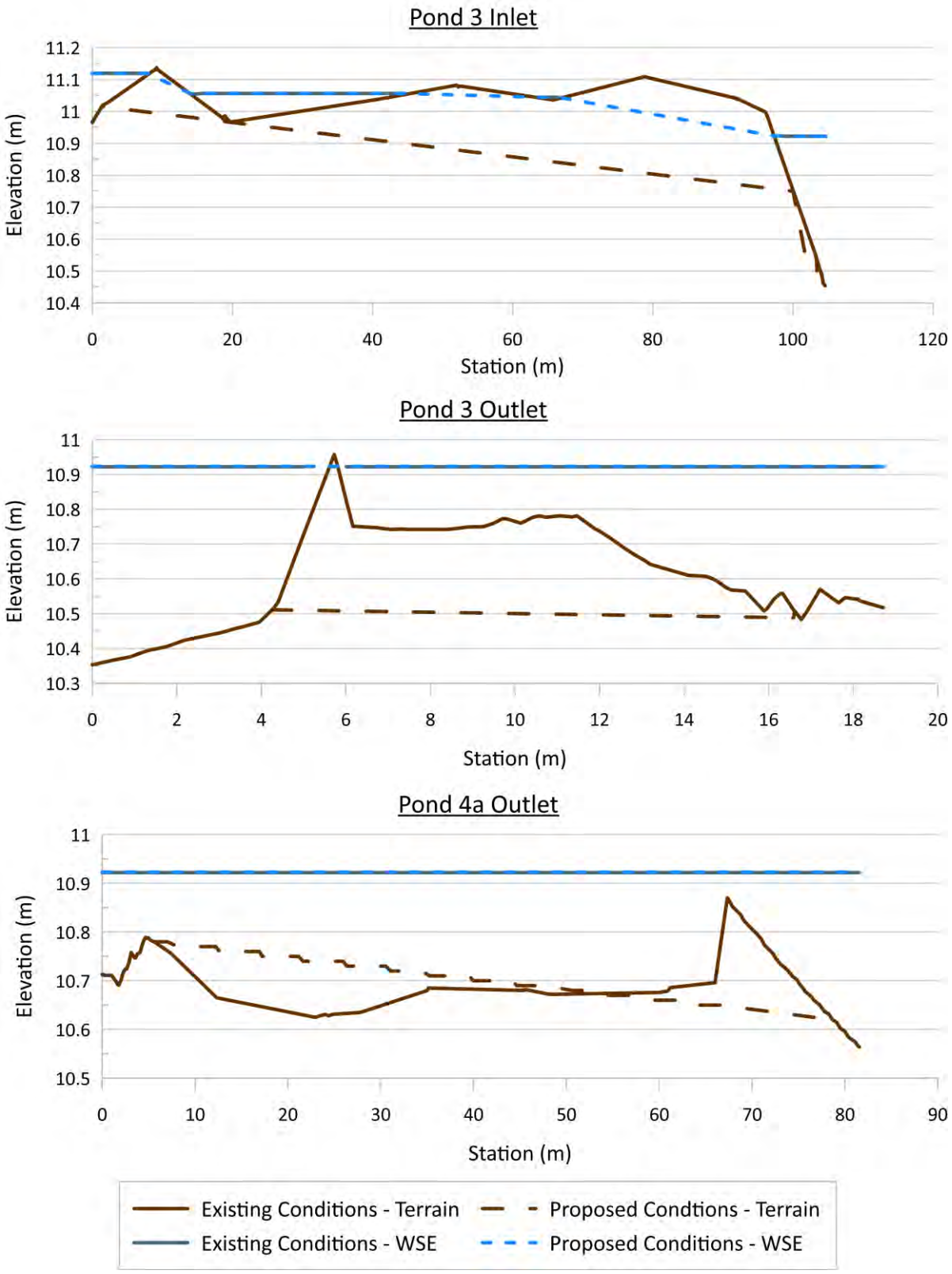

Figure 11: Longitudinal profile at the proposed channel modifications showing the existing profile, a potential proposed profile, and the simulated WSEs on 05-Aug-2021 at 17:15. Note that the proposed profile is to demonstrate the concept and will change during the detailed design phase.

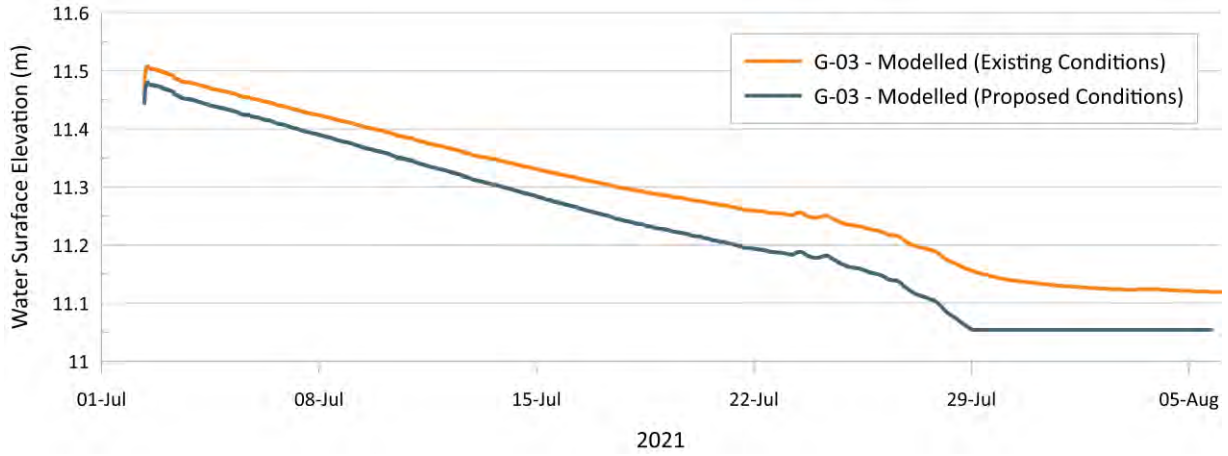

Figure 12: Comparison of the simulated WSE at G-03 for existing and proposed conditions.

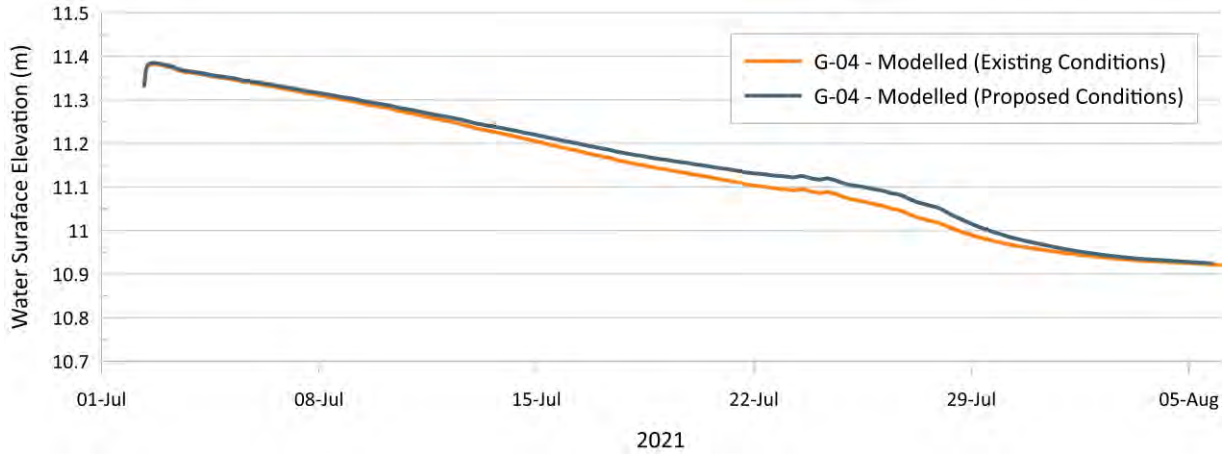

Figure 13: Comparison of the simulated WSE at G-04 for existing and proposed conditions.

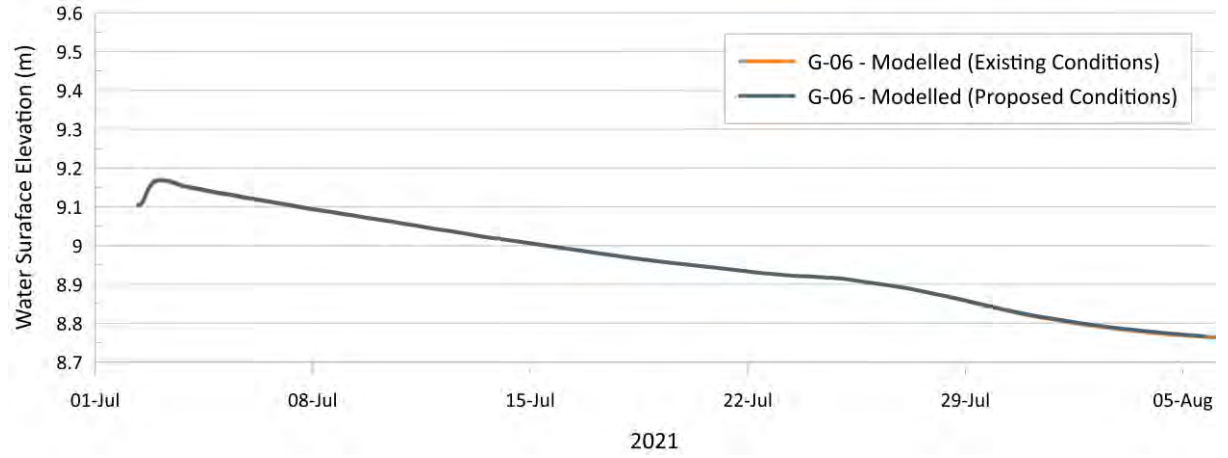

Figure 14: Comparison of the simulated WSE at G-06 for existing and proposed conditions.

5.4. Downstream Riffle

The objective is to install a riffle near the outlet of Pond 5 to increase the upstream water level (within Pond 5) and, if possible, improve connectivity to the small ponds immediately upstream (i.e. Ponds 5a-e). Several considerations informed the initial constraints:

- The riffle should be situated within an existing connector channel.
- The crest height should be minimized to the extent possible, to maintain similar characteristics with the reach-wide morphology.
- The riffle should be situated where potential flanking or spillover risks are minimized to avoid the need for additional berms in surrounding low-lying areas (minimize long-term maintenance).

Several riffle locations were evaluated for feasibility, including the transition between EOS-1/EOS-2, the outlet of Pond 6 and the outlet of Pond 5. The outlet of Pond 5 was deemed the most appropriate location because the other two options did not meet the constraint criteria listed above. This feasibility assessment considered a crest height of 0.5 m to estimate backwater because it blends well into the existing morphology at that location.

Map 7 shows a comparison of the existing pond extent to that under backwater conditions caused by the proposed riffle. To evaluate the increased habitat, a comparison of the total area in Pond 5 was completed for existing and proposed conditions. Pond 5 was the only waterbody included in the quantitative analysis even though Ponds 5f, 5e, 5d, 5c, and 5b also have increased connectivity and water levels, because there is no bathymetric data available for these ponds. To assess changes in areas the pond contour of the surveyed water level on September 19, 2021 (9.19 m) and the backwater contour (9.6 m) was used to export stage-area curves from the DSM surface for each condition. The total surface areas of the pond under existing and proposed conditions are ~353,000 m^2 and ~401,000 m^2, respectively. Overall, the change in Pond 5 water levels results in a relative reduction of shallow depths (<2 m) and an increase in relative depths greater than 2 m. Table 4 summarizes the results by depth and these results are plotted in Figure 15.

Table 4: Changes in total pond area in Pond 5 under existing and proposed conditions.

Depth Range (m)	Total Area (1000 m^2) – Existing Conditions	Total Area (1000 m^2) – Proposed Conditions
0 - 0.5	61.9	58.4
0.5 - 1	78.1	63.1
1 - 1.5	59.6	76.5
1.5 - 2	98.1	64.1
2 - 2.5	38.3	92.5
2.5 - 3	3.0	30.6
3 - 3.5	10.7	2.9
3.5 - 4	2.6	10.8
4 - 4.5	0.5	2.1
>4.5	0.0	0.4

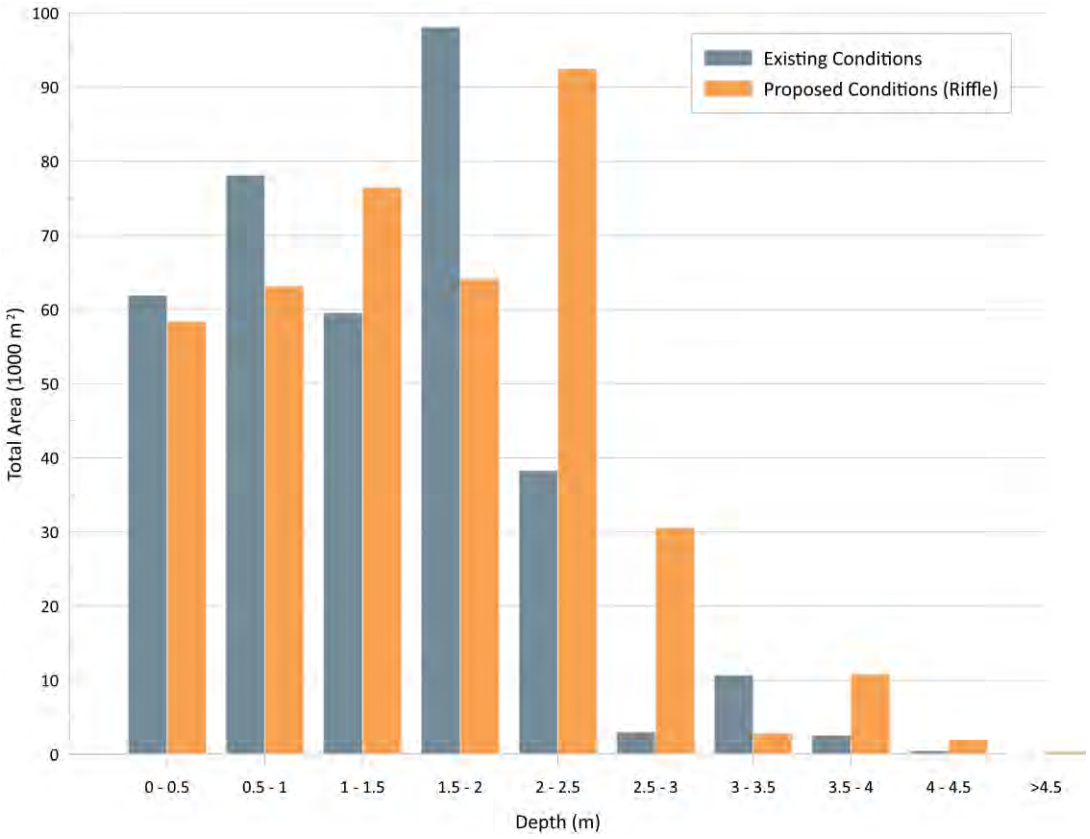

Figure 15: Comparison of total area (m^2) at depth between existing conditions and the proposed riffle condition in Pond 5.

Additional considerations to be assessed at the future design stages include:

- Materials (hydraulic stone sizing, permeability considerations)
- Construction (material sourcing, access and implementation)

5.5. Enhancement Option Summary

Each offsetting option has benefits and trade-offs, with some options requiring additional considerations at future design stages. Table 5 summarizes the benefits and trade-offs for each proposed design option. It should be noted that the cumulative impacts of implementing all of the design options have not been evaluated at this stage of analysis. The following conclusions can be drawn from the conceptual feasibility assessment:

- Culvert improvements are feasible, with the final configuration bring dependent on the specific fisheries objective. The analysis indicated that upstream fish migration from the EOS to Iqaluktuuttiaq will only occur for a short period. Modifying the culverts may impact the upstream pond (Pond 1) and the proportion of flow entering the EOS during the freshet. Impacts to Freshwater Creek, although expected to be minor, will need to be evaluated once the desired fisheries objectives have been established.

- The connector channels between Pond 2 and Pond 4 are feasible. The analysis indicated that the Pond 4 outlet is the primary hydraulic control for Ponds 4, 4a and 3. The connector between Ponds 2 and 3 will require design iteration of the upstream invert and slope to optimize the trade-off between increased passage and reductions to the Pond 2 water level. The field data revealed that it may also be feasible to enhance the connectors between Ponds 5a and 5. The hydraulic model developed for the EOS can be used to extend the feasibility assessment to the connectors between these ponds, should it develop as a preferred option.
- A riffle with a 0.5 m crest height was assessed to increase the overall wetted area of Pond 5, as well as the proportion of the pond having deeper water. In addition, the backwater was estimated to extend upstream to Pond 5b, which is likely to improve connectivity between these ponds. However, the design and construction complexity of this option is more significant, relative to the connector channel modifications, and additional considerations for materials and implementation methods will be required at future design phases.

Table 5: Conceptual offsetting options overview.

Offsetting Option	Description	Benefit	Trade-Off
Improving Road Crossing	Maintain Existing Crossing and Modify Upstream/Downstream Ponds Clear Span Bridge Replacing Culverts	Improves connectivity between the upstream and downstream ponds. Improves connectivity between Pond 1 and Pond 2.	Will likely result in lower headwater elevation in Pond 1, potentially decreasing available habitat. Changing hydraulic conveyance capacity at the crossing may impact flows in Freshwater Creek at higher flows during freshet.
Connector Channel Modifications	Create new fish passage channel along the thalweg to improve channel connection between ponds.	Improves connectivity between Pond 2, Pond 3, Pond4a, and Pond 4. Connection between the ponds exists for longer than under existing conditions.	May result in lower water elevations in the connected ponds (particularly Pond 2), potentially decreasing available habitat.
Downstream Riffle	Construct a riffle at the outlet of Pond 5 to increase water levels in Pond 5.	Increases water levels upstream of the riffle. Increases overall area and depth in Pond 5. Provides a connection to Ponds 5b-e.	Additional design and implementation considerations before feasibility can be confirmed. Design and construction complexity of this option is greater relative to the connector channels.

6. Considerations and Recommendations for Future Project Phases

Additional fieldwork, analysis, and design steps to be considered during future phases of the project are discussed below. These tasks will be contingent on which preferred offsetting options are advanced to design.

6.1. Field Assessments

It is recommended that the hydrometric program be continued in the 2022 open water season. Another year of hydrometric data will support the ongoing program by:

- Improving on the 2021 data gaps (i.e. a longer record for G-01 and G-02, additional discharge measurements to improve rating curves).
- Providing more baseline hydrologic data to better inform the variability of future designs and effectiveness monitoring of the preferred offsetting options.

Additional field data will be required to advance the design of the downstream riffle, should it be advanced as a preferred option. It is recommended that a survey be conducted in the general location of the proposed riffle to characterize the detailed topography and to identify any potential spill points that were not picked up in the DSM. Should the culvert improvements be selected as a preferred option it is recommended that the hydraulic controls of Freshwater Creek also be surveyed to help determine the extent of impacts to that system.

6.2. Modelling

GRA developed a model to conceptually evaluate the system that adequately captured relative water level changes and responses in the system. Section 4.5 outlined several recommendations for improvement of the 2D model to refine its predictions for future, more detailed analysis phases. This refined model will be required to advance the designs of any of the offsetting options and to estimate the potential cumulative impacts of the suite of preferred options. Given that the model did not consider local culvert hydraulics, a separate model may be required if modifications to the crossings are deemed as a preferred option.

6.3. Design

The detailed design tasks will vary based on the selected offsetting options. For the road crossing, this will depend on the options outlined in Table 3. Additional design steps for the connector channel modifications will include iterating the channel inverts, slopes, and cross-sectional dimensions to optimize connectivity while minimizing impacts to upstream water levels.

For the upstream suite of connections, this work will mostly focus on the connection between Ponds 2 and 3. The design for the downstream riffle will focus on refining the riffle geometry and completing hydraulic stability assessments for the proposed stone. For all of the options, construction considerations (e.g. access, erosion and sediment control, material sourcing) will need to be assessed.

7. Closure

GeoProcess Research Associates was contracted by Minnow Environmental to support Agnico Eagle Mines Limited in evaluating fish habitat offsetting options for the Madrid-Boston Project. The offsetting options evaluated in this report focus on the East Outflow System, which is an outlet of Iqaluktuuttiaq (formerly known as Grenier Lake). Fieldwork in 2021 consisted of a hydrometric monitoring program, a geomorphology assessment and a UAV-based aerial survey that informed a concept-level feasibility assessment of offsetting options. These options included improvements to an existing culvert crossing, enhancements to several connector channels and installing a riffle to increase depths upstream. The following key conclusions are drawn from this assessment.

The EOS extends for approximately 8 km from Iqaluktuuttiaq to the Arctic Ocean. Two dominant morphologies were identified, with the upstream portion of the EOS consisting of a series of ponds connected by short channels, and the downstream portion of steeper, more confined channels separated by smaller ponds. The offsetting options focused on the upstream portion of the system.

The upstream portion of the EOS has a very shallow gradient (0.05%) and is a low energy system, owing to the shallow gradient and the influence of pond backwater which reduces erosion potential.

The hydrometric monitoring program indicated that, in 2021, flows in the EOS ranged from approximately 8 m^3/s in early July to less than 0.01 m^3/s by the end of August.

During the peak of the freshet, the culvert crossing was controlling the inflow to the EOS until the Iqaluktuuttiaq level dropped (approximately mid-July).

A conceptual 2D hydraulic model was developed for the EOS to support an evaluation of the offsetting options. The preliminary results indicate that the model adequately captures the storage dynamics of the system, and several recommendations have been identified for model refinement during future project phases.

Three general offsetting options were explored in this assessment: improvements to the culvert crossing, improvements to the connector channels and installation of a riffle to provide backwater to upstream ponds.

Three options for potential improvements to the existing road crossing were identified including: maintaining the existing culverts and improving passage through the excavation of small channels at the inlet and outlet, replacing the crossing with a clear span bridge, and replacing some or all existing culverts with larger diameter culverts. Each option has associated benefits and trade-offs related to cost, design and construction complexity and the preferred option should be identified based on the specific objectives related to fisheries connectivity improvements (i.e. focusing on upstream or downstream migration).

Field and hydraulic modelling assessments indicated that improvements to the connector channels between Pond 2 and Pond 4 are feasible, with two of the three assessed channel modifications having a minimal impact to upstream pond levels. The specific geometry of these channels will be refined in future design phases to minimize impacts to upstream pond levels while increasing water depths to improve connectivity for a longer portion of the open water season. Field measurements also indicate that a similar approach could be feasible to increase connectivity between Ponds 5a and Pond 5 and can be evaluated (as an alternative to the riffle implementation) to improve connectivity within this portion of the EOS.

The outlet of Pond 5 is the most feasible location for construction of a riffle. A 0.5 m crest height was estimated to increase the overall area of Pond 5, as well as the proportion of deeper water within the pond. The backwater was estimated to extend upstream to Pond 5b, which is likely to improve connectivity between these ponds. However, the design and construction complexity of this option is more significant (relative to the connector channel modifications) and additional considerations related to materials and implementation will be required at future design phases.

Additional fieldwork is recommended to supplement the hydrometric monitoring program and to support future design and effectiveness monitoring phases of the project. Depending on the preferred options being advanced to design, improvements to the 2D model and additional hydraulic modelling of the culverts have been identified.

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HOPE BAY FISHERIES OFFSETTING: CONCEPTUAL OPTIONS EVALUATION FINAL REPORT

Prepared for Minnow Environmental Inc.
(a Trinity Consultants Company)

August 10, 2022

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Project Number P2020-427

Maps

Legend

- Hope Bay Mine Site
- Project Study Area

Notes: Background map provided by ESRI

N

0 25 50 km

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CREATED BY:	SG	PROJECT NO.:	P2020-427
CHECKED BY:	BP	DATE:	Aug 10, 2022

Map 1: Project Location

Coordinate System: UTM Zone 13 [EPSG:32613]

Hope Bay Fisheries Offsetting Conceptual Options

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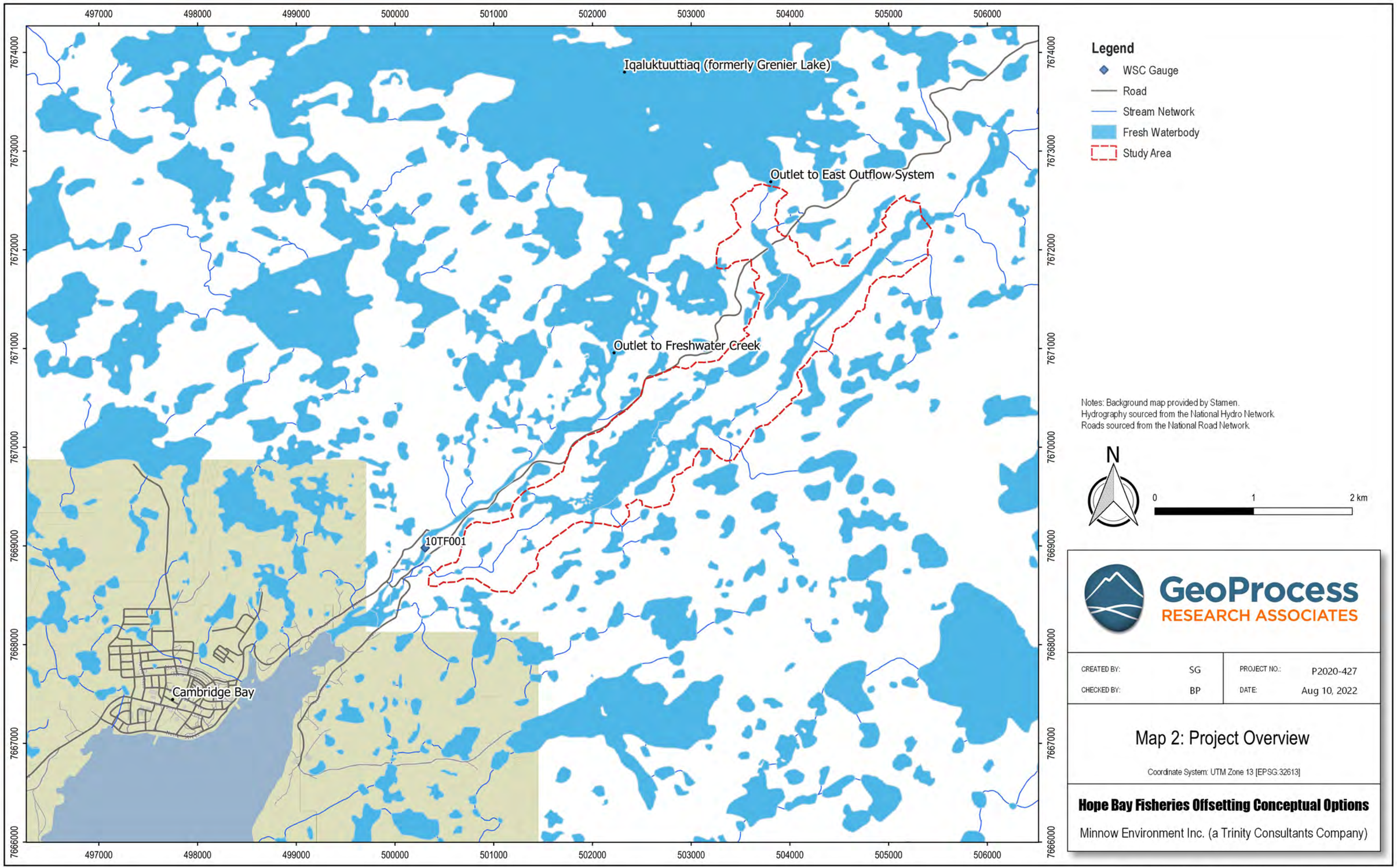
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Iqaluktuuttiaq (formerly Grenier Lake)
Outlet to East Outflow System
Outlet to Freshwater Creek
10TF001
Cambridge Bay
Legend
WSC Gauge
Road
Stream Network
Fresh Waterbody
Study Area
Notes: Background map provided by Stamen.
Hydrography sourced from the National Hydro Network.
Roads sourced from the National Road Network.
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GeoProcess
RESEARCH ASSOCIATES
CREATED BY: SG
CHECKED BY: BP
PROJECT NO.: P2020-427
DATE: Aug 10, 2022
Map 2: Project Overview
Coordinate System: UTM Zone 13 [EPSG:32613]
Hope Bay Fisheries Offsetting Conceptual Options
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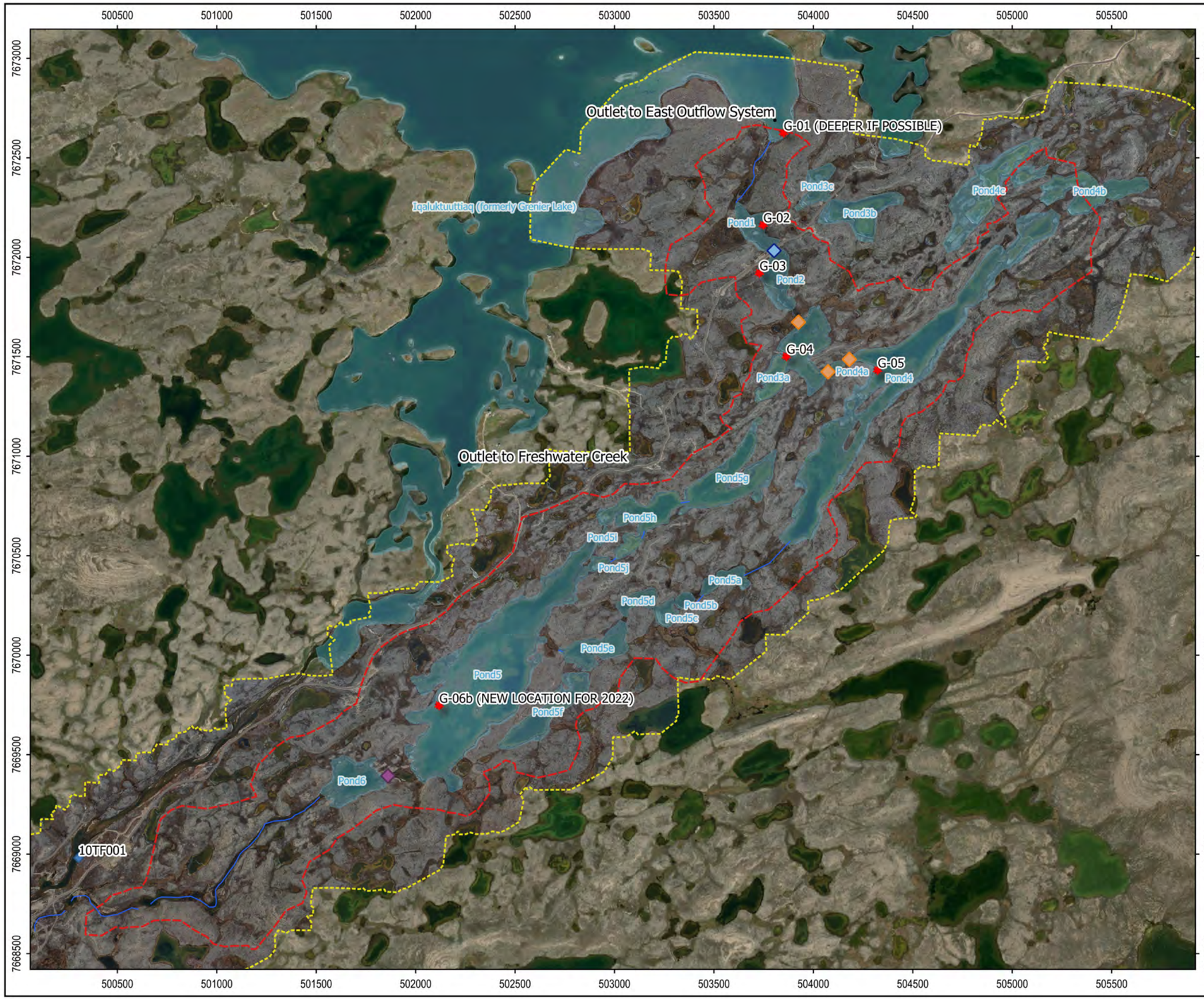

Legend

- WSC Gauge
- GRA Hydrometric Stations

Conceptual Offsetting Options

- Channel Notch
- Crossing Improvement
- Riffle
- Stream Network
- Study Area Waterbody
- Study Area
- Orthometric Imagery Extents

Notes: Background map provided by ESRI.
Ortho Imagery provided by GeoProcess.

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0 0.5 1 km

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Map 3: Existing Conditions and Evaluated Offsetting Locations

Coordinate System: UTM Zone 13 [EPSG:32613]

Hope Bay Fisheries Offsetting Conceptual Options

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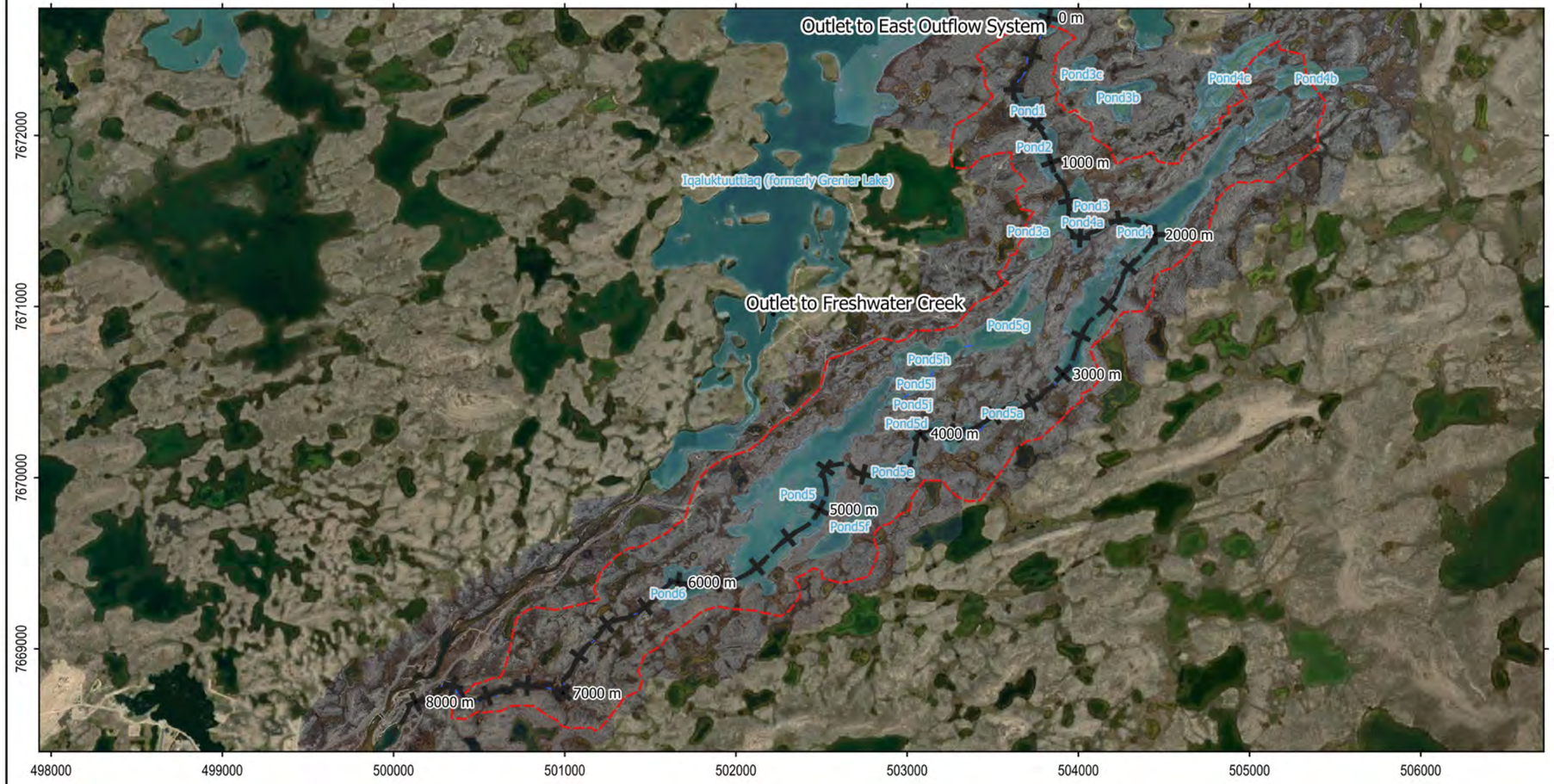

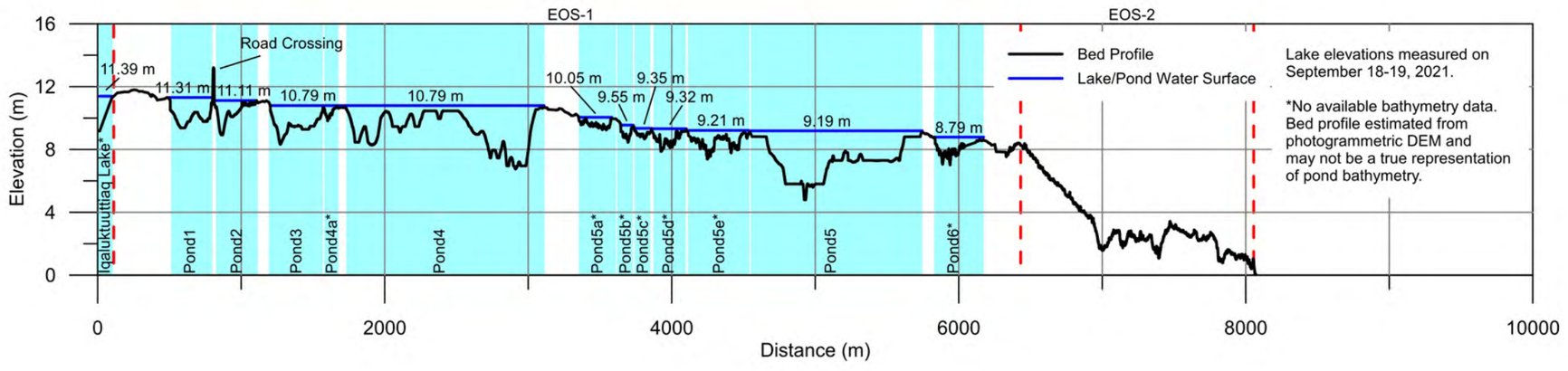

Legend

- Main Flowpath Profile
- Study Area
- Study Area Waterbody

Notes: Background map provided by ESRI.
Ortho Imagery provided by GeoProcess.

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0 750 1,500 m

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Map 4: Main Flowpath Profile

Coordinate System: UTM Zone 13 [EPSG:32613]

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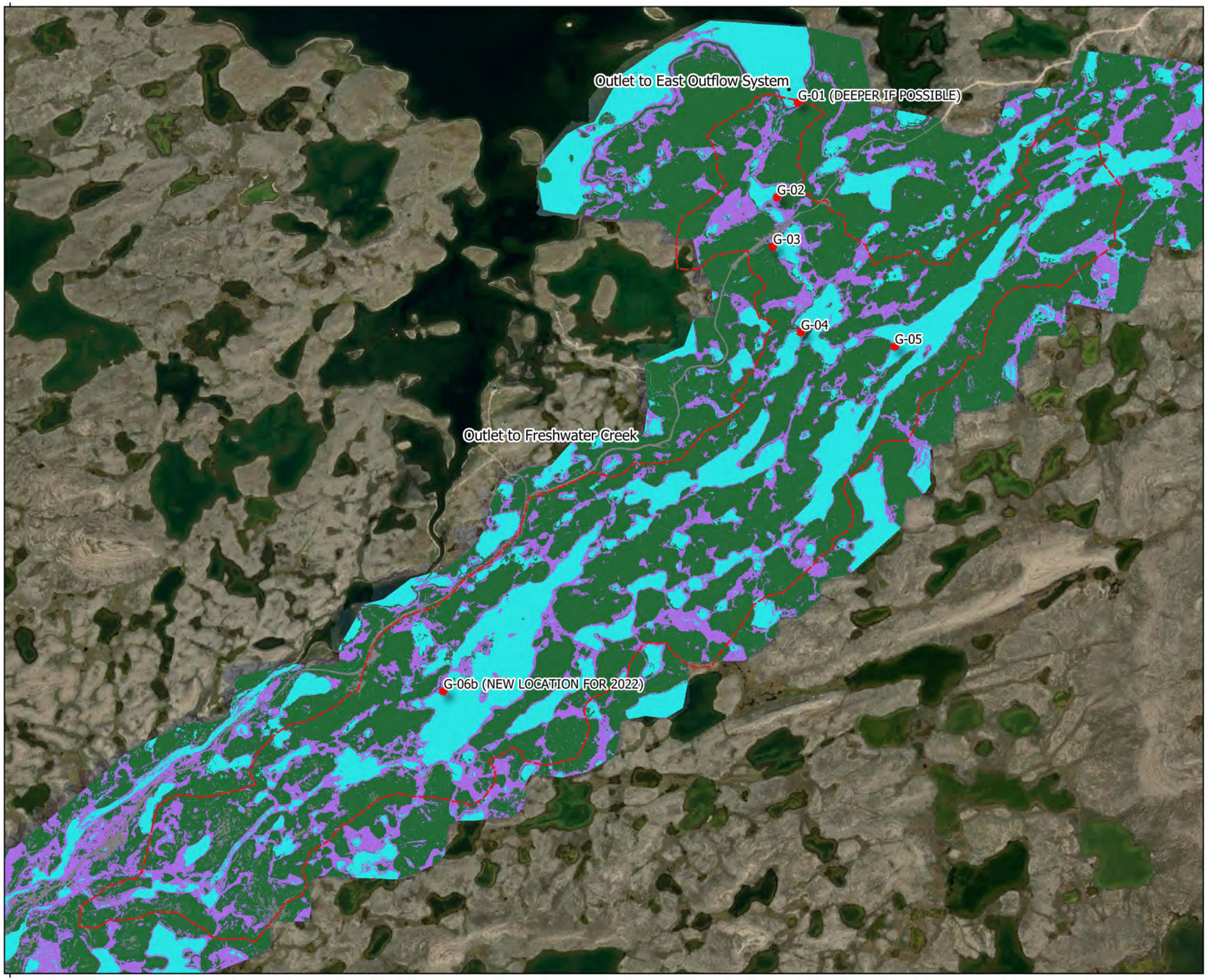

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Legend

- GRA Hydrometric Station
- Study Area

Landcover Classification
Band 1 (Gray)

- Littoral Zone
- Frequently Inundated
- Road
- Tundra

Notes: Background map provided by ESRI

N

0 0.5 1 km

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CHECKED BY:	BP	DATE:	Aug 10, 2022

Map 5: Landcover Classification

Coordinate System: UTM Zone 13 [EPSG:32613]

Hope Bay Fisheries Offsetting Conceptual Options

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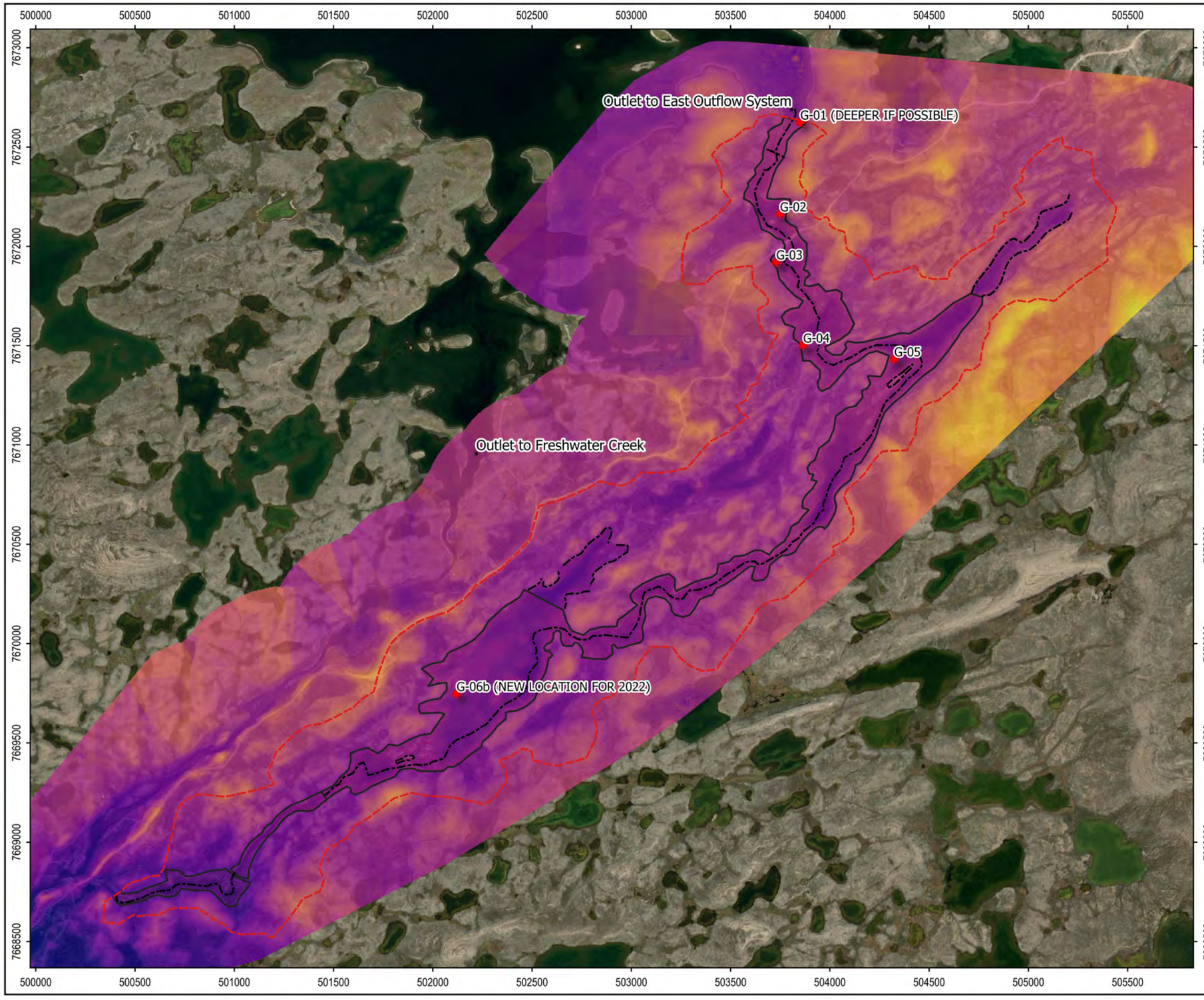

Legend

- GRA Hydrometric Station
- Hydraulic Model Breaklines
- Hydraulic Model Mesh Refinement Region
- Hydraulic Model Extents

DSM Elevation
Band 1 (Gray)
30
0

Notes: Background map provided by ESRI

N

0 0.5 1 km

GeoProcess RESEARCH ASSOCIATES

CREATED BY:	SG	PROJECT NO.:	P2020-427
CHECKED BY:	BP	DATE:	Aug 10, 2022

Map 6: Hydraulic Model Overview

Coordinate System: UTM Zone 13 [EPSG:32613]

Hope Bay Fisheries Offsetting Conceptual Options

Minnow Environment Inc. (a Trinity Consultants Company)

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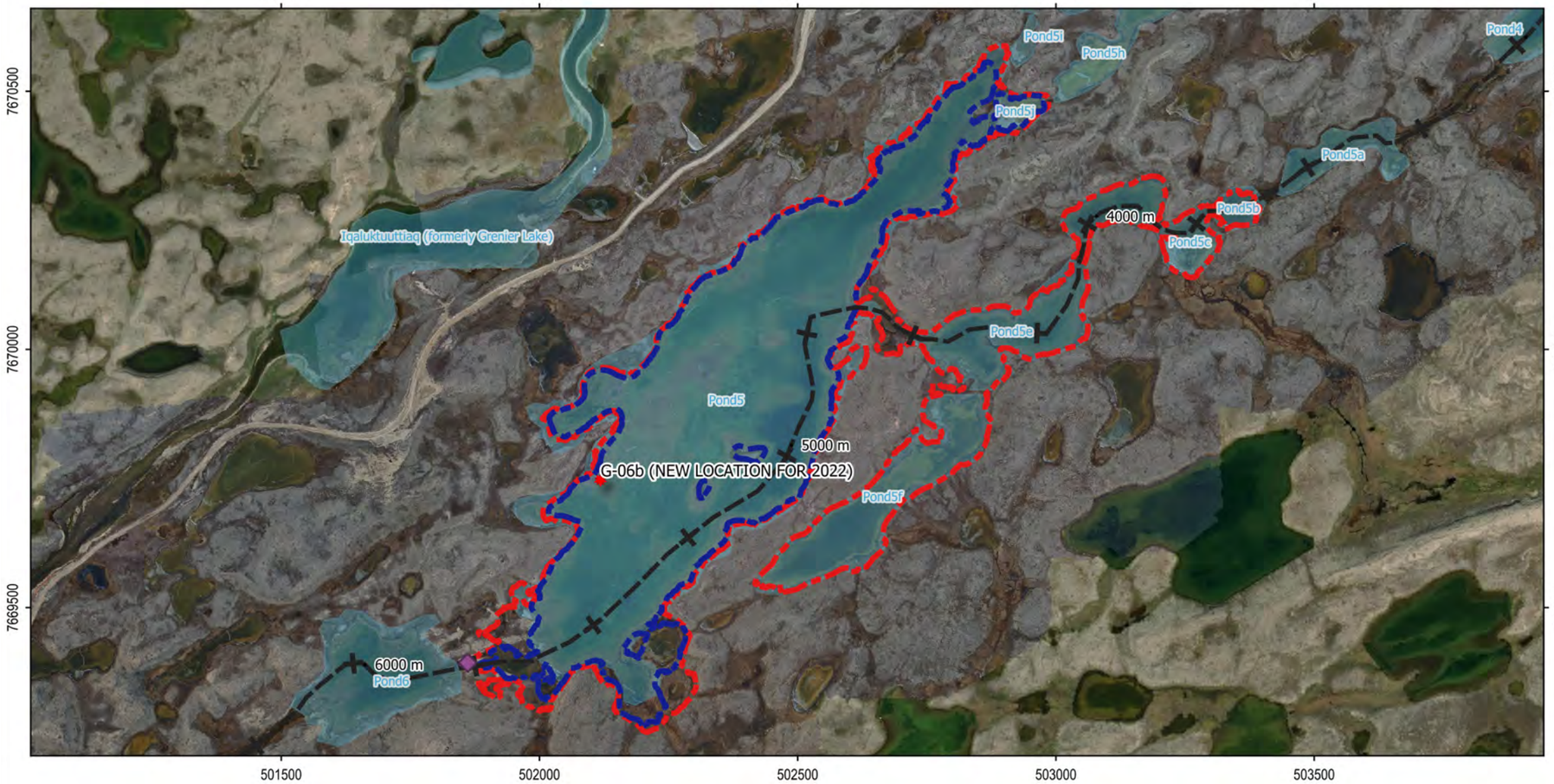


Legend

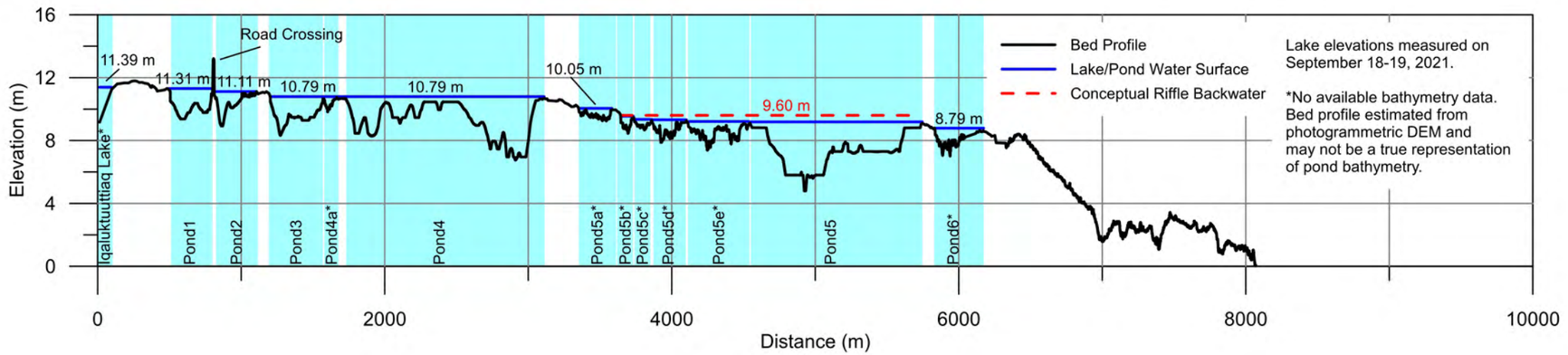
Conceptual Offsetting Options

- Riffle
- Existing Pond 5 - 9.19 m contour (Measured Sept 2021)
- Backwater Extents with Riffle (0.5 m Crest Height)
- Main Flowpath Profile

Notes: Background map provided by ESRI.
Ortho Imagery provided by GeoProcess.

N

0 250 500 m



Lake elevations measured on September 18-19, 2021.

*No available bathymetry data. Bed profile estimated from photogrammetric DEM and may not be a true representation of pond bathymetry.

GeoProcess RESEARCH ASSOCIATES

CREATED BY:	SG	PROJECT NO.:	P2020-427
CHECKED BY:	BP	DATE:	Aug 10, 2022

Map 7: Riffle Backwater Analysis

Coordinate System: UTM Zone 13 [EPSG:32613]

Hope Bay Fisheries Offsetting Conceptual Options

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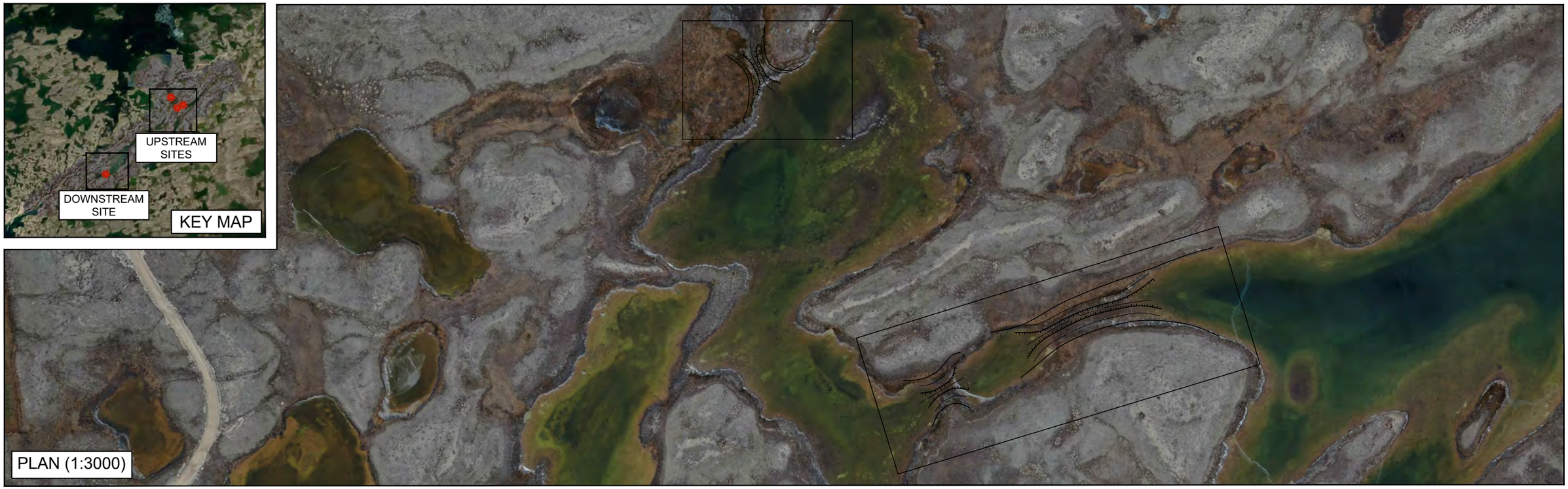
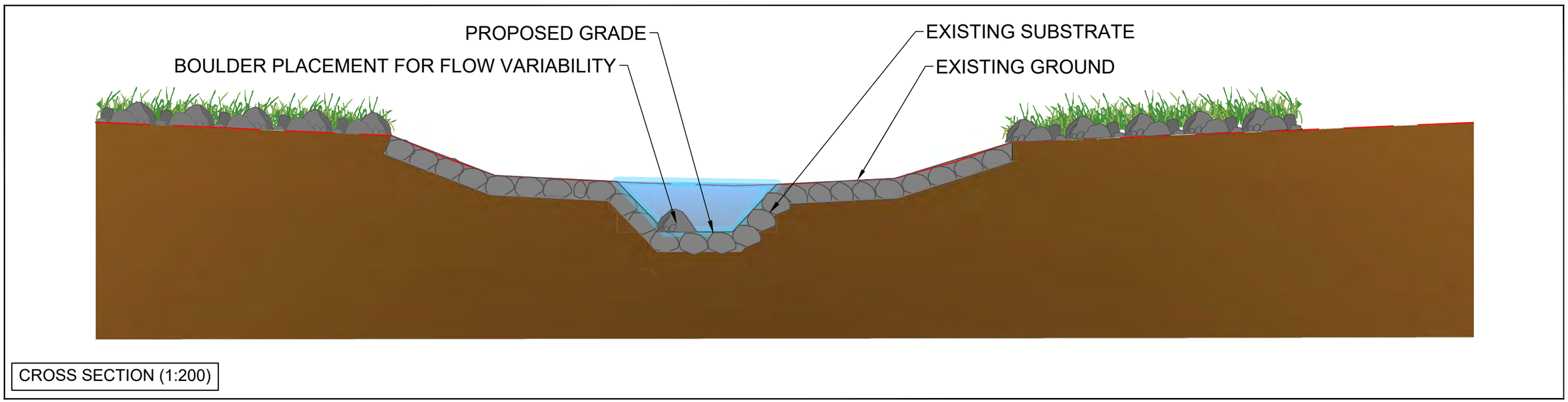
Appendix A

Conceptual Designs: Connector Channels and Downstream Riffle





GeoProcess RESEARCH ASSOCIATES

LEGEND

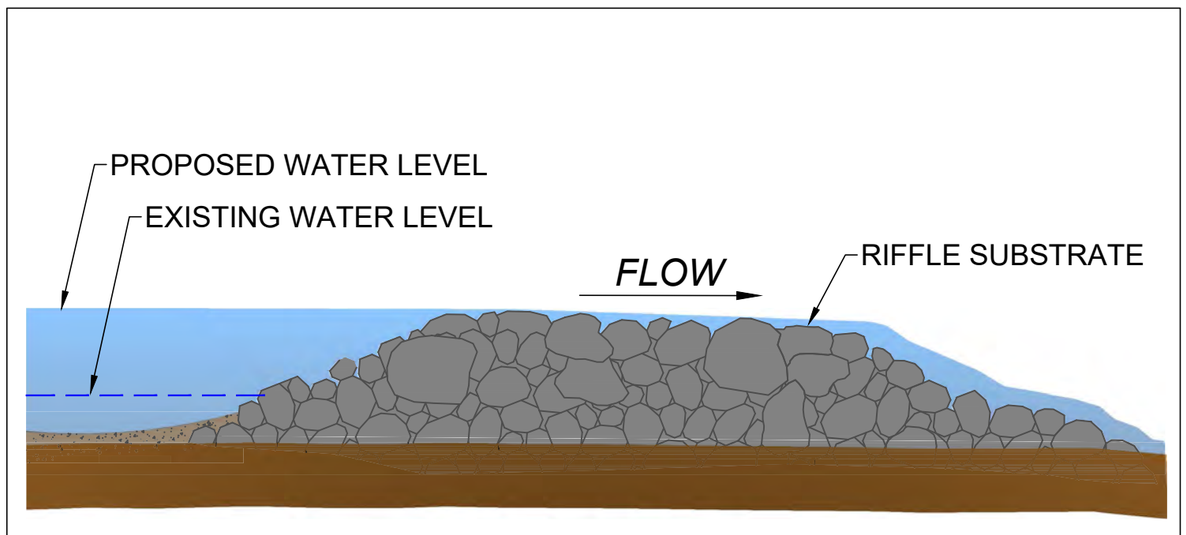
FOR DISCUSSION

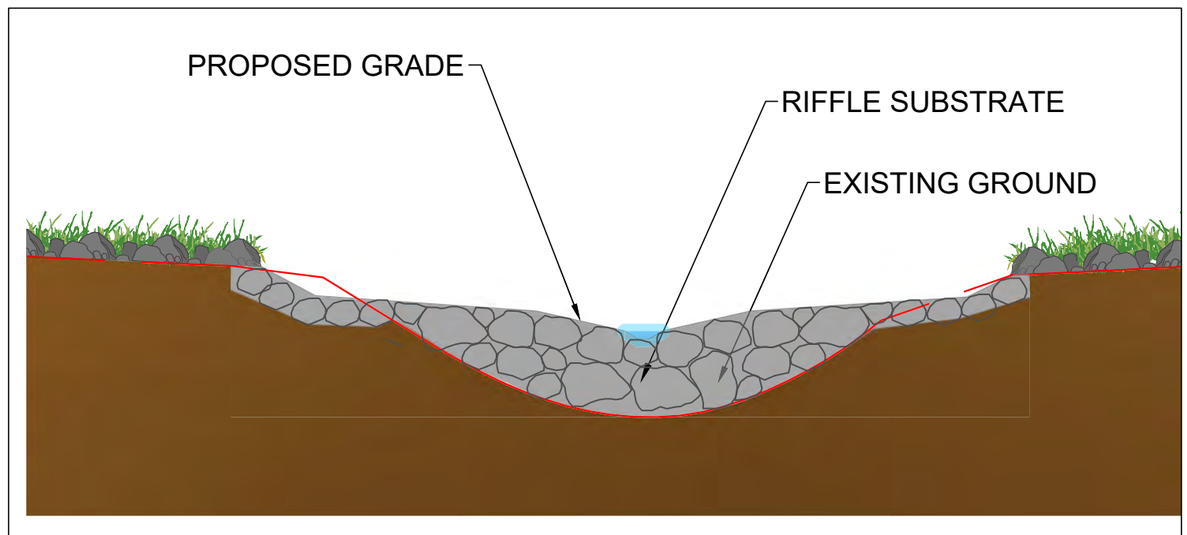
0 60 120
1:3000

0 4 8
1:200

HOPE BAY FISHERIES PROGRAM
PASSAGE ENHANCEMENTS - CONCEPT

Scale: as shown	Drawn By: SG	Figure No. 01
Date Issued: March 22, 2022	Checked By: BP	





GeoProcess RESEARCH ASSOCIATES

LEGEND

FOR DISCUSSION

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1:750

0 5 10
1:250

HOPE BAY FISHERIES PROGRAM
DOWNSTREAM RIFFLE - CONCEPT

Scale: as shown	Drawn By: SG	Figure No. 02
Date Issued: March 22, 2022	Checked By: BP	

APPENDIX D
HABITAT EVALUATION PROCEDURE

Table D.1: Summary of Arctic Charr Habitat Lost or Altered, Hope Bay Mine Operational Update

Impact	Watershed	Location	Habitat Type	Type or Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Spawning		Nursery		Foraging		Over-wintering	
										HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Water Use and Withdrawal	Doris and Roberts	Imniagut Outflow	10	Small Stream	Fines	120	6	0.17	0	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00
		Patch Outflow	12	River	Mixed	72	6	0.17	0	0.00	0.00	0.50	0.00	0.75	0.00	0.00	0.00
		P.O. Outflow	11	Large Stream	Mixed	17	6	0.17	0	0.00	0.00	0.50	0.00	0.50	0.00	0.00	0.00
		Ogama Inflow	12	River	Mixed	341	6	0.17	0	0.00	0.00	0.50	0.00	0.75	0.00	0.00	0.00
		Ogama Outflow	12	River	Mixed	195	6	0.17	0	0.00	0.00	0.50	0.00	0.75	0.00	0.00	0.00
		Doris Outflow	12	River	Mixed	1,120	7	0.14	1	0.00	0.00	0.50	80.00	0.75	120.00	0.00	0.00
		Little Roberts Outflow	12	River	Mixed	330	7	0.14	1	0.00	0.00	0.50	23.57	0.75	35.36	0.00	0.00
	Windy	Windy Lake Outflow	12	River	Mixed	2,118	6	0.17	1	0.00	0.00	0.50	180.03	0.75	270.05	0.00	0.00
Reduction in Duration of Flow	Doris and Roberts	Doris Outflow	12	River	Mixed	4,371	7	0.14	1	0.00	0.00	0.50	305.97	0.75	458.96	0.00	0.00
									Sum of SWSA	-	0.00	-	589.57	-	884.36	-	0.00
									Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
									Habitat Co-factor	-	1.00	-	1.00	-	1.00	-	1.00
									Life Function Habitat Units	**-**	**0**	**-**	**147**	**-**	**221**	**-**	**0**
									Total Habitat Units	**368**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. " -" = not applicable.

Table D.2: Summary of Lake Trout Habitat Lost or Altered, Hope Bay Mine Operational Update

Impact	Watershed	Location	Habitat Type	Type or Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Spawning		Nursery		Foraging		Over-wintering	
										HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Water Use and Withdrawal	Doris and Roberts Watershed	Imniagut Outflow	10	Small Stream	Fines	120	6	0.17	1	0.00	0.00	0.25	5.00	0.00	0.00	0.00	0.00
		Patch Outflow	12	River	Mixed	72	6	0.17	1	0.00	0.00	0.50	6.00	0.25	3.00	0.00	0.00
		P.O. Outflow	11	Large Stream	Mixed	17	6	0.17	1	0.00	0.00	0.50	1.42	0.25	0.71	0.00	0.00
		Ogama Inflow	12	River	Mixed	341	6	0.17	1	0.00	0.00	0.50	28.42	0.25	14.21	0.00	0.00
		Ogama Outflow	12	River	Mixed	195	6	0.17	1	0.00	0.00	0.50	16.25	0.25	8.13	0.00	0.00
		Doris Outflow	12	River	Mixed	1,120	7	0.14	1	0.00	0.00	0.50	80.00	0.25	40.00	0.00	0.00
		Little Roberts Outflow	12	River	Mixed	330	7	0.14	1	0.00	0.00	0.50	23.57	0.25	11.79	0.00	0.00
	Windy	Windy Lake Outflow	12	River	Mixed	2,118	6	0.17	1	0.00	0.00	0.50	180.03	0.25	90.02	0.00	0.00
Reduction in Duration of Flow	Doris and Roberts	Doris Outflow	12	River	Mixed	4,371	7	0.14	1	0.00	0.00	0.50	305.97	0.25	152.99	0.00	0.00
									Sum of SWSA	-	0.00	-	646.65	-	320.83	-	0.00
									Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
									Habitat Co-factor	-	1.00	-	1.00	-	1.00	-	1.00
									Life Function Habitat Units	-	**0.00**	-	**162**	-	**80.2**	-	**0.00**
									Total Habitat Units	**242**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. " -" = not applicable.

Table D.3: Summary of Cisco Habitat Lost or Altered, Hope Bay Mine Operational Update

Impact	Watershed	Location	Habitat Type	Type or Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Spawning		Nursery		Foraging		Over-wintering	
										HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Water Use and Withdrawal	Doris and Roberts Watershed	Imniagut Outflow	10	Small Stream	Fines	120	6	0.17	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Patch Outflow	12	River	Mixed	72	6	0.17	1	0.00	0.00	0.50	6.00	0.25	3.00	0.00	0.00
		P.O. Outflow	11	Large Stream	Mixed	17	6	0.17	1	0.00	0.00	0.50	1.42	0.25	0.71	0.00	0.00
		Ogama Inflow	12	River	Mixed	341	6	0.17	1	0.00	0.00	0.50	28.42	0.25	14.21	0.00	0.00
		Ogama Outflow	12	River	Mixed	195	6	0.17	1	0.00	0.00	0.50	16.25	0.25	8.13	0.00	0.00
		Doris Outflow	12	River	Mixed	1,120	7	0.14	1	0.00	0.00	0.50	80.00	0.25	40.00	0.00	0.00
		Little Roberts Outflow	12	River	Mixed	330	7	0.14	1	0.00	0.00	0.50	23.57	0.25	11.79	0.00	0.00
	Windy	Windy Lake Outflow	12	River	Mixed	2,118	6	0.17	1	0.00	0.00	0.50	180.03	0.25	90.02	0.00	0.00
Reduction in Duration of Flow	Doris and Roberts	Doris Outflow	12	River	Mixed	4,371	7	0.14	1	0.00	0.00	0.50	305.97	0.25	152.99	0.00	0.00
									Sum of SWSA	-	0.00	-	641.65	-	320.83	-	0.00
									Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
									Habitat Co-factor	-	1.00	-	1.00	-	1.00	-	1.00
									Life Function Habitat Units	**-**	**0.00**	**-**	**160**	**-**	**80.2**	**-**	**0.00**
									Total Habitat Units	**241**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. " -" = not applicable.

Table D.4: Summary of Slimy Sculpin Habitat Lost or Altered, Hope Bay Mine Operational Update

Impact	Watershed	Location	Habitat Type	Type or Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Spawning		Nursery		Foraging		Over-wintering	
										HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Water Use and Withdrawal	Doris and Roberts Watershed	Imniagut Outflow	10	Small Stream	Fines	120	6	0.17	1	0.00	0.00	0.00	0.00	0.25	5.00	0.00	0.00
		Patch Outflow	12	River	Mixed	72	6	0.17	1	1.00	12.00	1.00	12.00	1.00	12.00	0.00	0.00
		P.O. Outflow	11	Large Stream	Mixed	17	6	0.17	1	1.00	2.83	1.00	2.83	1.00	2.83	0.00	0.00
		Ogama Inflow	12	River	Mixed	341	6	0.17	1	1.00	56.83	1.00	56.83	1.00	56.83	0.00	0.00
		Ogama Outflow	12	River	Mixed	195	6	0.17	1	1.00	32.50	1.00	32.50	1.00	32.50	0.00	0.00
		Doris Outflow	12	River	Mixed	1,120	7	0.14	1	1.00	160.00	1.00	160.00	1.00	160.00	0.00	0.00
		Little Roberts Outflow	12	River	Mixed	330	7	0.14	1	1.00	47.14	1.00	47.14	1.00	47.14	0.00	0.00
	Windy	Windy Lake Outflow	12	River	Mixed	2,118	6	0.17	1	1.00	360.06	1.00	360.06	1.00	360.06	0.00	0.00
Reduction in Duration of Flow	Doris and Roberts	Doris Outflow	12	River	Mixed	4,371	7	0.14	1	1.00	611.94	1.00	611.94	1.00	611.94	0.00	0.00
									Sum of SWSA	-	1,283	-	1,283	-	1,288	-	0.00
									Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
									Habitat Co-factor	-	1.00	-	1.00	-	1.00	-	1.00
									Life Function Habitat Units	**-**	**321**	**-**	**321**	**-**	**322**	**-**	**0.00**
									Total Habitat Units	**964**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. " -" = not applicable.

Table D.5: Summary of Ninespine Stickleback Habitat Lost or Altered, Hope Bay Mine Operational Update

Impact	Watershed	Location	Habitat Type	Type or Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Spawning		Nursery		Foraging		Over-wintering	
										HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Water Use and Withdrawal	Doris and Roberts Watershed	Imniagut Outflow	10	Small Stream	Fines	120	6	0.17	1	1.00	20.00	1.00	20.00	1.00	20.00	0.00	0.00
		Patch Outflow	12	River	Mixed	72	6	0.17	1	0.00	0.00	0.50	6.00	0.50	6.00	0.50	6.00
		P.O. Outflow	11	Large Stream	Mixed	17	6	0.17	1	0.00	0.00	0.50	1.42	0.50	1.42	0.00	0.00
		Ogama Inflow	12	River	Mixed	341	6	0.17	1	0.00	0.00	0.50	28.42	0.50	28.42	0.50	28.42
		Ogama Outflow	12	River	Mixed	195	6	0.17	1	0.00	0.00	0.50	16.25	0.50	16.25	0.50	16.25
		Doris Outflow	12	River	Mixed	1,120	7	0.14	1	0.00	0.00	0.50	80.00	0.50	80.00	0.50	80.00
		Little Roberts Outflow	12	River	Mixed	330	7	0.14	1	0.00	0.00	0.50	23.57	0.50	23.57	0.50	23.57
	Windy	Windy Lake Outflow	12	River	Mixed	2,118	6	0.17	1	0.00	0.00	0.50	180.03	0.50	180.03	0.50	180.03
Reduction in Duration of Flow	Doris and Roberts	Doris Outflow	12	River	Mixed	4,371	7	0.14	1	0.00	0.00	0.50	305.97	0.50	305.97	0.50	305.97
									Sum of SWSA	-	20.00	-	661.65	-	661.65	-	640.24
									Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
									Habitat co-factor	-	1.00	-	1.00	-	1.00	-	1.00
									Life Function Habitat Units	**-**	**5.00**	**-**	**165**	**-**	**165**	**-**	**160**
									Total Habitat Units	**496**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. " -" = not applicable.

Table D.6: Summary of Lake Whitefish Habitat Lost or Altered, Hope Bay Mine Operational Update

Impact	Watershed	Location	Habitat Type	Type or Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Spawning		Nursery		Foraging		Over-wintering	
										HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Water Use and Withdrawal	Doris and Roberts Watershed	Imniagut Outflow	10	Small Stream	Fines	120	6	0.17	1	0.00	0.00	0.25	5.00	0.00	0.00	0.00	0.00
		Patch Outflow	12	River	Mixed	72	6	0.17	1	0.00	0.00	0.50	6.00	0.50	6.00	0.00	0.00
		P.O. Outflow	11	Large Stream	Mixed	17	6	0.17	1	0.00	0.00	0.50	1.42	0.50	1.42	0.00	0.00
		Ogama Inflow	12	River	Mixed	341	6	0.17	1	0.00	0.00	0.50	28.42	0.50	28.42	0.00	0.00
		Ogama Outflow	12	River	Mixed	195	6	0.17	1	0.00	0.00	0.50	16.25	0.50	16.25	0.00	0.00
		Doris Outflow	12	River	Mixed	1,120	7	0.14	1	0.00	0.00	0.50	80.00	0.50	80.00	0.00	0.00
		Little Roberts Outflow	12	River	Mixed	330	7	0.14	1	0.00	0.00	0.50	23.57	0.50	23.57	0.00	0.00
	Windy	Windy Lake Outflow	12	River	Mixed	2,118	6	0.17	1	0.00	0.00	0.50	180.03	0.50	180.03	0.00	0.00
Reduction in Duration of Flow	Doris and Roberts	Doris Outflow	12	River	Mixed	4,371	7	0.14	1	0.00	0.00	0.50	305.97	0.50	305.97	0.00	0.00
									Sum of SWSA	-	0.00	-	646.65	-	641.65	-	0.00
									Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
									Habitat Co-factor	-	1.00	-	1.00	-	1.00	-	1.00
									Life Function Habitat Units	**-**	**0**	**-**	**162**	**-**	**160**	**-**	**0**
									Total Habitat Units	**322**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. " -" = not applicable.

Table D.7: Summary of Arctic Charr Habitat Alteration Associated with Habitat Offsets, Hope Bay Mine Operational Update

Impact	Species	Waterbody	Habitat Type	Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Habitat Co-factor	Spawning		Nursery		Foraging		Over-wintering	
											HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Habitat Offset - Alteration	Arctic Char	Pond 1	1	<2 m	Fines	2,705	2	0.25	1	0.25	0.00	0.00	0.25	42.27	0.25	42.27	0.00	0.00
			2	<2 m	Mixed	2,015	2	0.25	1	0.25	0.00	0.00	0.25	31.48	0.25	31.48	0.00	0.00
			3	<2 m	Coarse	24,362	2	0.25	1	0.25	0.00	0.00	0.25	380.66	0.25	380.66	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.25	0.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.25	0.50	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.25	1.00	0.00	1.00	0.00	1.00	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.25	0.00	0.00	0.25	0.00	0.50	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.25	0.25	0.00	0.75	0.00	0.75	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.25	0.50	0.00	1.00	0.00	1.00	0.00	1.00	0.00
		Pond 2	1	<2 m	Fines	0	2	0.25	1	0.25	0.00	0.00	0.25	0.00	0.25	0.00	0.00	0.00
			2	<2 m	Mixed	3,517	2	0.25	1	0.25	0.00	0.00	0.25	54.95	0.25	54.95	0.00	0.00
			3	<2 m	Coarse	19,732	2	0.25	1	0.25	0.00	0.00	0.25	308.31	0.25	308.31	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.25	0.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.25	0.50	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.25	1.00	0.00	1.00	0.00	1.00	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.25	0.00	0.00	0.25	0.00	0.50	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.25	0.25	0.00	0.75	0.00	0.75	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.25	0.50	0.00	1.00	0.00	1.00	0.00	1.00	0.00
		Pond 3	1	<2 m	Fines	17,413	2	0.25	1	0.50	0.00	0.00	0.25	544.16	0.25	544.16	0.00	0.00
			2	<2 m	Mixed	3,305	2	0.25	1	0.50	0.00	0.00	0.25	103.28	0.25	103.28	0.00	0.00
			3	<2 m	Coarse	37,123	2	0.25	1	0.50	0.00	0.00	0.25	1,160.09	0.25	1,160.09	0.00	0.00
			4	2-4 m	Fines	541	2	0.25	1	0.50	0.00	0.00	0.25	16.91	0.50	33.81	0.75	50.72
			5	2-4 m	Mixed	0	2	0.25	1	0.50	0.50	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.50	1.00	0.00	1.00	0.00	1.00	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.50	0.00	0.00	0.25	0.00	0.50	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.50	0.25	0.00	0.75	0.00	0.75	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.50	0.50	0.00	1.00	0.00	1.00	0.00	1.00	0.00
		Pond 4a	1	<2 m	Fines	219	2	0.25	1	0.50	0.00	0.00	0.25	6.84	0.25	6.84	0.00	0.00
			2	<2 m	Mixed	876	2	0.25	1	0.50	0.00	0.00	0.25	27.38	0.25	27.38	0.00	0.00
			3	<2 m	Coarse	2,034	2	0.25	1	0.50	0.00	0.00	0.25	63.56	0.25	63.56	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.50	0.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.50	0.50	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.50	1.00	0.00	1.00	0.00	1.00	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.50	0.00	0.00	0.25	0.00	0.50	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.50	0.25	0.00	0.75	0.00	0.75	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.50	0.50	0.00	1.00	0.00	1.00	0.00	1.00	0.00
		Pond 5b to 5f	1	<2 m	Fines	12,099	2	0.25	1	0.25	0.00	0.00	0.25	189.05	0.25	189.05	0.00	0.00
			2	<2 m	Mixed	17,234	2	0.25	1	0.25	0.00	0.00	0.25	269.28	0.25	269.28	0.00	0.00
			3	<2 m	Coarse	62,177	2	0.25	1	0.25	0.00	0.00	0.25	971.52	0.25	971.52	0.00	0.00
			4	2-4 m	Fines	6,892	2	0.25	1	0.25	0.00	0.00	0.25	107.69	0.50	215.38	0.75	323.06
			5	2-4 m	Mixed	10	2	0.25	1	0.25	0.50	0.31	0.75	0.47	0.50	0.31	0.75	0.47
			6	2-4 m	Coarse	0	2	0.25	1	0.25	1.00	0.00	1.00	0.00	1.00	0.00	0.75	0.00
			7	>4 m	Fines	226	2	0.25	1	0.25	0.00	0.00	0.25	3.53	0.50	7.06	1.00	14.13
			8	>4 m	Mixed	0	2	0.25	1	0.25	0.25	0.00	0.75	0.00	0.75	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.25	0.50	0.00	1.00	0.00	1.00	0.00	1.00	0.00
		Pond 5	1	<2 m	Fines	70,796	2	0.25	1	1	0.00	0.00	0.25	4,424.75	0.25	4,424.75	0.00	0.00
			2	<2 m	Mixed	85,220	2	0.25	1	1	0.00	0.00	0.25	5,326.25	0.25	5,326.25	0.00	0.00
			3	<2 m	Coarse	141,683	2	0.25	1	1	0.00	0.00	0.25	8,855.19	0.25	8,855.19	0.00	0.00
			4	2-4 m	Fines	54,243	2	0.25	1	1	0.00	0.00	0.25	3,390.19	0.50	6,780.38	0.75	10,170.56
			5	2-4 m	Mixed	357	2	0.25	1	1	0.50	44.63	0.75	66.94	0.50	44.63	0.75	66.94
			6	2-4 m	Coarse	0	2	0.25	1	1	1.00	0.00	1.00	0.00	1.00	0.00	0.75	0.00
			7	>4 m	Fines	500	2	0.25	1	1	0.00	0.00	0.25	31.25	0.50	62.50	1.00	125.00
			8	>4 m	Mixed	0	2	0.25	1	1	0.25	0.00	0.75	0.00	0.75	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1	0.50	0.00	1.00	0.00	1.00	0.00	1.00	0.00
										Sum of SWSA	-	44.94	-	26,375.99	-	29,903.08	-	10,750.88
										Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
										Life Function Habitat Units	-	**11.2**	-	**6,594**	-	**7,476**	-	**2,688**
										Total Habitat Units	**16,769**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. "-" = Not applicable.

Table D.8: Summary of Cisco Habitat Alteration Associated with Habitat Offsets, Hope Bay Mine Operational Update

Impact	Species	Waterbody	Habitat Type	Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Habitat Co-factor	Spawning		Nursery		Foraging		Over-wintering	
											HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Habitat Offset - Alteration	Cisco	Pond 1	1	<2 m	Fines	2,705	2	0.25	1	0.25	0.50	84.53	0.00	0.00	0.25	42.27	0.00	0.00
			2	<2 m	Mixed	2,015	2	0.25	1	0.25	0.75	94.45	0.50	62.97	0.25	31.48	0.00	0.00
			3	<2 m	Coarse	24,362	2	0.25	1	0.25	0.75	1,141.97	1.00	1,522.63	0.25	380.66	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.25	0.50	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.25	1.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.25	1.00	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.25	0.25	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.25	0.75	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.25	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 2	1	<2 m	Fines	0	2	0.25	1	0.25	0.50	0.00	0.00	0.00	0.25	0.00	0.00	0.00
			2	<2 m	Mixed	3,517	2	0.25	1	0.25	0.75	164.86	0.50	109.91	0.25	54.95	0.00	0.00
			3	<2 m	Coarse	19,732	2	0.25	1	0.25	0.75	924.94	1.00	1,233.25	0.25	308.31	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.25	0.50	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.25	1.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.25	1.00	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.25	0.25	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.25	0.75	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.25	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 3	1	<2 m	Fines	17,413	2	0.25	1	0.50	0.50	1,088.31	0.00	0.00	0.25	544.16	0.00	0.00
			2	<2 m	Mixed	3,305	2	0.25	1	0.50	0.75	309.84	0.50	206.56	0.25	103.28	0.00	0.00
			3	<2 m	Coarse	37,123	2	0.25	1	0.50	0.75	3,480.28	1.00	4,640.38	0.25	1,160.09	0.00	0.00
			4	2-4 m	Fines	541	2	0.25	1	0.50	0.50	33.81	0.25	16.91	0.50	33.81	0.75	50.72
			5	2-4 m	Mixed	0	2	0.25	1	0.50	1.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.50	1.00	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.50	0.25	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.50	0.75	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.50	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 4a	1	<2 m	Fines	219	2	0.25	1	0.50	0.50	13.69	0.00	0.00	0.25	6.84	0.00	0.00
			2	<2 m	Mixed	876	2	0.25	1	0.50	0.75	82.14	0.50	54.76	0.25	27.38	0.00	0.00
			3	<2 m	Coarse	2,034	2	0.25	1	0.50	0.75	190.69	1.00	254.25	0.25	63.56	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.50	0.50	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.50	1.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.50	1.00	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.50	0.25	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.50	0.75	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.50	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 5b to 5f	1	<2 m	Fines	12,099	2	0.25	1	0.25	0.50	378.09	0.00	0.00	0.25	189.05	0.00	0.00
			2	<2 m	Mixed	17,234	2	0.25	1	0.25	0.75	807.84	0.50	538.56	0.25	269.28	0.00	0.00
			3	<2 m	Coarse	62,177	2	0.25	1	0.25	0.75	2,914.55	1.00	3,886.06	0.25	971.52	0.00	0.00
			4	2-4 m	Fines	6,892	2	0.25	1	0.25	0.50	215.38	0.25	107.69	0.50	215.38	0.75	323.06
			5	2-4 m	Mixed	10	2	0.25	1	0.25	1.00	0.63	0.25	0.16	0.50	0.31	0.75	0.47
			6	2-4 m	Coarse	0	2	0.25	1	0.25	1.00	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			7	>4 m	Fines	226	2	0.25	1	0.25	0.25	3.53	0.00	0.00	1.00	14.13	1.00	14.13
			8	>4 m	Mixed	0	2	0.25	1	0.25	0.75	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.25	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 5	1	<2 m	Fines	70,796	2	0.25	1	1	0.50	8,849.50	0.00	0.00	0.25	4,424.75	0.00	0.00
			2	<2 m	Mixed	85,220	2	0.25	1	1	0.75	15,978.75	0.50	10,652.50	0.25	5,326.25	0.00	0.00
			3	<2 m	Coarse	141,683	2	0.25	1	1	0.75	26,565.56	1.00	35,420.75	0.25	8,855.19	0.00	0.00
			4	2-4 m	Fines	54,243	2	0.25	1	1	0.50	6,780.38	0.25	3,390.19	0.50	6,780.38	0.75	10,170.56
			5	2-4 m	Mixed	357	2	0.25	1	1	1.00	89.25	0.25	22.31	0.50	44.63	0.75	66.94
			6	2-4 m	Coarse	0	2	0.25	1	1	1.00	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			7	>4 m	Fines	500	2	0.25	1	1	0.25	31.25	0.00	0.00	1.00	125.00	1.00	125.00
			8	>4 m	Mixed	0	2	0.25	1	1	0.75	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00
										Sum of SWSA	-	70,224	-	62,120	-	29,973	-	10,751
										Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
										Life Function Habitat Units	-	**17,556**	-	**15,530**	-	**7,493**	-	**2,688**
										Total Habitat Units	**43,267**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. "-" = Not applicable.

Table D.9: Summary of Lake Whitefish Habitat Alteration Associated with Habitat Offsets, Hope Bay Mine Operational Update

Impact	Species	Waterbody	Habitat Type	Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Habitat Co-factor	Spawning		Nursery		Foraging		Over-wintering	
											HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Habitat Offset - Alteration	Lake Whitefish	Pond 1	1	<2 m	Fines	2,705	2	0.25	1	0.25	0.00	0.00	0.25	42.27	0.25	42.27	0.00	0.00
			2	<2 m	Mixed	2,015	2	0.25	1	0.25	0.50	62.97	1.00	125.94	0.75	94.45	0.00	0.00
			3	<2 m	Coarse	24,362	2	0.25	1	0.25	0.50	761.31	0.75	1,141.97	0.75	1,141.97	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.25	0.00	0.00	0.00	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.25	0.75	0.00	0.50	0.00	0.75	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.25	0.75	0.00	0.25	0.00	0.75	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.25	0.00	0.00	0.00	0.00	0.75	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.25	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.25	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 2	1	<2 m	Fines	0	2	0.25	1	0.25	0.00	0.00	0.25	0.00	0.25	0.00	0.00	0.00
			2	<2 m	Mixed	3,517	2	0.25	1	0.25	0.50	109.91	1.00	219.81	0.75	164.86	0.00	0.00
			3	<2 m	Coarse	19,732	2	0.25	1	0.25	0.50	616.63	0.75	924.94	0.75	924.94	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.25	0.00	0.00	0.00	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.25	0.75	0.00	0.50	0.00	0.75	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.25	0.75	0.00	0.25	0.00	0.75	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.25	0.00	0.00	0.00	0.00	0.75	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.25	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.25	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 3	1	<2 m	Fines	17,413	2	0.25	1	0.50	0.00	0.00	0.25	544.16	0.25	544.16	0.00	0.00
			2	<2 m	Mixed	3,305	2	0.25	1	0.50	0.50	206.56	1.00	413.13	0.75	309.84	0.00	0.00
			3	<2 m	Coarse	37,123	2	0.25	1	0.50	0.50	2,320.19	0.75	3,480.28	0.75	3,480.28	0.00	0.00
			4	2-4 m	Fines	541	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.50	33.81	0.75	50.72
			5	2-4 m	Mixed	0	2	0.25	1	0.50	0.75	0.00	0.50	0.00	0.75	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.50	0.75	0.00	0.25	0.00	0.75	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.75	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.50	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.50	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 4a	1	<2 m	Fines	219	2	0.25	1	0.50	0.00	0.00	0.25	6.84	0.25	6.84	0.00	0.00
			2	<2 m	Mixed	876	2	0.25	1	0.50	0.50	54.76	1.00	109.52	0.75	82.14	0.00	0.00
			3	<2 m	Coarse	2,034	2	0.25	1	0.50	0.50	127.13	0.75	190.69	0.75	190.69	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.50	0.75	0.00	0.50	0.00	0.75	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.50	0.75	0.00	0.25	0.00	0.75	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.75	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.50	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.50	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 5b to 5f	1	<2 m	Fines	12,099	2	0.25	1	0.25	0.00	0.00	0.25	189.05	0.25	189.05	0.00	0.00
			2	<2 m	Mixed	17,234	2	0.25	1	0.25	0.50	538.56	1.00	1,077.13	0.75	807.84	0.00	0.00
			3	<2 m	Coarse	62,177	2	0.25	1	0.25	0.50	1,943.03	0.75	2,914.55	0.75	2,914.55	0.00	0.00
			4	2-4 m	Fines	6,892	2	0.25	1	0.25	0.00	0.00	0.00	0.00	0.50	215.38	0.75	323.06
			5	2-4 m	Mixed	10	2	0.25	1	0.25	0.75	0.47	0.50	0.31	0.75	0.47	0.75	0.47
			6	2-4 m	Coarse	0	2	0.25	1	0.25	0.75	0.00	0.25	0.00	0.75	0.00	0.75	0.00
			7	>4 m	Fines	226	2	0.25	1	0.25	0.00	0.00	0.00	0.00	0.75	10.59	1.00	14.13
			8	>4 m	Mixed	0	2	0.25	1	0.25	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.25	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 5	1	<2 m	Fines	70,796	2	0.25	1	1	0.00	0.00	0.25	4,424.75	0.25	4,424.75	0.00	0.00
			2	<2 m	Mixed	85,220	2	0.25	1	1	0.50	10,652.50	1.00	21,305.00	0.75	15,978.75	0.00	0.00
			3	<2 m	Coarse	141,683	2	0.25	1	1	0.50	17,710.38	0.75	26,565.56	0.75	26,565.56	0.00	0.00
			4	2-4 m	Fines	54,243	2	0.25	1	1	0.00	0.00	0.00	0.00	0.50	6,780.38	0.75	10,170.56
			5	2-4 m	Mixed	357	2	0.25	1	1	0.75	66.94	0.50	44.63	0.75	66.94	0.75	66.94
			6	2-4 m	Coarse	0	2	0.25	1	1	0.75	0.00	0.25	0.00	0.75	0.00	0.75	0.00
			7	>4 m	Fines	500	2	0.25	1	1	0.00	0.00	0.00	0.00	0.75	93.75	1.00	125.00
			8	>4 m	Mixed	0	2	0.25	1	1	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
										Sum of SWSA	-	35,171	-	63,720	-	65,064	-	10,751
										Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
										Life Function Habitat Units	-	**8,793**	-	**15,930**	-	**16,266**	-	**2,688**
										Total Habitat Units	**43,677**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. "-" = Not applicable.

Table D.10: Summary of Ninespine Stickleback Habitat Alteration Associated with Habitat Offsets, Hope Bay Mine Operational Update

Impact	Species	Waterbody	Habitat Type	Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Habitat Co-factor	Spawning		Nursery		Foraging		Over-wintering	
											HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Habitat Offset - Alteration	Ninespine Stickleback	Pond 1	1	<2 m	Fines	2,705	2	0.25	1	0.50	1.00	338.13	1.00	338.13	1.00	338.13	0.00	0.00
			2	<2 m	Mixed	2,015	2	0.25	1	0.50	0.50	125.94	0.50	125.94	0.75	188.91	0.00	0.00
			3	<2 m	Coarse	24,362	2	0.25	1	0.50	0.00	0.00	0.25	761.31	0.75	2,283.94	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
		Pond 2	1	<2 m	Fines	0	2	0.25	1	0.30	1.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00
			2	<2 m	Mixed	3,517	2	0.25	1	0.30	0.50	131.89	0.50	131.89	0.75	197.83	0.00	0.00
			3	<2 m	Coarse	19,732	2	0.25	1	0.30	0.00	0.00	0.25	369.98	0.75	1,109.93	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.30	0.00	0.00	0.00	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.30	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.30	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.30	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.30	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.30	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
		Pond 3	1	<2 m	Fines	17,413	2	0.25	1	0.75	1.00	3,264.94	1.00	3,264.94	1.00	3,264.94	0.00	0.00
			2	<2 m	Mixed	3,305	2	0.25	1	0.75	0.50	309.84	0.50	309.84	0.75	464.77	0.00	0.00
			3	<2 m	Coarse	37,123	2	0.25	1	0.75	0.00	0.00	0.25	1,740.14	0.75	5,220.42	0.00	0.00
			4	2-4 m	Fines	541	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.50	50.72	0.75	76.08
			5	2-4 m	Mixed	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
		Pond 4a	1	<2 m	Fines	219	2	0.25	1	0.75	1.00	41.06	1.00	41.06	1.00	41.06	0.00	0.00
			2	<2 m	Mixed	876	2	0.25	1	0.75	0.50	82.14	0.50	82.14	0.75	123.20	0.00	0.00
			3	<2 m	Coarse	2,034	2	0.25	1	0.75	0.00	0.00	0.25	95.34	0.75	286.03	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
		Pond 5b to 5f	1	<2 m	Fines	12,099	2	0.25	1	0.50	1.00	1,512.38	1.00	1,512.38	1.00	1,512.38	0.00	0.00
			2	<2 m	Mixed	17,234	2	0.25	1	0.50	0.50	1,077.13	0.50	1,077.13	0.75	1,615.69	0.00	0.00
			3	<2 m	Coarse	62,177	2	0.25	1	0.50	0.00	0.00	0.25	1,943.03	0.75	5,829.09	0.00	0.00
			4	2-4 m	Fines	6,892	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.50	430.75	0.75	646.13
			5	2-4 m	Mixed	10	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.25	0.31	0.75	0.94
			6	2-4 m	Coarse	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			7	>4 m	Fines	226	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.00	0.00	1.00	28.25
			8	>4 m	Mixed	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
		Pond 5	1	<2 m	Fines	70,796	2	0.25	1	1	1.00	17,699.00	1.00	17,699.00	1.00	17,699.00	0.00	0.00
			2	<2 m	Mixed	85,220	2	0.25	1	1	0.50	10,652.50	0.50	10,652.50	0.75	15,978.75	0.00	0.00
			3	<2 m	Coarse	141,683	2	0.25	1	1	0.00	0.00	0.25	8,855.19	0.75	26,565.56	0.00	0.00
			4	2-4 m	Fines	54,243	2	0.25	1	1	0.00	0.00	0.00	0.00	0.50	6,780.38	0.75	10,170.56
			5	2-4 m	Mixed	357	2	0.25	1	1	0.00	0.00	0.00	0.00	0.25	22.31	0.75	66.94
			6	2-4 m	Coarse	0	2	0.25	1	1	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			7	>4 m	Fines	500	2	0.25	1	1	0.00	0.00	0.00	0.00	0.00	0.00	1.00	125.00
			8	>4 m	Mixed	0	2	0.25	1	1	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
										Sum of SWSA	-	35,235	-	49,000	-	90,004	-	11,114
										Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
										Life Function Habitat Units	-	**8,809**	-	**12,250**	-	**22,501**	-	**2,778**
										Total Habitat Units	**46,338**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. "-" = Not applicable.

Table D.11: Summary of Arctic Charr Habitat Gains from Offsetting Measures, Hope Bay Mine Operational Update

Impact	Species	Waterbody	Habitat Type	Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Habitat Co-factor	Spawning		Nursery		Foraging		Over-wintering	
											HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Habitat Offset - Gains	Arctic Char	Pond 1	1	<2 m	Fines	2,705	2	0.25	1	0.50	0.00	0.00	0.25	84.53	0.25	84.53	0.00	0.00
			2	<2 m	Mixed	2,015	2	0.25	1	0.50	0.00	0.00	0.25	62.97	0.25	62.97	0.00	0.00
			3	<2 m	Coarse	24,362	2	0.25	1	0.50	0.00	0.00	0.25	761.31	0.25	761.31	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.50	0.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.50	0.50	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.50	1.00	0.00	1.00	0.00	1.00	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.50	0.00	0.00	0.25	0.00	0.50	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.50	0.25	0.00	0.75	0.00	0.75	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.50	0.50	0.00	1.00	0.00	1.00	0.00	1.00	0.00
		Pond 2	1	<2 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.25	0.00	0.25	0.00	0.00	0.00
			2	<2 m	Mixed	3,517	2	0.25	1	0.75	0.00	0.00	0.25	164.86	0.25	164.86	0.00	0.00
			3	<2 m	Coarse	18,296	2	0.25	1	0.75	0.00	0.00	0.25	857.61	0.25	857.61	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.75	0.50	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.75	1.00	0.00	1.00	0.00	1.00	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.25	0.00	0.50	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.75	0.25	0.00	0.75	0.00	0.75	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.75	0.50	0.00	1.00	0.00	1.00	0.00	1.00	0.00
		Pond 3	1	<2 m	Fines	17,413	2	0.25	1	1.00	0.00	0.00	0.25	1,088.31	0.25	1,088.31	0.00	0.00
			2	<2 m	Mixed	3,305	2	0.25	1	1.00	0.00	0.00	0.25	206.56	0.25	206.56	0.00	0.00
			3	<2 m	Coarse	37,123	2	0.25	1	1.00	0.00	0.00	0.25	2,320.19	0.25	2,320.19	0.00	0.00
			4	2-4 m	Fines	541	2	0.25	1	1.00	0.00	0.00	0.25	33.81	0.50	67.63	0.75	101.44
			5	2-4 m	Mixed	0	2	0.25	1	1.00	0.50	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	1.00	1.00	0.00	1.00	0.00	1.00	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	1.00	0.00	0.00	0.25	0.00	0.50	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	1.00	0.25	0.00	0.75	0.00	0.75	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	0.50	0.00	1.00	0.00	1.00	0.00	1.00	0.00
		Pond 4a	1	<2 m	Fines	219	2	0.25	1	1.00	0.00	0.00	0.25	13.69	0.25	13.69	0.00	0.00
			2	<2 m	Mixed	876	2	0.25	1	1.00	0.00	0.00	0.25	54.76	0.25	54.76	0.00	0.00
			3	<2 m	Coarse	2,034	2	0.25	1	1.00	0.00	0.00	0.25	127.13	0.25	127.13	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	1.00	0.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	1.00	0.50	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	1.00	1.00	0.00	1.00	0.00	1.00	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	1.00	0.00	0.00	0.25	0.00	0.50	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	1.00	0.25	0.00	0.75	0.00	0.75	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	0.50	0.00	1.00	0.00	1.00	0.00	1.00	0.00
		Pond 5b to 5f	1	<2 m	Fines	15,024	2	0.25	1	1.00	0.00	0.00	0.25	939.00	0.25	939.00	0.00	0.00
			2	<2 m	Mixed	21,449	2	0.25	1	1.00	0.00	0.00	0.25	1,340.56	0.25	1,340.56	0.00	0.00
			3	<2 m	Coarse	76,735	2	0.25	1	1.00	0.00	0.00	0.25	4,795.94	0.25	4,795.94	0.00	0.00
			4	2-4 m	Fines	8,634	2	0.25	1	1.00	0.00	0.00	0.25	539.63	0.50	1,079.25	0.75	1,618.88
			5	2-4 m	Mixed	12	2	0.25	1	1.00	0.50	1.50	0.75	2.25	0.50	1.50	0.75	2.25
			6	2-4 m	Coarse	0	2	0.25	1	1.00	1.00	0.00	1.00	0.00	1.00	0.00	0.75	0.00
			7	>4 m	Fines	283	2	0.25	1	1.00	0.00	0.00	0.25	17.69	0.50	35.38	1.00	70.75
			8	>4 m	Mixed	0	2	0.25	1	1.00	0.25	0.00	0.75	0.00	0.75	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	0.50	0.00	1.00	0.00	1.00	0.00	1.00	0.00
		Pond 5	1	<2 m	Fines	62,330	2	0.25	1	1.00	0.00	0.00	0.25	3,895.65	0.25	3,895.65	0.00	0.00
			2	<2 m	Mixed	75,029	2	0.25	1	1.00	0.00	0.00	0.25	4,689.33	0.25	4,689.33	0.00	0.00
			3	<2 m	Coarse	124,740	2	0.25	1	1.00	0.00	0.00	0.25	7,796.27	0.25	7,796.27	0.00	0.00
			4	2-4 m	Fines	136,006	2	0.25	1	1.00	0.00	0.00	0.25	8,500.35	0.50	17,000.69	0.75	25,501.04
			5	2-4 m	Mixed	894	2	0.25	1	1.00	0.50	111.81	0.75	167.71	0.50	111.81	0.75	167.71
			6	2-4 m	Coarse	0	2	0.25	1	1.00	1.00	0.00	1.00	0.00	1.00	0.00	0.75	0.00
			7	>4 m	Fines	2,500	2	0.25	1	1.00	0.00	0.00	0.25	156.25	0.50	312.50	1.00	625.00
			8	>4 m	Mixed	0	2	0.25	1	1.00	0.25	0.00	0.75	0.00	0.75	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	0.50	0.00	1.00	0.00	1.00	0.00	1.00	0.00
										Sum of SWSA	-	113	-	38,616	-	47,807	-	28,087
										Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
										Life Function Habitat Units	**-**	**28.3**	**-**	**9,654**	**-**	**11,952**	**-**	**7,022**
										Total Habitat Units	**28,656**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. "-" = Not applicable.

Table D.12: Summary of Cisco Habitat Gains from Offsetting Measures, Hope Bay Mine Operational Update

Impact	Species	Waterbody	Habitat Type	Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Habitat Co-factor	Spawning		Nursery		Foraging		Over-wintering	
											HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Habitat Offset - Gains	Cisco	Pond 1	1	<2 m	Fines	2,705	2	0.25	1	0.50	0.50	169.06	0.00	0.00	0.25	84.53	0.00	0.00
			2	<2 m	Mixed	2,015	2	0.25	1	0.50	0.75	188.91	0.50	125.94	0.25	62.97	0.00	0.00
			3	<2 m	Coarse	24,362	2	0.25	1	0.50	0.75	2,283.94	1.00	3,045.25	0.25	761.31	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.50	0.50	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.50	1.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.50	1.00	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.50	0.25	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.50	0.75	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.50	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 2	1	<2 m	Fines	0	2	0.25	1	0.75	0.50	0.00	0.00	0.00	0.25	0.00	0.00	0.00
			2	<2 m	Mixed	3,517	2	0.25	1	0.75	0.75	494.58	0.50	329.72	0.25	164.86	0.00	0.00
			3	<2 m	Coarse	18,296	2	0.25	1	0.75	0.75	2,572.84	1.00	3,430.45	0.25	857.61	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.75	0.50	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.75	1.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.75	1.00	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.75	0.25	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.75	0.75	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.75	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 3	1	<2 m	Fines	17,413	2	0.25	1	1.00	0.50	2,176.63	0.00	0.00	0.25	1,088.31	0.00	0.00
			2	<2 m	Mixed	3,305	2	0.25	1	1.00	0.75	619.69	0.50	413.13	0.25	206.56	0.00	0.00
			3	<2 m	Coarse	37,123	2	0.25	1	1.00	0.75	6,960.56	1.00	9,280.75	0.25	2,320.19	0.00	0.00
			4	2-4 m	Fines	541	2	0.25	1	1.00	0.50	67.63	0.25	33.81	0.50	67.63	0.75	101.44
			5	2-4 m	Mixed	0	2	0.25	1	1.00	1.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	1.00	1.00	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	1.00	0.25	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	1.00	0.75	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 4a	1	<2 m	Fines	219	2	0.25	1	1.00	0.50	27.38	0.00	0.00	0.25	13.69	0.00	0.00
			2	<2 m	Mixed	876	2	0.25	1	1.00	0.75	164.27	0.50	109.52	0.25	54.76	0.00	0.00
			3	<2 m	Coarse	2,034	2	0.25	1	1.00	0.75	381.38	1.00	508.50	0.25	127.13	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	1.00	0.50	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	1.00	1.00	0.00	0.25	0.00	0.50	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	1.00	1.00	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	1.00	0.25	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	1.00	0.75	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 5b to 5f	1	<2 m	Fines	15,024	2	0.25	1	1.00	0.50	1,878.00	0.00	0.00	0.25	939.00	0.00	0.00
			2	<2 m	Mixed	21,449	2	0.25	1	1.00	0.75	4,021.69	0.50	2,681.13	0.25	1,340.56	0.00	0.00
			3	<2 m	Coarse	76,735	2	0.25	1	1.00	0.75	14,387.81	1.00	19,183.75	0.25	4,795.94	0.00	0.00
			4	2-4 m	Fines	8,634	2	0.25	1	1.00	0.50	1,079.25	0.25	539.63	0.50	1,079.25	0.75	1,618.88
			5	2-4 m	Mixed	12	2	0.25	1	1.00	1.00	3.00	0.25	0.75	0.50	1.50	0.75	2.25
			6	2-4 m	Coarse	0	2	0.25	1	1.00	1.00	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			7	>4 m	Fines	283	2	0.25	1	1.00	0.25	17.69	0.00	0.00	1.00	70.75	1.00	70.75
			8	>4 m	Mixed	0	2	0.25	1	1.00	0.75	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 5	1	<2 m	Fines	62,330	2	0.25	1	1.00	0.50	7,791.31	0.00	0.00	0.25	3,895.65	0.00	0.00
			2	<2 m	Mixed	75,029	2	0.25	1	1.00	0.75	14,067.98	0.50	9,378.65	0.25	4,689.33	0.00	0.00
			3	<2 m	Coarse	124,740	2	0.25	1	1.00	0.75	23,388.81	1.00	31,185.08	0.25	7,796.27	0.00	0.00
			4	2-4 m	Fines	136,006	2	0.25	1	1.00	0.50	17,000.69	0.25	8,500.35	0.50	17,000.69	0.75	25,501.04
			5	2-4 m	Mixed	894	2	0.25	1	1.00	1.00	223.62	0.25	55.90	0.50	111.81	0.75	167.71
			6	2-4 m	Coarse	0	2	0.25	1	1.00	1.00	0.00	0.75	0.00	0.50	0.00	0.75	0.00
			7	>4 m	Fines	2,500	2	0.25	1	1.00	0.25	156.25	0.00	0.00	1.00	625.00	1.00	625.00
			8	>4 m	Mixed	0	2	0.25	1	1.00	0.75	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00
										Sum of SWSA	-	100,123	-	88,802	-	48,155	-	28,087
										Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
										Life Function Habitat Units	**-**	**25,030.7**	**-**	**22,201**	**-**	**12,039**	**-**	**7,022**
										Total Habitat Units	**66,292**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. "-" = Not applicable.

Table D.13: Summary of Lake Whitefish Habitat Gains from Offsetting Measures, Hope Bay Mine Operational Update

Impact	Species	Waterbody	Habitat Type	Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Habitat Co-factor	Spawning		Nursery		Foraging		Over-wintering	
											HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Habitat Offset - Gains	Lake Whitefish	Pond 1	1	<2 m	Fines	2,705	2	0.25	1	0.50	0.00	0.00	0.25	84.53	0.25	84.53	0.00	0.00
			2	<2 m	Mixed	2,015	2	0.25	1	0.50	0.50	125.94	1.00	251.88	0.75	188.91	0.00	0.00
			3	<2 m	Coarse	24,362	2	0.25	1	0.50	0.50	1,522.63	0.75	2,283.94	0.75	2,283.94	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.50	0.75	0.00	0.50	0.00	0.75	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.50	0.75	0.00	0.25	0.00	0.75	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.50	0.00	0.00	0.00	0.00	0.75	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.50	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.50	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 2	1	<2 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.25	0.00	0.25	0.00	0.00	0.00
			2	<2 m	Mixed	3,517	2	0.25	1	0.75	0.50	329.72	1.00	659.44	0.75	494.58	0.00	0.00
			3	<2 m	Coarse	18,296	2	0.25	1	0.75	0.50	1,715.23	0.75	2,572.84	0.75	2,572.84	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.75	0.75	0.00	0.50	0.00	0.75	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.75	0.75	0.00	0.25	0.00	0.75	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.75	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.75	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.75	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 3	1	<2 m	Fines	17,413	2	0.25	1	1.00	0.00	0.00	0.25	1,088.31	0.25	1,088.31	0.00	0.00
			2	<2 m	Mixed	3,305	2	0.25	1	1.00	0.50	413.13	1.00	826.25	0.75	619.69	0.00	0.00
			3	<2 m	Coarse	37,123	2	0.25	1	1.00	0.50	4,640.38	0.75	6,960.56	0.75	6,960.56	0.00	0.00
			4	2-4 m	Fines	541	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.50	67.63	0.75	101.44
			5	2-4 m	Mixed	0	2	0.25	1	1.00	0.75	0.00	0.50	0.00	0.75	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	1.00	0.75	0.00	0.25	0.00	0.75	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.75	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	1.00	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 4a	1	<2 m	Fines	219	2	0.25	1	1.00	0.00	0.00	0.25	13.69	0.25	13.69	0.00	0.00
			2	<2 m	Mixed	876	2	0.25	1	1.00	0.50	109.52	1.00	219.03	0.75	164.27	0.00	0.00
			3	<2 m	Coarse	2,034	2	0.25	1	1.00	0.50	254.25	0.75	381.38	0.75	381.38	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	1.00	0.75	0.00	0.50	0.00	0.75	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	1.00	0.75	0.00	0.25	0.00	0.75	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.75	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	1.00	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 5b to 5f	1	<2 m	Fines	15,024	2	0.25	1	1.00	0.00	0.00	0.25	939.00	0.25	939.00	0.00	0.00
			2	<2 m	Mixed	21,449	2	0.25	1	1.00	0.50	2,681.13	1.00	5,362.25	0.75	4,021.69	0.00	0.00
			3	<2 m	Coarse	76,735	2	0.25	1	1.00	0.50	9,591.88	0.75	14,387.81	0.75	14,387.81	0.00	0.00
			4	2-4 m	Fines	8,634	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.50	1,079.25	0.75	1,618.88
			5	2-4 m	Mixed	12	2	0.25	1	1.00	0.75	2.25	0.50	1.50	0.75	2.25	0.75	2.25
			6	2-4 m	Coarse	0	2	0.25	1	1.00	0.75	0.00	0.25	0.00	0.75	0.00	0.75	0.00
			7	>4 m	Fines	283	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.75	53.06	1.00	70.75
			8	>4 m	Mixed	0	2	0.25	1	1.00	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
		Pond 5	1	<2 m	Fines	62,330	2	0.25	1	1.00	0.00	0.00	0.25	3,895.65	0.25	3,895.65	0.00	0.00
			2	<2 m	Mixed	75,029	2	0.25	1	1.00	0.50	9,378.65	1.00	18,757.30	0.75	14,067.98	0.00	0.00
			3	<2 m	Coarse	124,740	2	0.25	1	1.00	0.50	15,592.54	0.75	23,388.81	0.75	23,388.81	0.00	0.00
			4	2-4 m	Fines	136,006	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.50	17,000.69	0.75	25,501.04
			5	2-4 m	Mixed	894	2	0.25	1	1.00	0.75	167.71	0.50	111.81	0.75	167.71	0.75	167.71
			6	2-4 m	Coarse	0	2	0.25	1	1.00	0.75	0.00	0.25	0.00	0.75	0.00	0.75	0.00
			7	>4 m	Fines	2,500	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.75	468.75	1.00	625.00
			8	>4 m	Mixed	0	2	0.25	1	1.00	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
										Sum of SWSA	-	46,525	-	82,186	-	94,393	-	28,087
										Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
										Life Function Habitat Units	**-**	**11,631.2**	**-**	**20,546**	**-**	**23,598**	**-**	**7,022**
										Total Habitat Units	**62,798**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. "-" = Not applicable.

Table D.14: Summary of Ninespine Stickleback Habitat Gains from Offsetting Measures, Hope Bay Mine Operational Update

Impact	Species	Waterbody	Habitat Type	Depth	Substrate	Area (m^2)	No. of Species	Species Weight	Access Factor	Habitat Co-factor	Spawning		Nursery		Foraging		Over-wintering	
											HSI	SWSA	HSI	SWSA	HSI	SWSA	HSI	SWSA
Habitat Offset - Gains	Ninespine Stickleback	Pond 1	1	<2 m	Fines	2,705	2	0.25	1	0.75	1.00	507.19	1.00	507.19	1.00	507.19	0.00	0.00
			2	<2 m	Mixed	2,015	2	0.25	1	0.75	0.50	188.91	0.50	188.91	0.75	283.36	0.00	0.00
			3	<2 m	Coarse	24,362	2	0.25	1	0.75	0.00	0.00	0.25	1,141.97	0.75	3,425.91	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
		Pond 2	1	<2 m	Fines	0	2	0.25	1	0.75	1.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00
			2	<2 m	Mixed	3,517	2	0.25	1	0.75	0.50	329.72	0.50	329.72	0.75	494.58	0.00	0.00
			3	<2 m	Coarse	18,296	2	0.25	1	0.75	0.00	0.00	0.25	857.61	0.75	2,572.84	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	0.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
		Pond 3	1	<2 m	Fines	17,413	2	0.25	1	1.00	1.00	4,353.25	1.00	4,353.25	1.00	4,353.25	0.00	0.00
			2	<2 m	Mixed	3,305	2	0.25	1	1.00	0.50	413.13	0.50	413.13	0.75	619.69	0.00	0.00
			3	<2 m	Coarse	37,123	2	0.25	1	1.00	0.00	0.00	0.25	2,320.19	0.75	6,960.56	0.00	0.00
			4	2-4 m	Fines	541	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.50	67.63	0.75	101.44
			5	2-4 m	Mixed	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
		Pond 4a	1	<2 m	Fines	219	2	0.25	1	1.00	1.00	54.75	1.00	54.75	1.00	54.75	0.00	0.00
			2	<2 m	Mixed	876	2	0.25	1	1.00	0.50	109.52	0.50	109.52	0.75	164.27	0.00	0.00
			3	<2 m	Coarse	2,034	2	0.25	1	1.00	0.00	0.00	0.25	127.13	0.75	381.38	0.00	0.00
			4	2-4 m	Fines	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.50	0.00	0.75	0.00
			5	2-4 m	Mixed	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			6	2-4 m	Coarse	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			7	>4 m	Fines	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			8	>4 m	Mixed	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
		Pond 5b to 5f	1	<2 m	Fines	15,024	2	0.25	1	1.00	1.00	3,756.00	1.00	3,756.00	1.00	3,756.00	0.00	0.00
			2	<2 m	Mixed	21,449	2	0.25	1	1.00	0.50	2,681.13	0.50	2,681.13	0.75	4,021.69	0.00	0.00
			3	<2 m	Coarse	76,735	2	0.25	1	1.00	0.00	0.00	0.25	4,795.94	0.75	14,387.81	0.00	0.00
			4	2-4 m	Fines	8,634	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.50	1,079.25	0.75	1,618.88
			5	2-4 m	Mixed	12	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.25	0.75	0.75	2.25
			6	2-4 m	Coarse	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			7	>4 m	Fines	283	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	70.75
			8	>4 m	Mixed	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
		Pond 5	1	<2 m	Fines	62,330	2	0.25	1	1	1.00	15,582.62	1.00	15,582.62	1.00	15,582.62	0.00	0.00
			2	<2 m	Mixed	75,029	2	0.25	1	1	0.50	9,378.65	0.50	9,378.65	0.75	14,067.98	0.00	0.00
			3	<2 m	Coarse	124,740	2	0.25	1	1	0.00	0.00	0.25	7,796.27	0.75	23,388.81	0.00	0.00
			4	2-4 m	Fines	136,006	2	0.25	1	1	0.00	0.00	0.00	0.00	0.50	17,000.69	0.75	25,501.04
			5	2-4 m	Mixed	894	2	0.25	1	1	0.00	0.00	0.00	0.00	0.25	55.90	0.75	167.71
			6	2-4 m	Coarse	0	2	0.25	1	1	0.00	0.00	0.00	0.00	0.25	0.00	0.75	0.00
			7	>4 m	Fines	2,500	2	0.25	1	1	0.00	0.00	0.00	0.00	0.00	0.00	1.00	625.00
			8	>4 m	Mixed	0	2	0.25	1	1	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
			9	>4 m	Coarse	0	2	0.25	1	1	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
										Sum of SWSA	-	37,355	-	54,394	-	113,227	-	28,087
										Life Function Weight	-	0.25	-	0.25	-	0.25	-	0.25
										Life Function Habitat Units	-	**9,339**	-	**13,598**	-	**28,307**	-	**7,022**
										Total Habitat Units	**58,266**							

Notes: "HSI" = Habitat Suitability Index. "SWSA" = Species Weighted Suitable Area. "-" = Not applicable.

APPENDIX E
ANALYSIS OF INCREASED WATER WITHDRAWALS

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MEMO

TO	Sam Gordon, Permitting Specialist, Agnico Eagle Mines Limited
FROM	Craig Neufeld, Partner in Charge, ERM Kevin Murphy, Project Manager, ERM Matt Friend, Hydrology SME, ERM Kelcie Nice, Hydrology Lead, ERM
DATE	5 November 2025
REFERENCE	0790131
SUBJECT	Hope Bay Mine: Windy Lake Outflow Hydraulic Analysis

Dear Sam:

ERM Consultants Canada Ltd. (ERM) is pleased to present this memo to support water management planning at the Hope Bay Mine (the Mine). At the request of Agnico Eagle Mines Limited (Agnico Eagle), ERM developed a HEC-RAS model to estimate hydraulic parameters at the Windy Lake outflow. The results are summarized in this accompanying memo.

1. INTRODUCTION

ERM understands that Agnico Eagle seeks to restart operations at the Mine using underground mining methods (the Project). Agnico Eagle anticipates water needs of 2,856,940 m^3/year, a volume that exceeds the currently permitted volume under Agnico Eagle's existing Water Licences. Three lakes have been identified as potential water sources; Doris Lake, Patch Lake, and Windy Lake. Each lake is located near the Mine area and Agnico Eagle has existing Water Licences associated with each lake, which may need amending based on increased water needs. As Agnico Eagle prepares for the restart of operational activities at the Mine, Agnico Eagle seeks to understand additional water withdrawal capacity from Doris Lake, Patch Lake, and Windy Lake, and how those withdrawals would affect the hydrologic system and fish habitat of these three lakes and their outflows.

ERM previously developed a GoldSim water balance model to determine how additional water withdrawals from Doris Lake, Patch Lake, and Windy Lake have the potential to affect the hydrological system (ERM 2025). The GoldSim model results are summarized in a separate memo. There are also existing models developed for the Final Environmental Impact Statement (FEIS) that assess impacts to fish habitat for the outflows of Patch, PO, Ogama, Doris and Little Roberts Lakes, however no models have previously been completed for Windy Lake as previously permitted withdrawal volumes were limited to less than 10% of the baseline outflow volume. The model ERM developed for this memo is to support the assessment of impacts to fish habitat in Windy Lake outflow that might occur if withdrawal volumes were increased.

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1.1 SCOPE OF WORK

ERM was retained by Agnico Eagle in July 2025 to prepare a hydraulic model for the Windy Lake outflow and prepare a summary of results.

1.2 OBJECTIVES

The purpose of the hydraulic model is to estimate hydraulic parameters for Windy Lake outflow to determine potential effects of the additional water withdrawals on water levels and velocities, and how these potential effects may influence fish habitat along the channel connecting Windy Lake to Glenn Lake (Windy Lake outflow). This purpose is achieved by constructing a hydraulic model of the channel using US Army Corps of Engineers, Hydrologic Engineering Center's – River Analysis System (HEC-RAS) software. Agnico Eagle will use the model results to support the development of the water management plan and fish habitat assessment for the Project.

This memo describes the methods used to model the Windy Lake outflow and channel including the inputs, construction and calibration methodology, limitations, assumptions, and results.

2. METHODOLOGY

The following sections provide a description of the HEC-RAS modeling software and methodology used to develop key modelling components.

2.1 MODEL OVERVIEW

HEC-RAS simulates one-dimensional (1D) steady- and unsteady-state flow conditions using channel geometry, channel bed roughness data, boundary conditions, and flow data. The 1D model simplifies the river system by considering flow and velocity primarily in one direction along the main channel. To remain consistent with models built for the outflows of Patch, Ogama, Doris, and Little Roberts Lakes, ERM selected 1D steady-state settings for the HEC-RAS model simulation for the Windy Lake channel. A 1D model is an appropriate application to model the effects water withdrawals from the proposed Project will have on fish habitat along the channel.

Under steady-state flow conditions, HEC-RAS calculates water surface profiles and flood elevations in channels under conditions where the flow does not change over time. When running steady-state, HEC-RAS allows the user to select subcritical flow (dominated by tranquil, gravitational forces) which is characterized by a Froude number <1. Subcritical flow is used in geographical areas of tranquil meandering flows and is calculated from downstream to upstream, requiring a downstream boundary condition. Supercritical flow (dominated by rapid, inertial forces) is characterized by a Froude number >1 and is calculated from upstream to downstream, requiring an upstream boundary condition. Mixed flow is a condition where the flow regime can fluctuate between subcritical and supercritical within the same model channel. Mixed regime requires both upstream and downstream boundary conditions.

The elevation profile of the channel indicates there are majority areas of relatively tranquil flows combined with a few areas of increased slope resulting in supercritical flows. Due to the combination of subcritical and supercritical flows, ERM selected a mixed regime to obtain the results for Windy Lake outflow.

2.2 MODEL DEVELOPMENT

2.2.1 CHANNEL GEOMETRY DATA

In HEC-RAS, channel geometry is defined primarily through a series of cross-sections that represent the river's shape, elevation, and features along the channel. Channel cross-sectional data, including channel width, depth, and side slope are collected through a field survey. This data is used to model the channel in HEC-RAS to determine how water will behave along the length of the channel.

Agnico Eagle retained Minnow Environmental Inc. (Minnow) to measure channel geometry at 45 transect locations along Windy Lake outflow, with data collected during high-flow conditions (June) and low-flow conditions (July) of 2025. Geometry data was collected along the entire channel, beginning in the south at Windy Lake and ending in the north at Glenn Lake.

The field crew prioritized transect locations at areas important for fish habitat, and where notable changes in channel conditions, such as width, depth, and slope, were observed. Transects were placed perpendicular to flow, with the field crews collecting the following data:

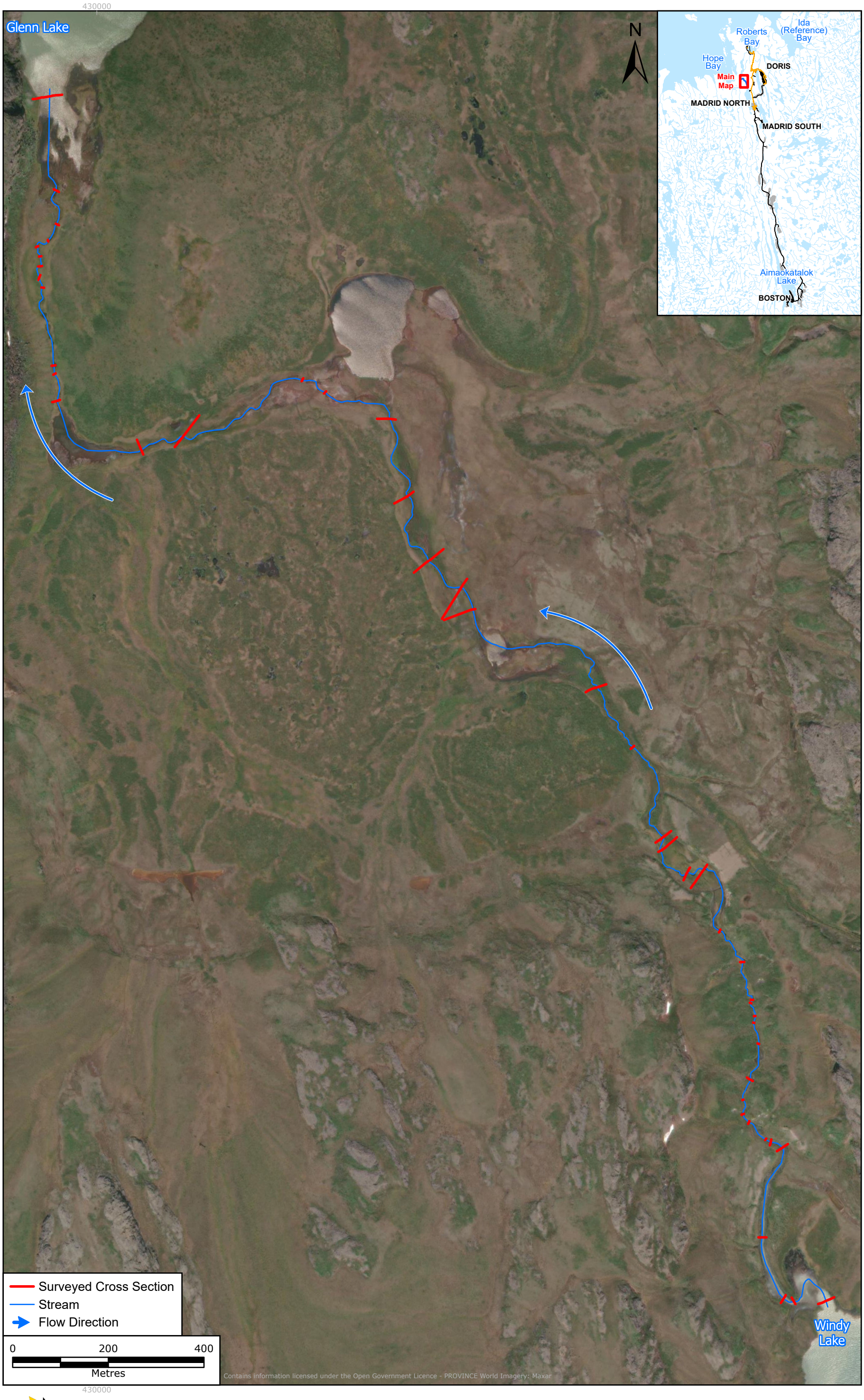
- Elevation of the channel bottom in varying intervals along the transect;
- Transect invert elevation;
- Wetted edge locations;
- Slope breakpoints;
- GPS locations of each measurement to assist in geo-referencing; and
- One water surface elevation measurement per transect.

Minnow also obtained a total of seven (7) flow measurements along the channel (two in June and five in July). Tabular results of the channel geometry and flow data collected by Minnow are provided in Appendix A.

Minnow provided the collected field data to ERM for HEC-RAS model development. ERM imported the transect data into ArcGIS to verify the geo-referenced data points. The channel thalweg was then developed in ArcGIS by linking the surveyed invert elevations for each transect, beginning with the southernmost transect at Windy Lake and progressing northward to Glenn Lake. In sections where the invert did not align with satellite imagery, the transect data points were shifted to follow the channel center line depicted in satellite imagery. Considering the inherent inaccuracies of field survey data that can arise from a variety of sources including; human errors, limitations of instruments, insufficient satellite availability, and environmental factors, this practice is appropriate. Furthermore, moving the cross-sections did not change the shape of the channel and therefore will not have an impact on flow calculations.

Digitized cross-sections to be imported into HEC-RAS were next developed in ArcGIS by linking each surveyed point within an individual transect, from west to east per methodology outlined in HEC-RAS. An image of the digitized channel centreline and surveyed cross-sections is provided in Figure 2.2-1.

FIGURE 2.2-1 CHANNEL CENTRELINE AND SURVEYED CROSS-SECTIONS



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2.2.2 BOUNDARY CONDITIONS

HEC-RAS utilizes boundary conditions to parameterize the upstream (beginning) and downstream (ending) flow conditions of the model. These inputs are used to determine hydraulic conditions at the beginning and end of the channel, which assist in predicting flow conditions along the channel and increase the accuracy of the model results. In a steady-state HEC-RAS model, boundary conditions can be in various forms including: known water surface elevation, critical depth, normal depth, or a rating curve.

ERM used the known water surface elevation of 18.01 metres above sea level (m) from July 2025 survey data as the upstream boundary condition. Based on measured invert elevations at the end of the channel, a slope of 0.001 was utilized for the downstream boundary condition.

2.2.3 FLOW DATA

Flow data is required for the model to simulate water surface profiles, wetted area, and velocity, amongst other hydraulic parameters. Required flow data for steady-state in HEC-RAS is a single flow rate.

ERM previously developed a GoldSim water balance model in 2024 to determine how water withdrawals from Windy Lake have the potential to affect the hydrologic system. Results of this assessment were then used to assess how water withdrawals from the proposed Project may affect fish habitat using Fisheries and Oceans Canada (DFO) guidance and methods used during development of the Mine's Final Environmental Impact Statement (FEIS) (ERM 2025).

As part of the 2024 assessment, resulting mean monthly streamflow rates from the GoldSim water balance model were compared with the mean monthly streamflow rates developed during the FEIS to evaluate how proposed changes to water withdrawals deviate from those originally anticipated (ERM 2025).

The mean monthly streamflow rates from the 2024 GoldSim water balance model and the FEIS were used as inputs for the HEC-RAS model to evaluate the effect the change in flow rates have on hydraulic conditions in the channel connecting Windy Lake to Glenn Lake.

The 18 streamflow rates assessed are provided in Table 2.2-1.

TABLE 2.2-1 FLOW SCENARIOS

Month	FEIS		2024 Assessment	
	Baseline (m^3/s)[a]	With Project (m^3/s)[a]	Baseline (m^3/s)[a]	With Project (m^3/s)[a]
June	0.183	0.178	0.185	0.156
July	0.079	0.072	0.239	0.222
August	0.027	0.023	0.132	0.125
September	0.025	0.022	0.089	0.083

Month	FEIS		2024 Assessment	
	Baseline (m^3/s)[a]	With Project (m^3/s)[a]	Baseline (m^3/s)[a]	With Project (m^3/s)[a]
October	N/A[b]	N/A[b]	0.047	0.043
Average	**0.026**	**0.024**	**0.058**	**0.053**

Notes:
[a] m^3/s (cubic metres per second).
[b] N/A – Flow rate was 0.00 m^3/s and therefore not analyzed.

2.2.4 MANNING'S N

HEC-RAS uses the Manning's N to represent the riverbed roughness; a parameter that determines flow resistance in open channels and flow areas. The roughness coefficient indicates how much the surface roughness of a channel affects flow. At each cross-section, Manning's N can be defined for three locations: the channel, the left bank, and the right bank. In areas of high vegetation, Manning's N values are inversely related and increase as flow decreases. This is caused by shallow/low flow water encountering greater resistance from vegetation.

While collecting geometry data, Minnow took photographs at transects to support the selection of appropriate Manning's N roughness coefficients. From these photographs it is apparent the area is primarily marsh and emergent wetlands. Emergent wetlands are marshy areas with abundant herbaceous and grasslike plants with roots in the soil that grow upright through the water's surface. Emergent wetlands are defined by dense, soft-stemmed vegetation and saturated soils (USEPA 2025). Manning's N can range from 0.16 to 0.55 for areas classified as vegetated marsh and 0.04 to 0.085 for areas classified as emergent wetlands.

Selected Manning's N values for the model range from 0.04 to 0.55. Photos 2.2-1 through 2.2-8 provide a representation of vegetation along the channel.

2.3 MODEL CALIBRATION

Model calibration is conducted to align model results with real-world observations. Model calibration is the process of adjusting model parameters so that the model produces results that match observed field data, such as water surface elevations or flows from known events.

2.3.1 CHANNEL GEOMETRY

To appropriately calibrate the channel geometry in the model, additional cross-sections were added utilizing HEC-RAS' ability to interpolate channel stations and cross-section elevations, based on the closest downstream and upstream cross-section geometry. An additional 99 cross-sections were added to the channel at an approximate interval of 50 metres. In areas of model instability and abrupt geometry changes, cross-sections were added at approximately 10-metre intervals. An image of the channel centreline and surveyed as well as interpolated cross-sections is provided in Figure 2.3-1.

Photo 2.2-1 Reach 1 Transect 2.

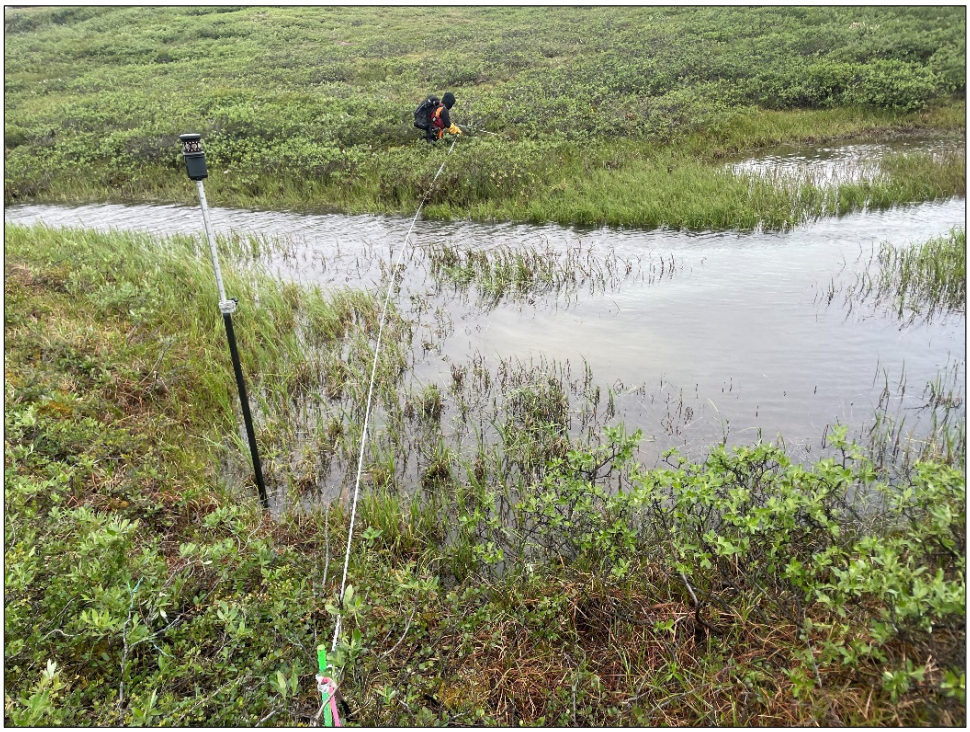


Photo 2.2-2 Reach 1 Transect 11.

Photo 2.2-3 Reach 2 Transect 3.

Photo 2.2-4 Reach 2 Transect 6.

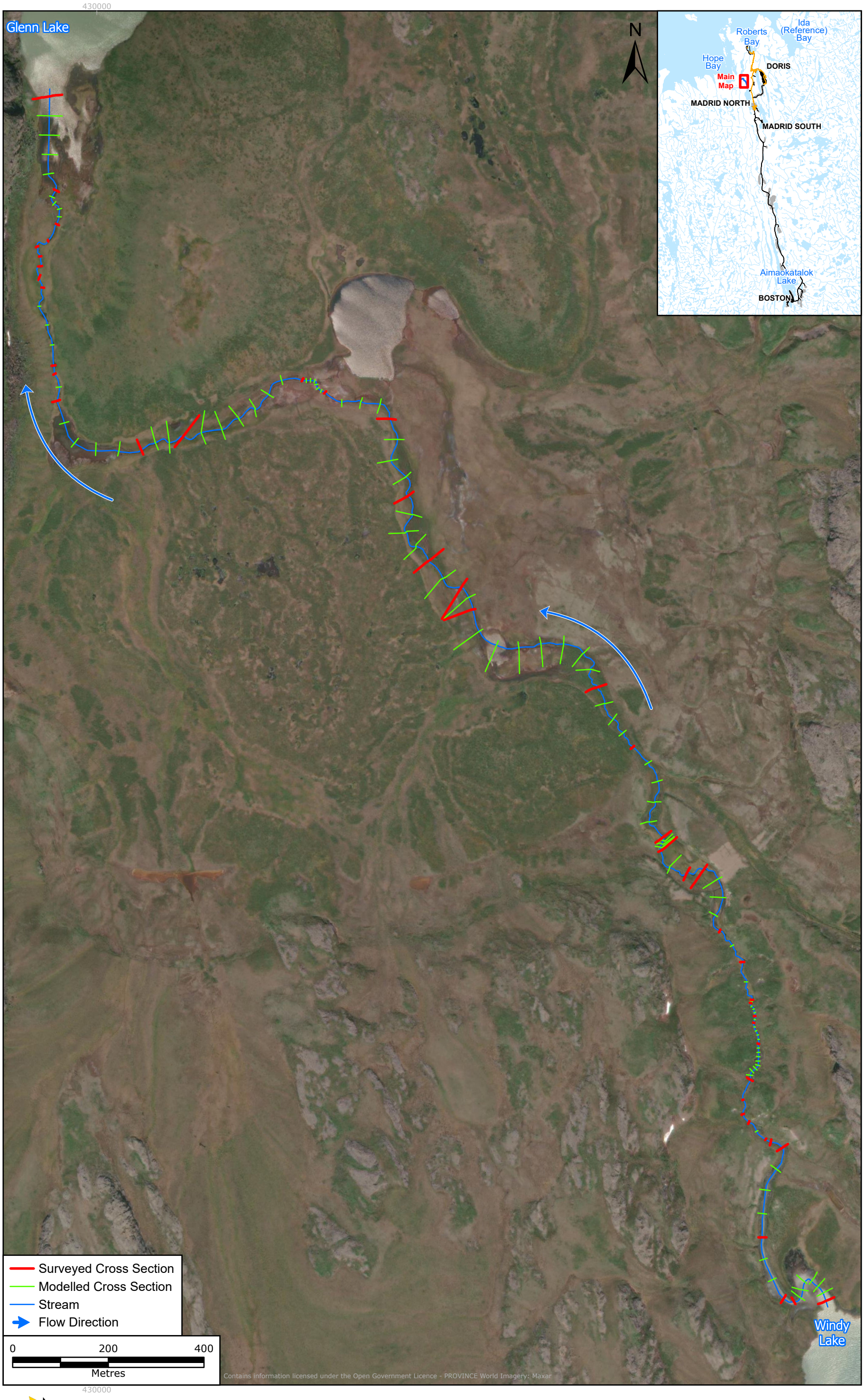
Photo 2.2-5 Reach 3 Transect 6.

Photo 2.2-6 Reach 4 Transect 1.

Photo 2.2-7 Reach 4 Transect 6.

Photo 2.2-8 Reach 5 Transect 8.

FIGURE 2.3-1 SURVEYED AND MODELLED CROSS-SECTIONS



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2.3.2 BOUNDARY CONDITIONS

An upstream depth of 18.01 m was used as the upstream flow boundary to calibrate the model. This depth was observed at the outlet of Windy Lake during the July 2025 survey. Once calibrated, this depth was used in subsequent flows regimes as the upstream boundary condition. For the downstream boundary condition, HEC-RAS requires the user to input a channel-bed slope.
A channel-bed slope of 0.001 was calculated based on invert elevations of the last two transects taken during the July 2025 survey. This was used as the downstream boundary condition.

2.3.3 FLOW DATA

Flow measurements were collected during high-flow (June) and low-flow (July) conditions to assist in model calibration. Field flow measurements are provided in Table 2.3-1.

TABLE 2.3-1 FIELD FLOW MEASUREMENTS

Transect ID	Easting (m)[a]	Northing (m)[a]	Flow Rate (m^3/s)[b]
June—High-Flow			
R1-T3	431393.00	7555550.00	0.367
R1-T12	431387.00	7555796.00	0.483
July—Low-Flow			
R1-T3	431393.00	7555550.00	0.02
R1-T12	431387.00	7555796.00	0.19
R3-T6	430787.00	7556708.00	0.106
R5-T1	430425.00	7557195.00	0.111
R5-T13	429910.00	7557502.00	0.083

Notes:
[a] m (metres).
[b] m^3/s (cubic metres per second).

The average flow measurement value during the July low-flow visit is 0.093 metres cubed per second (m^3/s). This average value was used to calibrate the model.

2.3.4 MANNING'S N

The main parameter adjusted during model calibration was Manning's N. An initial Manning's N value was selected from known reference ranges (USACE 2025) using a combination of channel geometry and observed vegetation in the area. To calibrate the model, this value was then adjusted uniformly across the model until modelled water surface elevations along the entire channel oscillated between below and above observed water surface elevations. The model was then fine-tuned with the following process:

- In areas where modelled water surface elevation was greater than surveyed, Manning's N was lowered to decrease roughness and increase the channels ability to convey water; and
- Where modelled water surface elevation was lower than surveyed, Manning's N was raised to increase roughness and decrease the ability of the channel to convey water.

Table 2.3-2 provides a summary of surveyed water surface elevations, modelled water surface elevations, absolute difference, and corresponding Manning's N selected for the surveyed cross-sections. The average absolute difference and weighted Manning's N across the channel are 0.05 m and 0.17 m respectively.

TABLE 2.3-2 CALIBRATION RESULTS

Reach	Cross-Section	Surveyed WSEL[a] (m)[b]	Modelled WSEL (m)[b]	Absolute Difference (m)[b]	Weighted Manning's N
Reach 1	4241	18.01	18.00	0.01	0.46
	4119	17.96	17.93	0.03	0.34
	4095	17.95	17.91	0.04	0.21
	3956	17.88	17.88	0.00	0.19
	3757	17.86	17.87	0.01	0.19
	3729	17.85	17.86	0.01	0.17
	3717	17.82	17.83	0.01	0.18
	3665	17.62	17.59	0.03	0.20
	3643	17.54	17.53	0.01	0.17
	3611	17.41	17.35	0.06	0.20
	3565	17.32	17.30	0.02	0.17
	3483	17.23	17.25	0.02	0.12
Reach 2	3436	17.15	17.14	0.01	0.28
	3422	16.88	16.88	0.00	0.07
	3391	16.81	16.81	0.00	0.27
	3383	16.53	16.44	0.09	0.40
	3290	16.22	16.21	0.01	0.26
	3200	16.13	16.16	0.03	0.15

Reach	Cross-Section	Surveyed WSEL[a] (m)[b]	Modelled WSEL (m)[b]	Absolute Difference (m)[b]	Weighted Manning's N
Reach 3	3038	16.00	16.00	0.00	0.12
	2995	15.82	15.83	0.01	0.12
	2907	15.40	15.45	0.05	0.13
	2876	15.33	15.24	0.09	0.12
	2645	14.60	14.68	0.08	0.08
	2488	14.37	14.27	0.10	0.19
Reach 4	2104	13.70	13.70	0.00	0.12
	2050	13.68	13.67	0.01	0.12
	1954	13.63	13.58	0.04	0.08
	1783	13.30	13.28	0.02	0.06
	1596	12.55	12.55	0.00	0.07
	1432	11.88	11.90	0.03	0.13
Reach 5	1370	11.73	11.68	0.05	0.12
	1063	11.48	11.55	0.07	0.10
	961	11.37	11.37	0.00	0.11
	719	11.15	11.21	0.06	0.10
	660	10.98	10.90	0.08	0.12
	642	10.74	10.82	0.08	0.06
	468	10.48	10.55	0.07	0.11
	447	10.26	10.23	0.03	0.17
	419	9.81	9.84	0.03	0.08
	396	9.63	9.71	0.08	0.04
	373	9.58	9.64	0.06	0.10
	340	9.51	9.56	0.05	0.11
	300	9.43	9.42	0.01	0.20
	218	9.33	9.14	0.19	0.55
	16	9.26	8.94	0.32	0.54

Notes:
[a] WSEL (water surface elevation).
[b] m (metres).

2.4 ASSUMPTIONS

ERM made the following assumptions in developing the HEC-RAS model for Windy Lake outflow:

- Steady-state flow was selected for the channel. Steady-state flow assumes conditions where the flow does not change over time, i.e., the rate of mass and energy entering a system equals the rate at which they leave with no accumulation or depletion over the period of analysis. Steady-state was assumed for the purpose of analyzing each of the 18 flow scenarios individually. This is consistent with previous analyses conducted for Patch, Ogama, Doris, and Little Roberts Lakes.
- Mixed regime flow conditions were assumed based on the elevation profile of the channel. The elevation profile indicates the flow regime of Windy Lake outflow is primarily relatively tranquil, with a few areas of increased slope that produce increased velocity and supercritical flows.

2.5 LIMITATIONS

Near the end of Windy Lake channel where it empties into Glenn Lake, the channel widens significantly and experiences lake backwatering effects. At this location in the outflow, the model has difficulty in correctly estimating water surface elevation. To appropriately parameterize this location, a storage area could be added, however insufficient field data was available to do this. Instead, Manning's N was increased as an attempt to lower water levels in the area to reflect observed field data. The difference in measured and modelled water surface elevations for stations 218 and 16 are 0.19 and 0.32 metres respectively. Model accuracy and reliability is decreased in this area and should be noted for the subsequent assessment of fish habitat.

The transitory nature of field data limits modelling because it is a snapshot in time. Long-term or rapid changes in parameters are not captured therefore making the model less transferable to varying conditions. For the purposes of this analysis, the data collected is sufficient for determining the proposed Project's effects to fish habitat along the channel.

3. RESULTS

Tables 3-1 through 3-4 provide a summary of the average changes in hydraulic properties across the entire channel. Reported hydraulic properties include maximum channel depth, average channel depth, wetted width, and average velocity. Detailed results of the flow scenarios are summarized per reach and per cross-section and are available to Agnico Eagle in Appendix B to assist in the prediction of the potential effects to fish habitat.

3.1 MAXIMUM CHANNEL DEPTH

Potential Project effects on maximum channel depth are summarized in Table 3-1.

The largest change in the average of the maximum channel depth predicted by FEIS flows occurs in August and is 0.019 (5.73% increase). The largest change in the average of the maximum channel depth predicted by 2024 assessment flows occurs in June and is 0.026 m (4.41% relative increase).

TABLE 3-1 AVERAGE OF MAXIMUM CHANNEL DEPTH

Average of Maximum Channel Depth (m)[a]								
Month	**FEIS**				**2024 Assessment**			
	Baseline (m)	**With Project (m)**	**Difference (m)**	**Relative Difference (%)**	**Baseline Flow (m)**	**With Project Flow (m)**	**Difference (m)**	**Relative Difference (%)**
June	0.581	0.577	0.005	0.78%	0.583	0.557	0.026	4.41%
July	0.464	0.452	0.012	2.65%	0.623	0.611	0.012	1.94%
August	0.326	0.307	0.019	5.73%	0.534	0.526	0.008	1.42%
September	0.317	0.302	0.014	4.54%	0.480	0.470	0.010	2.08%
October	N/A[b]	N/A[b]	N/A[b]	N/A[b]	0.393	0.382	0.011	2.81%

Notes:
[a] m (metres).
[b] N/A – Flow rate was 0.00 m^3/s and therefore not analyzed.

TABLE 3-2 AVERAGE CHANNEL DEPTH

Average Channel Depth (m)[a]								
Month	**FEIS**				**2024 Assessment**			
	Baseline Flow (m)	**With Project Flow (m)**	**Difference (m)**	**Relative Difference (%)**	**Baseline Flow (m)**	**With Project Flow (m)**	**Difference (m)**	**Relative Difference (%)**
June	0.212	0.210	0.002	0.85%	0.212	0.202	0.010	4.55%
July	0.196	0.197	-0.001	-0.46%	0.231	0.225	0.007	2.88%
August	0.179	0.172	0.007	3.81%	0.197	0.195	0.001	0.74%
September	0.176	0.170	0.006	3.40%	0.195	0.195	-0.001	-0.36%
October	N/A[b]	N/A[b]	N/A[b]	N/A[b]	0.197	0.195	0.002	0.85%

Notes:
[a] m (metres).
[b] N/A – Flow rate was 0.00 m^3/s and therefore not analyzed.

TABLE 3-3 AVERAGE WETTED WIDTH

Average Wetted Width (m)[a]								
Month	**FEIS**				**2024 Assessment**			
	Baseline Flow (m)	**With Project Flow (m)**	**Difference (m)**	**Relative Difference (%)**	**Baseline Flow (m)**	**With Project Flow (m)**	**Difference (m)**	**Relative Difference (%)**
June	17.094	16.873	0.221	1.30%	17.177	15.842	1.335	7.77%
July	9.333	8.687	0.646	6.92%	19.119	18.563	0.555	2.91%
August	4.538	4.254	0.284	6.26%	14.468	14.014	0.455	3.14%
September	4.375	4.196	0.179	4.08%	10.380	9.742	0.638	6.15%
October	N/A[b]	N/A[b]	N/A[b]	N/A[b]	6.208	5.841	0.366	5.90%

Note:
[a] m (metres).
[b] N/A – Flow rate was 0.00 m^3/s and therefore not analyzed.

TABLE 3-4 AVERAGE CHANNEL VELOCITY

Average Channel Velocity (m^2/s)[a]								
Month	**FEIS**				**2024 Assessment**			
	Baseline (m^2/s)	**With Project (m^2/s)**	**Difference (m^2/s)**	**Relative Difference (%)**	**Baseline (m^2/s)**	**With Project (m^2/s)**	**Difference (m^2/s)**	**Relative Difference (%)**
June	0.142	0.141	0.001	0.49%	0.143	0.135	0.007	5.06%
July	0.110	0.107	0.003	2.66%	0.153	0.150	0.003	2.04%
August	0.087	0.083	0.004	4.16%	0.129	0.127	0.002	1.46%
September	0.086	0.083	0.003	3.64%	0.113	0.111	0.002	2.14%
October	N/A[b]	N/A[b]	N/A[b]	N/A[b]	0.097	0.095	0.001	0.00%

Notes:
[a] m2/s (squared metres per second).
[b] N/A – Flow rate was 0.00 m^3/s and therefore not analyzed.

3.2 AVERAGE CHANNEL DEPTH

Potential Project effects on average channel depth are summarized in Table 3-2.

The largest change in the average channel depth predicted by FEIS flows occurs in August and is 0.007 (3.81% increase). The largest change in the average channel depth predicted by 2024 assessment flows occurs in June and is 0.010 m (4.55% relative increase).

3.3 AVERAGE WETTED WIDTH

Potential Project effects on average wetted width are summarized in Table 3-3.

The largest change in the average wetted width predicted by FEIS flows occurs in July and is 0.646 m (6.92% increase). The largest change in the average wetted width predicted by 2024 assessment flows occurs in June and is 1.335 m (7.77% relative increase).

3.4 AVERAGE CHANNEL VELOCITY

Potential Project effects on average channel velocity along the channel are provided in Table 3-4.

The largest change in the average channel velocity predicted by FEIS flows occurs in August and is 0.004 m^3/s (4.16% increase). The largest change in the average of the maximum channel depth predicted by 2024 assessment flows occurs in June and is 0.007 m^3/s (5.06% relative increase).

4. SUMMARY

Agnico Eagle seeks to restart mining operations at the Mine using underground mining methods. The restart of operations requires additional water needs, anticipated to be beyond currently permitted withdrawal volumes.

To assess the potential effects of the Project on Windy Lake outflow hydraulic conditions, ERM developed a 1D steady-state mixed regime HEC-RAS model. Minnow collected transect survey data of the channel to support the development and calibration of the model.

A total of 18 flow scenarios (nine developed during ERM's 2024 hydraulic assessment and nine developed for the FEIS) were analyzed using the HEC-RAS model. Results are provided in Section 3 and can be used during predictions of the potential effects of the additional water withdrawals on fish habitat along the channel. Table 4-1 below summarizes the largest changes in the four parameters reported.

TABLE 4-1 SUMMARY OF RESULTS

Parameter	FEIS			2024 Assessment		
	Maximum Difference	Maximum Relative Difference (%)	Month	Maximum Difference	Maximum Relative Difference (%)	Month
Average of Maximum Channel Depth (m)[a]	0.019	5.73%	August	0.026	4.41%	June
Average Channel Depth (m)[a]	0.007	3.81%	August	0.010	4.55%	June
Average Wetted Width (m)[a]	0.646	6.92%	July	1.335	7.77%	June
Average Channel Velocity (m^2/s)[b]	0.004	4.16%	August	0.007	5.06%	June

Notes:
[a] m (metres).
[b] m^2/s (squared metres per second).

5. REFERENCES

ERM. 2025. *Hope Bay Additional Withdrawal Memo*. Environmental Resources Management.

USACE. 2025. *HEC-RAS Hydraulic Reference Manual*. Retrieved from https://www.hec.usace.army.mil/confluence/rasdocs/ras1dtechref/6.6/basic-data-requirements/geometric-data/energy-loss-coefficients.

USEPA. 2025. C*lassification and Types of Wetlands.* Retrieved from https://www.epa.gov/wetlands/classification-and-types-wetlands#undefined.

APPENDIX A CHANNEL GEOMETRY AND FLOW DATA

Windy Lake Outflow Survey Code and Pint ID Key

Code	Point	Full Name	Comment
BM		Benchmark	Permanent or temporary
BF		Bankfull	
	BF1	Right Bankfull	
	BF2	Left Bankfull	
BS		Backsight	Initial survey backsight only
	GLK	Glenn Lake	
HC		Hydraulic Control	Instream islands, bars, and rocks that were unsubmerged at the time of the survey.
LB		Left Bank	Looking downstream in the direction of the flow.
	LBE	Left Bank Edge	
	MAIN	Main Channel	
	OLDCHL	Old Channel	Channel located between transect 4 and 5, west f T4-R6 and south-southeast of R5-T1
	R	Reach	
RB		Right Bank	Looking downstream of the direction of flow.
	RBE	Right Bank Edge	
	SIDE	Side Channel	Corresponding to a secondary or tertiary channel
	T	Transect	
TBP		Top of Bed Point	Streambed elevation point
TOR		Top of Rebar	
TW		Thalweg	Deepest point of the stream, not always measured if stream bed was nearly flat
WL		Water Level	
	WLO	Windy Lake Outflow	

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Reach	Transect	Point ID	Northing	Easting	Elevation	Code
1		WLO-BM-1/WLO-HYDRO	7554948.00	431404.00	21.284	BM
1		BM-R1-BM2	7555138.83	431313.14	36.223	BM
1		WINDY LAKE WL	7555251.79	431544.79	18.109	WL
1	1	R1-T1-WL	7555265.63	431541.02	18.096	WL
1	1	R1-T1-TOR	7555267.16	431544.56	18.693	TOR
1	2	R1-T2-TOR	7555274.13	431448.75	18.647	TOR
1	2	R1-T2-WL	7555270.21	431451.14	18.054	WL
1	3	R1-T3-TOR	7555272.02	431442.01	18.617	TOR
1	3	R1-T3-WL	7555267.87	431439.74	18.080	WL
1	4	R1-T4-TOR	7555391.81	431402.05	18.728	TOR
1	4	R1-T4-WL	7555391.79	431398.88	18.058	WL
1	5	R1-T5-TOR	7555587.16	431446.49	18.571	TOR
1	5	R1-T5-WL	7555586.35	431444.78	18.062	WL
1	6	R1-T6-TOR	7555598.39	431411.90	18.485	TOR
1	6	R1-T6-WL	7555592.91	431410.44	18.068	WL
1	7	R1-T7-TOR	7555602.08	431402.89	18.432	TOR
1	7	R1-T7-WL	7555596.40	431399.22	17.990	WL
1	8	R1-T8-TOR	7555635.92	431366.06	18.410	TOR
1	8	R1-T8-WL	7555631.79	431363.72	17.924	WL
1	9	R1-T9-TOR	7555650.36	431354.67	18.327	TOR
1	9	R1-T9-WL	7555649.54	431352.80	17.858	WL
1	10	R1-T10-TOR	7555680.34	431353.84	18.229	TOR
1	10	R1-T10-WL	7555679.63	431352.36	17.707	WL
1		WLO-BM3	7555619.03	431790.27	41.298	BM
1	11	R1-T11-TOR	7555718.60	431373.18	18.075	TOR
1	11	R1-T11-WL	7555719.06	431371.40	17.578	WL
1	12	R1-T12-TOR	7555796.11	431384.06	17.921	TOR
1	12	R1-T12-WL	7555796.66	431382.21	17.514	WL
2	1	R2-T1-TOR	7555840.25	431375.70	17.898	TOR
2	1	R2-T1-WL	7555841.39	431370.85	17.436	WL
2	2	R2-T2-TOR	7555854.79	431375.09	17.911	TOR
2	2	R2-T2-WL	7555854.02	431372.41	17.195	WL
2	3	R2-T3-TOR	7555882.18	431367.33	17.462	TOR
2	3	R2-T3-WL	7555882.55	431365.23	17.133	WL
2	4	R2-T4-TOR	7555888.98	431369.07	17.367	TOR
2	4	R2-T4-WL	7555888.49	431364.57	16.868	WL
2	5	R2-T5-TOR	7555968.11	431356.04	17.332	TOR
2	5	R2-T5-WL	7555967.78	431351.68	16.630	WL
2	6	R2-T6-TOR	7556035.31	431304.62	16.802	TOR
2	6	R2-T6-WL	7556032.03	431303.30	16.341	WL
3	1	R3-T1-TOR	7556179.07	431283.48	20.042	TOR

3	1	R3-T1-WL	7556160.93	431270.72	16.203	WL
3	2	R3-T2-TOR	7556165.63	431241.24	16.448	TOR
3	2	R3-T2-WL	7556165.62	431241.25	16.062	WL
3	3	R3-T3-TOR	7556197.32	431174.46	15.960	TOR
3	3	R3-T3-WL	7556221.70	431203.27	15.721	WL
3	4	R3-T4-TOR	7556242.19	431202.40	18.396	TOR
3	4	R3-T4-WL	7556225.65	431180.53	15.480	WL
3	5	R3-T5-TOR	7556421.16	431127.83	15.703	TOR
3	5	R3-T5-WL	7556413.75	431118.40	14.936	WL
3	6	R3-T6-TOR	7556546.77	431061.50	14.810	TOR
3	6	R3-T6-WL	7556539.35	431039.81	14.397	WL
4	1	R4-T1-TOR	7556706.07	430792.62	14.214	TOR
4		WLO-BM4	7555846.22	431405.44	38.056	BM
4		WLO-BM5	7555977.50	431296.90	28.557	BM
4	1	R4-T1-WL	7556706.07	430792.62	13.945	WL
4	2	R4-T2-TOR	7556761.55	430769.16	14.199	TOR
4	2	R4-T2-WL	7556755.44	430765.29	13.870	WL
4	3	R4-T3-TOR	7556807.02	430694.83	14.041	TOR
4	3	R4-T3-WL	7556806.40	430693.95	13.755	WL
4	4	R4-T4-TOR	7556948.12	430658.76	13.749	TOR
4	4	R4-T4-WL	7556941.81	430650.62	13.447	WL
4		WLO-BM6	7556004.45	431262.07	26.323	BM
4		WLO-BM7	7557096.70	430689.08	21.117	BM
4	5	T4-T5-TOR	7557103.96	430614.92	13.552	TOR
4	5	T4-T5-WL	7557104.13	430613.87	12.458	WL
4	6	T4-T6-TOR	7557156.71	430618.15	13.035	TOR
4	6	T4-T6-WL	7557156.45	430618.40	12.089	WL
5	1	R5-T1-TOR	7557189.37	430432.61	12.845	TOR
5	1	R5-T1-WL	7557187.61	430431.71	12.003	WL
5	2	R5-T2-TOR	7557073.30	430184.73	12.557	TOR
5	2	R5-T2-WL	7557071.41	430183.43	11.918	WL
5	3	R5-T3-TOR	7557050.80	430087.45	11.966	TOR
5	3	R5-T3-WL	7557047.01	430089.03	11.523	WL
5	4	R5-T4-TOR	7557143.15	429922.39	11.961	TOR
5	4	R5-T4-WL	7557142.08	429919.05	11.294	WL
5	5	R5-T5-TOR	7557199.61	429915.92	11.751	TOR
5	5	R5-T5-WL	7557198.89	429914.60	11.142	WL
5	6	R5-T6-TOR	7557218.37	429916.60	11.826	TOR
5	6	R5-T6-WL	7557215.51	429911.12	10.901	WL
5	7	R5-T7-TOR	7557378.00	429891.59	11.242	TOR
5	7	R5-T7-WL	7557378.84	429887.22	10.664	WL
5	8	R5-T8-TOR	7557401.21	429882.95	11.012	TOR
5	8	R5-T8-WL	7557399.90	429882.17	10.437	WL
5	9	R5-T9-TOR	7557424.12	429881.96	10.648	TOR

5	9	R5-T9-WL	7557423.41	429879.40	9.853	WL
5	10	R5-T10-TOR	7557444.57	429889.73	10.452	TOR
5	10	R5-T10-WL	7557444.33	429887.67	10.011	WL
5	11	R5-T11-TOR	7557470.26	429884.38	10.364	TOR
5	11	R5-T11-WL	7557466.90	429882.01	9.940	WL
5	12	R5-T12-TOR	7557474.33	429893.04	10.332	TOR
5	12	R5-T12-WL	7557476.87	429894.19	9.837	WL
5	13	R5-T13-TOR	7557508.12	429923.90	10.225	TOR
5	13	R5-T13-WL	7557510.36	429919.02	9.692	WL
5	14	R5-T14-TOR	7557577.78	429923.82	9.982	TOR
5	14	R5-T14-WL	7557579.96	429919.08	9.620	WL

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Reach	Transect	Point ID	Northing	Easting	Elevation	Code
1		BM1 WLO HYDO	7554948.00	431404.00	21.284	BM
1		BM-R1-BM2	7555138.83	431313.14	36.439	BM
1		WINDY-LAKE	7555251.79	431544.79	18.020	WL
1	1	R1-T1-TOR	7555267.16	431544.56	18.560	TOR
1	1	R1-T1-WL	7555265.63	431541.02	18.010	WL
1	1	R1-T1-BF1	7555266.32	431542.63	18.149	BF
1	1	R1-T1-RB	7555266.01	431541.95	18.024	RB
1	1	R1-T1-TBP1	7555263.78	431537.29	17.955	TBP
1	1	R1-T1-TBP2	7555263.04	431535.75	17.982	TBP
1	1	R1-T1-TBP3	7555262.20	431533.95	17.948	TBP
1	1	R1-T1-TBP4	7555261.45	431532.09	17.870	TBP
1	1	R1-T1-TBP5	7555260.63	431530.19	17.644	TBP
1	1	R1-T1-TBP6	7555259.97	431528.39	17.530	TBP
1	1	R1-T1-TBP7	7555259.29	431526.46	17.481	TBP
1	1	R1-T1-TBP8	7555258.45	431524.67	17.403	TBP
1	1	R1-T1-TBP9	7555257.44	431522.96	17.460	TBP
1	1	R1-T1-TBP10	7555256.63	431521.11	17.462	TBP
1	1	R1-T1-TBP11	7555255.61	431519.38	17.442	TBP
1	1	R1-T1-TBP12	7555254.94	431517.47	17.453	TBP
1	1	R1-T1-TBP13	7555254.24	431515.58	17.467	TBP
1	1	R1-T1-TBP14	7555253.71	431513.83	17.443	TBP
1	1	R1-T1-TBP15	7555253.22	431511.93	17.529	TBP
1	1	R1-T1-TBP16	7555252.63	431510.03	17.782	TBP
1	1	R1-T1-LB	7555252.66	431509.75	18.010	LB
1	1	R1-T1-BF2	7555252.35	431509.03	18.174	BF
1	2	R1-T2-TOR	7555274.13	431448.75	18.665	TOR
1	2	R1-T2-WL	7555270.21	431451.14	17.963	WL
1	2	R1-T2-BF1	7555273.08	431449.46	18.084	BF
1	2	R1-T2-RBE	7555270.90	431450.80	17.956	BF
1	2	R1-T2-TBP1	7555268.48	431452.11	17.873	TBP
1	2	R1-T2-TBP2	7555266.73	431453.10	17.817	TBP
1	2	R1-T2-TBP3	7555264.99	431454.06	17.488	TBP
1	2	R1-T2-TW	7555264.47	431454.24	17.581	TW
1	2	R1-T2-TBP4	7555263.24	431455.10	17.733	TBP
1	2	R1-T2-TBP5	7555261.57	431456.19	17.894	TBP
1	2	R1-T2-HC	7555259.77	431457.06	17.848	HC
1	2	R1-T2-HC1	7555259.43	431457.41	17.903	HC
1	2	R1-T2-HC2	7555252.69	431461.42	17.932	HC
1	2	R1-T2-TBP6	7555252.17	431461.77	17.880	TBP
1	2	R1-T2-TBP7	7555250.35	431462.78	17.885	TBP
1	2	R1-T2-TB8	7555248.65	431463.83	17.862	TBP

1	2	R1-T2-LBE	7555246.19	431465.26	17.944	LB
1	2	R1-T2-BF2	7555243.76	431466.71	17.987	BF
1	3	R1-T3-TOR	7555272.02	431442.01	18.634	TOR
1	3	R1-T3-WL	7555267.87	431439.74	17.953	WL
1	3	R1-T3-RBE	7555271.01	431441.41	18.115	RB
1	3	R1-T3-BF1	7555270.78	431441.35	18.137	BF
1	3	R1-T3-RBE1	7555268.67	431440.21	17.956	RB
1	3	R1-T3-TBP1	7555268.11	431439.87	17.874	TBP
1	3	R1-T3-TBP2	7555267.27	431439.33	17.872	TBP
1	3	R1-T3-TBP3	7555266.42	431438.80	17.785	TBP
1	3	R1-T3-TBP4	7555265.56	431438.29	17.601	TBP
1	3	R1-T3-TBP5	7555264.74	431437.78	17.480	TBP
1	3	R1-T3-TBP6	7555263.87	431437.25	17.482	TBP
1	3	R1-T3-TW	7555263.30	431437.02	17.506	TW
1	3	R1-T3-TBP7	7555263.03	431436.69	17.640	TBP
1	3	R1-T3-TBP8	7555262.24	431436.12	17.627	TBP
1	3	R1-T3-TBP9	7555261.38	431435.62	17.632	TBP
1	3	R1-T3-TBP10	7555260.49	431435.11	17.679	TBP
1	3	R1-T3-TBP11	7555259.63	431434.60	17.755	TBP
1	3	R1-T3-TBP12	7555258.83	431434.03	17.805	TBP
1	3	R1-T3-LBE	7555257.89	431433.50	17.912	LB
1	3	R1-T3-BF2	7555254.50	431431.08	17.997	BF
1	4	R1-T4-TOR	7555391.81	431402.05	18.706	TOR
1	4	R1-T4-WL	7555391.79	431398.88	17.879	WL
1	4	R1-T4-BF1	7555391.69	431401.07	18.046	BF
1	4	R1-T4-RBE	7555391.75	431399.38	17.877	RB
1	4	R1-T4-TBP1	7555391.77	431397.84	17.784	TBP
1	4	R1-T4-TBP2	7555391.79	431396.87	17.759	TBP
1	4	R1-T4-TBP3	7555391.73	431395.87	17.616	TBP
1	4	R1-T4-TBP4	7555391.72	431394.86	17.498	TBP
1	4	R1-T4-TBP5	7555391.66	431393.82	17.536	TBP
1	4	R1-T4-TBP6	7555391.66	431392.86	17.428	TBP
1	4	R1-T4-TW	7555391.73	431392.07	17.408	TW
1	4	R1-T4-TBP7	7555391.71	431391.85	17.413	TBP
1	4	R1-T4-TBP8	7555391.63	431390.84	17.403	TBP
1	4	R1-T4-TBP9	7555391.53	431389.86	17.435	TBP
1	4	R1-T4-TBP11	7555391.49	431388.81	17.461	TBP
1	4	R1-T4-TBP12	7555391.52	431387.79	17.659	TBP
1	4	R1-T4-TBP13	7555391.56	431386.86	17.679	TBP
1	4	R1-T4-LBE	7555391.53	431385.78	17.869	LBE
1	4	R1-T4-BF2	7555391.79	431384.19	18.102	BF
1		R1-BM3-BS	7555401.91	431366.81	19.881	BM
1		R1-BM3-BM	7555392.43	431205.88	39.733	BM
1	5	R1-T5-TOR	7555587.16	431446.49	18.570	TOR

1	5	R1-T5-WL	7555586.35	431444.78	17.857	WL
1	5	R1-T5-BF1	7555586.85	431445.91	18.110	BF
1	5	R1-T5-RBE	7555586.53	431445.14	17.837	RB
1	5	R1-T5-TBP1	7555585.52	431443.87	17.640	TBP
1	5	R1-T5-TBP2	7555584.40	431442.16	17.316	TBP
1	5	R1-T5-TBP3	7555583.32	431440.42	17.478	TBP
1	5	R1-T5-TBP4	7555582.28	431438.76	17.530	TBP
1	5	R1-T5-TBP5	7555581.03	431437.16	17.450	TBP
1	5	R1-T5-TW	7555579.74	431434.86	17.245	TW
1	5	R1-T5-TBP6	7555579.82	431435.62	17.286	TBP
1	5	R1-T5-TBP7	7555578.90	431433.86	17.433	TBP
1	5	R1-T5-TBP8	7555577.59	431432.24	17.410	TBP
1	5	R1-T5-TBP9	7555576.67	431430.54	17.429	TBP
1	5	R1-T5-LBE	7555575.57	431428.67	17.820	LB
1	5	R1-T5-BF2	7555571.99	431422.77	18.137	BF
1	6	R1-T6-TOR	7555598.39	431411.90	18.462	TOR
1	6	R1-T6-WL	7555592.91	431410.44	17.853	WL
1	6	R1-T6-BF1	7555596.57	431411.34	17.921	BF
1	6	R1-T6-RBE	7555593.60	431410.58	17.825	RB
1	6	R1-T6-TBP1	7555592.59	431410.46	17.736	TBP
1	6	R1-T6-TBP2	7555592.13	431410.33	17.694	TBP
1	6	R1-T6-TBP3	7555591.73	431410.21	17.585	TBP
1	6	R1-T6-TBP4	7555591.56	431410.16	17.380	TBP
1	6	R1-T6-TBP5	7555591.20	431410.15	17.396	TBP
1	6	R1-T6-TW	7555591.00	431410.15	17.383	TW
1	6	R1-T6-TBP6	7555590.71	431410.05	17.404	TBP
1	6	R1-T6-TBP7	7555590.12	431410.00	17.543	TBP
1	6	R1-T6-TBP8	7555589.65	431409.94	17.654	TBP
1	6	R1-T6-TBP9	7555589.19	431409.75	17.711	TBP
1	6	R1-T6-TBP10	7555588.65	431409.61	17.789	TBP
1	6	R1-T6-TBP11	7555588.22	431409.45	17.817	TBP
1	6	R1-T6-TBP12	7555587.68	431409.34	17.798	TBP
1	6	R1-T6-TBP13	7555587.25	431409.19	17.817	TBP
1	6	R1-T6-LBE	7555586.80	431409.10	17.833	LB
1	6	R1-T6-BF2	7555584.15	431407.94	17.986	BF
1	7	R1-T7-TOR	7555602.08	431402.89	18.376	TOR
1	7	R1-T7-WL	7555596.40	431399.22	17.821	WL
1	7	R1-T7-BF1	7555598.24	431400.71	17.833	BF
1	7	R1-T7-RBE	7555598.07	431400.44	17.775	RB
1	7	R1-T7-TBP1	7555597.62	431400.23	17.756	TBP
1	7	R1-T7-TBP2	7555597.14	431399.95	17.754	TBP
1	7	R1-T7-TW	7555596.10	431399.16	17.498	TW
1	7	R1-T7-TBP3	7555596.74	431399.71	17.731	TBP
1	7	R1-T7-TBP4	7555596.40	431399.41	17.729	TBP

1	7	R1-T7-TBP5	7555596.27	431399.23	17.510	TBP
1	7	R1-T7-TBP6	7555595.97	431399.11	17.578	TBP
1	7	R1-T7-TBP7	7555595.55	431398.86	17.728	TBP
1	7	R1-T7-LBE	7555595.45	431398.59	17.795	LB
1	7	R1-T7-BF2	7555595.13	431398.35	17.839	BF
1	8	R1-T8-TOR	7555635.92	431366.06	18.368	TOR
1	8	R1-T8-WL	7555631.79	431363.72	17.616	WL
1	8	R1-T8-BF1	7555634.79	431365.53	17.753	BF
1	8	R1-T8-RBE	7555634.37	431365.29	17.619	RB
1	8	R1-T8-TBP1	7555634.06	431365.18	17.549	TBP
1	8	R1-T8-TBP2	7555633.58	431365.05	17.490	TBP
1	8	R1-T8-TBP3	7555633.14	431364.89	17.377	TBP
1	8	R1-T8-TBP4	7555632.86	431364.74	17.152	TBP
1	8	R1-T8-TW	7555632.60	431364.46	17.182	TW
1	8	R1-T8-TBP5	7555632.66	431364.67	17.170	TBP
1	8	R1-T8-TBP6	7555632.17	431364.49	17.222	TBP
1	8	R1-T8-TBP7	7555631.75	431364.27	17.453	TBP
1	8	R1-T8-TBP8	7555631.34	431364.10	17.531	TBP
1	8	R1-T8-LBE	7555630.84	431363.75	17.621	LB
1	8	R1-T8-BF2	7555629.02	431362.94	17.770	BF
1	9	R1-T9-TOR	7555650.36	431354.67	18.262	TOR
1	9	R1-T9-WL	7555649.54	431352.80	17.538	WL
1	9	R1-T9-BF1	7555650.27	431354.16	17.824	BF
1	9	R1-T9-RBE	7555649.95	431353.82	17.527	RB
1	9	R1-T9-TBP1	7555649.87	431353.42	17.464	TBP
1	9	R1-T9-TBP2	7555649.66	431352.98	17.429	TBP
1	9	R1-T9-TBP3	7555649.42	431352.50	17.362	TBP
1	9	R1-T9-TBP4	7555649.32	431352.23	17.263	TBP
1	9	R1-T9-TBP5	7555649.40	431352.15	16.990	TBP
1	9	R1-T9-TW	7555649.34	431352.07	17.024	TW
1	9	R1-T9-TBP6	7555649.13	431351.73	16.999	TBP
1	9	R1-T9-TBP7	7555648.92	431351.37	17.194	TBP
1	9	R1-T9-TBP8	7555648.87	431351.11	17.306	TBP
1	9	R1-T9-TBP9	7555648.75	431350.60	17.338	TBP
1	9	R1-T9-TBP10	7555648.61	431350.17	17.429	TBP
1	9	R1-T9-TBP11	7555648.39	431349.63	17.485	TBP
1	9	R1-T9-LBE	7555648.40	431349.44	17.533	LB
1	9	R1-T9-BF2	7555648.18	431349.12	17.647	BF
1	10	R1-T10-TOR	7555680.34	431353.84	18.163	TOR
1	10	R1-T10-WL	7555679.63	431352.36	17.411	WL
1	10	R1-T10-BF1	7555679.91	431352.99	17.548	BF
1	10	R1-T10-RBE	7555679.59	431352.69	17.397	RB
1	10	R1-T10-TBP1	7555679.49	431352.46	17.354	TBP
1	10	R1-T10-TBP2	7555679.42	431352.32	17.264	TBP

1	10	R1-T10-TBP3	7555679.37	431352.22	16.718	TBP
1	10	R1-T10-TW	7555679.41	431352.08	16.748	TW
1	10	R1-T10-TBP4	7555679.22	431351.82	16.788	TBP
1	10	R1-T10-TBP5	7555679.13	431351.66	17.304	TBP
1	10	R1-T10-TBP6	7555679.03	431351.46	17.467	TBP
1	10	R1-T10-LBE	7555679.17	431351.61	17.398	LB
1	10	R1-T10-BF2	7555678.75	431350.62	17.593	BF
1	11	R1-T11-TOR	7555718.60	431373.18	18.024	TOR
1	11	R1-T11-WL	7555719.06	431371.40	17.324	WL
1	11	R1-T11-BF1	7555718.79	431372.59	17.505	BF
1	11	R1-T11-RBE	7555718.84	431371.94	17.339	RB
1	11	R1-T11-TBP1	7555719.25	431372.01	17.246	TBP
1	11	R1-T11-TBP2	7555719.65	431371.12	17.175	TBP
1	11	R1-T11-TBP3	7555720.06	431370.20	17.008	TBP
1	11	R1-T11-TBP4	7555720.50	431369.32	16.917	TBP
1	11	R1-T11-TBP5	7555720.99	431368.39	16.958	TBP
1	11	R1-T11-TBP6	7555721.38	431367.51	16.923	TBP
1	11	R1-T11-TW1	7555721.83	431367.15	16.868	TW
1	11	R1-T11-TBP7	7555721.84	431366.61	16.926	TBP
1	11	R1-T11-TBP8	7555722.36	431365.81	17.159	TBP
1	11	R1-T11-TBP9	7555722.88	431364.97	17.213	TBP
1	11	R1-T11-TBP10	7555723.39	431364.10	17.212	TBP
1	11	R1-T11-TBP11	7555723.86	431363.23	17.246	TBP
1	11	R1-T11-TBP12	7555724.41	431362.34	17.256	TBP
1	11	R1-T11-TBP13	7555725.10	431361.60	17.259	TBP
1	11	R1-T11-LBE	7555725.63	431361.03	17.293	LB
1	11	R1-T11-BF2	7555726.19	431360.27	17.481	BF
1		R1-BM4	7555670.00	431292.47	24.634	BM
1		R1-BM5	7555797.21	431544.92	40.799	BM
1	12	R1-T12-TOR	7555796.11	431384.06	17.851	TOR
1	12	R1-T12-WL	7555796.66	431382.21	17.233	WL
1	12	R1-T12-BF1	7555796.52	431382.67	17.321	BF
1	12	R1-T12-RBE	7555796.58	431382.49	17.213	RB
1	12	R1-T12-TBP1	7555796.61	431381.94	17.068	TBP
1	12	R1-T12-TBP2	7555796.68	431381.54	17.012	TBP
1	12	R1-T12-TBP3	7555796.73	431381.30	16.745	TBP
1	12	R1-T12-TW	7555797.00	431381.07	16.715	TW
1	12	R1-T12-TBP4	7555796.92	431380.61	16.692	TBP
1	12	R1-T12-TBP5	7555797.06	431380.44	17.011	TBP
1	12	R1-T12-TBP6	7555797.21	431380.07	17.095	TBP
1	12	R1-T12-LBE	7555797.47	431379.52	17.223	LB
1	12	R1-T12-BF2	7555797.61	431379.12	17.427	BF
1	12	R2-T1-TOR	7555840.25	431375.70	17.863	TOR
1	12	R2-T1-WL	7555841.39	431370.85	17.15	WL

1	12	R2-T1-BF1	7555841.24	431372.05	17.216	BF
1	12	R2-T1-RBE	7555841.18	431371.76	17.158	RB
1	12	R2-T1-TBP1	7555841.32	431371.14	17.107	TBP
1	12	R2-T1-TW	7555841.42	431370.63	16.778	TW
1	12	R2-T1-TBP2	7555841.42	431370.84	17.05	TBP
1	12	R2-T1-TBP3	7555841.40	431370.66	16.777	TBP
1	12	R2-T1-TBP4	7555841.51	431370.06	16.844	TBP
1	12	R2-T1-TBP5	7555841.56	431369.85	17	TBP
1	12	R2-T1-LBE	7555841.79	431369.64	17.148	LB
1	12	R2-T1-BF2	7555841.73	431369.45	17.233	BF
2	2	R2-T2-TOR	7555854.79	431375.09	17.840	TOR
2	2	R2-T2-WL	7555854.02	431372.41	16.876	WL
2	2	R2-T2-BF1	7555854.39	431373.27	16.922	BF
2	2	R2-T2-RBE	7555854.26	431372.77	16.878	RB
2	2	R2-T2-TBP1	7555854.25	431372.45	16.741	TBP
2	2	R2-T2-TBP2	7555854.21	431372.20	16.654	TBP
2	2	R2-T2-TBP3	7555854.22	431371.98	16.098	TBP
2	2	R2-T2-TW	7555854.16	431371.93	16.103	TW
2	2	R2-T2-TBP4	7555854.24	431371.69	16.115	TBP
2	2	R2-T2-TBP5	7555854.17	431371.51	16.605	TBP
2	2	R2-T2-TBP6	7555854.12	431371.15	16.670	TBP
2	2	R2-T2-LBE	7555854.05	431370.41	16.867	LB
2	2	R2-T2-BF2	7555853.98	431370.02	17.208	BF
2	3	R2-T3-TOR	7555882.18	431367.33	17.433	TOR
2	3	R2-T3-WL	7555882.55	431365.23	16.814	WL
2	3	R2-T3-BF1	7555882.50	431366.37	16.990	BF
2	3	R2-T3-RBE	7555882.75	431365.50	16.812	RB
2	3	R2-T3-TBP1	7555882.75	431365.38	16.740	TBP
2	3	R2-T3-TBP2	7555882.80	431365.35	16.442	TBP
2	3	R2-T3-TW	7555882.84	431365.12	16.429	TW
2	3	R2-T3-TBP3	7555883.04	431364.79	16.534	TBP
2	3	R2-T3-TBP4	7555883.07	431364.68	16.662	TBP
2	3	R2-T3-LBE	7555883.06	431364.55	16.768	LB
2	3	R2-T3-BF2	7555883.55	431363.24	16.986	BF
2	4	R2-T4-TOR	7555888.98	431369.07	17.328	TOR
2	4	R2-T4-WL	7555888.49	431364.57	16.530	WL
2	4	R2-T4-BF1	7555888.88	431368.08	16.787	BF
2	4	R2-T4-RBE	7555888.80	431366.99	16.533	RB
2	4	R2-T4-TBP1	7555888.83	431366.58	16.458	TBP
2	4	R2-T4-TBP2	7555888.84	431366.07	16.271	TBP
2	4	R2-T4-TBP3	7555888.80	431365.63	16.036	TBP
2	4	R2-T4-TW	7555888.83	431364.98	15.420	TW
2	4	R2-T4-TBP4	7555888.89	431364.63	15.873	TBP
2	4	R2-T4-TBP5	7555888.95	431364.34	16.198	TBP

2	4	R2-T4-TBP6	7555888.97	431363.96	16.394	TBP
2	4	R2-T4-LBE	7555888.77	431363.98	16.488	LB
2	4	R2-T4-BF2	7555888.77	431362.82	16.732	BF
2	5	R2-T5-TOR	7555968.11	431356.04	17.295	TOR
2	5	R2-T5-WL	7555967.78	431351.68	16.220	WL
2	5	R2-T5-BF1	7555968.01	431354.71	16.443	BF
2	5	R2-T5-RBE	7555968.00	431354.46	16.235	RB
2	5	R2-T5-TBP1	7555967.84	431354.08	15.889	TBP
2	5	R2-T5-TW	7555968.06	431353.64	15.446	TW
2	5	R2-T5-TBP2	7555967.93	431353.45	15.482	TBP
2	5	R2-T5-TBP4	7555967.78	431352.46	15.685	TBP
2	5	R2-T5-TBP5	7555967.85	431352.17	15.695	TBP
2	5	R2-T5-TBP6	7555967.81	431351.78	15.753	TBP
2	5	R2-T5-HC1	7555967.75	431351.43	16.199	HC
2	5	R2-T5-HC2	7555967.65	431349.95	16.296	HC
2	5	R2-T5-HC3	7555967.58	431348.79	16.227	HC
2	5	R2-T5-TBP7	7555967.47	431348.55	16.117	TBP
2	5	R2-T5-TBP8	7555967.49	431348.21	16.078	TBP
2	5	R2-T5-TBP9	7555967.48	431347.98	16.010	TBP
2	5	R2-T5-LBE	7555967.57	431347.16	16.226	LB
2	5	R2-T5-BF2	7555967.57	431345.86	16.444	BF
2		R1-BM6	7556058.62	431205.20	25.239	BM
2		R1-BM7	7556003.26	431148.36	38.044	BM
2		SAS 29	7555955.32	431139.36	51.094	BM
2	6	R2-T6-TOR	7556035.31	431304.62	16.773	TOR
2	6	R2-T6-WL	7556032.03	431303.30	16.130	WL
2	6	R2-T6-BF1	7556033.56	431303.83	16.235	BF
2	6	R2-T6-RBE	7556032.65	431303.46	16.104	RB
2	6	R2-T6-TBP1	7556032.56	431303.42	16.101	TBP
2	6	R2-T6-TBP2	7556032.08	431303.23	16.053	TBP
2	6	R2-T6-TBP3	7556031.63	431303.02	16.000	TBP
2	6	R2-T6-TBP4	7556031.60	431302.98	15.936	TBP
2	6	R2-T6-TBP5	7556031.42	431302.96	15.577	TBP
2	6	R2-T6-TBP6	7556031.10	431302.88	15.344	TBP
2	6	R2-T6-TBP7	7556030.69	431302.72	15.227	TBP
2	6	R2-T6-TW	7556030.50	431302.50	15.229	TW
2	6	R2-T6-TBP8	7556030.27	431302.45	15.924	TBP
2	6	R2-T6-TBP9	7556029.74	431302.15	16.035	TBP
2	6	R2-T6-TBP10	7556029.24	431301.97	16.046	TBP
2	6	R2-T6-LBE	7556028.97	431301.91	16.117	LB
2	6	R2-T6-BF2	7556027.36	431300.96	16.300	BF
3	1	R3-T1-TOR	7556179.07	431283.48	20.053	TOR
3	1	R3-T1-WL	7556160.93	431270.72	15.997	WL
3	1	R3-T1-BF1	7556169.38	431276.54	16.420	BF

3	1	R3-T1-BF-TOE	7556168.52	431276.00	16.074	BF
3	1	R3-T1-HC1	7556167.91	431275.65	16.057	HC
3	1	R3-T1-RBE	7556161.25	431271.01	15.958	RB
3	1	R3-T1-TBP1	7556161.25	431270.96	15.940	TBP
3	1	R3-T1-TBP2	7556160.79	431270.70	15.806	TBP
3	1	R3-T1-TBP3	7556160.45	431270.47	15.571	TBP
3	1	R3-T1-TW	7556160.23	431270.27	15.500	TW
3	1	R3-T1-TBP4	7556160.02	431270.23	15.538	TBP
3	1	R3-T1-TBP5	7556159.67	431270.02	15.832	TBP
3	1	R3-T1-TBP6	7556159.17	431269.63	15.980	TBP
3	1	R3-T1-LBE	7556159.26	431269.59	15.987	LB
3	1	R3-T1-HC3	7556154.90	431266.53	16.032	HC
3	1	R3-T1-HC4	7556150.48	431263.39	16.042	HC
3	1	R3-T1-HC5	7556146.34	431260.70	16.214	HC
3	1	R3-T1-HC6	7556140.18	431256.30	16.002	HC
3	1	R3-T1-HC7	7556135.54	431253.20	16.005	HC
3	1	R3-T1-HC8	7556131.33	431250.53	16.100	HC
3	1	R3-T1-HC9	7556126.47	431246.69	16.147	HC
3	1	R3-T1-BF2	7556120.48	431242.46	16.345	BF
3	2	R3-T2-TOR	7556165.63	431241.24	16.427	TOR
3	2	R3-T2-WL	7556165.62	431241.25	15.824	WL
3	2	R3-T2-BF1	7556165.40	431241.25	16.061	BF
3	2	R3-T2-RBE	7556157.69	431236.55	15.879	RB
3	2	R3-T2-TBP1	7556163.87	431240.19	15.901	TBP
3	2	R3-T2-TBP2	7556163.00	431239.68	15.895	TBP
3	2	R3-T2-TBP3	7556162.04	431239.27	15.893	TBP
3	2	R3-T2-TBP4	7556161.23	431238.76	15.877	TBP
3	2	R3-T2-TBP5	7556160.36	431238.26	15.905	TBP
3	2	R3-T2-TBP6	7556159.48	431237.79	15.926	TBP
3	2	R3-T2-TBP7	7556158.62	431237.32	15.923	TBP
3	2	R3-T2-TBP8	7556157.71	431236.85	15.903	TBP
3	2	R3-T2-TBP9	7556156.83	431236.36	15.830	TBP
3	2	R3-T2-TBP10	7556156.01	431235.83	15.820	TBP
3	2	R3-T2-TBP11	7556155.03	431235.25	15.810	TBP
3	2	R3-T2-TBP12	7556154.28	431234.84	15.771	TBP
3	2	R3-T2-TBP13	7556153.79	431234.60	15.665	TBP
3	2	R3-T2-TBP14	7556153.41	431234.31	15.351	TBP
3	2	R3-T2-TW	7556153.47	431233.96	15.263	TW
3	2	R3-T2-TBP15	7556153.04	431234.04	15.452	TBP
3	2	R3-T2-TBP16	7556152.59	431233.72	15.767	TBP
3	2	R3-T2-TBP17	7556152.22	431233.45	15.827	TBP
3	2	R3-T2-LBE	7556152.17	431233.30	15.864	LB
3	2	R3-T2-BF2	7556138.59	431227.72	16.032	BF
3	3	R3-T3-TOR	7556197.32	431174.46	15.884	TOR

3	3	R3-T3-WL	7556221.70	431203.27	15.397	WL
3	3	R3-T3-BF1	7556223.06	431204.58	15.813	BF
3	3	R3-T3-HC1	7556222.29	431203.83	15.424	HC
3	3	R3-T3-HC2	7556219.89	431201.31	15.291	HC
3	3	R3-T3-HC3	7556217.07	431198.11	15.384	HC
3	3	R3-T3-HC4	7556213.74	431194.49	15.416	HC
3	3	R3-T3-HC5	7556210.56	431190.64	15.438	HC
3	3	R3-T3-HC6	7556207.17	431186.50	15.445	HC
3	3	R3-T3-HC7	7556203.66	431182.91	15.513	HC
3	3	R3-T3-HC8	7556200.38	431179.05	15.583	HC
3	3	R3-T3-HC9	7556197.55	431174.88	15.569	HC
3	3	R3-T3-RBE1	7556196.45	431173.58	15.570	RB
3	3	R3-T3-TW1	7556196.41	431173.40	15.456	TW
3	3	R3-T3-LBE1	7556196.24	431173.22	15.567	LB
3	3	R3-T3-LBE2	7556195.61	431172.17	15.600	HC
3	3	R3-T3-RBE2-MAIN	7556195.17	431170.78	15.565	RB
3	3	R3-T3-TBP1	7556195.73	431170.74	15.555	TBP
3	3	R3-T3-TBP2	7556195.60	431170.47	15.502	TBP
3	3	R3-T3-TW-MAIN	7556194.58	431170.36	15.355	TW
3	3	R3-T3-TBP3	7556195.42	431170.31	15.263	TBP
3	3	R3-T3-TBP4	7556195.23	431169.96	15.384	TBP
3	3	R3-T3-TBP5	7556195.15	431169.64	15.529	TBP
3	3	R3-T3-TBP6	7556195.11	431169.18	15.584	TBP
3	3	R3-T3-LBE2-MAIN	7556194.69	431169.40	15.528	LB
3	3	R3-T3-BF2	7556192.48	431165.46	15.769	BF
3		R1-BM8	7556208.02	431296.83	19.979	BM
3	4	R3-T4-TOR	7556242.19	431202.40	18.390	TOR
3	4	R3-T4-WL	7556225.65	431180.53	15.334	WL
3	4	R3-T4-BF1	7556235.69	431193.57	15.576	BF
3	4	R3-T4-RBE	7556227.83	431183.93	15.347	RB
3	4	R3-T4-TBP1	7556227.66	431183.41	15.281	TBP
3	4	R3-T4-TBP2	7556226.44	431181.84	15.277	TBP
3	4	R3-T4-TBP3	7556225.19	431180.22	15.142	TBP
3	4	R3-T4-TBP4	7556224.89	431179.77	15.029	TBP
3	4	R3-T4-TBP5	7556224.74	431179.37	15.001	TBP
3	4	R3-T4-TBP6	7556224.63	431179.24	14.732	TBP
3	4	R3-T4-TW	7556224.46	431179.03	14.703	TW
3	4	R3-T4-TBP7	7556224.48	431178.73	14.723	TBP
3	4	R3-T4-TBP8	7556224.27	431178.52	15.063	TBP
3	4	R3-T4-TBP9	7556223.87	431178.11	15.185	TBP
3	4	R3-T4-TBP10	7556222.62	431176.78	15.287	TBP
3	4	R3-T4-TBP11	7556221.35	431175.28	15.348	TBP
3	4	R3-T4-LBE	7556221.20	431174.54	15.402	LB
3	4	R3-T4-TBP12	7556220.10	431173.71	15.424	TBP

3	4	R3-T4-HC1	7556219.35	431172.01	15.436	HC
3	4	R3-T4-TBP13	7556219.06	431171.92	15.429	TBP
3	4	R3-T4-TBP14	7556217.95	431170.27	15.466	TBP
3	4	R3-T4-TBP15	7556216.81	431168.60	15.503	TBP
3	4	R3-T4-HC2	7556216.71	431168.34	15.497	HC
3	4	R3-T4-RBE2	7556215.21	431166.26	15.496	RB
3	4	R3-T4-TW2	7556214.96	431165.97	15.228	TW
3	4	R3-T4-TBP16	7556215.71	431167.00	15.472	TBP
3	4	R3-T4-TBP17	7556215.43	431166.60	15.440	TBP
3	4	R3-T4-TBP18	7556215.14	431166.21	15.436	TBP
3	4	R3-T4-TBP19	7556215.05	431166.10	15.278	TBP
3	4	R3-T4-TBP20	7556214.76	431165.75	15.253	TBP
3	4	R3-T4-TBP21	7556214.65	431165.57	15.407	TBP
3	4	R3-T4-LBE2	7556214.28	431164.98	15.532	LB
3	4	R3-T4-BF2	7556212.76	431162.94	15.666	BF
3	5	R3-T5-TOR	7556421.16	431127.83	15.732	TOR
3	5	R3-T5-WL	7556413.75	431118.40	14.599	WL
3	5	R3-T5-BF1	7556414.36	431119.03	14.704	BF
3	5	R3-T5-RBE1-SIDE	7556413.75	431118.40	14.637	RB
3	5	R3-T5-TW-SIDE	7556413.54	431118.25	14.549	TW
3	5	R3-T5-LBE1-SIDE	7556413.37	431118.11	14.658	LB
3	5	R3-T5-HC1	7556412.84	431117.48	14.668	HC
3	5	R3-T5-RBE2-MAIN	7556412.21	431116.78	14.600	RB
3	5	R3-T5-TBP1	7556412.12	431116.64	14.381	TBP
3	5	R3-T5-TBP2	7556411.70	431116.22	14.350	TBP
3	5	R3-T5-TW-MAIN	7556411.87	431116.53	14.364	TW
3	5	R3-T5-LBE2-MAIN	7556411.52	431115.95	14.618	LB
3	5	R3-T5-BF2	7556408.14	431111.56	14.837	BF
3	6	R3-T6-TOR	7556546.77	431061.50	14.841	TOR
3	6	R3-T6-WL	7556539.35	431039.81	14.369	WL
3	6	R3-T6-BF1	7556545.18	431057.07	14.325	BF
3	6	R3-T6-RBE	7556544.60	431055.05	14.278	RB
3	6	R3-T6-TBP1	7556544.60	431054.81	14.276	TBP
3	6	R3-T6-TBP2	7556543.92	431053.01	14.260	TBP
3	6	R3-T6-TBP3	7556543.22	431051.09	14.204	TBP
3	6	R3-T6-TBP4	7556542.52	431049.01	14.171	TBP
3	6	R3-T6-TBP5	7556542.01	431047.24	14.225	TBP
3	6	R3-T6-TBP6	7556541.23	431045.40	14.178	TBP
3	6	R3-T6-TBP7	7556540.63	431043.52	14.215	TBP
3	6	R3-T6-TBP8	7556540.02	431041.68	14.230	TBP
3	6	R3-T6-TBP9	7556539.29	431039.80	14.222	TBP
3	6	R3-T6-TBP10	7556539.12	431039.37	14.094	TBP
3	6	R3-T6-TW	7556539.24	431039.09	13.806	TW
3	6	R3-T6-TBP11	7556539.21	431039.14	13.803	TBP

3	6	R3-T6-TBP12	7556539.08	431038.76	13.867	TBP
3	6	R3-T6-TBP13	7556538.90	431038.22	14.005	TBP
3	6	R3-T6-TBP14	7556538.90	431037.84	14.180	TBP
3	6	R3-T6-TBP15	7556538.34	431035.80	14.216	TBP
3	6	R3-T6-TBP16	7556537.80	431033.85	14.225	TBP
3	6	R3-T6-TBP17	7556537.32	431031.87	14.181	TBP
3	6	R3-T6-TBP18	7556536.75	431030.39	14.105	TBP
3	6	R3-T6-TBP19	7556536.15	431028.37	14.154	TBP
3	6	R3-T6-TBP20	7556535.43	431026.43	14.173	TBP
3	6	R3-T6-TBP21	7556534.71	431024.64	14.226	TBP
3	6	R3-T6-TBP22	7556533.81	431022.84	14.244	TBP
3	6	R3-T6-LBE	7556532.38	431019.99	14.271	LB
3	6	R3-T6-BF2	7556528.45	431013.94	14.356	BF
3		R3-BM9	7556468.36	430969.65	16.098	BM
3		R3-BM10	7556594.32	431403.36	21.664	BM
4	1	R4-T1-TOR	7556706.07	430792.62	14.247	TOR
4	1	R4-T1-WL	7556705.54	430788.33	13.695	WL
4	1	R4-T1-BF1	7556706.07	430792.27	13.830	BF
4	1	R4-T1-RBE	7556705.50	430788.61	13.698	RB
4	1	R4-T1-TBP1	7556705.43	430788.21	13.537	TBP
4	1	R4-T1-TBP2	7556705.39	430787.73	13.443	TBP
4	1	R4-T1-TW	7556705.32	430787.23	13.337	TW
4	1	R4-T1-TBP3	7556705.24	430787.17	13.344	TBP
4	1	R4-T1-TBP4	7556705.31	430786.67	13.348	TBP
4	1	R4-T1-TBP5	7556705.29	430786.19	13.373	TBP
4	1	R4-T1-TBP6	7556705.24	430785.71	13.348	TBP
4	1	R4-T1-TBP7	7556705.17	430785.17	13.433	TBP
4	1	R4-T1-TBP8	7556705.19	430784.65	13.567	TBP
4	1	R4-T1-TBP9	7556705.16	430784.18	13.637	TBP
4	1	R4-T1-LBE	7556704.91	430783.80	13.702	LB
4	1	R4-T1-BF2	7556696.48	430714.80	13.901	BF
4	2	R4-T2-TOR	7556761.55	430769.16	14.122	TOR
4	2	R4-T2-WL	7556755.44	430765.29	13.676	WL
4	2	R4-T2-BF1	7556769.31	430775.07	13.707	BF
4	2	R4-T2-RBE	7556756.91	430766.26	13.685	RB
4	2	R4-T2-TBP1	7556755.98	430765.75	13.604	TBP
4	2	R4-T2-TBP2	7556755.11	430765.32	13.615	TBP
4	2	R4-T2-TBP3	7556754.23	430764.81	13.618	TBP
4	2	R4-T2-TBP4	7556753.38	430764.22	13.586	TBP
4	2	R4-T2-TBP5	7556752.59	430763.67	13.589	TBP
4	2	R4-T2-TBP6	7556751.76	430763.09	13.598	TBP
4	2	R4-T2-TW	7556751.55	430762.89	13.359	TW
4	2	R4-T2-TBP7	7556751.48	430762.95	13.305	TBP
4	2	R4-T2-TBP8	7556751.26	430762.79	13.396	TBP

4	2	R4-T2-TBP9	7556750.87	430762.51	13.378	TBP
4	2	R4-T2-TBP10	7556750.56	430762.26	13.370	TBP
4	2	R4-T2-TBP11	7556750.06	430761.96	13.403	TBP
4	2	R4-T2-TBP12	7556749.61	430761.80	13.474	TBP
4	2	R4-T2-TBP13	7556748.72	430761.31	13.564	TBP
4	2	R4-T2-TBP14	7556747.79	430760.84	13.553	TBP
4	2	R4-T2-TBP15	7556747.04	430760.28	13.598	TBP
4	2	R4-T2-TBP16	7556746.19	430759.69	13.591	TBP
4	2	R4-T2-TBP17	7556745.34	430759.20	13.591	TBP
4	2	R4-T2-LBE	7556744.64	430758.75	13.676	LB
4	2	R4-T2-BF2	7556685.90	430722.59	13.950	BF
4	3	R4-T3-TOR	7556807.02	430694.83	13.939	TOR
4	3	R4-T3-WL	7556806.40	430693.95	13.625	WL
4	3	R4-T3-BF1	7556823.21	430725.24	13.587	BF
4	3	R4-T3-RBE	7556806.67	430694.25	13.603	RB
4	3	R4-T3-TBP1	7556806.27	430693.64	13.402	TBP
4	3	R4-T3-TBP2	7556805.94	430693.21	13.302	TBP
4	3	R4-T3-TW	7556805.78	430692.88	12.953	TW
4	3	R4-T3-TBP3	7556805.69	430692.70	12.990	TBP
4	3	R4-T3-TBP4	7556805.40	430692.24	13.360	TBP
4	3	R4-T3-TBP5	7556805.20	430691.87	13.505	TBP
4	3	R4-T3-TBP6	7556802.58	430686.60	13.583	TBP
4	3	R4-T3-TBP7	7556799.94	430680.76	13.561	TBP
4	3	R4-T3-LBE	7556805.08	430691.32	13.596	LB
4	3	R4-T3-BF2	7556797.15	430675.88	13.702	BF
4	4	R4-T4-TOR	7556948.12	430658.76	13.656	TOR
4	4	R4-T4-WL	7556941.81	430650.62	13.304	WL
4	4	R4-T4-BF1	7556949.80	430661.00	13.308	BF
4	4	R4-T4-RBE	7556941.96	430650.93	13.267	RB
4	4	R4-T4-TBP1	7556941.60	430650.45	13.229	TBP
4	4	R4-T4-TBP2	7556941.26	430650.05	13.081	TBP
4	4	R4-T4-TBP3	7556941.08	430649.92	13.057	TBP
4	4	R4-T4-TW	7556940.96	430649.76	12.877	TW
4	4	R4-T4-TBP4	7556940.92	430649.81	12.864	TBP
4	4	R4-T4-TBP5	7556940.81	430649.45	12.920	TBP
4	4	R4-T4-TBP6	7556940.66	430649.23	13.038	TBP
4	4	R4-T4-TBP7	7556940.32	430648.82	13.214	TBP
4	4	R4-T4-LBE	7556940.35	430648.97	13.258	LB
4	4	R4-T4-BF2	7556925.07	430620.95	13.601	BF
4		R4-BM11	7556907.66	430595.61	14.575	BM
4		R4-BM12	7556568.92	430748.50	14.643	BM
4	5	R4-T5-TOR	7557103.96	430614.92	12.946	TOR
4	5	R4-T5-WL	7557104.13	430613.87	12.548	WL
4	5	R4-T5-BF1	7557102.47	430625.90	12.762	BF

4	5	R4-T5-RBE	7557104.06	430614.01	12.518	RB
4	5	R4-T5-TBP1	7557104.13	430613.86	12.435	TBP
4	5	R4-T5-TBP2	7557104.11	430613.75	12.043	TBP
4	5	R4-T5-TW	7557104.09	430613.68	12.045	TW
4	5	R4-T5-TBP3	7557104.08	430613.54	12.047	TBP
4	5	R4-T5-TBP4	7557104.18	430612.90	12.301	TBP
4	5	R4-T5-TBP5	7557104.22	430612.74	12.434	TBP
4	5	R4-T5-TBP6	7557104.21	430612.41	12.452	TBP
4	5	R4-T5-LBE	7557104.35	430611.97	12.522	LB
4	5	R4-T5-BF2	7557104.21	430586.71	12.661	BF
4	6	R4-T6-TOR	7557156.45	430618.40	12.414	TOR
4	6	R4-T6-WL-MAIN	7557156.34	430617.97	11.986	WL
4	6	R4-T6-WL-SIDE1	7557154.49	430609.09	12.110	WL
4	6	R4-T6-WL-CH3	7557153.27	430602.46	12.285	WL
4	6	R4-Y6-OLDCHL-WL	7557160.55	430479.48	11.875	WL
4	6	R4-T6-BF1	7557158.98	430633.70	12.225	BF
4	6	R4-T6-RBE-MAIN	7557156.41	430618.10	12.012	RB
4	6	R4-T6-TBP1	7557156.36	430618.02	11.922	TBP
4	6	R4-T6-TBP2	7557156.25	430617.45	11.845	TBP
4	6	R4-T6-TBP3	7557156.06	430616.96	11.810	TBP
4	6	R4-T6-TW-MAIN	7557156.05	430616.66	11.849	TW
4	6	R4-T6-TBP4	7557155.90	430616.54	11.784	TBP
4	6	R4-T6-TBP5	7557155.80	430616.02	11.849	TBP
4	6	R4-T6-TBP6	7557155.73	430615.54	11.868	TBP
4	6	R4-T6-LBE-MAIN	7557155.82	430615.31	11.974	LB
4	6	R4-T6-HC1	7557155.26	430612.88	12.170	HC
4	6	R4-T6-RBE-SIDE1	7557155.08	430610.97	12.063	RB
4	6	R4-T6-TW-SIDE2	7557154.99	430610.67	11.924	TW
4	6	R4-T6-LBE-SIDE3	7557154.58	430608.52	12.114	LB
4	6	R4-T6-RBE-CH3	7557153.62	430603.78	12.266	RB
4	6	R4-T6-TW-CH3	7557153.35	430602.49	12.191	TW
4	6	R4-T6-BF2	7557151.01	430591.73	12.343	BF
4	6	R4-T6-OLDCHL-RBE	7557161.74	430480.36	11.938	RB
4	6	R4-T6-OLDCHL-TW	7557159.58	430478.24	11.720	TW
4	6	R4-T6-OLDCHL-LBE	7557157.08	430475.85	11.871	LB
5	1	R5-T1-TOR	7557189.37	430432.61	12.246	TOR
5	1	R5-T1-WL	7557187.61	430431.71	11.734	WL
5	1	R5-T1-BF1	7557189.10	430432.48	11.885	BF
5	1	R5-T1-RBE	7557187.74	430431.79	11.736	RB
5	1	R5-T1-TBP1	7557187.06	430431.52	11.529	TBP
5	1	R5-T1-TBP2	7557186.63	430431.30	11.326	TBP
5	1	R5-T1-TBP3	7557186.19	430431.00	11.249	TBP
5	1	R5-T1-TBP4	7557185.76	430430.82	11.211	TBP
5	1	R5-T1-TW	7557184.62	430430.22	11.075	TW

5	1	R5-T1-TBP5	7557185.37	430430.59	11.169	TBP
5	1	R5-T1-TBP6	7557184.96	430430.18	11.109	TBP
5	1	R5-T1-TBP7	7557184.56	430429.95	11.076	TBP
5	1	R5-T1-TBP8	7557184.25	430429.73	11.118	TBP
5	1	R5-T1-TBP9	7557184.04	430429.63	11.233	TBP
5	1	R5-T1-TBP10	7557183.71	430429.64	11.578	TBP
5	1	R5-T1-LBE	7557183.34	430429.54	11.751	LB
5	1	R5-T1-BF2	7557182.71	430429.13	11.912	BF
5		R5-BM13	7557270.62	430215.08	18.755	BM
5		R5-BM14	7557163.03	429839.40	22.154	BM
5	2	R5-T2-TOR	7557073.30	430184.73	12.262	TOR
5	2	R5-T2-WL	7557071.41	430183.43	11.481	WL
5	2	R5-T2-BF1	7557115.40	430217.02	11.723	BF
5	2	R5-T2-RBE	7557072.44	430184.12	11.480	RB
5	2	R5-T2-TBP1	7557072.29	430183.97	11.397	TBP
5	2	R5-T2-TBP2	7557072.18	430183.86	11.292	TBP
5	2	R5-T2-TW	7557071.92	430183.73	11.252	TW
5	2	R5-T2-TBP3	7557071.73	430183.52	11.271	TBP
5	2	R5-T2-TBP4	7557071.36	430183.22	11.463	TBP
5	2	R5-T2-LBE	7557071.09	430183.15	11.474	LB
5	2	R5-T2-BF2	7557049.19	430165.58	11.680	BF
5	3	R5-T3-TOR	7557050.80	430087.45	11.796	TOR
5	3	R5-T3-WL	7557047.01	430089.03	11.374	WL
5	3	R5-T3-BF1	7557066.75	430080.73	11.702	BF
5	3	R5-T3-RBE	7557047.22	430088.99	11.366	RB
5	3	R5-T3-TBP1	7557046.54	430089.15	11.200	TBP
5	3	R5-T3-TBP2	7557046.05	430089.39	11.093	TBP
5	3	R5-T3-TBP3	7557045.63	430089.59	10.990	TBP
5	3	R5-T3-TBP4	7557045.30	430089.73	10.949	TBP
5	3	R5-T3-TBP5	7557045.22	430089.81	10.748	TBP
5	3	R5-T3-TW	7557045.16	430089.78	10.749	TW
5	3	R5-T3-TBP6	7557044.69	430090.02	10.804	TBP
5	3	R5-T3-TBP7	7557044.52	430090.13	10.907	TBP
5	3	R5-T3-TBP8	7557044.25	430090.23	11.008	TBP
5	3	R5-T3-TBP9	7557043.72	430090.46	11.146	TBP
5	3	R5-T3-TBP10	7557043.35	430090.75	11.152	TBP
5	3	R5-T3-TBP11	7557042.97	430091.01	11.145	TBP
5	3	R5-T3-TBP12	7557042.52	430091.22	11.291	TBP
5	3	R5-T3-LBE	7557041.73	430091.41	11.328	LB
5	3	R5-T3-BF2	7557035.88	430093.79	11.641	BF
5	4	R5-T4-TOR	7557143.15	429922.39	11.824	TOR
5	4	R5-T4-WL	7557142.08	429919.05	11.149	WL
5	4	R5-T4-BF1	7557143.68	429923.68	11.511	BF
5	4	R5-T4-RBE	7557142.22	429919.37	11.185	RB

5	4	R5-T4-TBP1	7557142.07	429918.54	11.033	TBP
5	4	R5-T4-TBP2	7557141.89	429918.07	11.001	TBP
5	4	R5-T4-TW	7557141.60	429917.53	10.839	TW
5	4	R5-T4-TBP3	7557141.62	429917.58	10.883	TBP
5	4	R5-T4-TBP4	7557141.60	429917.33	10.962	TBP
5	4	R5-T4-TBP5	7557141.52	429917.07	10.847	TBP
5	4	R5-T4-TBP6	7557141.36	429916.80	11.010	TBP
5	4	R5-T4-HC1	7557141.31	429916.52	11.156	HC
5	4	R5-T4-HC2	7557141.17	429916.24	11.296	HC
5	4	R5-T4-HC3	7557141.13	429916.17	11.184	HC
5	4	R5-T4-TBP7	7557141.12	429916.07	10.940	TBP
5	4	R5-T4-LBE	7557141.03	429915.71	11.153	LB
5	4	R5-T4-BF2	7557139.02	429907.69	11.573	BF
5	5	R5-T5-TOR	7557199.61	429915.92	11.605	TOR
5	5	R5-T5-WL	7557198.89	429914.60	10.978	WL
5	5	R5-T5-BF1	7557199.91	429916.48	11.339	BF
5	5	R5-T5-RBE	7557198.99	429914.78	10.992	RB
5	5	R5-T5-TBP1	7557198.85	429914.58	10.860	TBP
5	5	R5-T5-TBP2	7557198.73	429914.39	10.755	TBP
5	5	R5-T5-TW	7557198.65	429914.24	10.536	TW
5	5	R5-T5-TBP3	7557198.63	429914.21	10.532	TBP
5	5	R5-T5-TBP4	7557198.57	429914.01	10.536	TBP
5	5	R5-T5-TBP5	7557198.53	429914.01	10.920	TBP
5	5	R5-T5-LBE	7557198.47	429913.88	10.989	LB
5	5	R5-T5-BF2	7557197.08	429911.34	11.293	BF
5	6	R5-T6-TOR	7557218.37	429916.60	11.687	TOR
5	6	R5-T6-WL	7557215.51	429911.12	10.737	WL
5	6	R5-T6-BF1	7557216.23	429914.52	10.978	BF
5	6	R5-T6-RBE	7557215.76	429911.84	10.704	RB
5	6	R5-T6-TBP1	7557215.60	429910.77	10.565	TBP
5	6	R5-T6-TBP2	7557215.62	429910.61	10.526	TBP
5	6	R5-T6-TW	7557215.61	429910.54	10.447	TW
5	6	R5-T6-TBP3	7557215.49	429910.22	10.453	TBP
5	6	R5-T6-LBE	7557215.50	429910.02	10.751	LB
5	6	R5-T6-BF2	7557215.27	429906.12	10.904	BF
5	7	R5-T7-TOR	7557378.00	429891.59	11.080	TOR
5	7	R5-T7-WL	7557378.84	429887.22	10.484	WL
5	7	R5-T7-BF1	7557378.23	429890.35	10.729	BF
5	7	R5-T7-RBE	7557378.68	429887.39	10.544	RB
5	7	R5-T7-TBP1	7557378.65	429887.24	10.101	TBP
5	7	R5-T7-TBP2	7557378.75	429887.11	10.142	TBP
5	7	R5-T7-TBP3	7557378.78	429886.90	10.389	TBP
5	7	R5-T7-TBP4	7557378.82	429886.59	10.270	TBP
5	7	R5-T7-TBP5	7557378.82	429886.41	9.777	TBP

5	7	R5-T7-TW	7557378.86	429886.32	9.787	TW
5	7	R5-T7-TBP6	7557378.87	429886.29	9.820	TBP
5	7	R5-T7-LBE	7557378.86	429886.21	10.524	LB
5	7	R5-T7-BF2	7557379.10	429884.72	10.717	BF
5	8	R5-T8-TOR	7557401.21	429882.95	10.838	TOR
5	8	R5-T8-SIDE-WL	7557405.05	429884.35	10.177	WL
5	8	R5-T8-MAIN-WL	7557399.90	429882.17	10.255	WL
5	8	R5-T8-BF1	7557405.11	429884.75	10.526	BF
5	8	R5-T8-SIDE-RBE	7557405.03	429884.71	10.440	RB
5	8	R5-T8-SIDE-TW	7557405.05	429884.53	10.146	TW
5	8	R5-T8-SIDE-LBE	7557405.03	429884.25	10.464	LB
5	8	R5-T8-HC	7557402.60	429883.58	10.553	HC
5	8	R5-T8-MAIN-RBE	7557399.94	429882.40	10.303	RB
5	8	R5-T8-MAIN-TBP1	7557399.77	429882.33	10.084	TBP
5	8	R5-T8-MAIN-TW	7557399.44	429882.24	9.993	TW
5	8	R5-T8-MAIN-TBP2	7557399.37	429882.16	9.968	TBP
5	8	R5-T8-MAIN-TBP3	7557398.99	429882.12	10.003	TBP
5	8	R5-T8-MAIN-LBE	7557398.71	429882.10	10.254	LB
5	8	R5-T8-BF2	7557395.00	429880.44	10.390	BF
5	9	R5-T9-TOR	7557424.12	429881.96	10.465	TOR
5	9	R5-T9-WL	7557423.41	429879.40	9.810	WL
5	9	R5-T9-BF1	7557424.30	429883.79	10.101	BF
5	9	R5-T9-RBE	7557423.68	429879.47	9.839	RB
5	9	R5-T9-TBP1	7557423.73	429879.38	9.590	TBP
5	9	R5-T9-TBP2	7557423.57	429879.02	9.596	TBP
5	9	R5-T9-TW	7557423.52	429879.22	9.570	TW
5	9	R5-T9-TBP3	7557423.54	429878.65	9.715	TBP
5	9	R5-T9-TBP4	7557423.50	429878.42	9.732	TBP
5	9	R5-T9-LBE	7557423.48	429878.33	9.820	LB
5	9	R5-T9-BF2	7557422.99	429875.72	10.101	BF
5	10	R5-T10-TOR	7557444.57	429889.73	10.260	TOR
5	10	R5-T10-WL	7557444.33	429887.67	9.634	WL
5	10	R5-T10-BF1	7557444.63	429890.05	9.927	BF
5	10	R5-T10-RBE	7557444.31	429887.72	9.758	RB
5	10	R5-T10-TW	7557444.33	429887.66	9.197	TW
5	10	R5-T10-TBP1	7557444.27	429887.66	9.196	TBP
5	10	R5-T10-TBP2	7557444.25	429887.39	9.188	TBP
5	10	R5-T10-LBE	7557444.23	429887.35	9.733	LB
5	10	R5-T10-BF2	7557443.91	429884.93	9.893	BF
5	11	R5-T11-TOR	7557470.26	429884.38	10.175	TOR
5	11	R5-T11-WL	7557466.90	429882.01	9.579	WL
5	11	R5-T11-BF1	7557467.59	429883.29	9.741	BF
5	11	R5-T11-RBE	7557467.02	429882.16	9.610	RB
5	11	R5-T11-TBP1	7557467.00	429882.04	9.446	TBP

5	11	R5-T11-TBP2	7557466.91	429881.89	9.326	TBP
5	11	R5-T11-TW	7557466.85	429881.86	9.049	TW
5	11	R5-T11-TBP3	7557466.73	429881.63	9.054	TBP
5	11	R5-T11-TBP4	7557466.65	429881.37	9.054	TBP
5	11	R5-T11-TBP5	7557466.57	429881.23	9.504	TBP
5	11	R5-T11-LBE	7557465.98	429880.24	9.557	LB
5	11	R5-T11-BF2	7557464.99	429878.34	9.685	BF
5	12	R5-T12-TOR	7557474.33	429893.04	10.149	TOR
5	12	R5-T12-WL	7557476.87	429894.19	9.507	WL
5	12	R5-T12-BF1	7557475.51	429894.56	9.678	BF
5	12	R5-T12-RBE	7557476.71	429894.22	9.490	RB
5	12	R5-T12-TBP1	7557476.88	429894.35	9.332	TBP
5	12	R5-T12-TBP2	7557477.24	429894.37	9.217	TBP
5	12	R5-T12-TW	7557477.57	429894.22	9.147	TW
5	12	R5-T12-TBP3	7557477.59	429894.21	9.129	TBP
5	12	R5-T12-TBP4	7557478.29	429894.12	9.268	TBP
5	12	R5-T12-LBE	7557478.31	429893.95	9.542	LB
5	12	R5-T12-BF2	7557479.05	429893.74	9.601	BF
5	13	R5-T13-TOR	7557508.12	429923.90	9.975	TOR
5	13	R5-T13-WL	7557510.36	429919.02	9.429	WL
5	13	R5-T13-BF1	7557509.23	429921.63	9.503	BF
5	13	R5-T13-RBE	7557510.15	429919.42	9.426	RB
5	13	R5-T13-TBP1	7557510.47	429918.87	9.305	TBP
5	13	R5-T13-TBP2	7557510.66	429918.43	9.218	TBP
5	13	R5-T13-TBP3	7557510.86	429917.96	9.156	TBP
5	13	R5-T13-TBP4	7557511.09	429917.50	9.173	TBP
5	13	R5-T13-TBP5	7557511.27	429917.02	9.208	TBP
5	13	R5-T13-TBP6	7557511.42	429916.64	9.160	TBP
5	13	R5-T13-TW	7557511.44	429916.63	9.140	TW
5	13	R5-T13-TBP7	7557511.69	429916.14	9.227	TBP
5	13	R5-T13-LBE	7557512.08	429915.61	9.459	LB
5	13	R5-T13-BF2	7557512.26	429914.98	9.536	BF
5	14	R5-T14-TOR	7557577.78	429923.82	9.781	TOR
5	14	R5-T14-WL	7557579.96	429919.08	9.332	WL
5	14	R5-T14-BF1	7557578.77	429921.51	9.413	BF
5	14	R5-T14-RBE	7557579.77	429919.67	9.319	RB
5	14	R5-T14-TBP1	7557580.08	429919.33	9.261	TBP
5	14	R5-T14-TBP2	7557580.69	429918.52	9.062	TBP
5	14	R5-T14-TBP3	7557581.20	429917.66	8.887	TBP
5	14	R5-T14-TBP4	7557581.71	429916.79	8.597	TBP
5	14	R5-T14-TW	7557581.82	429916.09	8.501	TW
5	14	R5-T14-TBP5	7557581.92	429915.70	8.590	TBP
5	14	R5-T14-TBP6	7557582.30	429914.85	8.831	TBP
5	14	R5-T14-TBP7	7557582.79	429913.96	8.890	TBP

5	14	R5-T14-TBP8	7557583.29	429913.11	9.157	TBP
5	14	R5-T14-TBP9	7557583.59	429912.16	9.271	TBP
5	14	R5-T14-LBE	7557583.91	429911.62	9.334	LB
5	14	R5-T14-BF2	7557584.38	429910.58	9.395	BF
5	15	R5-T15-TOR	7557772.79	429866.62	9.939	TOR
5	15	R5-T15-WL	7557774.79	429867.59	9.262	WL
5	15	R5-T15-BF2	7557772.84	429866.94	9.492	BF
5	15	R5-T15-LBE	7557773.12	429867.45	9.272	LB
5	15	R5-T15-TBP1	7557773.29	429869.41	9.204	TBP
5	15	R5-T15-TBP2	7557773.63	429872.64	9.096	TBP
5	15	R5-T15-TBP3	7557774.14	429875.39	8.825	TBP
5	15	R5-T15-TBP4	7557774.81	429878.25	8.718	TBP
5	15	R5-T15-TBP5	7557775.17	429880.72	8.693	TBP
5	15	R5-T15-TBP6	7557775.88	429883.03	8.663	TBP
5	15	R5-T15-TBP7	7557776.62	429885.86	8.732	TBP
5	15	R5-T15-TBP8	7557776.48	429888.86	8.767	TBP
5	15	R5-T15-TBP9	7557776.86	429891.72	8.783	TBP
5	15	R5-T15-TBP10	7557777.55	429894.76	8.789	TBP
5	15	R5-T15-TBP11	7557778.07	429897.77	8.876	TBP
5	15	R5-T15-TBP12	7557778.50	429900.52	8.833	TBP
5	15	R5-T15-TBP13	7557778.82	429903.41	8.780	TBP
5	15	R5-T15-TBP14	7557779.69	429905.98	8.843	TBP
5	15	R5-T15-TBP15	7557780.33	429909.10	8.865	TBP
5	15	R5-T15-TBP16	7557780.71	429912.34	8.950	TBP
5	15	R5-T15-TBP17	7557781.18	429915.10	9.063	TBP
5	15	R5-T15-TBP18	7557781.21	429918.61	9.088	TBP
5	15	R5-T15-TBP19	7557781.34	429921.62	9.164	TBP
5	15	R5-T15-RBE	7557781.62	429925.51	9.248	RB
5	15	R5-T15-BF1	7557782.35	429928.18	9.398	BF
		GLENN LAKE HYDRO	7562001.00	430410.00	12.070	BM
		GLK-WL	7561988.08	430415.58	9.485	WL

Water Level Survey Elevation Profiles Final

Reach	Transect	Point ID	Northing (m)	Easting (m)
1		WINDY LAKE WL	7555251.8	431544.8
1	1	R1-T1-WL	7555265.6	431541.0
1	2	R1-T2-WL	7555270.2	431451.1
1	3	R1-T3-WL	7555267.9	431439.7
1	4	R1-T4-WL	7555391.8	431398.9
1	5	R1-T5-WL	7555586.3	431444.8
1	6	R1-T6-WL	7555592.9	431410.4
1	7	R1-T7-WL	7555596.4	431399.2
1	8	R1-T8-WL	7555631.8	431363.7
1	9	R1-T9-WL	7555649.5	431352.8
1	10	R1-T10-WL	7555679.6	431352.4
1	11	R1-T11-WL	7555719.1	431371.4
1	12	R1-T12-WL	7555796.7	431382.2
2	1	R2-T1-WL	7555841.4	431370.9
2	2	R2-T2-WL	7555854.0	431372.4
2	3	R2-T3-WL	7555882.6	431365.2
2	4	R2-T4-WL	7555888.5	431364.6
2	5	R2-T5-WL	7555967.8	431351.7
2	6	R2-T6-WL	7556032.0	431303.3
3	1	R3-T1-WL	7556160.9	431270.7
3	2	R3-T2-WL	7556165.6	431241.2
3	3	R3-T3-WL	7556221.7	431203.3
3	4	R3-T4-WL	7556225.6	431180.5
3	5	R3-T5-WL	7556413.8	431118.4
3	6	R3-T6-WL	7556539.3	431039.8
4	1	R4-T1-WL	7556706.1	430792.6
4	2	R4-T2-WL	7556755.4	430765.3
4	3	R4-T3-WL	7556806.4	430694.0
4	4	R4-T4-WL	7556941.8	430650.6
4	5	T4-T5-WL	7557104.1	430613.9
4	6	T4-T6-WL	7557156.5	430618.4
5	1	R5-T1-WL	7557187.6	430431.7
5	2	R5-T2-WL	7557071.4	430183.4
5	3	R5-T3-WL	7557047.0	430089.0
5	4	R5-T4-WL	7557142.1	429919.0
5	5	R5-T5-WL	7557198.9	429914.6
5	6	R5-T6-WL	7557215.5	429911.1
5	7	R5-T7-WL	7557378.8	429887.2
5	8	R5-T8-WL	7557399.9	429882.2
5	9	R5-T9-WL	7557423.4	429879.4
5	10	R5-T10-WL	7557444.3	429887.7

5	11	R5-T11-WL	7557466.9	429882.0
5	12	R5-T12-WL	7557476.9	429894.2
5	13	R5-T13-WL	7557510.4	429919.0
5	14	R5-T14-WL	7557580.0	429919.1
5	15	R5-T15-WL	7557774.8	429867.6

Water Level Elevation		Distance from Origin
June	July	(m)
18.109	18.020	0
18.096	18.010	14.3
18.054	17.963	95.4
18.080	17.953	106.3
18.058	17.879	202.2
18.062	17.857	349.2
18.068	17.853	366.6
17.990	17.821	374.1
17.924	17.616	420.9
17.858	17.538	441.7
17.707	17.411	469.1
17.578	17.324	498.4
17.514	17.233	568.6
17.436	17.150	614.7
17.195	16.876	626.4
17.133	16.814	655.8
16.868	16.530	661.7
16.630	16.220	741.6
16.341	16.130	816.8
16.203	15.997	949.5
16.062	15.824	962.9
15.721	15.397	1028.3
15.480	15.334	1039.8
14.936	14.599	1237.7
14.397	14.369	1383.0
13.945	13.695	1637.3
13.870	13.676	1693.7
13.755	13.625	1772.2
13.447	13.304	1912.0
12.458	12.548	2073.1
12.089	11.986	2118.0
12.003	11.734	2233.0
11.918	11.481	2272.5
11.523	11.374	2311.3
11.294	11.149	2493.2
11.142	10.978	2539.4
10.901	10.737	2554.4
10.664	10.484	2696.6
10.437	10.255	2716.4
9.853	9.810	2736.7
10.011	9.634	2748.3

9.940	9.579	2769.8
9.837	9.507	2770.5
9.692	9.429	2782.8
9.620	9.332	2839.6
	9.262	3029.6

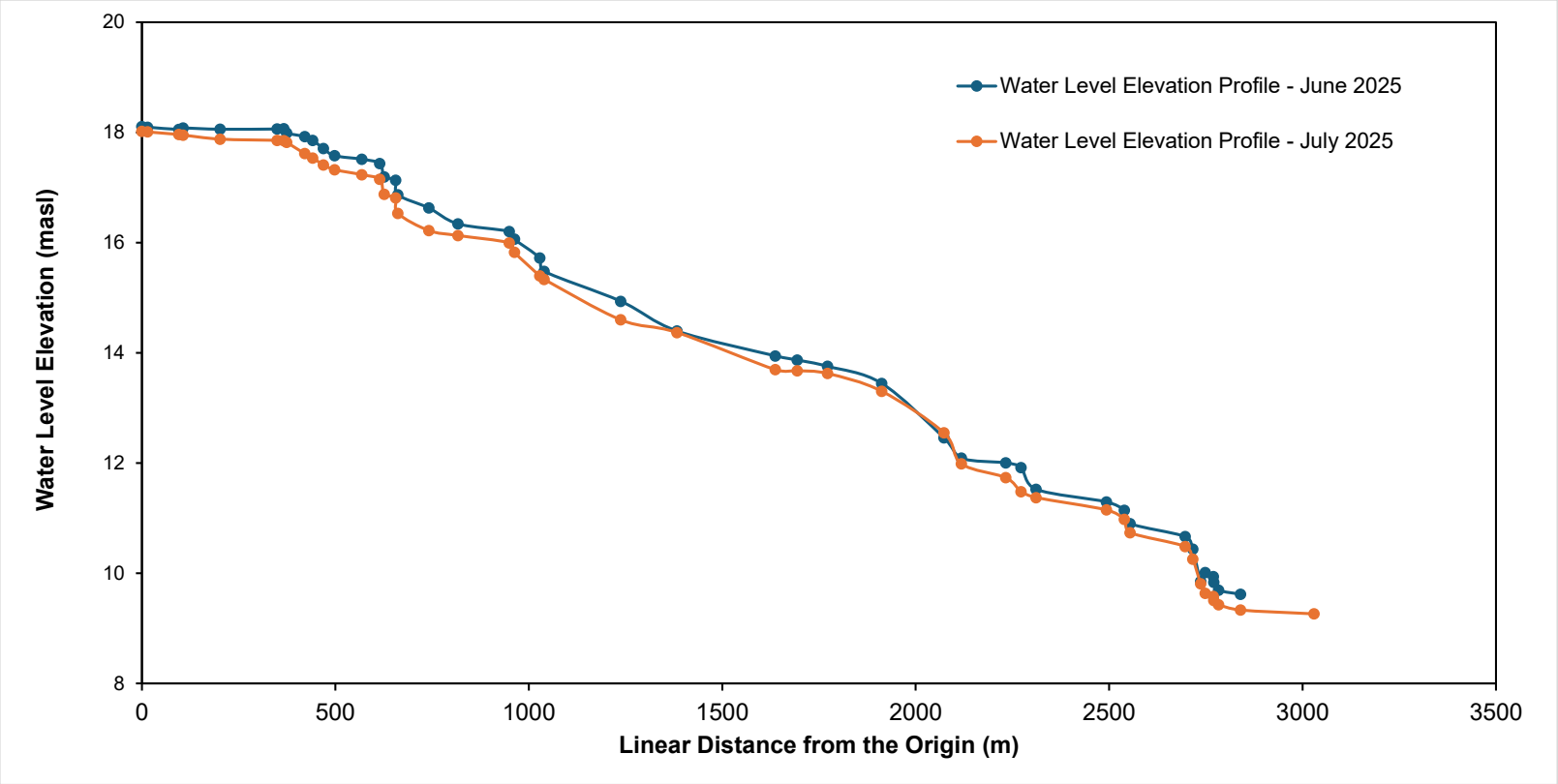

Figure 1: Water Lelvel Elevation Profiles for Windy Lake Outflow, June and July 2025

Note: Origin refers to the Windy Lake water water level location measured in July.

Discrete Streamflow Measurements for Windy Lake Outflow

Date	Method	Transect Location	Easting (m)	Northing (m)	Area (m^2)	Mean Velocity (m/s)	Streamflow (m^3/s)	Streamflow (L/s)	Comments
10-Jun-25	Standard velocity/area [a]	R1-T3	431393.00	7555550.00	4.75	0.08	0.367	366.7	
11-Jun-25	Standard velocity/area [b]	R1-T12	431387.00	7555796.00	1.48	0.33	0.483	483.1	
19-Jul-25	Standard velocity/area [b]	R1-T3	431393.00	7555550.00	2.57	0.02	0.052	51.9	
20-Jul-25	Standard velocity/area [b]	R1-T12	431387.00	7555796.00	0.61	0.19	0.115	115.2	
23-Jul-25	Standard velocity/area [b]	R3-T6/R4-T1	430787.00	7556708.00	1.02	0.10	0.106	106.1	Station between R3 and R4.
23-Jul-25	Standard velocity/area [b]	R5-T1	430425.00	7557195.00	1.61	0.07	0.111	110.5	
23-Jul-25	Standard velocity/area [b]	R5-T13	429910.00	7557502.00	0.79	0.11	0.083	83.2	

High flow/freshet flow measurements recorded during June 2025.

Notes: "R" = Reach. "T" = Transect. Reach and transect numbers were ordered from upstream to downstream.

[a] Standard velocity/area - velocity-area method using manual techniques with a wading rod and velocity meter at stream cross-sections.

APPENDIX B DETAILED RESULTS OF FLOW SCENARIOS

APPENDIX B: DETAILED RESULTS OF FLOW SCENARIOS

TABLE B-1 SUMMARY OF FLOW RESULTS PER REACH

Reach	Baseline												Modelled Changes											
	FEIS						2024 Assessment						FEIS						2024 Assessment					
	Variable	June	July	Aug	Sep	Mean Monthly	June	July	Aug	Sep	Oct	Mean Monthly	Variable	June	July	Aug	Sep	Mean Monthly	June	July	Aug	Sep	Oct	Mean Monthly
Reach 1	Average Depth (m)[a]	0.32	0.23	0.21	0.20	0.24	0.32	0.36	0.28	0.24	0.23	0.29	Average Depth (m)[a]	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.00	0.01
													Average Depth (%)	1.51%	2.24%	3.60%	3.58%	2.73%	7.29%	3.72%	2.13%	2.27%	0.61%	3.20%
	Maximum Depth (m)	0.62	0.48	0.34	0.33	0.44	0.62	0.67	0.56	0.50	0.41	0.55	Maximum Depth (m)	0.01	0.01	0.02	0.02	0.01	0.03	0.02	0.01	0.01	0.01	0.02
													Maximum Depth (%)	0.89%	2.55%	6.07%	4.79%	3.58%	5.20%	2.36%	1.73%	1.99%	2.69%	2.79%
	Top Width (m)	15.77	13.08	7.83	7.65	11.08	15.79	16.23	15.00	13.69	9.13	13.97	Top Width (m)	0.06	0.55	0.30	0.17	0.27	0.36	0.08	0.16	0.35	0.31	0.25
													Top Width (%)	0.42%	3.77%	6.02%	3.65%	3.46%	2.85%	0.56%	1.33%	2.40%	4.25%	2.28%
	WSEL[b] (m)	17.74	17.60	17.46	17.45	17.56	17.74	17.79	17.68	17.62	17.53	17.67	WSEL[b] (m)	0.01	0.01	0.02	0.01	0.01	0.03	0.02	0.01	0.01	0.01	0.02
													WSEL (%)	0.03%	0.07%	0.11%	0.08%	0.07%	0.18%	0.09%	0.05%	0.05%	0.07%	0.09%
	Average Velocity (m/s)[c]	0.08	0.06	0.04	0.04	0.05	0.08	0.09	0.07	0.06	0.05	0.07	Average Velocity (m/s)[c]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
													Average Velocity (%)	1.09%	4.31%	0.00%	0.00%	1.35%	6.09%	3.75%	0.81%	2.01%	0.00%	2.53%
Reach 2	Average Depth (m)[a]	0.28	0.26	0.25	0.24	0.26	0.28	0.30	0.27	0.26	0.27	0.27	Average Depth (m)[a]	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
													Average Depth (%)	0.66%	-0.61%	5.13%	3.22%	2.10%	2.58%	2.45%	-0.46%	1.05%	0.47%	1.22%
	Maximum Depth (m)	0.81	0.64	0.44	0.42	0.58	0.81	0.86	0.74	0.66	0.54	0.72	Maximum Depth (m)	0.01	0.02	0.02	0.02	0.02	0.04	0.02	0.01	0.01	0.02	0.02
													Maximum Depth (%)	0.64%	3.04%	5.67%	5.08%	3.61%	4.72%	2.01%	1.56%	2.19%	3.32%	2.76%
	Top Width (m)	6.83	3.58	1.26	1.23	3.22	6.86	7.59	5.80	4.36	1.71	5.26	Top Width (m)	0.08	0.43	0.07	0.05	0.16	0.55	0.20	0.18	0.40	0.12	0.29
													Top Width (%)	1.47%	6.89%	5.69%	4.18%	4.56%	9.49%	3.15%	3.95%	5.25%	6.28%	5.62%
	WSEL[b] (m)	16.67	16.50	16.30	16.29	16.44	16.67	16.73	16.60	16.52	16.40	16.58	WSEL[b] (m)	0.01	0.02	0.03	0.02	0.02	0.04	0.02	0.01	0.01	0.02	0.02
													WSEL (%)	0.03%	0.10%	0.15%	0.11%	0.10%	0.21%	0.10%	0.07%	0.09%	0.11%	0.11%
	Average Velocity (m/s)[c]	0.20	0.16	0.12	0.12	0.15	0.20	0.22	0.18	0.16	0.14	0.18	Average Velocity (m/s)[c]	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
													Average Velocity (%)	0.44%	2.53%	6.08%	5.46%	3.63%	5.29%	1.71%	1.82%	2.18%	0.84%	2.37%

Reach	Baseline												Modelled Changes											
	FEIS						2024 Assessment						FEIS						2024 Assessment					
	Variable	June	July	Aug	Sep	Mean Monthly	June	July	Aug	Sep	Oct	Mean Monthly	Variable	June	July	Aug	Sep	Mean Monthly	June	July	Aug	Sep	Oct	Mean Monthly
Reach 3	Average Depth (m)[a]	0.10	0.12	0.12	0.12	0.12	0.10	0.10	0.10	0.11	0.13	0.11	Average Depth (m)[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00
													Average Depth (%)	-0.20%	0.80%	1.11%	0.80%	0.63%	1.84%	4.68%	-1.84%	-5.13%	-0.82%	-0.25%
	Maximum Depth (m)	0.47	0.39	0.27	0.27	0.35	0.47	0.49	0.44	0.40	0.33	0.42	Maximum Depth (m)	0.00	0.01	0.02	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.01
													Maximum Depth (%)	0.76%	2.91%	6.15%	4.22%	3.51%	3.50%	1.57%	0.82%	2.52%	3.03%	2.29%
	Top Width (m)	25.16	12.46	3.08	3.08	10.94	25.32	29.09	19.64	13.93	7.10	19.01	Top Width (m)	0.47	0.98	0.50	0.33	0.57	2.77	1.18	0.96	0.97	0.95	1.37
													Top Width (%)	2.74%	8.52%	10.29%	8.37%	7.48%	13.19%	4.66%	5.90%	9.82%	8.14%	8.34%
	WSEL[b] (m)	14.82	14.74	14.62	14.62	14.70	14.82	14.84	14.79	14.75	14.68	14.78	WSEL[b] (m)	0.00	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
													WSEL (%)	0.02%	0.06%	0.11%	0.09%	0.07%	0.11%	0.04%	0.04%	0.06%	0.08%	0.06%
	Average Velocity (m/s)[c]	0.14	0.12	0.11	0.11	0.12	0.14	0.15	0.13	0.12	0.11	0.13	Average Velocity (m/s)[c]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
													Average Velocity (%)	0.10%	0.90%	4.91%	5.14%	2.76%	3.01%	0.92%	1.50%	1.03%	1.11%	1.51%
Reach 4	Average Depth (m)[a]	0.12	0.15	0.14	0.14	0.13	0.12	0.14	0.11	0.13	0.16	0.13	Average Depth (m)[a]	0.00	-0.01	0.01	0.01	0.00	0.01	0.00	0.00	-0.01	0.00	0.00
													Average Depth (%)	0.00%	-14.69%	4.35%	4.92%	-1.35%	7.47%	2.97%	1.58%	-11.17%	1.01%	0.37%
	Maximum Depth (m)	0.46	0.38	0.26	0.26	0.34	0.46	0.49	0.43	0.40	0.32	0.42	Maximum Depth (m)	0.00	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
													Maximum Depth (%)	0.70%	3.00%	7.32%	5.36%	4.10%	3.84%	1.93%	1.36%	2.10%	3.31%	2.51%
	Top Width (m)	23.89	6.39	2.90	2.90	9.02	24.01	26.71	19.98	8.53	4.06	16.66	Top Width (m)	0.29	0.91	0.21	0.15	0.39	1.87	0.75	0.71	1.34	0.20	0.98
													Top Width (%)	1.27%	14.76%	6.95%	5.47%	7.11%	8.03%	2.82%	3.85%	12.82%	5.32%	6.57%
	WSEL[b] (m)	12.76	12.68	12.56	12.56	12.64	12.76	12.78	12.73	12.69	12.62	12.72	WSEL[b] (m)	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
													WSEL (%)	0.03%	0.08%	0.12%	0.09%	0.08%	0.12%	0.07%	0.04%	0.05%	0.09%	0.07%
	Average Velocity (m/s)[c]	0.15	0.12	0.10	0.10	0.11	0.15	0.16	0.13	0.12	0.10	0.13	Average Velocity (m/s)[c]	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
													Average Velocity (%)	0.81%	2.52%	2.23%	1.85%	1.85%	6.28%	0.98%	1.95%	3.44%	-0.29%	2.47%

Reach	Baseline												Modelled Changes											
	FEIS						2024 Assessment						FEIS						2024 Assessment					
	Variable	June	July	Aug	Sep	Mean Monthly	June	July	Aug	Sep	Oct	Mean Monthly	Variable	June	July	Aug	Sep	Mean Monthly	June	July	Aug	Sep	Oct	Mean Monthly
Reach 5	Average Depth (m)[a]	0.20	0.20	0.17	0.32	0.22	0.20	0.21	0.19	0.20	0.19	0.20	Average Depth (m)[a]	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
													Average Depth (%)	1.16%	-0.75%	1.79%	3.46%	1.42%	3.79%	1.83%	0.77%	-0.24%	2.09%	1.65%
	Maximum Depth (m)	0.56	0.45	0.32	5.02	1.59	0.57	0.61	0.52	0.46	0.38	0.51	Maximum Depth (m)	0.01	0.01	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01
													Maximum Depth (%)	1.09%	2.69%	5.40%	4.66%	3.46%	4.80%	1.97%	1.53%	2.13%	2.49%	2.58%
	Top Width (m)	15.14	8.94	5.21	10.33	9.91	15.24	17.68	12.44	9.62	6.76	12.35	Top Width (m)	0.26	0.49	0.30	0.18	0.31	1.48	0.70	0.42	0.42	0.29	0.66
													Top Width (%)	1.67%	6.59%	6.60%	4.10%	4.74%	10.29%	4.28%	4.21%	5.21%	4.30%	5.66%
	WSEL[b] (m)	10.58	10.46	10.34	0.09	7.87	10.58	10.62	10.53	10.48	10.40	10.52	WSEL[b] (m)	0.00	0.01	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01
													WSEL (%)	0.04%	0.12%	0.16%	0.13%	0.11%	0.25%	0.12%	0.07%	0.09%	0.11%	0.13%
	Average Velocity (m/s)[c]	0.17	0.12	0.09	0.16	0.14	0.17	0.18	0.15	0.13	0.10	0.15	Average Velocity (m/s)[c]	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
													Average Velocity (%)	-0.10%	2.88%	4.30%	2.45%	2.38%	4.69%	2.80%	0.71%	2.46%	1.35%	2.40%
Entire Channel	Average Depth (m)[a]	0.21	0.20	0.18	0.18	0.19	0.21	0.23	0.20	0.19	0.20	0.21	Average Depth (m)[a]	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00
													Average Depth (%)	0.85%	-0.46%	3.81%	3.40%	1.90%	4.55%	2.88%	0.74%	-0.36%	0.85%	1.73%
	Maximum Depth (m)	0.58	0.46	0.33	0.32	0.42	0.58	0.62	0.53	0.48	0.39	0.52	Maximum Depth (m)	0.00	0.01	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01
													Maximum Depth (%)	0.78%	2.65%	5.73%	4.54%	3.42%	4.41%	1.94%	1.42%	2.08%	2.81%	2.53%
	Top Width (m)	16.83	9.33	4.54	4.37	8.77	17.18	19.12	14.47	10.38	6.21	13.47	Top Width (m)	0.22	0.65	0.28	0.18	0.33	1.33	0.56	0.45	0.64	0.37	0.67
													Top Width (%)	1.30%	6.92%	6.26%	4.08%	4.64%	7.77%	2.91%	3.14%	6.15%	5.90%	5.17%
	WSEL[b] (m)	14.27	14.24	14.10	14.09	14.17	14.35	14.39	14.31	14.25	14.17	14.29	WSEL[c] (m)	0.00	0.01	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01
													WSEL (%)	0.03%	0.08%	0.13%	0.10%	0.09%	0.18%	0.08%	0.05%	0.07%	0.09%	0.09%
	Average Velocity (m/s)[c]	0.15	0.11	0.09	0.09	0.11	0.14	0.15	0.13	0.11	0.10	0.13	Average Velocity (m/s)[c]	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
													Average Velocity (%)	0.49%	2.66%	4.16%	3.64%	2.74%	5.06%	2.04%	1.46%	2.14%	1.36%	2.41%

Notes:

[a] m = metres.

[b] WSEL = water surface elevation.

[c] m/s = metres per second.

TABLE B-2 TABULAR FLOW RESULTS PER CROSS-SECTION

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS June—0.183 (m/s)					FEIS June—0.178 m/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1	4241	0.44	0.70	35.90	18.10	0.01	0.43	0.70	35.85	18.10	0.01	0.01	2.27%	0.00	0.00%	0.05	0.14%	0.00	0.00%	0.00	0.00%
	4224*	0.39	0.69	35.43	18.10	0.01	0.39	0.68	35.34	18.10	0.01	0.00	0.00%	0.01	1.45%	0.09	0.25%	0.00	0.00%	0.00	0.00%
	4206*	0.35	0.67	35.18	18.10	0.02	0.35	0.67	35.06	18.09	0.02	0.00	0.00%	0.00	0.00%	0.12	0.34%	0.01	0.06%	0.00	0.00%
	4189*	0.31	0.66	34.90	18.10	0.02	0.31	0.65	34.83	18.09	0.02	0.00	0.00%	0.01	1.52%	0.07	0.20%	0.01	0.06%	0.00	0.00%
	4171*	0.28	0.64	34.58	18.09	0.02	0.27	0.63	34.51	18.08	0.02	0.01	3.57%	0.01	1.56%	0.07	0.20%	0.01	0.06%	0.00	0.00%
	4154*	0.24	0.62	34.26	18.08	0.03	0.24	0.61	34.18	18.08	0.03	0.00	0.00%	0.01	1.61%	0.08	0.23%	0.00	0.00%	0.00	0.00%
	4136*	0.21	0.59	33.86	18.07	0.04	0.20	0.59	33.77	18.06	0.03	0.01	4.76%	0.00	0.00%	0.09	0.27%	0.01	0.06%	0.01	25.00%
	4119	0.17	0.55	33.16	18.04	0.05	0.16	0.55	33.06	18.03	0.05	0.01	5.88%	0.00	0.00%	0.10	0.30%	0.01	0.06%	0.00	0.00%
	4095	0.25	0.54	17.73	18.02	0.05	0.24	0.53	17.67	18.01	0.05	0.01	4.00%	0.01	1.85%	0.06	0.34%	0.01	0.06%	0.00	0.00%
	4049*	0.27	0.55	16.33	18.00	0.04	0.27	0.54	16.12	18.00	0.04	0.00	0.00%	0.01	1.82%	0.21	1.29%	0.00	0.00%	0.00	0.00%
	4002*	0.31	0.56	15.50	17.99	0.04	0.31	0.55	15.44	17.98	0.04	0.00	0.00%	0.01	1.79%	0.06	0.39%	0.01	0.06%	0.00	0.00%
	3956	0.37	0.57	14.35	17.98	0.04	0.36	0.57	14.32	17.97	0.04	0.01	2.70%	0.00	0.00%	0.03	0.21%	0.01	0.06%	0.00	0.00%
	3906*	0.38	0.60	17.04	17.97	0.03	0.38	0.60	16.98	17.96	0.03	0.00	0.00%	0.00	0.00%	0.06	0.35%	0.01	0.06%	0.00	0.00%
	3857*	0.40	0.64	19.55	17.96	0.02	0.39	0.64	19.45	17.96	0.02	0.01	2.50%	0.00	0.00%	0.10	0.51%	0.00	0.00%	0.00	0.00%
	3807*	0.42	0.68	22.05	17.96	0.02	0.42	0.67	21.94	17.96	0.02	0.00	0.00%	0.01	1.47%	0.11	0.50%	0.00	0.00%	0.00	0.00%
	3757	0.44	0.72	24.71	17.96	0.02	0.44	0.71	24.60	17.96	0.02	0.00	0.00%	0.01	1.39%	0.11	0.45%	0.00	0.00%	0.00	0.00%
	3729	0.19	0.58	12.42	17.96	0.09	0.19	0.57	12.33	17.95	0.09	0.00	0.00%	0.01	1.72%	0.09	0.72%	0.01	0.06%	0.00	0.00%
	3717	0.24	0.43	5.71	17.93	0.14	0.24	0.42	5.71	17.92	0.14	0.00	0.00%	0.01	2.33%	0.00	0.00%	0.01	0.06%	0.00	0.00%
	3691*	0.22	0.49	6.23	17.81	0.15	0.21	0.48	6.23	17.81	0.15	0.01	4.55%	0.01	2.04%	0.00	0.00%	0.00	0.00%	0.00	0.00%
	3665	0.25	0.57	5.94	17.72	0.13	0.25	0.56	5.84	17.71	0.13	0.00	0.00%	0.01	1.75%	0.10	1.68%	0.01	0.06%	0.00	0.00%
	3643	0.31	0.67	5.36	17.66	0.13	0.30	0.67	5.35	17.66	0.13	0.01	3.23%	0.00	0.00%	0.01	0.19%	0.00	0.00%	0.00	0.00%
	3611	0.26	0.76	2.24	17.48	0.34	0.26	0.75	2.19	17.47	0.34	0.00	0.00%	0.01	1.32%	0.05	2.23%	0.01	0.06%	0.00	0.00%
	3565	0.29	0.56	14.30	17.43	0.05	0.29	0.55	14.25	17.42	0.05	0.00	0.00%	0.01	1.79%	0.05	0.35%	0.01	0.06%	0.00	0.00%
	3556*	0.31	0.57	13.19	17.42	0.05	0.30	0.57	13.14	17.42	0.05	0.01	3.23%	0.00	0.00%	0.05	0.38%	0.00	0.00%	0.00	0.00%
	3547*	0.32	0.59	12.07	17.42	0.05	0.31	0.58	12.03	17.41	0.05	0.01	3.13%	0.01	1.69%	0.04	0.33%	0.01	0.06%	0.00	0.00%
	3538*	0.33	0.61	10.93	17.42	0.06	0.33	0.60	10.89	17.41	0.06	0.00	0.00%	0.01	1.64%	0.04	0.37%	0.01	0.06%	0.00	0.00%
	3528*	0.34	0.62	9.78	17.41	0.06	0.34	0.62	9.74	17.41	0.06	0.00	0.00%	0.00	0.00%	0.04	0.41%	0.00	0.00%	0.00	0.00%
	3519*	0.35	0.64	8.60	17.41	0.07	0.35	0.63	8.57	17.40	0.06	0.00	0.00%	0.01	1.56%	0.03	0.35%	0.01	0.06%	0.01	14.29%
	3510*	0.36	0.65	7.39	17.40	0.07	0.36	0.65	7.37	17.40	0.07	0.00	0.00%	0.00	0.00%	0.02	0.27%	0.00	0.00%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS June—0.183 (m/s)					FEIS June—0.178 m/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1 *(cont'd)*	3501*	0.37	0.66	6.18	17.40	0.08	0.36	0.66	6.16	17.39	0.08	0.01	2.70%	0.00	0.00%	0.02	0.32%	0.01	0.06%	0.00	0.00%
	3492*	0.37	0.67	4.96	17.38	0.10	0.36	0.67	4.95	17.38	0.10	0.01	2.70%	0.00	0.00%	0.01	0.20%	0.00	0.00%	0.00	0.00%
	3483	0.36	0.68	3.75	17.37	0.14	0.35	0.68	3.73	17.37	0.14	0.01	2.78%	0.00	0.00%	0.02	0.53%	0.00	0.00%	0.00	0.00%
	3474*	0.34	0.65	3.67	17.36	0.15	0.34	0.65	3.66	17.36	0.15	0.00	0.00%	0.00	0.00%	0.01	0.27%	0.00	0.00%	0.00	0.00%
	3464*	0.33	0.62	3.59	17.35	0.16	0.33	0.62	3.57	17.34	0.16	0.00	0.00%	0.00	0.00%	0.02	0.56%	0.01	0.06%	0.00	0.00%
	3455*	0.32	0.59	3.45	17.33	0.19	0.31	0.58	3.45	17.33	0.19	0.01	3.13%	0.01	1.69%	0.00	0.00%	0.00	0.00%	0.00	0.00%
	3446*	0.31	0.55	3.31	17.31	0.20	0.30	0.55	3.31	17.31	0.20	0.01	3.23%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Reach 2	3436	0.26	0.48	3.18	17.26	0.24	0.25	0.47	3.18	17.25	0.24	0.01	3.85%	0.01	2.08%	0.00	0.00%	0.01	0.06%	0.00	0.00%
	3429*	0.26	0.58	2.62	17.02	0.29	0.26	0.58	2.53	17.02	0.29	0.00	0.00%	0.00	0.00%	0.09	3.44%	0.00	0.00%	0.00	0.00%
	3422	0.35	0.91	3.11	17.01	0.17	0.35	0.91	3.10	17.00	0.17	0.00	0.00%	0.00	0.00%	0.01	0.32%	0.01	0.06%	0.00	0.00%
	3414*	0.32	0.82	3.12	17.00	0.19	0.31	0.82	3.12	17.00	0.19	0.01	3.13%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
	3406*	0.28	0.73	3.14	16.99	0.21	0.28	0.72	3.13	16.99	0.21	0.00	0.00%	0.01	1.37%	0.01	0.32%	0.00	0.00%	0.00	0.00%
	3399*	0.24	0.63	3.16	16.98	0.31	0.23	0.63	3.15	16.98	0.30	0.01	4.17%	0.00	0.00%	0.01	0.32%	0.00	0.00%	0.01	3.23%
	3391	0.19	0.50	2.70	16.93	0.42	0.19	0.50	2.64	16.93	0.41	0.00	0.00%	0.00	0.00%	0.06	2.22%	0.00	0.00%	0.01	2.38%
	3390*	0.22	0.55	2.46	16.86	0.37	0.22	0.55	2.40	16.85	0.37	0.00	0.00%	0.00	0.00%	0.06	2.44%	0.01	0.06%	0.00	0.00%
	3389	0.25	0.61	2.29	16.78	0.33	0.25	0.60	2.23	16.78	0.33	0.00	0.00%	0.01	1.64%	0.06	2.62%	0.00	0.00%	0.00	0.00%
	3388*	0.28	0.68	2.34	16.73	0.28	0.28	0.67	2.27	16.72	0.28	0.00	0.00%	0.01	1.47%	0.07	2.99%	0.01	0.06%	0.00	0.00%
	3387*	0.31	0.77	2.58	16.69	0.24	0.31	0.76	2.50	16.68	0.23	0.00	0.00%	0.01	1.30%	0.08	3.10%	0.01	0.06%	0.01	4.17%
	3386*	0.33	0.87	2.92	16.66	0.19	0.33	0.86	2.84	16.66	0.19	0.00	0.00%	0.01	1.15%	0.08	2.74%	0.00	0.00%	0.00	0.00%
	3385*	0.35	0.97	3.34	16.65	0.16	0.35	0.97	3.26	16.64	0.16	0.00	0.00%	0.00	0.00%	0.08	2.40%	0.01	0.06%	0.00	0.00%
	3384*	0.37	1.09	3.81	16.63	0.13	0.37	1.08	3.74	16.63	0.13	0.00	0.00%	0.01	0.92%	0.07	1.84%	0.00	0.00%	0.00	0.00%
	3383	0.40	1.21	4.32	16.63	0.11	0.40	1.20	4.25	16.62	0.11	0.00	0.00%	0.01	0.83%	0.07	1.62%	0.01	0.06%	0.00	0.00%
	3337*	0.30	1.00	5.91	16.44	0.11	0.29	1.00	5.86	16.43	0.11	0.01	3.33%	0.00	0.00%	0.05	0.85%	0.01	0.06%	0.00	0.00%
	3290	0.32	0.90	8.33	16.35	0.08	0.32	0.89	8.29	16.34	0.08	0.00	0.00%	0.01	1.11%	0.04	0.48%	0.01	0.06%	0.00	0.00%
	3245*	0.30	0.96	7.26	16.30	0.10	0.30	0.96	7.20	16.29	0.10	0.00	0.00%	0.00	0.00%	0.06	0.83%	0.01	0.06%	0.00	0.00%
	3200	0.31	1.03	6.44	16.26	0.11	0.31	1.02	6.40	16.25	0.11	0.00	0.00%	0.01	0.97%	0.04	0.62%	0.01	0.06%	0.00	0.00%
	3160*	0.17	0.92	16.98	16.22	0.10	0.17	0.92	16.81	16.21	0.10	0.00	0.00%	0.00	0.00%	0.17	1.00%	0.01	0.06%	0.00	0.00%
	3119*	0.13	0.82	27.12	16.18	0.09	0.13	0.81	26.88	16.18	0.09	0.00	0.00%	0.01	1.22%	0.24	0.88%	0.00	0.00%	0.00	0.00%
	3079*	0.11	0.71	33.11	16.14	0.09	0.11	0.71	32.69	16.14	0.09	0.00	0.00%	0.00	0.00%	0.42	1.27%	0.00	0.00%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS June—0.183 (m/s)					FEIS June—0.178 m/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 3	3038	0.06	0.56	32.12	16.06	0.17	0.06	0.55	31.74	16.05	0.17	0.00	0.00%	0.01	1.79%	0.38	1.18%	0.01	0.06%	0.00	0.00%
	2995	0.07	0.65	24.18	15.91	0.13	0.07	0.64	23.49	15.91	0.13	0.00	0.00%	0.01	1.54%	0.69	2.85%	0.00	0.00%	0.00	0.00%
	2951*	0.04	0.41	19.54	15.67	0.32	0.04	0.41	18.70	15.67	0.31	0.00	0.00%	0.00	0.00%	0.84	4.30%	0.00	0.00%	0.01	3.13%
	2907	0.09	0.24	29.79	15.50	0.09	0.09	0.23	29.59	15.50	0.09	0.00	0.00%	0.01	4.17%	0.20	0.67%	0.00	0.00%	0.00	0.00%
	2899*	0.06	0.35	27.51	15.48	0.16	0.06	0.35	27.12	15.47	0.17	0.00	0.00%	0.00	0.00%	0.39	1.42%	0.01	0.06%	-0.01	-6.25%
	2891*	0.14	0.44	5.84	15.42	0.23	0.14	0.43	5.68	15.42	0.23	0.00	0.00%	0.01	2.27%	0.16	2.74%	0.00	0.00%	0.00	0.00%
	2884*	0.11	0.51	9.20	15.36	0.19	0.13	0.51	7.01	15.35	0.19	-0.02	-18.18%	0.00	0.00%	2.19	23.80%	0.01	0.07%	0.00	0.00%
	2876	0.13	0.62	11.29	15.33	0.13	0.13	0.62	11.10	15.32	0.13	0.00	0.00%	0.00	0.00%	0.19	1.68%	0.01	0.07%	0.00	0.00%
	2830*	0.14	0.57	10.22	15.20	0.13	0.14	0.57	10.13	15.20	0.13	0.00	0.00%	0.00	0.00%	0.09	0.88%	0.00	0.00%	0.00	0.00%
	2783*	0.15	0.52	9.04	15.08	0.14	0.15	0.51	8.75	15.08	0.14	0.00	0.00%	0.01	1.92%	0.29	3.21%	0.00	0.00%	0.00	0.00%
	2737*	0.11	0.48	12.23	14.97	0.15	0.12	0.48	11.49	14.97	0.15	-0.01	-9.09%	0.00	0.00%	0.74	6.05%	0.00	0.00%	0.00	0.00%
	2691*	0.12	0.45	12.27	14.87	0.18	0.12	0.45	12.06	14.87	0.17	0.00	0.00%	0.00	0.00%	0.21	1.71%	0.00	0.00%	0.01	5.56%
	2645	0.13	0.39	7.99	14.74	0.22	0.13	0.39	7.93	14.74	0.22	0.00	0.00%	0.00	0.00%	0.06	0.75%	0.00	0.00%	0.00	0.00%
	2606*	0.10	0.40	14.65	14.61	0.17	0.09	0.39	14.49	14.61	0.17	0.01	10.00%	0.01	2.50%	0.16	1.09%	0.00	0.00%	0.00	0.00%
	2566*	0.08	0.40	20.16	14.48	0.17	0.08	0.40	19.99	14.48	0.17	0.00	0.00%	0.00	0.00%	0.17	0.84%	0.00	0.00%	0.00	0.00%
	2527*	0.08	0.43	27.89	14.37	0.13	0.07	0.43	27.53	14.37	0.13	0.01	12.50%	0.00	0.00%	0.36	1.29%	0.00	0.00%	0.00	0.00%
	2488	0.10	0.51	42.16	14.31	0.06	0.10	0.51	41.88	14.31	0.06	0.00	0.00%	0.00	0.00%	0.28	0.66%	0.00	0.00%	0.00	0.00%
	2440*	0.10	0.50	44.41	14.25	0.06	0.10	0.50	44.10	14.25	0.06	0.00	0.00%	0.00	0.00%	0.31	0.70%	0.00	0.00%	0.00	0.00%
	2392*	0.10	0.50	45.87	14.18	0.06	0.10	0.49	45.51	14.18	0.06	0.00	0.00%	0.01	2.00%	0.36	0.78%	0.00	0.00%	0.00	0.00%
	2344*	0.09	0.49	47.21	14.12	0.06	0.09	0.49	46.78	14.12	0.06	0.00	0.00%	0.00	0.00%	0.43	0.91%	0.00	0.00%	0.00	0.00%
	2296*	0.09	0.49	47.73	14.06	0.07	0.09	0.48	47.17	14.05	0.07	0.00	0.00%	0.01	2.04%	0.56	1.17%	0.01	0.07%	0.00	0.00%
	2248*	0.08	0.46	40.23	13.97	0.09	0.08	0.46	39.61	13.97	0.09	0.00	0.00%	0.00	0.00%	0.62	1.54%	0.00	0.00%	0.00	0.00%
	2200*	0.06	0.43	33.55	13.88	0.12	0.06	0.43	33.00	13.88	0.12	0.00	0.00%	0.00	0.00%	0.55	1.64%	0.00	0.00%	0.00	0.00%
	2152*	0.07	0.42	28.75	13.82	0.12	0.07	0.42	27.65	13.81	0.12	0.00	0.00%	0.00	0.00%	1.10	3.83%	0.01	0.07%	0.00	0.00%
Reach 4	2104	0.08	0.43	28.05	13.76	0.11	0.08	0.42	27.19	13.76	0.11	0.00	0.00%	0.01	2.33%	0.86	3.07%	0.00	0.00%	0.00	0.00%
	2077*	0.09	0.42	30.88	13.74	0.07	0.09	0.42	30.05	13.74	0.07	0.00	0.00%	0.00	0.00%	0.83	2.69%	0.00	0.00%	0.00	0.00%
	2050	0.07	0.41	40.32	13.72	0.07	0.07	0.41	39.87	13.72	0.07	0.00	0.00%	0.00	0.00%	0.45	1.12%	0.00	0.00%	0.00	0.00%
	2002*	0.06	0.55	55.23	13.68	0.08	0.06	0.55	54.82	13.67	0.08	0.00	0.00%	0.00	0.00%	0.41	0.74%	0.01	0.07%	0.00	0.00%
	1954	0.05	0.67	66.06	13.62	0.10	0.05	0.67	65.85	13.62	0.10	0.00	0.00%	0.00	0.00%	0.21	0.32%	0.00	0.00%	0.00	0.00%
	1911*	0.05	0.62	52.75	13.55	0.11	0.05	0.61	52.42	13.55	0.10	0.00	0.00%	0.01	1.61%	0.33	0.63%	0.00	0.00%	0.01	9.09%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS June—0.183 (m/s)					FEIS June—0.178 m/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 4 *(cont'd)*	1868*	0.06	0.57	41.47	13.48	0.11	0.06	0.57	41.19	13.48	0.11	0.00	0.00%	0.00	0.00%	0.28	0.68%	0.00	0.00%	0.00	0.00%
	1825*	0.08	0.53	33.26	13.42	0.12	0.08	0.53	33.03	13.42	0.12	0.00	0.00%	0.00	0.00%	0.23	0.69%	0.00	0.00%	0.00	0.00%
	1783	0.07	0.47	22.78	13.33	0.19	0.07	0.47	22.61	13.33	0.19	0.00	0.00%	0.00	0.00%	0.17	0.75%	0.00	0.00%	0.00	0.00%
	1736*	0.07	0.50	21.84	13.16	0.20	0.07	0.50	21.30	13.15	0.20	0.00	0.00%	0.00	0.00%	0.54	2.47%	0.01	0.08%	0.00	0.00%
	1689*	0.07	0.52	19.90	12.98	0.21	0.07	0.52	19.44	12.97	0.21	0.00	0.00%	0.00	0.00%	0.46	2.31%	0.01	0.08%	0.00	0.00%
	1642*	0.07	0.55	20.91	12.80	0.20	0.07	0.55	20.44	12.79	0.19	0.00	0.00%	0.00	0.00%	0.47	2.25%	0.01	0.08%	0.01	5.00%
	1596	0.07	0.56	21.55	12.61	0.22	0.07	0.56	21.13	12.60	0.21	0.00	0.00%	0.00	0.00%	0.42	1.95%	0.01	0.08%	0.01	4.55%
	1555*	0.07	0.48	20.56	12.44	0.19	0.07	0.47	20.09	12.44	0.19	0.00	0.00%	0.01	2.08%	0.47	2.29%	0.00	0.00%	0.00	0.00%
	1514*	0.07	0.39	18.89	12.27	0.18	0.07	0.38	18.71	12.27	0.18	0.00	0.00%	0.01	2.56%	0.18	0.95%	0.00	0.00%	0.00	0.00%
	1472*	0.11	0.33	14.14	12.13	0.14	0.11	0.33	14.02	12.13	0.14	0.00	0.00%	0.00	0.00%	0.12	0.85%	0.00	0.00%	0.00	0.00%
	1431*	0.14	0.23	6.48	11.95	0.20	0.14	0.23	6.48	11.95	0.20	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
	1432	0.13	0.25	6.26	11.88	0.24	0.13	0.24	6.15	11.87	0.24	0.00	0.00%	0.01	4.00%	0.11	1.76%	0.01	0.08%	0.00	0.00%
	1414*	0.17	0.28	5.21	11.81	0.21	0.17	0.27	5.13	11.81	0.21	0.00	0.00%	0.01	3.57%	0.08	1.54%	0.00	0.00%	0.00	0.00%
	1405*	0.22	0.33	5.15	11.78	0.16	0.22	0.33	5.10	11.78	0.16	0.00	0.00%	0.00	0.00%	0.05	0.97%	0.00	0.00%	0.00	0.00%
	1396*	0.28	0.41	5.53	11.77	0.12	0.28	0.41	5.50	11.76	0.12	0.00	0.00%	0.00	0.00%	0.03	0.54%	0.01	0.08%	0.00	0.00%
	1387*	0.35	0.50	5.96	11.76	0.09	0.35	0.50	5.94	11.76	0.09	0.00	0.00%	0.00	0.00%	0.02	0.34%	0.00	0.00%	0.00	0.00%
	1379*	0.41	0.59	6.38	11.76	0.07	0.41	0.59	6.36	11.75	0.07	0.00	0.00%	0.00	0.00%	0.02	0.31%	0.01	0.09%	0.00	0.00%
Reach 5	1370	0.47	0.68	6.93	11.75	0.06	0.47	0.68	6.87	11.75	0.06	0.00	0.00%	0.00	0.00%	0.06	0.87%	0.00	0.00%	0.00	0.00%
	1326*	0.30	0.65	9.75	11.75	0.06	0.30	0.64	9.47	11.74	0.06	0.00	0.00%	0.01	1.54%	0.28	2.87%	0.01	0.09%	0.00	0.00%
	1282*	0.17	0.61	15.56	11.74	0.07	0.18	0.61	15.13	11.73	0.07	-0.01	-5.88%	0.00	0.00%	0.43	2.76%	0.01	0.09%	0.00	0.00%
	1238*	0.12	0.57	23.20	11.72	0.08	0.12	0.57	22.67	11.72	0.08	0.00	0.00%	0.00	0.00%	0.53	2.28%	0.00	0.00%	0.00	0.00%
	1194*	0.10	0.53	31.43	11.70	0.10	0.10	0.53	30.85	11.70	0.10	0.00	0.00%	0.00	0.00%	0.58	1.85%	0.00	0.00%	0.00	0.00%
	1151*	0.09	0.48	39.37	11.68	0.10	0.09	0.48	38.77	11.68	0.10	0.00	0.00%	0.00	0.00%	0.60	1.52%	0.00	0.00%	0.00	0.00%
	1107*	0.08	0.42	45.56	11.65	0.11	0.08	0.42	44.95	11.65	0.11	0.00	0.00%	0.00	0.00%	0.61	1.34%	0.00	0.00%	0.00	0.00%
	1063	0.07	0.35	44.86	11.60	0.13	0.07	0.34	44.16	11.60	0.13	0.00	0.00%	0.01	2.86%	0.70	1.56%	0.00	0.00%	0.00	0.00%
	1029*	0.08	0.45	27.27	11.53	0.15	0.07	0.45	26.47	11.53	0.16	0.01	12.50%	0.00	0.00%	0.80	2.93%	0.00	0.00%	-0.01	-6.67%
	995*	0.11	0.57	19.05	11.49	0.12	0.11	0.57	18.39	11.48	0.12	0.00	0.00%	0.00	0.00%	0.66	3.46%	0.01	0.09%	0.00	0.00%
	961	0.18	0.72	15.33	11.47	0.08	0.18	0.72	14.97	11.46	0.08	0.00	0.00%	0.00	0.00%	0.36	2.35%	0.01	0.09%	0.00	0.00%
	913*	0.18	0.68	15.24	11.45	0.08	0.17	0.68	14.93	11.45	0.08	0.01	5.56%	0.00	0.00%	0.31	2.03%	0.00	0.00%	0.00	0.00%
	864*	0.17	0.65	14.60	11.43	0.09	0.17	0.64	14.33	11.43	0.09	0.00	0.00%	0.01	1.54%	0.27	1.85%	0.00	0.00%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS June—0.183 (m/s)					FEIS June—0.178 m/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 5 *(cont'd)*	816*	0.17	0.60	13.41	11.40	0.09	0.17	0.60	13.20	11.40	0.09	0.00	0.00%	0.00	0.00%	0.21	1.57%	0.00	0.00%	0.00	0.00%
	767*	0.17	0.55	11.54	11.37	0.11	0.17	0.54	11.36	11.36	0.11	0.00	0.00%	0.01	1.82%	0.18	1.56%	0.01	0.09%	0.00	0.00%
	719	0.17	0.47	8.77	11.31	0.15	0.17	0.47	8.64	11.30	0.15	0.00	0.00%	0.00	0.00%	0.13	1.48%	0.01	0.09%	0.00	0.00%
	689*	0.18	0.56	6.64	11.24	0.18	0.18	0.55	6.53	11.24	0.18	0.00	0.00%	0.01	1.79%	0.11	1.66%	0.00	0.00%	0.00	0.00%
	660	0.22	0.45	1.02	10.98	0.80	0.22	0.44	1.01	10.97	0.79	0.00	0.00%	0.01	2.22%	0.01	0.98%	0.01	0.09%	0.01	1.25%
	642	0.15	0.47	7.84	10.91	0.22	0.14	0.46	7.81	10.91	0.22	0.01	6.67%	0.01	2.13%	0.03	0.38%	0.00	0.00%	0.00	0.00%
	598*	0.16	0.59	7.23	10.87	0.20	0.16	0.58	7.19	10.86	0.20	0.00	0.00%	0.01	1.69%	0.04	0.55%	0.01	0.09%	0.00	0.00%
	555*	0.18	0.71	6.69	10.82	0.19	0.17	0.70	6.64	10.82	0.19	0.01	5.56%	0.01	1.41%	0.05	0.75%	0.00	0.00%	0.00	0.00%
	512*	0.19	0.83	6.20	10.78	0.19	0.19	0.83	6.13	10.77	0.19	0.00	0.00%	0.00	0.00%	0.07	1.13%	0.01	0.09%	0.00	0.00%
	468	0.19	0.90	4.65	10.68	0.25	0.18	0.90	4.53	10.68	0.25	0.01	5.26%	0.00	0.00%	0.12	2.58%	0.00	0.00%	0.00	0.00%
	447	0.18	0.29	1.43	10.25	0.71	0.18	0.28	1.41	10.25	0.70	0.00	0.00%	0.01	3.45%	0.02	1.40%	0.00	0.00%	0.01	1.41%
	419	0.15	0.39	4.89	9.96	0.32	0.14	0.38	4.78	9.95	0.32	0.01	6.67%	0.01	2.56%	0.11	2.25%	0.01	0.10%	0.00	0.00%
	396	0.12	0.64	2.94	9.83	0.65	0.12	0.64	2.80	9.83	0.65	0.00	0.00%	0.00	0.00%	0.14	4.76%	0.00	0.00%	0.00	0.00%
	373	0.22	0.71	5.62	9.75	0.20	0.21	0.70	5.62	9.75	0.20	0.01	4.55%	0.01	1.41%	0.00	0.00%	0.00	0.00%	0.00	0.00%
	340	0.25	0.54	3.76	9.66	0.22	0.24	0.53	3.73	9.66	0.22	0.01	4.00%	0.01	1.85%	0.03	0.80%	0.00	0.00%	0.00	0.00%
	300	0.19	0.38	7.20	9.52	0.15	0.18	0.37	7.16	9.51	0.15	0.01	5.26%	0.01	2.63%	0.04	0.56%	0.01	0.11%	0.00	0.00%
	284*	0.21	0.43	6.33	9.44	0.14	0.22	0.42	6.12	9.43	0.14	-0.01	-4.76%	0.01	2.33%	0.21	3.32%	0.01	0.11%	0.00	0.00%
	267*	0.26	0.49	6.00	9.37	0.12	0.26	0.48	5.92	9.37	0.12	0.00	0.00%	0.01	2.04%	0.08	1.33%	0.00	0.00%	0.00	0.00%
	251*	0.29	0.58	6.68	9.33	0.09	0.29	0.57	6.58	9.33	0.09	0.00	0.00%	0.01	1.72%	0.10	1.50%	0.00	0.00%	0.00	0.00%
	235*	0.33	0.68	7.58	9.31	0.07	0.33	0.68	7.48	9.31	0.07	0.00	0.00%	0.00	0.00%	0.10	1.32%	0.00	0.00%	0.00	0.00%
	218	0.37	0.78	8.38	9.28	0.06	0.37	0.78	8.26	9.28	0.06	0.00	0.00%	0.00	0.00%	0.12	1.43%	0.00	0.00%	0.00	0.00%
	178*	0.33	0.66	15.36	9.19	0.04	0.33	0.65	15.20	9.18	0.04	0.00	0.00%	0.01	1.52%	0.16	1.04%	0.01	0.11%	0.00	0.00%
	137*	0.31	0.58	22.35	9.15	0.03	0.31	0.57	22.09	9.14	0.03	0.00	0.00%	0.01	1.72%	0.26	1.16%	0.01	0.11%	0.00	0.00%
	97*	0.29	0.52	29.43	9.12	0.02	0.29	0.51	29.11	9.11	0.02	0.00	0.00%	0.01	1.92%	0.32	1.09%	0.01	0.11%	0.00	0.00%
	56*	0.27	0.46	36.57	9.09	0.02	0.27	0.45	36.09	9.09	0.02	0.00	0.00%	0.01	2.17%	0.48	1.31%	0.00	0.00%	0.00	0.00%
	16	0.25	0.40	43.67	9.07	0.02	0.25	0.40	42.95	9.06	0.02	0.00	0.00%	0.00	0.00%	0.72	1.65%	0.01	0.11%	0.00	0.00%
Average		**0.21**	**0.58**	**17.09**	**14.35**	**0.14**	**0.21**	**0.58**	**16.87**	**14.35**	**0.14**	**0.00**	**0.85%**	**0.00**	**0.78%**	**0.22**	**1.30%**	**0.00**	**0.03%**	**0.00**	**0.49%**

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS July—0.079 m^3/s					FEIS July—0.072 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1	4241	0.37	0.57	30.84	17.98	0.01	0.38	0.56	28.46	17.97	0.01	-0.01	-2.70%	0.01	1.75%	2.38	7.72%	0.01	0.06%	0.00	0.00%
	4224*	0.32	0.56	30.55	17.98	0.01	0.33	0.55	28.04	17.96	0.01	-0.01	-3.13%	0.01	1.79%	2.51	8.22%	0.02	0.11%	0.00	0.00%
	4206*	0.26	0.55	30.85	17.97	0.01	0.28	0.54	28.23	17.96	0.01	-0.02	-7.69%	0.01	1.82%	2.62	8.49%	0.01	0.06%	0.00	0.00%
	4189*	0.22	0.53	30.42	17.97	0.01	0.22	0.52	29.69	17.96	0.01	0.00	0.00%	0.01	1.89%	0.73	2.40%	0.01	0.06%	0.00	0.00%
	4171*	0.19	0.52	29.92	17.97	0.02	0.18	0.51	29.20	17.96	0.01	0.01	5.26%	0.01	1.92%	0.72	2.41%	0.01	0.06%	0.01	50.00%
	4154*	0.15	0.50	29.42	17.96	0.02	0.14	0.49	28.70	17.95	0.02	0.01	6.67%	0.01	2.00%	0.72	2.45%	0.01	0.06%	0.00	0.00%
	4136*	0.12	0.47	28.60	17.95	0.03	0.11	0.46	27.86	17.94	0.03	0.01	8.33%	0.01	2.13%	0.74	2.59%	0.01	0.06%	0.00	0.00%
	4119	0.09	0.42	20.21	17.91	0.06	0.09	0.41	16.99	17.90	0.06	0.00	0.00%	0.01	2.38%	3.22	15.93%	0.01	0.06%	0.00	0.00%
	4095	0.21	0.41	11.96	17.89	0.03	0.20	0.40	11.75	17.88	0.03	0.01	4.76%	0.01	2.44%	0.21	1.76%	0.01	0.06%	0.00	0.00%
	4049*	0.22	0.42	12.03	17.87	0.03	0.22	0.41	11.82	17.86	0.03	0.00	0.00%	0.01	2.38%	0.21	1.75%	0.01	0.06%	0.00	0.00%
	4002*	0.26	0.43	12.01	17.86	0.03	0.25	0.42	11.83	17.85	0.02	0.01	3.85%	0.01	2.33%	0.18	1.50%	0.01	0.06%	0.01	33.33%
	3956	0.28	0.45	13.20	17.86	0.02	0.27	0.44	12.97	17.85	0.02	0.01	3.57%	0.01	2.22%	0.23	1.74%	0.01	0.06%	0.00	0.00%
	3906*	0.31	0.49	14.90	17.85	0.02	0.30	0.48	14.75	17.84	0.02	0.01	3.23%	0.01	2.04%	0.15	1.01%	0.01	0.06%	0.00	0.00%
	3857*	0.33	0.53	17.05	17.85	0.01	0.33	0.52	16.86	17.84	0.01	0.00	0.00%	0.01	1.89%	0.19	1.11%	0.01	0.06%	0.00	0.00%
	3807*	0.35	0.56	19.42	17.85	0.01	0.35	0.55	19.20	17.84	0.01	0.00	0.00%	0.01	1.79%	0.22	1.13%	0.01	0.06%	0.00	0.00%
	3757	0.37	0.60	21.94	17.85	0.01	0.37	0.59	21.70	17.84	0.01	0.00	0.00%	0.01	1.67%	0.24	1.09%	0.01	0.06%	0.00	0.00%
	3729	0.15	0.47	7.98	17.85	0.07	0.15	0.46	7.50	17.84	0.06	0.00	0.00%	0.01	2.13%	0.48	6.02%	0.01	0.06%	0.01	14.29%
	3717	0.14	0.32	5.41	17.82	0.11	0.13	0.31	5.27	17.81	0.11	0.01	7.14%	0.01	3.13%	0.14	2.59%	0.01	0.06%	0.00	0.00%
	3691*	0.17	0.35	3.91	17.68	0.12	0.17	0.34	3.79	17.67	0.12	0.00	0.00%	0.01	2.86%	0.12	3.07%	0.01	0.06%	0.00	0.00%
	3665	0.21	0.42	3.67	17.57	0.10	0.20	0.40	3.51	17.55	0.10	0.01	4.76%	0.02	4.76%	0.16	4.36%	0.02	0.11%	0.00	0.00%
	3643	0.19	0.51	4.48	17.50	0.10	0.18	0.50	4.32	17.49	0.10	0.01	5.26%	0.01	1.96%	0.16	3.57%	0.01	0.06%	0.00	0.00%
	3611	0.39	0.61	0.91	17.33	0.22	0.40	0.60	0.87	17.32	0.21	-0.01	-2.56%	0.01	1.64%	0.04	4.40%	0.01	0.06%	0.01	4.55%
	3565	0.17	0.40	12.51	17.27	0.04	0.16	0.39	11.59	17.26	0.04	0.01	5.88%	0.01	2.50%	0.92	7.35%	0.01	0.06%	0.00	0.00%
	3556*	0.18	0.42	11.47	17.27	0.04	0.18	0.41	10.97	17.25	0.04	0.00	0.00%	0.01	2.38%	0.50	4.36%	0.02	0.12%	0.00	0.00%
	3547*	0.20	0.44	10.45	17.27	0.04	0.19	0.42	10.12	17.25	0.04	0.01	5.00%	0.02	4.55%	0.33	3.16%	0.02	0.12%	0.00	0.00%
	3538*	0.22	0.45	9.45	17.26	0.04	0.21	0.44	9.22	17.25	0.04	0.01	4.55%	0.01	2.22%	0.23	2.43%	0.01	0.06%	0.00	0.00%
	3528*	0.23	0.47	8.43	17.26	0.04	0.22	0.45	8.24	17.24	0.04	0.01	4.35%	0.02	4.26%	0.19	2.25%	0.02	0.12%	0.00	0.00%
	3519*	0.24	0.48	7.41	17.25	0.05	0.23	0.47	7.25	17.24	0.04	0.01	4.17%	0.01	2.08%	0.16	2.16%	0.01	0.06%	0.01	20.00%
	3510*	0.25	0.50	6.40	17.25	0.05	0.24	0.48	6.25	17.23	0.05	0.01	4.00%	0.02	4.00%	0.15	2.34%	0.02	0.12%	0.00	0.00%
	3501*	0.26	0.51	5.37	17.24	0.06	0.25	0.50	5.23	17.23	0.06	0.01	3.85%	0.01	1.96%	0.14	2.61%	0.01	0.06%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS July—0.079 m^3/s					FEIS July—0.072 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1 *(cont'd)*	3492*	0.26	0.52	4.33	17.23	0.07	0.25	0.51	4.18	17.22	0.07	0.01	3.85%	0.01	1.92%	0.15	3.46%	0.01	0.06%	0.00	0.00%
	3483	0.25	0.53	3.27	17.22	0.10	0.24	0.52	3.17	17.21	0.09	0.01	4.00%	0.01	1.89%	0.10	3.06%	0.01	0.06%	0.01	10.00%
	3474*	0.24	0.51	3.18	17.21	0.11	0.23	0.49	3.06	17.20	0.10	0.01	4.17%	0.02	3.92%	0.12	3.77%	0.01	0.06%	0.01	9.09%
	3464*	0.22	0.48	3.07	17.20	0.11	0.22	0.46	2.94	17.19	0.11	0.00	0.00%	0.02	4.17%	0.13	4.23%	0.01	0.06%	0.00	0.00%
	3455*	0.21	0.44	2.93	17.19	0.14	0.21	0.43	2.81	17.17	0.13	0.00	0.00%	0.01	2.27%	0.12	4.10%	0.02	0.12%	0.01	7.14%
	3446*	0.20	0.41	2.78	17.17	0.15	0.20	0.39	2.64	17.15	0.14	0.00	0.00%	0.02	4.88%	0.14	5.04%	0.02	0.12%	0.01	6.67%
Reach 2	3436	0.20	0.34	2.07	17.11	0.19	0.20	0.32	1.94	17.10	0.19	0.00	0.00%	0.02	5.88%	0.13	6.28%	0.01	0.06%	0.00	0.00%
	3429*	0.27	0.43	1.38	16.86	0.21	0.26	0.41	1.33	16.85	0.21	0.01	3.70%	0.02	4.65%	0.05	3.62%	0.01	0.06%	0.00	0.00%
	3422	0.28	0.75	2.32	16.85	0.12	0.28	0.74	2.22	16.84	0.12	0.00	0.00%	0.01	1.33%	0.10	4.31%	0.01	0.06%	0.00	0.00%
	3414*	0.25	0.67	2.21	16.85	0.14	0.25	0.65	2.10	16.83	0.14	0.00	0.00%	0.02	2.99%	0.11	4.98%	0.02	0.12%	0.00	0.00%
	3406*	0.23	0.57	2.03	16.84	0.17	0.23	0.56	1.91	16.82	0.17	0.00	0.00%	0.01	1.75%	0.12	5.91%	0.02	0.12%	0.00	0.00%
	3399*	0.21	0.48	1.75	16.82	0.23	0.21	0.46	1.60	16.81	0.22	0.00	0.00%	0.02	4.17%	0.15	8.57%	0.01	0.06%	0.01	4.35%
	3391	0.22	0.35	1.06	16.78	0.34	0.23	0.33	0.95	16.76	0.33	-0.01	-4.55%	0.02	5.71%	0.11	10.38%	0.02	0.12%	0.01	2.94%
	3390*	0.24	0.38	1.08	16.68	0.31	0.23	0.37	1.05	16.67	0.30	0.01	4.17%	0.01	2.63%	0.03	2.78%	0.01	0.06%	0.01	3.23%
	3389	0.23	0.42	1.20	16.59	0.28	0.22	0.40	1.17	16.58	0.28	0.01	4.35%	0.02	4.76%	0.03	2.50%	0.01	0.06%	0.00	0.00%
	3388*	0.23	0.47	1.33	16.52	0.25	0.22	0.45	1.29	16.50	0.25	0.01	4.35%	0.02	4.26%	0.04	3.01%	0.02	0.12%	0.00	0.00%
	3387*	0.25	0.54	1.49	16.47	0.21	0.24	0.52	1.44	16.45	0.21	0.01	4.00%	0.02	3.70%	0.05	3.36%	0.02	0.12%	0.00	0.00%
	3386*	0.28	0.63	1.67	16.43	0.17	0.27	0.61	1.60	16.41	0.17	0.01	3.57%	0.02	3.17%	0.07	4.19%	0.02	0.12%	0.00	0.00%
	3385*	0.32	0.74	1.88	16.41	0.13	0.31	0.71	1.80	16.39	0.13	0.01	3.13%	0.03	4.05%	0.08	4.26%	0.02	0.12%	0.00	0.00%
	3384*	0.36	0.85	2.15	16.40	0.10	0.35	0.83	2.05	16.37	0.10	0.01	2.78%	0.02	2.35%	0.10	4.65%	0.03	0.18%	0.00	0.00%
	3383	0.39	0.97	2.45	16.39	0.08	0.39	0.95	2.34	16.37	0.08	0.00	0.00%	0.02	2.06%	0.11	4.49%	0.02	0.12%	0.00	0.00%
	3337*	0.38	0.81	2.75	16.24	0.08	0.36	0.79	2.69	16.22	0.07	0.02	5.26%	0.02	2.47%	0.06	2.18%	0.02	0.12%	0.01	12.50%
	3290	0.35	0.73	4.47	16.18	0.05	0.35	0.72	4.32	16.16	0.05	0.00	0.00%	0.01	1.37%	0.15	3.36%	0.02	0.12%	0.00	0.00%
	3245*	0.31	0.82	4.20	16.15	0.06	0.36	0.80	3.44	16.14	0.06	-0.05	-16.13%	0.02	2.44%	0.76	18.10%	0.01	0.06%	0.00	0.00%
	3200	0.30	0.90	4.38	16.13	0.07	0.30	0.89	4.12	16.11	0.06	0.00	0.00%	0.01	1.11%	0.26	5.94%	0.02	0.12%	0.01	14.29%
	3160*	0.17	0.81	8.71	16.11	0.07	0.16	0.80	8.24	16.09	0.06	0.01	5.88%	0.01	1.23%	0.47	5.40%	0.02	0.12%	0.01	14.29%
	3119*	0.12	0.72	12.50	16.08	0.07	0.11	0.71	11.76	16.07	0.07	0.01	8.33%	0.01	1.39%	0.74	5.92%	0.01	0.06%	0.00	0.00%
	3079*	0.07	0.61	15.60	16.05	0.09	0.10	0.60	9.48	16.03	0.09	-0.03	-42.86%	0.01	1.64%	6.12	39.23%	0.02	0.12%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS July—0.079 m^3/s					FEIS July—0.072 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 3	3038	0.20	0.43	2.21	15.93	0.18	0.20	0.41	2.05	15.91	0.18	0.00	0.00%	0.02	4.65%	0.16	7.24%	0.02	0.13%	0.00	0.00%
	2995	0.24	0.51	2.43	15.77	0.13	0.24	0.49	2.27	15.76	0.13	0.00	0.00%	0.02	3.92%	0.16	6.58%	0.01	0.06%	0.00	0.00%
	2951*	0.16	0.37	2.65	15.63	0.19	0.16	0.36	2.50	15.62	0.18	0.00	0.00%	0.01	2.70%	0.15	5.66%	0.01	0.06%	0.01	5.26%
	2907	0.05	0.18	22.52	15.44	0.10	0.06	0.17	19.06	15.44	0.09	-0.01	-20.00%	0.01	5.56%	3.46	15.36%	0.00	0.00%	0.01	10.00%
	2899*	0.07	0.27	6.26	15.40	0.22	0.07	0.26	5.38	15.39	0.22	0.00	0.00%	0.01	3.70%	0.88	14.06%	0.01	0.06%	0.00	0.00%
	2891*	0.13	0.32	2.67	15.30	0.23	0.13	0.31	2.43	15.29	0.23	0.00	0.00%	0.01	3.13%	0.24	8.99%	0.01	0.07%	0.00	0.00%
	2884*	0.16	0.40	2.81	15.24	0.18	0.17	0.38	2.44	15.22	0.18	-0.01	-6.25%	0.02	5.00%	0.37	13.17%	0.02	0.13%	0.00	0.00%
	2876	0.17	0.51	4.17	15.21	0.11	0.17	0.50	3.71	15.20	0.11	0.00	0.00%	0.01	1.96%	0.46	11.03%	0.01	0.07%	0.00	0.00%
	2830*	0.14	0.47	4.88	15.10	0.11	0.14	0.46	4.65	15.09	0.11	0.00	0.00%	0.01	2.13%	0.23	4.71%	0.01	0.07%	0.00	0.00%
	2783*	0.14	0.42	4.78	14.98	0.11	0.14	0.41	4.60	14.97	0.11	0.00	0.00%	0.01	2.38%	0.18	3.77%	0.01	0.07%	0.00	0.00%
	2737*	0.16	0.38	4.40	14.87	0.11	0.16	0.37	4.20	14.86	0.11	0.00	0.00%	0.01	2.63%	0.20	4.55%	0.01	0.07%	0.00	0.00%
	2691*	0.15	0.36	4.78	14.78	0.13	0.15	0.35	4.40	14.77	0.12	0.00	0.00%	0.01	2.78%	0.38	7.95%	0.01	0.07%	0.01	7.69%
	2645	0.10	0.32	5.78	14.67	0.16	0.11	0.31	4.55	14.66	0.16	-0.01	-10.00%	0.01	3.13%	1.23	21.28%	0.01	0.07%	0.00	0.00%
	2606*	0.06	0.34	11.06	14.55	0.13	0.06	0.34	10.45	14.55	0.12	0.00	0.00%	0.00	0.00%	0.61	5.52%	0.00	0.00%	0.01	7.69%
	2566*	0.05	0.36	15.58	14.44	0.13	0.05	0.35	12.06	14.43	0.13	0.00	0.00%	0.01	2.78%	3.52	22.59%	0.01	0.07%	0.00	0.00%
	2527*	0.05	0.39	20.70	14.33	0.11	0.05	0.38	15.11	14.32	0.12	0.00	0.00%	0.01	2.56%	5.59	27.00%	0.01	0.07%	-0.01	-9.09%
	2488	0.07	0.46	33.68	14.26	0.05	0.07	0.45	32.79	14.25	0.05	0.00	0.00%	0.01	2.17%	0.89	2.64%	0.01	0.07%	0.00	0.00%
	2440*	0.07	0.45	34.36	14.19	0.04	0.07	0.44	33.50	14.19	0.04	0.00	0.00%	0.01	2.22%	0.86	2.50%	0.00	0.00%	0.00	0.00%
	2392*	0.07	0.44	34.23	14.13	0.05	0.06	0.44	33.20	14.12	0.05	0.01	14.29%	0.00	0.00%	1.03	3.01%	0.01	0.07%	0.00	0.00%
	2344*	0.07	0.44	33.54	14.07	0.05	0.06	0.43	32.96	14.06	0.05	0.01	14.29%	0.01	2.27%	0.58	1.73%	0.01	0.07%	0.00	0.00%
	2296*	0.06	0.42	32.41	13.99	0.06	0.05	0.41	30.59	13.98	0.06	0.01	16.67%	0.01	2.38%	1.82	5.62%	0.01	0.07%	0.00	0.00%
	2248*	0.19	0.37	4.50	13.88	0.09	0.18	0.36	4.33	13.87	0.09	0.01	5.26%	0.01	2.70%	0.17	3.78%	0.01	0.07%	0.00	0.00%
	2200*	0.18	0.33	4.18	13.78	0.10	0.18	0.31	4.04	13.77	0.10	0.00	0.00%	0.02	6.06%	0.14	3.35%	0.01	0.07%	0.00	0.00%
	2152*	0.20	0.33	4.40	13.72	0.09	0.19	0.32	4.29	13.71	0.09	0.01	5.00%	0.01	3.03%	0.11	2.50%	0.01	0.07%	0.00	0.00%
Reach 4	2104	0.23	0.35	4.80	13.69	0.07	0.22	0.34	4.72	13.68	0.07	0.01	4.35%	0.01	2.86%	0.08	1.67%	0.01	0.07%	0.00	0.00%
	2077*	0.17	0.35	9.46	13.67	0.05	0.16	0.35	9.35	13.67	0.05	0.01	5.88%	0.00	0.00%	0.11	1.16%	0.00	0.00%	0.00	0.00%
	2050	0.10	0.35	13.99	13.66	0.05	0.10	0.35	13.84	13.65	0.05	0.00	0.00%	0.00	0.00%	0.15	1.07%	0.01	0.07%	0.00	0.00%
	2002*	0.13	0.49	11.31	13.62	0.06	0.12	0.48	11.06	13.61	0.05	0.01	7.69%	0.01	2.04%	0.25	2.21%	0.01	0.07%	0.01	16.67%
	1954	0.08	0.61	11.38	13.57	0.09	0.12	0.60	6.54	13.56	0.09	-0.04	-50.00%	0.01	1.64%	4.84	42.53%	0.01	0.07%	0.00	0.00%
	1911*	0.13	0.55	6.41	13.48	0.09	0.13	0.54	6.02	13.47	0.09	0.00	0.00%	0.01	1.82%	0.39	6.08%	0.01	0.07%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS July—0.079 m^3/s					FEIS July—0.072 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 4 *(cont'd)*	1868*	0.16	0.50	5.54	13.41	0.09	0.15	0.49	5.27	13.40	0.09	0.01	6.25%	0.01	2.00%	0.27	4.87%	0.01	0.07%	0.00	0.00%
	1825*	0.09	0.47	9.07	13.35	0.10	0.16	0.46	4.64	13.34	0.10	-0.07	-77.78%	0.01	2.13%	4.43	48.84%	0.01	0.07%	0.00	0.00%
	1783	0.13	0.40	3.90	13.27	0.16	0.17	0.39	2.69	13.25	0.16	-0.04	-30.77%	0.01	2.50%	1.21	31.03%	0.02	0.15%	0.00	0.00%
	1736*	0.16	0.42	3.07	13.08	0.17	0.18	0.40	2.48	13.06	0.16	-0.02	-12.50%	0.02	4.76%	0.59	19.22%	0.02	0.15%	0.01	5.88%
	1689*	0.12	0.44	4.03	12.90	0.17	0.18	0.43	2.45	12.89	0.16	-0.06	-50.00%	0.01	2.27%	1.58	39.21%	0.01	0.08%	0.01	5.88%
	1642*	0.09	0.48	5.88	12.72	0.16	0.13	0.46	3.75	12.71	0.15	-0.04	-44.44%	0.02	4.17%	2.13	36.22%	0.01	0.08%	0.01	6.25%
	1596	0.11	0.49	4.05	12.53	0.18	0.21	0.47	2.05	12.52	0.17	-0.10	-90.91%	0.02	4.08%	2.00	49.38%	0.01	0.08%	0.01	5.56%
	1555*	0.14	0.40	3.71	12.36	0.15	0.16	0.39	2.99	12.35	0.15	-0.02	-14.29%	0.01	2.50%	0.72	19.41%	0.01	0.08%	0.00	0.00%
	1514*	0.12	0.32	4.83	12.20	0.14	0.13	0.31	3.91	12.19	0.14	-0.01	-8.33%	0.01	3.13%	0.92	19.05%	0.01	0.08%	0.00	0.00%
	1472*	0.07	0.27	11.57	12.07	0.11	0.07	0.26	10.81	12.07	0.11	0.00	0.00%	0.01	3.70%	0.76	6.57%	0.00	0.00%	0.00	0.00%
	1431*	0.09	0.17	5.79	11.89	0.15	0.09	0.16	5.73	11.88	0.15	0.00	0.00%	0.01	5.88%	0.06	1.04%	0.01	0.08%	0.00	0.00%
	1432	0.10	0.17	4.19	11.80	0.19	0.10	0.16	4.04	11.79	0.18	0.00	0.00%	0.01	5.88%	0.15	3.58%	0.01	0.08%	0.01	5.26%
	1414*	0.11	0.18	3.90	11.71	0.18	0.10	0.17	3.83	11.70	0.18	0.01	9.09%	0.01	5.56%	0.07	1.79%	0.01	0.09%	0.00	0.00%
	1405*	0.15	0.23	4.27	11.67	0.12	0.15	0.22	4.22	11.66	0.12	0.00	0.00%	0.01	4.35%	0.05	1.17%	0.01	0.09%	0.00	0.00%
	1396*	0.22	0.31	4.75	11.66	0.08	0.21	0.30	4.70	11.65	0.07	0.01	4.55%	0.01	3.23%	0.05	1.05%	0.01	0.09%	0.01	12.50%
	1387*	0.29	0.40	5.26	11.66	0.05	0.28	0.39	5.19	11.65	0.05	0.01	3.45%	0.01	2.50%	0.07	1.33%	0.01	0.09%	0.00	0.00%
	1379*	0.35	0.49	5.76	11.66	0.04	0.35	0.48	5.70	11.65	0.04	0.00	0.00%	0.01	2.04%	0.06	1.04%	0.01	0.09%	0.00	0.00%
Reach 5	1370	0.42	0.58	6.23	11.66	0.03	0.42	0.57	6.17	11.65	0.03	0.00	0.00%	0.01	1.72%	0.06	0.96%	0.01	0.09%	0.00	0.00%
	1326*	0.39	0.56	5.71	11.66	0.04	0.39	0.55	5.66	11.65	0.03	0.00	0.00%	0.01	1.79%	0.05	0.88%	0.01	0.09%	0.01	25.00%
	1282*	0.37	0.53	5.19	11.65	0.04	0.36	0.52	5.14	11.64	0.04	0.01	2.70%	0.01	1.89%	0.05	0.96%	0.01	0.09%	0.00	0.00%
	1238*	0.20	0.49	8.05	11.65	0.05	0.24	0.49	6.45	11.64	0.05	-0.04	-20.00%	0.00	0.00%	1.60	19.88%	0.01	0.09%	0.00	0.00%
	1194*	0.10	0.46	14.81	11.64	0.06	0.11	0.45	13.00	11.63	0.06	-0.01	-10.00%	0.01	2.17%	1.81	12.22%	0.01	0.09%	0.00	0.00%
	1151*	0.07	0.42	22.69	11.62	0.07	0.07	0.41	20.86	11.62	0.07	0.00	0.00%	0.01	2.38%	1.83	8.07%	0.00	0.00%	0.00	0.00%
	1107*	0.06	0.37	29.18	11.60	0.09	0.06	0.37	27.37	11.59	0.08	0.00	0.00%	0.00	0.00%	1.81	6.20%	0.01	0.09%	0.01	11.11%
	1063	0.04	0.29	25.71	11.54	0.14	0.04	0.29	23.70	11.54	0.14	0.00	0.00%	0.00	0.00%	2.01	7.82%	0.00	0.00%	0.00	0.00%
	1029*	0.11	0.35	4.70	11.43	0.16	0.14	0.34	3.38	11.42	0.16	-0.03	-27.27%	0.01	2.86%	1.32	28.09%	0.01	0.09%	0.00	0.00%
	995*	0.18	0.45	4.39	11.36	0.10	0.19	0.43	3.85	11.35	0.10	-0.01	-5.56%	0.02	4.44%	0.54	12.30%	0.01	0.09%	0.00	0.00%
	961	0.23	0.60	6.36	11.35	0.05	0.23	0.58	6.05	11.33	0.05	0.00	0.00%	0.02	3.33%	0.31	4.87%	0.02	0.18%	0.00	0.00%
	913*	0.21	0.57	6.52	11.33	0.06	0.21	0.55	6.15	11.32	0.06	0.00	0.00%	0.02	3.51%	0.37	5.67%	0.01	0.09%	0.00	0.00%
	864*	0.18	0.53	7.24	11.31	0.06	0.19	0.52	6.51	11.30	0.06	-0.01	-5.56%	0.01	1.89%	0.73	10.08%	0.01	0.09%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS July—0.079 m^3/s					FEIS July—0.072 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 5 *(cont'd)*	816*	0.16	0.49	7.30	11.29	0.07	0.16	0.48	6.65	11.28	0.07	0.00	0.00%	0.01	2.04%	0.65	8.90%	0.01	0.09%	0.00	0.00%
	767*	0.15	0.44	6.49	11.26	0.08	0.16	0.42	5.98	11.25	0.08	-0.01	-6.67%	0.02	4.55%	0.51	7.86%	0.01	0.09%	0.00	0.00%
	719	0.15	0.35	4.60	11.19	0.12	0.15	0.34	4.21	11.18	0.11	0.00	0.00%	0.01	2.86%	0.39	8.48%	0.01	0.09%	0.01	8.33%
	689*	0.16	0.44	3.50	11.12	0.14	0.17	0.42	3.15	11.11	0.14	-0.01	-6.25%	0.02	4.55%	0.35	10.00%	0.01	0.09%	0.00	0.00%
	660	0.21	0.35	0.71	10.88	0.54	0.20	0.34	0.69	10.87	0.51	0.01	4.76%	0.01	2.86%	0.02	2.82%	0.01	0.09%	0.03	5.56%
	642	0.12	0.35	4.00	10.80	0.19	0.12	0.34	3.59	10.79	0.18	0.00	0.00%	0.01	2.86%	0.41	10.25%	0.01	0.09%	0.01	5.26%
	598*	0.15	0.46	3.32	10.74	0.17	0.15	0.44	2.87	10.72	0.17	0.00	0.00%	0.02	4.35%	0.45	13.55%	0.02	0.19%	0.00	0.00%
	555*	0.18	0.57	2.86	10.68	0.16	0.19	0.55	2.33	10.66	0.16	-0.01	-5.56%	0.02	3.51%	0.53	18.53%	0.02	0.19%	0.00	0.00%
	512*	0.21	0.68	2.43	10.62	0.16	0.24	0.66	1.89	10.60	0.16	-0.03	-14.29%	0.02	2.94%	0.54	22.22%	0.02	0.19%	0.00	0.00%
	468	0.34	0.74	1.21	10.52	0.19	0.33	0.72	1.21	10.50	0.18	0.01	2.94%	0.02	2.70%	0.00	0.00%	0.02	0.19%	0.01	5.26%
	447	0.17	0.26	1.34	10.23	0.35	0.17	0.27	1.35	10.23	0.31	0.00	0.00%	-0.01	-3.85%	-0.01	-0.75%	0.00	0.00%	0.04	11.43%
	419	0.16	0.24	1.58	9.81	0.30	0.15	0.22	1.56	9.79	0.31	0.01	6.25%	0.02	8.33%	0.02	1.27%	0.02	0.20%	-0.01	-3.33%
	396	0.43	0.49	0.42	9.68	0.43	0.42	0.47	0.42	9.66	0.41	0.01	2.33%	0.02	4.08%	0.00	0.00%	0.02	0.21%	0.02	4.65%
	373	0.18	0.56	3.13	9.61	0.17	0.18	0.55	2.84	9.60	0.16	0.00	0.00%	0.01	1.79%	0.29	9.27%	0.01	0.10%	0.01	5.88%
	340	0.25	0.40	2.11	9.53	0.15	0.24	0.39	2.01	9.52	0.15	0.01	4.00%	0.01	2.50%	0.10	4.74%	0.01	0.10%	0.00	0.00%
	300	0.17	0.26	3.97	9.40	0.12	0.16	0.25	3.89	9.39	0.11	0.01	5.88%	0.01	3.85%	0.08	2.02%	0.01	0.11%	0.01	8.33%
	284*	0.17	0.29	4.13	9.30	0.12	0.16	0.28	4.02	9.29	0.11	0.01	5.88%	0.01	3.45%	0.11	2.66%	0.01	0.11%	0.01	8.33%
	267*	0.17	0.33	4.26	9.21	0.11	0.16	0.32	4.14	9.20	0.11	0.01	5.88%	0.01	3.03%	0.12	2.82%	0.01	0.11%	0.00	0.00%
	251*	0.20	0.40	4.71	9.16	0.08	0.19	0.39	4.58	9.14	0.08	0.01	5.00%	0.01	2.50%	0.13	2.76%	0.02	0.22%	0.00	0.00%
	235*	0.26	0.51	5.46	9.14	0.06	0.25	0.49	5.32	9.12	0.05	0.01	3.85%	0.02	3.92%	0.14	2.56%	0.02	0.22%	0.01	16.67%
	218	0.31	0.62	6.18	9.12	0.04	0.30	0.60	6.05	9.10	0.04	0.01	3.23%	0.02	3.23%	0.13	2.10%	0.02	0.22%	0.00	0.00%
	178*	0.26	0.52	12.38	9.05	0.02	0.25	0.51	12.14	9.04	0.02	0.01	3.85%	0.01	1.92%	0.24	1.94%	0.01	0.11%	0.00	0.00%
	137*	0.23	0.45	18.78	9.02	0.02	0.22	0.44	18.48	9.01	0.02	0.01	4.35%	0.01	2.22%	0.30	1.60%	0.01	0.11%	0.00	0.00%
	97*	0.21	0.40	25.48	9.00	0.02	0.20	0.39	25.12	8.99	0.02	0.01	4.76%	0.01	2.50%	0.36	1.41%	0.01	0.11%	0.00	0.00%
	56*	0.18	0.35	32.34	8.98	0.01	0.18	0.34	31.94	8.97	0.01	0.00	0.00%	0.01	2.86%	0.40	1.24%	0.01	0.11%	0.00	0.00%
	16	0.16	0.29	39.21	8.96	0.01	0.15	0.28	38.84	8.95	0.01	0.01	6.25%	0.01	3.45%	0.37	0.94%	0.01	0.11%	0.00	0.00%
Average		**0.20**	**0.46**	**9.33**	**14.24**	**0.11**	**0.20**	**0.45**	**8.69**	**14.22**	**0.11**	**0.00**	**-0.46%**	**0.01**	**2.65%**	**0.65**	**6.92%**	**0.01**	**0.08%**	**0.00**	**2.66%**

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS - August—0.027 m^3/s					FEIS August—0.023 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1	4241	0.33	0.44	23.61	17.84	0.00	0.31	0.41	23.40	17.82	0.00	0.02	6.06%	0.03	6.82%	0.21	0.89%	0.02	0.11%	0.00	0.00%
	4224*	0.31	0.42	20.97	17.84	0.00	0.29	0.40	20.76	17.82	0.00	0.02	6.45%	0.02	4.76%	0.21	1.00%	0.02	0.11%	0.00	0.00%
	4206*	0.28	0.41	18.33	17.84	0.01	0.27	0.39	18.12	17.82	0.00	0.01	3.57%	0.02	4.88%	0.21	1.15%	0.02	0.11%	0.01	100.00%
	4189*	0.26	0.40	15.72	17.84	0.01	0.24	0.38	15.48	17.82	0.01	0.02	7.69%	0.02	5.00%	0.24	1.53%	0.02	0.11%	0.00	0.00%
	4171*	0.23	0.38	13.17	17.83	0.01	0.22	0.36	12.83	17.81	0.01	0.01	4.35%	0.02	5.26%	0.34	2.58%	0.02	0.11%	0.00	0.00%
	4154*	0.21	0.37	10.56	17.83	0.01	0.20	0.35	10.20	17.81	0.01	0.01	4.76%	0.02	5.41%	0.36	3.41%	0.02	0.11%	0.00	0.00%
	4136*	0.18	0.35	7.81	17.82	0.02	0.17	0.33	7.47	17.80	0.02	0.01	5.56%	0.02	5.71%	0.34	4.35%	0.02	0.11%	0.00	0.00%
	4119	0.14	0.30	4.55	17.79	0.04	0.13	0.28	4.20	17.77	0.04	0.01	7.14%	0.02	6.67%	0.35	7.69%	0.02	0.11%	0.00	0.00%
	4095	0.16	0.29	8.29	17.77	0.02	0.15	0.27	7.80	17.75	0.02	0.01	6.25%	0.02	6.90%	0.49	5.91%	0.02	0.11%	0.00	0.00%
	4049*	0.15	0.31	9.94	17.76	0.02	0.15	0.29	8.40	17.74	0.02	0.00	0.00%	0.02	6.45%	1.54	15.49%	0.02	0.11%	0.00	0.00%
	4002*	0.18	0.33	10.33	17.76	0.01	0.17	0.31	10.01	17.74	0.01	0.01	5.56%	0.02	6.06%	0.32	3.10%	0.02	0.11%	0.00	0.00%
	3956	0.23	0.35	10.40	17.75	0.01	0.22	0.33	10.16	17.73	0.01	0.01	4.35%	0.02	5.71%	0.24	2.31%	0.02	0.11%	0.00	0.00%
	3906*	0.24	0.39	13.04	17.75	0.01	0.23	0.37	12.63	17.73	0.01	0.01	4.17%	0.02	5.13%	0.41	3.14%	0.02	0.11%	0.00	0.00%
	3857*	0.26	0.43	15.47	17.75	0.01	0.25	0.41	15.15	17.73	0.01	0.01	3.85%	0.02	4.65%	0.32	2.07%	0.02	0.11%	0.00	0.00%
	3807*	0.28	0.47	17.84	17.75	0.01	0.27	0.45	17.56	17.73	0.00	0.01	3.57%	0.02	4.26%	0.28	1.57%	0.02	0.11%	0.01	100.00%
	3757	0.31	0.51	20.18	17.75	0.00	0.29	0.49	19.93	17.73	0.00	0.02	6.45%	0.02	3.92%	0.25	1.24%	0.02	0.11%	0.00	0.00%
	3729	0.18	0.37	3.93	17.75	0.04	0.17	0.35	3.58	17.73	0.04	0.01	5.56%	0.02	5.41%	0.35	8.91%	0.02	0.11%	0.00	0.00%
	3717	0.10	0.23	3.56	17.73	0.07	0.11	0.22	2.88	17.72	0.07	-0.01	-10.00%	0.01	4.35%	0.68	19.10%	0.01	0.06%	0.00	0.00%
	3691*	0.09	0.22	2.54	17.54	0.11	0.09	0.21	2.44	17.53	0.11	0.00	0.00%	0.01	4.55%	0.10	3.94%	0.01	0.06%	0.00	0.00%
	3665	0.17	0.25	1.90	17.40	0.08	0.15	0.22	1.74	17.37	0.09	0.02	11.76%	0.03	12.00%	0.16	8.42%	0.03	0.17%	-0.01	-12.50%
	3643	0.17	0.33	1.69	17.32	0.09	0.19	0.30	1.32	17.29	0.09	-0.02	-11.76%	0.03	9.09%	0.37	21.89%	0.03	0.17%	0.00	0.00%
	3611	0.34	0.45	0.69	17.17	0.11	0.33	0.43	0.68	17.15	0.10	0.01	2.94%	0.02	4.44%	0.01	1.45%	0.02	0.12%	0.01	9.09%
	3565	0.15	0.24	5.48	17.11	0.03	0.14	0.22	5.26	17.09	0.03	0.01	6.67%	0.02	8.33%	0.22	4.01%	0.02	0.12%	0.00	0.00%
	3556*	0.16	0.26	5.26	17.10	0.03	0.15	0.23	5.06	17.08	0.03	0.01	6.25%	0.03	11.54%	0.20	3.80%	0.02	0.12%	0.00	0.00%
	3547*	0.18	0.27	5.02	17.10	0.03	0.16	0.25	4.81	17.08	0.03	0.02	11.11%	0.02	7.41%	0.21	4.18%	0.02	0.12%	0.00	0.00%
	3538*	0.18	0.29	4.87	17.10	0.03	0.17	0.27	4.56	17.08	0.03	0.01	5.56%	0.02	6.90%	0.31	6.37%	0.02	0.12%	0.00	0.00%
	3528*	0.19	0.30	4.53	17.09	0.03	0.18	0.28	4.29	17.07	0.03	0.01	5.26%	0.02	6.67%	0.24	5.30%	0.02	0.12%	0.00	0.00%
	3519*	0.21	0.32	4.07	17.09	0.03	0.20	0.30	3.88	17.07	0.03	0.01	4.76%	0.02	6.25%	0.19	4.67%	0.02	0.12%	0.00	0.00%
	3510*	0.22	0.34	3.65	17.09	0.03	0.21	0.32	3.36	17.07	0.03	0.01	4.55%	0.02	5.88%	0.29	7.95%	0.02	0.12%	0.00	0.00%
	3501*	0.22	0.35	3.20	17.08	0.04	0.22	0.33	2.85	17.06	0.04	0.00	0.00%	0.02	5.71%	0.35	10.94%	0.02	0.12%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS - August—0.027 m^3/s					FEIS August—0.023 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1 *(cont'd)*	3492*	0.22	0.37	2.63	17.08	0.05	0.22	0.35	2.36	17.06	0.04	0.00	0.00%	0.02	5.41%	0.27	10.27%	0.02	0.12%	0.01	20.00%
	3483	0.21	0.38	1.99	17.07	0.07	0.21	0.36	1.77	17.05	0.06	0.00	0.00%	0.02	5.26%	0.22	11.06%	0.02	0.12%	0.01	14.29%
	3474*	0.20	0.36	1.85	17.07	0.07	0.21	0.34	1.63	17.05	0.07	-0.01	-5.00%	0.02	5.56%	0.22	11.89%	0.02	0.12%	0.00	0.00%
	3464*	0.20	0.33	1.68	17.06	0.08	0.21	0.31	1.53	17.04	0.07	-0.01	-5.00%	0.02	6.06%	0.15	8.93%	0.02	0.12%	0.01	12.50%
	3455*	0.19	0.31	1.63	17.05	0.09	0.18	0.29	1.58	17.03	0.08	0.01	5.26%	0.02	6.45%	0.05	3.07%	0.02	0.12%	0.01	11.11%
	3446*	0.17	0.27	1.65	17.03	0.10	0.15	0.26	1.60	17.02	0.09	0.02	11.76%	0.01	3.70%	0.05	3.03%	0.01	0.06%	0.01	10.00%
Reach 2	3436	0.13	0.20	1.42	16.98	0.15	0.12	0.19	1.37	16.97	0.14	0.01	7.69%	0.01	5.00%	0.05	3.52%	0.01	0.06%	0.01	6.67%
	3429*	0.16	0.25	1.02	16.69	0.17	0.14	0.23	0.98	16.66	0.17	0.02	12.50%	0.02	8.00%	0.04	3.92%	0.03	0.18%	0.00	0.00%
	3422	0.28	0.58	1.22	16.68	0.08	0.30	0.56	1.07	16.66	0.07	-0.02	-7.14%	0.02	3.45%	0.15	12.30%	0.02	0.12%	0.01	12.50%
	3414*	0.29	0.49	0.97	16.68	0.09	0.32	0.47	0.85	16.66	0.09	-0.03	-10.34%	0.02	4.08%	0.12	12.37%	0.02	0.12%	0.00	0.00%
	3406*	0.29	0.41	0.82	16.67	0.11	0.28	0.39	0.80	16.65	0.10	0.01	3.45%	0.02	4.88%	0.02	2.44%	0.02	0.12%	0.01	9.09%
	3399*	0.23	0.32	0.81	16.66	0.15	0.21	0.30	0.79	16.65	0.14	0.02	8.70%	0.02	6.25%	0.02	2.47%	0.01	0.06%	0.01	6.67%
	3391	0.15	0.20	0.74	16.63	0.24	0.14	0.19	0.72	16.62	0.23	0.01	6.67%	0.01	5.00%	0.02	2.70%	0.01	0.06%	0.01	4.17%
	3390*	0.14	0.24	0.87	16.54	0.22	0.13	0.23	0.85	16.53	0.21	0.01	7.14%	0.01	4.17%	0.02	2.30%	0.01	0.06%	0.01	4.55%
	3389	0.13	0.27	0.94	16.45	0.22	0.12	0.26	0.90	16.43	0.21	0.01	7.69%	0.01	3.70%	0.04	4.26%	0.02	0.12%	0.01	4.55%
	3388*	0.14	0.30	0.85	16.35	0.23	0.13	0.28	0.78	16.33	0.23	0.01	7.14%	0.02	6.67%	0.07	8.24%	0.02	0.12%	0.00	0.00%
	3387*	0.16	0.33	0.78	16.25	0.22	0.15	0.30	0.71	16.23	0.21	0.01	6.25%	0.03	9.09%	0.07	8.97%	0.02	0.12%	0.01	4.55%
	3386*	0.19	0.38	0.83	16.18	0.17	0.17	0.35	0.75	16.15	0.17	0.02	10.53%	0.03	7.89%	0.08	9.64%	0.03	0.19%	0.00	0.00%
	3385*	0.23	0.48	0.98	16.15	0.12	0.22	0.44	0.89	16.11	0.12	0.01	4.35%	0.04	8.33%	0.09	9.18%	0.04	0.25%	0.00	0.00%
	3384*	0.28	0.59	1.19	16.14	0.08	0.27	0.55	1.09	16.10	0.08	0.01	3.57%	0.04	6.78%	0.10	8.40%	0.04	0.25%	0.00	0.00%
	3383	0.33	0.71	1.42	16.13	0.06	0.32	0.68	1.32	16.10	0.05	0.01	3.03%	0.03	4.23%	0.10	7.04%	0.03	0.19%	0.01	16.67%
	3337*	0.25	0.56	1.82	15.99	0.06	0.25	0.53	1.62	15.96	0.06	0.00	0.00%	0.03	5.36%	0.20	10.99%	0.03	0.19%	0.00	0.00%
	3290	0.29	0.49	2.62	15.94	0.04	0.27	0.46	2.55	15.90	0.03	0.02	6.90%	0.03	6.12%	0.07	2.67%	0.04	0.25%	0.01	25.00%
	3245*	0.30	0.58	2.28	15.91	0.04	0.27	0.55	2.23	15.88	0.04	0.03	10.00%	0.03	5.17%	0.05	2.19%	0.03	0.19%	0.00	0.00%
	3200	0.50	0.68	1.45	15.90	0.04	0.47	0.65	1.42	15.87	0.03	0.03	6.00%	0.03	4.41%	0.03	2.07%	0.03	0.19%	0.01	25.00%
	3160*	0.42	0.60	1.54	15.89	0.04	0.40	0.57	1.50	15.86	0.04	0.02	4.76%	0.03	5.00%	0.04	2.60%	0.03	0.19%	0.00	0.00%
	3119*	0.34	0.51	1.61	15.88	0.05	0.32	0.49	1.56	15.85	0.05	0.02	5.88%	0.02	3.92%	0.05	3.11%	0.03	0.19%	0.00	0.00%
	3079*	0.25	0.42	1.61	15.85	0.07	0.23	0.39	1.55	15.82	0.06	0.02	8.00%	0.03	7.14%	0.06	3.73%	0.03	0.19%	0.01	14.29%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS - August—0.027 m^3/s					FEIS August—0.023 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 3	3038	0.15	0.24	1.07	15.74	0.17	0.13	0.21	1.00	15.71	0.17	0.02	13.33%	0.03	12.50%	0.07	6.54%	0.03	0.19%	0.00	0.00%
	2995	0.20	0.35	1.48	15.62	0.09	0.19	0.34	1.42	15.60	0.08	0.01	5.00%	0.01	2.86%	0.06	4.05%	0.02	0.13%	0.01	11.11%
	2951*	0.14	0.28	1.66	15.54	0.11	0.14	0.27	1.57	15.53	0.10	0.00	0.00%	0.01	3.57%	0.09	5.42%	0.01	0.06%	0.01	9.09%
	2907	0.05	0.11	7.64	15.38	0.09	0.04	0.11	7.05	15.37	0.09	0.01	20.00%	0.00	0.00%	0.59	7.72%	0.01	0.07%	0.00	0.00%
	2899*	0.08	0.18	1.57	15.30	0.20	0.08	0.17	1.42	15.29	0.20	0.00	0.00%	0.01	5.56%	0.15	9.55%	0.01	0.07%	0.00	0.00%
	2891*	0.12	0.17	0.81	15.15	0.28	0.11	0.15	0.77	15.14	0.27	0.01	8.33%	0.02	11.76%	0.04	4.94%	0.01	0.07%	0.01	3.57%
	2884*	0.17	0.23	0.89	15.07	0.18	0.16	0.21	0.85	15.05	0.17	0.01	5.88%	0.02	8.70%	0.04	4.49%	0.02	0.13%	0.01	5.56%
	2876	0.18	0.35	1.56	15.05	0.09	0.18	0.33	1.44	15.03	0.09	0.00	0.00%	0.02	5.71%	0.12	7.69%	0.02	0.13%	0.00	0.00%
	2830*	0.15	0.34	1.90	14.98	0.09	0.15	0.33	1.72	14.96	0.09	0.00	0.00%	0.01	2.94%	0.18	9.47%	0.02	0.13%	0.00	0.00%
	2783*	0.10	0.32	3.00	14.88	0.09	0.11	0.30	2.52	14.87	0.09	-0.01	-10.00%	0.02	6.25%	0.48	16.00%	0.01	0.07%	0.00	0.00%
	2737*	0.10	0.27	2.99	14.76	0.09	0.09	0.26	2.86	14.75	0.09	0.01	10.00%	0.01	3.70%	0.13	4.35%	0.01	0.07%	0.00	0.00%
	2691*	0.12	0.23	2.45	14.65	0.10	0.11	0.21	2.36	14.63	0.10	0.01	8.33%	0.02	8.70%	0.09	3.67%	0.02	0.14%	0.00	0.00%
	2645	0.14	0.18	1.51	14.53	0.13	0.13	0.17	1.46	14.52	0.13	0.01	7.14%	0.01	5.56%	0.05	3.31%	0.01	0.07%	0.00	0.00%
	2606*	0.12	0.21	1.82	14.42	0.12	0.11	0.19	1.73	14.41	0.12	0.01	8.33%	0.02	9.52%	0.09	4.95%	0.01	0.07%	0.00	0.00%
	2566*	0.12	0.23	1.77	14.31	0.13	0.11	0.21	1.57	14.29	0.13	0.01	8.33%	0.02	8.70%	0.20	11.30%	0.02	0.14%	0.00	0.00%
	2527*	0.16	0.29	1.75	14.23	0.10	0.15	0.27	1.64	14.21	0.09	0.01	6.25%	0.02	6.90%	0.11	6.29%	0.02	0.14%	0.01	10.00%
	2488	0.06	0.38	9.83	14.18	0.06	0.08	0.36	6.29	14.16	0.06	-0.02	-33.33%	0.02	5.26%	3.54	36.01%	0.02	0.14%	0.00	0.00%
	2440*	0.07	0.37	8.82	14.12	0.05	0.08	0.35	5.91	14.10	0.05	-0.01	-14.29%	0.02	5.41%	2.91	32.99%	0.02	0.14%	0.00	0.00%
	2392*	0.09	0.35	5.37	14.03	0.06	0.14	0.33	2.98	14.02	0.05	-0.05	-55.56%	0.02	5.71%	2.39	44.51%	0.01	0.07%	0.01	16.67%
	2344*	0.15	0.32	3.28	13.95	0.06	0.14	0.31	3.08	13.93	0.05	0.01	6.67%	0.01	3.13%	0.20	6.10%	0.02	0.14%	0.01	16.67%
	2296*	0.14	0.30	3.30	13.87	0.06	0.14	0.28	3.15	13.85	0.05	0.00	0.00%	0.02	6.67%	0.15	4.55%	0.02	0.14%	0.01	16.67%
	2248*	0.13	0.25	3.14	13.76	0.07	0.12	0.24	3.01	13.75	0.06	0.01	7.69%	0.01	4.00%	0.13	4.14%	0.01	0.07%	0.01	14.29%
	2200*	0.11	0.21	2.99	13.66	0.08	0.10	0.19	2.86	13.64	0.08	0.01	9.09%	0.02	9.52%	0.13	4.35%	0.02	0.15%	0.00	0.00%
	2152*	0.13	0.20	3.25	13.60	0.07	0.11	0.19	3.10	13.58	0.06	0.02	15.38%	0.01	5.00%	0.15	4.62%	0.02	0.15%	0.01	14.29%
Reach 4	2104	0.16	0.23	3.73	13.57	0.04	0.15	0.22	3.61	13.56	0.04	0.01	6.25%	0.01	4.35%	0.12	3.22%	0.01	0.07%	0.00	0.00%
	2077*	0.10	0.24	6.34	13.56	0.04	0.09	0.22	5.70	13.54	0.04	0.01	10.00%	0.02	8.33%	0.64	10.09%	0.02	0.15%	0.00	0.00%
	2050	0.12	0.24	3.28	13.54	0.07	0.11	0.21	3.02	13.52	0.07	0.01	8.33%	0.03	12.50%	0.26	7.93%	0.02	0.15%	0.00	0.00%
	2002*	0.10	0.34	3.27	13.47	0.08	0.12	0.31	2.11	13.44	0.09	-0.02	-20.00%	0.03	8.82%	1.16	35.47%	0.03	0.22%	-0.01	-12.50%
	1954	0.19	0.45	1.74	13.40	0.08	0.19	0.42	1.57	13.38	0.08	0.00	0.00%	0.03	6.67%	0.17	9.77%	0.02	0.15%	0.00	0.00%
	1911*	0.17	0.42	1.82	13.35	0.09	0.17	0.40	1.68	13.33	0.08	0.00	0.00%	0.02	4.76%	0.14	7.69%	0.02	0.15%	0.01	11.11%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS - August—0.027 m^3/s					FEIS August—0.023 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 4 *(cont'd)*	1868*	0.12	0.38	2.91	13.29	0.08	0.11	0.36	2.66	13.27	0.08	0.01	8.33%	0.02	5.26%	0.25	8.59%	0.02	0.15%	0.00	0.00%
	1825*	0.13	0.34	2.61	13.22	0.08	0.13	0.32	2.43	13.21	0.08	0.00	0.00%	0.02	5.88%	0.18	6.90%	0.01	0.08%	0.00	0.00%
	1783	0.13	0.26	1.55	13.12	0.13	0.12	0.24	1.44	13.11	0.13	0.01	7.69%	0.02	7.69%	0.11	7.10%	0.01	0.08%	0.00	0.00%
	1736*	0.14	0.27	1.32	12.93	0.14	0.14	0.25	1.22	12.91	0.14	0.00	0.00%	0.02	7.41%	0.10	7.58%	0.02	0.15%	0.00	0.00%
	1689*	0.16	0.27	1.15	12.73	0.15	0.15	0.25	1.09	12.71	0.14	0.01	6.25%	0.02	7.41%	0.06	5.22%	0.02	0.16%	0.01	6.67%
	1642*	0.17	0.28	1.05	12.53	0.15	0.16	0.26	1.01	12.51	0.14	0.01	5.88%	0.02	7.14%	0.04	3.81%	0.02	0.16%	0.01	6.67%
	1596	0.19	0.31	1.01	12.35	0.14	0.18	0.29	0.98	12.33	0.13	0.01	5.26%	0.02	6.45%	0.03	2.97%	0.02	0.16%	0.01	7.14%
	1555*	0.15	0.25	1.44	12.21	0.12	0.14	0.24	1.39	12.20	0.12	0.01	6.67%	0.01	4.00%	0.05	3.47%	0.01	0.08%	0.00	0.00%
	1514*	0.12	0.21	1.99	12.09	0.11	0.12	0.20	1.91	12.08	0.10	0.00	0.00%	0.01	4.76%	0.08	4.02%	0.01	0.08%	0.01	9.09%
	1472*	0.09	0.20	3.75	12.00	0.08	0.09	0.18	3.43	11.99	0.07	0.00	0.00%	0.02	10.00%	0.32	8.53%	0.01	0.08%	0.01	12.50%
	1431*	0.06	0.11	4.09	11.83	0.12	0.05	0.11	3.88	11.83	0.11	0.01	16.67%	0.00	0.00%	0.21	5.13%	0.00	0.00%	0.01	8.33%
	1432	0.06	0.11	3.09	11.74	0.14	0.06	0.10	2.97	11.73	0.13	0.00	0.00%	0.01	9.09%	0.12	3.88%	0.01	0.09%	0.01	7.14%
	1414*	0.06	0.11	3.01	11.64	0.15	0.06	0.10	2.94	11.64	0.13	0.00	0.00%	0.01	9.09%	0.07	2.33%	0.00	0.00%	0.02	13.33%
	1405*	0.07	0.12	3.28	11.56	0.11	0.06	0.10	3.02	11.55	0.13	0.01	14.29%	0.02	16.67%	0.26	7.93%	0.01	0.09%	-0.02	-18.18%
	1396*	0.13	0.20	4.23	11.55	0.05	0.12	0.18	4.03	11.53	0.05	0.01	7.69%	0.02	10.00%	0.20	4.73%	0.02	0.17%	0.00	0.00%
	1387*	0.21	0.29	4.74	11.55	0.03	0.19	0.27	4.65	11.53	0.03	0.02	9.52%	0.02	6.90%	0.09	1.90%	0.02	0.17%	0.00	0.00%
	1379*	0.28	0.38	5.20	11.55	0.02	0.26	0.36	5.12	11.53	0.02	0.02	7.14%	0.02	5.26%	0.08	1.54%	0.02	0.17%	0.00	0.00%
Reach 5	1370	0.35	0.48	5.64	11.55	0.01	0.34	0.46	5.55	11.53	0.01	0.01	2.86%	0.02	4.17%	0.09	1.60%	0.02	0.17%	0.00	0.00%
	1326*	0.33	0.45	5.11	11.55	0.02	0.31	0.43	5.02	11.53	0.01	0.02	6.06%	0.02	4.44%	0.09	1.76%	0.02	0.17%	0.01	50.00%
	1282*	0.30	0.42	4.58	11.55	0.02	0.29	0.40	4.48	11.53	0.02	0.01	3.33%	0.02	4.76%	0.10	2.18%	0.02	0.17%	0.00	0.00%
	1238*	0.28	0.40	4.07	11.55	0.02	0.27	0.38	3.95	11.53	0.02	0.01	3.57%	0.02	5.00%	0.12	2.95%	0.02	0.17%	0.00	0.00%
	1194*	0.25	0.37	3.55	11.55	0.03	0.24	0.35	3.42	11.52	0.03	0.01	4.00%	0.02	5.41%	0.13	3.66%	0.03	0.26%	0.00	0.00%
	1151*	0.22	0.34	3.04	11.54	0.04	0.21	0.32	2.89	11.52	0.04	0.01	4.55%	0.02	5.88%	0.15	4.93%	0.02	0.17%	0.00	0.00%
	1107*	0.08	0.30	5.93	11.53	0.06	0.17	0.28	2.34	11.51	0.06	-0.09	-112.50%	0.02	6.67%	3.59	60.54%	0.02	0.17%	0.00	0.00%
	1063	0.12	0.22	1.66	11.47	0.14	0.13	0.20	1.32	11.45	0.14	-0.01	-8.33%	0.02	9.09%	0.34	20.48%	0.02	0.17%	0.00	0.00%
	1029*	0.12	0.22	1.62	11.30	0.14	0.11	0.20	1.53	11.28	0.14	0.01	8.33%	0.02	9.09%	0.09	5.56%	0.02	0.18%	0.00	0.00%
	995*	0.15	0.30	2.21	11.22	0.08	0.14	0.28	2.07	11.20	0.08	0.01	6.67%	0.02	6.67%	0.14	6.33%	0.02	0.18%	0.00	0.00%
	961	0.18	0.45	4.28	11.20	0.04	0.16	0.44	4.13	11.18	0.03	0.02	11.11%	0.01	2.22%	0.15	3.50%	0.02	0.18%	0.01	25.00%
	913*	0.17	0.43	3.98	11.19	0.04	0.16	0.41	3.85	11.17	0.04	0.01	5.88%	0.02	4.65%	0.13	3.27%	0.02	0.18%	0.00	0.00%
	864*	0.16	0.39	3.77	11.18	0.04	0.16	0.38	3.56	11.16	0.04	0.00	0.00%	0.01	2.56%	0.21	5.57%	0.02	0.18%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS - August—0.027 m^3/s					FEIS August—0.023 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 5 *(cont'd)*	816*	0.15	0.36	3.54	11.16	0.05	0.15	0.34	3.33	11.14	0.05	0.00	0.00%	0.02	5.56%	0.21	5.93%	0.02	0.18%	0.00	0.00%
	767*	0.14	0.31	3.21	11.13	0.06	0.13	0.30	3.05	11.12	0.06	0.01	7.14%	0.01	3.23%	0.16	4.98%	0.01	0.09%	0.00	0.00%
	719	0.10	0.22	2.52	11.06	0.10	0.09	0.21	2.38	11.05	0.10	0.01	10.00%	0.01	4.55%	0.14	5.56%	0.01	0.09%	0.00	0.00%
	689*	0.16	0.28	1.47	10.97	0.11	0.15	0.26	1.38	10.95	0.11	0.01	6.25%	0.02	7.14%	0.09	6.12%	0.02	0.18%	0.00	0.00%
	660	0.17	0.25	0.49	10.78	0.31	0.17	0.23	0.46	10.76	0.29	0.00	0.00%	0.02	8.00%	0.03	6.12%	0.02	0.19%	0.02	6.45%
	642	0.11	0.23	1.61	10.68	0.15	0.11	0.22	1.51	10.67	0.14	0.00	0.00%	0.01	4.35%	0.10	6.21%	0.01	0.09%	0.01	6.67%
	598*	0.12	0.30	1.53	10.58	0.15	0.11	0.29	1.50	10.57	0.14	0.01	8.33%	0.01	3.33%	0.03	1.96%	0.01	0.09%	0.01	6.67%
	555*	0.15	0.39	1.37	10.50	0.13	0.14	0.36	1.20	10.48	0.13	0.01	6.67%	0.03	7.69%	0.17	12.41%	0.02	0.19%	0.00	0.00%
	512*	0.19	0.49	1.23	10.43	0.12	0.18	0.47	1.10	10.41	0.11	0.01	5.26%	0.02	4.08%	0.13	10.57%	0.02	0.19%	0.01	8.33%
	468	0.22	0.56	0.96	10.34	0.13	0.22	0.54	0.87	10.32	0.12	0.00	0.00%	0.02	3.57%	0.09	9.38%	0.02	0.19%	0.01	7.69%
	447	0.16	0.24	1.27	10.21	0.13	0.15	0.23	1.21	10.20	0.13	0.01	6.25%	0.01	4.17%	0.06	4.72%	0.01	0.10%	0.00	0.00%
	419	0.04	0.07	0.91	9.64	0.67	0.04	0.06	0.89	9.63	0.63	0.00	0.00%	0.01	14.29%	0.02	2.20%	0.01	0.10%	0.04	5.97%
	396	0.27	0.30	0.39	9.49	0.26	0.25	0.27	0.38	9.46	0.24	0.02	7.41%	0.03	10.00%	0.01	2.56%	0.03	0.32%	0.02	7.69%
	373	0.29	0.40	0.92	9.45	0.10	0.28	0.38	0.89	9.43	0.09	0.01	3.45%	0.02	5.00%	0.03	3.26%	0.02	0.21%	0.01	10.00%
	340	0.17	0.27	1.63	9.40	0.09	0.16	0.26	1.60	9.39	0.09	0.01	5.88%	0.01	3.70%	0.03	1.84%	0.01	0.11%	0.00	0.00%
	300	0.10	0.16	3.20	9.30	0.08	0.09	0.15	3.10	9.29	0.08	0.01	10.00%	0.01	6.25%	0.10	3.13%	0.01	0.11%	0.00	0.00%
	284*	0.10	0.19	3.28	9.21	0.08	0.09	0.18	3.19	9.20	0.08	0.01	10.00%	0.01	5.26%	0.09	2.74%	0.01	0.11%	0.00	0.00%
	267*	0.10	0.21	3.16	9.10	0.09	0.09	0.20	2.93	9.08	0.09	0.01	10.00%	0.01	4.76%	0.23	7.28%	0.02	0.22%	0.00	0.00%
	251*	0.12	0.25	3.05	9.01	0.08	0.12	0.23	2.65	8.99	0.08	0.00	0.00%	0.02	8.00%	0.40	13.11%	0.02	0.22%	0.00	0.00%
	235*	0.17	0.36	4.01	8.98	0.04	0.15	0.34	3.82	8.97	0.04	0.02	11.76%	0.02	5.56%	0.19	4.74%	0.01	0.11%	0.00	0.00%
	218	0.22	0.47	4.81	8.97	0.03	0.21	0.45	4.64	8.95	0.02	0.01	4.55%	0.02	4.26%	0.17	3.53%	0.02	0.22%	0.01	33.33%
	178*	0.19	0.40	9.86	8.93	0.01	0.19	0.39	9.57	8.92	0.01	0.00	0.00%	0.01	2.50%	0.29	2.94%	0.01	0.11%	0.00	0.00%
	137*	0.17	0.35	15.27	8.92	0.01	0.16	0.34	14.90	8.90	0.01	0.01	5.88%	0.01	2.86%	0.37	2.42%	0.02	0.22%	0.00	0.00%
	97*	0.14	0.30	21.12	8.90	0.01	0.13	0.29	20.59	8.89	0.01	0.01	7.14%	0.01	3.33%	0.53	2.51%	0.01	0.11%	0.00	0.00%
	56*	0.12	0.26	28.11	8.89	0.01	0.11	0.25	27.03	8.88	0.01	0.01	8.33%	0.01	3.85%	1.08	3.84%	0.01	0.11%	0.00	0.00%
	16	0.09	0.21	34.88	8.87	0.01	0.09	0.20	33.10	8.86	0.01	0.00	0.00%	0.01	4.76%	1.78	5.10%	0.01	0.11%	0.00	0.00%
Average		**0.18**	**0.33**	**4.54**	**14.10**	**0.09**	**0.17**	**0.31**	**4.25**	**14.08**	**0.08**	**0.01**	**3.81%**	**0.02**	**5.73%**	**0.28**	**6.26%**	**0.02**	**0.13%**	**0.00**	**4.16%**

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS September—0.025 m^3/s					FEIS September—0.022 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1	4241	0.32	0.42	23.50	17.83	0.00	0.31	0.41	23.35	17.81	0.00	0.01	3.13%	0.01	2.38%	0.15	0.64%	0.02	0.11%	0.00	0.00%
	4224*	0.30	0.41	20.86	17.83	0.00	0.29	0.40	20.71	17.81	0.00	0.01	3.33%	0.01	2.44%	0.15	0.72%	0.02	0.11%	0.00	0.00%
	4206*	0.28	0.40	18.22	17.83	0.00	0.26	0.39	18.06	17.81	0.00	0.02	7.14%	0.01	2.50%	0.16	0.88%	0.02	0.11%	0.00	0.00%
	4189*	0.25	0.39	15.58	17.83	0.01	0.24	0.37	15.42	17.81	0.01	0.01	4.00%	0.02	5.13%	0.16	1.03%	0.02	0.11%	0.00	0.00%
	4171*	0.23	0.37	12.96	17.82	0.01	0.22	0.36	12.77	17.81	0.01	0.01	4.35%	0.01	2.70%	0.19	1.47%	0.01	0.06%	0.00	0.00%
	4154*	0.20	0.36	10.37	17.82	0.01	0.19	0.34	10.12	17.81	0.01	0.01	5.00%	0.02	5.56%	0.25	2.41%	0.01	0.06%	0.00	0.00%
	4136*	0.17	0.34	7.64	17.81	0.02	0.16	0.32	7.36	17.80	0.02	0.01	5.88%	0.02	5.88%	0.28	3.66%	0.01	0.06%	0.00	0.00%
	4119	0.13	0.29	4.36	17.78	0.04	0.13	0.28	4.12	17.76	0.04	0.00	0.00%	0.01	3.45%	0.24	5.50%	0.02	0.11%	0.00	0.00%
	4095	0.15	0.28	7.99	17.76	0.02	0.14	0.27	7.72	17.75	0.02	0.01	6.67%	0.01	3.57%	0.27	3.38%	0.01	0.06%	0.00	0.00%
	4049*	0.16	0.30	8.71	17.75	0.02	0.15	0.28	8.27	17.74	0.02	0.01	6.25%	0.02	6.67%	0.44	5.05%	0.01	0.06%	0.00	0.00%
	4002*	0.17	0.32	10.15	17.74	0.01	0.17	0.30	9.94	17.73	0.01	0.00	0.00%	0.02	6.25%	0.21	2.07%	0.01	0.06%	0.00	0.00%
	3956	0.22	0.34	10.26	17.74	0.01	0.21	0.33	10.11	17.73	0.01	0.01	4.55%	0.01	2.94%	0.15	1.46%	0.01	0.06%	0.00	0.00%
	3906*	0.24	0.38	12.79	17.74	0.01	0.23	0.36	12.54	17.73	0.01	0.01	4.17%	0.02	5.26%	0.25	1.95%	0.01	0.06%	0.00	0.00%
	3857*	0.25	0.42	15.28	17.74	0.01	0.25	0.40	15.08	17.73	0.01	0.00	0.00%	0.02	4.76%	0.20	1.31%	0.01	0.06%	0.00	0.00%
	3807*	0.27	0.45	17.67	17.74	0.01	0.27	0.44	17.50	17.73	0.00	0.00	0.00%	0.01	2.22%	0.17	0.96%	0.01	0.06%	0.01	100.00%
	3757	0.30	0.49	20.03	17.74	0.00	0.29	0.48	19.87	17.73	0.00	0.01	3.33%	0.01	2.04%	0.16	0.80%	0.01	0.06%	0.00	0.00%
	3729	0.18	0.36	3.72	17.74	0.04	0.17	0.35	3.51	17.73	0.04	0.01	5.56%	0.01	2.78%	0.21	5.65%	0.01	0.06%	0.00	0.00%
	3717	0.11	0.22	2.97	17.72	0.08	0.11	0.21	2.84	17.71	0.07	0.00	0.00%	0.01	4.55%	0.13	4.38%	0.01	0.06%	0.01	12.50%
	3691*	0.09	0.21	2.49	17.54	0.11	0.09	0.21	2.41	17.53	0.11	0.00	0.00%	0.00	0.00%	0.08	3.21%	0.01	0.06%	0.00	0.00%
	3665	0.16	0.23	1.81	17.38	0.09	0.15	0.21	1.72	17.37	0.08	0.01	6.25%	0.02	8.70%	0.09	4.97%	0.01	0.06%	0.01	11.11%
	3643	0.19	0.31	1.40	17.30	0.09	0.18	0.29	1.28	17.28	0.09	0.01	5.26%	0.02	6.45%	0.12	8.57%	0.02	0.12%	0.00	0.00%
	3611	0.33	0.44	0.69	17.16	0.11	0.32	0.42	0.68	17.14	0.10	0.01	3.03%	0.02	4.55%	0.01	1.45%	0.02	0.12%	0.01	9.09%
	3565	0.14	0.23	5.37	17.10	0.03	0.13	0.21	5.21	17.08	0.03	0.01	7.14%	0.02	8.70%	0.16	2.98%	0.02	0.12%	0.00	0.00%
	3556*	0.15	0.25	5.16	17.09	0.03	0.14	0.23	5.00	17.08	0.03	0.01	6.67%	0.02	8.00%	0.16	3.10%	0.01	0.06%	0.00	0.00%
	3547*	0.17	0.26	4.90	17.09	0.03	0.16	0.24	4.76	17.07	0.03	0.01	5.88%	0.02	7.69%	0.14	2.86%	0.02	0.12%	0.00	0.00%
	3538*	0.18	0.28	4.71	17.09	0.03	0.17	0.26	4.50	17.07	0.03	0.01	5.56%	0.02	7.14%	0.21	4.46%	0.02	0.12%	0.00	0.00%
	3528*	0.19	0.29	4.41	17.08	0.03	0.18	0.28	4.22	17.07	0.03	0.01	5.26%	0.01	3.45%	0.19	4.31%	0.01	0.06%	0.00	0.00%
	3519*	0.20	0.31	3.97	17.08	0.03	0.19	0.29	3.83	17.06	0.03	0.01	5.00%	0.02	6.45%	0.14	3.53%	0.02	0.12%	0.00	0.00%
	3510*	0.22	0.33	3.46	17.08	0.03	0.21	0.31	3.32	17.06	0.03	0.01	4.55%	0.02	6.06%	0.14	4.05%	0.02	0.12%	0.00	0.00%
	3501*	0.22	0.34	3.02	17.07	0.04	0.22	0.33	2.76	17.06	0.04	0.00	0.00%	0.01	2.94%	0.26	8.61%	0.01	0.06%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS September—0.025 m^3/s					FEIS September—0.022 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1 *(cont'd)*	3492*	0.22	0.36	2.49	17.07	0.05	0.22	0.34	2.28	17.05	0.04	0.00	0.00%	0.02	5.56%	0.21	8.43%	0.02	0.12%	0.01	20.00%
	3483	0.21	0.37	1.89	17.06	0.06	0.21	0.36	1.71	17.05	0.06	0.00	0.00%	0.01	2.70%	0.18	9.52%	0.01	0.06%	0.00	0.00%
	3474*	0.21	0.35	1.74	17.06	0.07	0.21	0.33	1.58	17.04	0.07	0.00	0.00%	0.02	5.71%	0.16	9.20%	0.02	0.12%	0.00	0.00%
	3464*	0.21	0.32	1.58	17.05	0.08	0.20	0.31	1.52	17.04	0.07	0.01	4.76%	0.01	3.13%	0.06	3.80%	0.01	0.06%	0.01	12.50%
	3455*	0.18	0.30	1.61	17.04	0.08	0.18	0.28	1.57	17.03	0.08	0.00	0.00%	0.02	6.67%	0.04	2.48%	0.01	0.06%	0.00	0.00%
	3446*	0.16	0.27	1.63	17.03	0.10	0.15	0.25	1.59	17.01	0.09	0.01	6.25%	0.02	7.41%	0.04	2.45%	0.02	0.12%	0.01	10.00%
Reach 2	3436	0.12	0.20	1.39	16.98	0.15	0.12	0.19	1.35	16.97	0.14	0.00	0.00%	0.01	5.00%	0.04	2.88%	0.01	0.06%	0.01	6.67%
	3429*	0.15	0.24	1.00	16.67	0.17	0.14	0.22	0.97	16.66	0.16	0.01	6.67%	0.02	8.33%	0.03	3.00%	0.01	0.06%	0.01	5.88%
	3422	0.28	0.57	1.15	16.67	0.08	0.30	0.55	1.03	16.65	0.07	-0.02	-7.14%	0.02	3.51%	0.12	10.43%	0.02	0.12%	0.01	12.50%
	3414*	0.30	0.48	0.91	16.67	0.09	0.32	0.47	0.82	16.65	0.08	-0.02	-6.67%	0.01	2.08%	0.09	9.89%	0.02	0.12%	0.01	11.11%
	3406*	0.28	0.40	0.81	16.66	0.11	0.27	0.38	0.80	16.65	0.10	0.01	3.57%	0.02	5.00%	0.01	1.23%	0.01	0.06%	0.01	9.09%
	3399*	0.22	0.31	0.80	16.66	0.14	0.21	0.30	0.79	16.64	0.13	0.01	4.55%	0.01	3.23%	0.01	1.25%	0.02	0.12%	0.01	7.14%
	3391	0.14	0.20	0.73	16.62	0.24	0.14	0.18	0.72	16.61	0.23	0.00	0.00%	0.02	10.00%	0.01	1.37%	0.01	0.06%	0.01	4.17%
	3390*	0.14	0.23	0.86	16.54	0.21	0.13	0.22	0.85	16.53	0.21	0.01	7.14%	0.01	4.35%	0.01	1.16%	0.01	0.06%	0.00	0.00%
	3389	0.13	0.27	0.92	16.44	0.22	0.12	0.25	0.89	16.43	0.21	0.01	7.69%	0.02	7.41%	0.03	3.26%	0.01	0.06%	0.01	4.55%
	3388*	0.13	0.29	0.81	16.34	0.23	0.13	0.27	0.76	16.33	0.22	0.00	0.00%	0.02	6.90%	0.05	6.17%	0.01	0.06%	0.01	4.35%
	3387*	0.16	0.32	0.74	16.24	0.22	0.15	0.30	0.69	16.22	0.21	0.01	6.25%	0.02	6.25%	0.05	6.76%	0.02	0.12%	0.01	4.55%
	3386*	0.18	0.37	0.79	16.17	0.17	0.17	0.34	0.74	16.14	0.18	0.01	5.56%	0.03	8.11%	0.05	6.33%	0.03	0.19%	-0.01	-5.88%
	3385*	0.23	0.46	0.93	16.13	0.12	0.21	0.43	0.87	16.10	0.12	0.02	8.70%	0.03	6.52%	0.06	6.45%	0.03	0.19%	0.00	0.00%
	3384*	0.28	0.57	1.14	16.12	0.08	0.27	0.54	1.06	16.09	0.08	0.01	3.57%	0.03	5.26%	0.08	7.02%	0.03	0.19%	0.00	0.00%
	3383	0.33	0.69	1.37	16.11	0.06	0.32	0.67	1.29	16.09	0.05	0.01	3.03%	0.02	2.90%	0.08	5.84%	0.02	0.12%	0.01	16.67%
	3337*	0.25	0.54	1.72	15.97	0.06	0.25	0.52	1.57	15.95	0.06	0.00	0.00%	0.02	3.70%	0.15	8.72%	0.02	0.13%	0.00	0.00%
	3290	0.28	0.47	2.59	15.92	0.03	0.26	0.45	2.54	15.90	0.03	0.02	7.14%	0.02	4.26%	0.05	1.93%	0.02	0.13%	0.00	0.00%
	3245*	0.28	0.56	2.25	15.90	0.04	0.27	0.54	2.21	15.88	0.04	0.01	3.57%	0.02	3.57%	0.04	1.78%	0.02	0.13%	0.00	0.00%
	3200	0.48	0.66	1.43	15.89	0.04	0.47	0.64	1.42	15.87	0.03	0.01	2.08%	0.02	3.03%	0.01	0.70%	0.02	0.13%	0.01	25.00%
	3160*	0.41	0.58	1.52	15.88	0.04	0.39	0.56	1.50	15.86	0.04	0.02	4.88%	0.02	3.45%	0.02	1.32%	0.02	0.13%	0.00	0.00%
	3119*	0.33	0.50	1.59	15.87	0.05	0.31	0.48	1.56	15.85	0.05	0.02	6.06%	0.02	4.00%	0.03	1.89%	0.02	0.13%	0.00	0.00%
	3079*	0.24	0.41	1.58	15.84	0.07	0.23	0.39	1.54	15.82	0.06	0.01	4.17%	0.02	4.88%	0.04	2.53%	0.02	0.13%	0.01	14.29%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS September—0.025 m^3/s					FEIS September—0.022 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 3	3038	0.14	0.22	1.04	15.72	0.17	0.13	0.21	0.98	15.71	0.17	0.01	7.14%	0.01	4.55%	0.06	5.77%	0.01	0.06%	0.00	0.00%
	2995	0.20	0.34	1.45	15.61	0.09	0.19	0.33	1.41	15.59	0.08	0.01	5.00%	0.01	2.94%	0.04	2.76%	0.02	0.13%	0.01	11.11%
	2951*	0.14	0.27	1.62	15.54	0.11	0.14	0.26	1.55	15.53	0.10	0.00	0.00%	0.01	3.70%	0.07	4.32%	0.01	0.06%	0.01	9.09%
	2907	0.04	0.11	7.34	15.37	0.09	0.04	0.11	6.90	15.37	0.09	0.00	0.00%	0.00	0.00%	0.44	5.99%	0.00	0.00%	0.00	0.00%
	2899*	0.08	0.17	1.49	15.30	0.20	0.08	0.17	1.38	15.29	0.20	0.00	0.00%	0.00	0.00%	0.11	7.38%	0.01	0.07%	0.00	0.00%
	2891*	0.12	0.16	0.79	15.14	0.27	0.11	0.15	0.76	15.13	0.27	0.01	8.33%	0.01	6.25%	0.03	3.80%	0.01	0.07%	0.00	0.00%
	2884*	0.16	0.22	0.87	15.06	0.18	0.15	0.20	0.84	15.04	0.18	0.01	6.25%	0.02	9.09%	0.03	3.45%	0.02	0.13%	0.00	0.00%
	2876	0.18	0.34	1.51	15.04	0.09	0.18	0.32	1.34	15.02	0.09	0.00	0.00%	0.02	5.88%	0.17	11.26%	0.02	0.13%	0.00	0.00%
	2830*	0.15	0.34	1.82	14.97	0.09	0.15	0.32	1.66	14.95	0.09	0.00	0.00%	0.02	5.88%	0.16	8.79%	0.02	0.13%	0.00	0.00%
	2783*	0.10	0.31	2.82	14.88	0.09	0.11	0.30	2.38	14.86	0.09	-0.01	-10.00%	0.01	3.23%	0.44	15.60%	0.02	0.13%	0.00	0.00%
	2737*	0.10	0.27	2.93	14.76	0.09	0.09	0.26	2.83	14.75	0.08	0.01	10.00%	0.01	3.70%	0.10	3.41%	0.01	0.07%	0.01	11.11%
	2691*	0.11	0.22	2.41	14.64	0.10	0.11	0.21	2.33	14.63	0.09	0.00	0.00%	0.01	4.55%	0.08	3.32%	0.01	0.07%	0.01	10.00%
	2645	0.13	0.17	1.48	14.52	0.13	0.12	0.16	1.44	14.51	0.12	0.01	7.69%	0.01	5.88%	0.04	2.70%	0.01	0.07%	0.01	7.69%
	2606*	0.12	0.20	1.77	14.41	0.12	0.11	0.19	1.70	14.40	0.12	0.01	8.33%	0.01	5.00%	0.07	3.95%	0.01	0.07%	0.00	0.00%
	2566*	0.11	0.22	1.68	14.30	0.13	0.11	0.21	1.52	14.28	0.13	0.00	0.00%	0.01	4.55%	0.16	9.52%	0.02	0.14%	0.00	0.00%
	2527*	0.15	0.28	1.70	14.22	0.10	0.15	0.27	1.61	14.21	0.09	0.00	0.00%	0.01	3.57%	0.09	5.29%	0.01	0.07%	0.01	10.00%
	2488	0.07	0.37	7.63	14.17	0.06	0.08	0.36	5.57	14.16	0.06	-0.01	-14.29%	0.01	2.70%	2.06	27.00%	0.01	0.07%	0.00	0.00%
	2440*	0.07	0.36	7.14	14.11	0.05	0.08	0.35	5.17	14.09	0.05	-0.01	-14.29%	0.01	2.78%	1.97	27.59%	0.02	0.14%	0.00	0.00%
	2392*	0.11	0.34	4.18	14.02	0.06	0.14	0.32	2.91	14.01	0.05	-0.03	-27.27%	0.02	5.88%	1.27	30.38%	0.01	0.07%	0.01	16.67%
	2344*	0.14	0.31	3.18	13.94	0.06	0.14	0.30	3.03	13.93	0.05	0.00	0.00%	0.01	3.23%	0.15	4.72%	0.01	0.07%	0.01	16.67%
	2296*	0.14	0.29	3.22	13.86	0.06	0.13	0.28	3.12	13.85	0.05	0.01	7.14%	0.01	3.45%	0.10	3.11%	0.01	0.07%	0.01	16.67%
	2248*	0.13	0.24	3.07	13.76	0.06	0.12	0.23	2.96	13.74	0.06	0.01	7.69%	0.01	4.17%	0.11	3.58%	0.02	0.15%	0.00	0.00%
	2200*	0.11	0.20	2.93	13.65	0.08	0.10	0.19	2.83	13.64	0.08	0.01	9.09%	0.01	5.00%	0.10	3.41%	0.01	0.07%	0.00	0.00%
	2152*	0.12	0.19	3.19	13.59	0.07	0.11	0.18	3.07	13.58	0.06	0.01	8.33%	0.01	5.26%	0.12	3.76%	0.01	0.07%	0.01	14.29%
Reach 4	2104	0.16	0.23	3.67	13.56	0.04	0.15	0.21	3.59	13.55	0.04	0.01	6.25%	0.02	8.70%	0.08	2.18%	0.01	0.07%	0.00	0.00%
	2077*	0.10	0.23	6.02	13.55	0.04	0.09	0.22	5.59	13.54	0.04	0.01	10.00%	0.01	4.35%	0.43	7.14%	0.01	0.07%	0.00	0.00%
	2050	0.12	0.23	3.17	13.53	0.07	0.11	0.21	2.97	13.52	0.07	0.01	8.33%	0.02	8.70%	0.20	6.31%	0.01	0.07%	0.00	0.00%
	2002*	0.11	0.33	2.86	13.46	0.08	0.12	0.31	2.05	13.44	0.09	-0.01	-9.09%	0.02	6.06%	0.81	28.32%	0.02	0.15%	-0.01	-12.50%
	1954	0.19	0.44	1.66	13.39	0.08	0.19	0.42	1.52	13.37	0.08	0.00	0.00%	0.02	4.55%	0.14	8.43%	0.02	0.15%	0.00	0.00%
	1911*	0.17	0.41	1.75	13.34	0.08	0.17	0.40	1.64	13.33	0.08	0.00	0.00%	0.01	2.44%	0.11	6.29%	0.01	0.07%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS September—0.025 m^3/s					FEIS September—0.022 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 4 *(cont'd)*	1868*	0.12	0.37	2.79	13.28	0.08	0.11	0.36	2.59	13.27	0.08	0.01	8.33%	0.01	2.70%	0.20	7.17%	0.01	0.08%	0.00	0.00%
	1825*	0.13	0.33	2.52	13.21	0.08	0.12	0.32	2.38	13.20	0.07	0.01	7.69%	0.01	3.03%	0.14	5.56%	0.01	0.08%	0.01	12.50%
	1783	0.13	0.25	1.50	13.12	0.13	0.12	0.24	1.42	13.10	0.13	0.01	7.69%	0.01	4.00%	0.08	5.33%	0.02	0.15%	0.00	0.00%
	1736*	0.14	0.26	1.27	12.92	0.14	0.14	0.24	1.20	12.90	0.14	0.00	0.00%	0.02	7.69%	0.07	5.51%	0.02	0.15%	0.00	0.00%
	1689*	0.16	0.26	1.12	12.72	0.14	0.15	0.25	1.08	12.70	0.14	0.01	6.25%	0.01	3.85%	0.04	3.57%	0.02	0.16%	0.00	0.00%
	1642*	0.17	0.27	1.04	12.52	0.15	0.16	0.26	1.00	12.51	0.14	0.01	5.88%	0.01	3.70%	0.04	3.85%	0.01	0.08%	0.01	6.67%
	1596	0.19	0.30	0.99	12.34	0.14	0.17	0.28	0.97	12.33	0.13	0.02	10.53%	0.02	6.67%	0.02	2.02%	0.01	0.08%	0.01	7.14%
	1555*	0.15	0.25	1.42	12.21	0.12	0.14	0.23	1.38	12.20	0.12	0.01	6.67%	0.02	8.00%	0.04	2.82%	0.01	0.08%	0.00	0.00%
	1514*	0.12	0.21	1.94	12.09	0.11	0.11	0.20	1.89	12.08	0.10	0.01	8.33%	0.01	4.76%	0.05	2.58%	0.01	0.08%	0.01	9.09%
	1472*	0.09	0.19	3.60	11.99	0.08	0.09	0.18	3.32	11.98	0.07	0.00	0.00%	0.01	5.26%	0.28	7.78%	0.01	0.08%	0.01	12.50%
	1431*	0.05	0.11	3.97	11.83	0.12	0.05	0.10	3.80	11.82	0.11	0.00	0.00%	0.01	9.09%	0.17	4.28%	0.01	0.08%	0.01	8.33%
	1432	0.06	0.11	3.03	11.73	0.13	0.06	0.10	2.93	11.73	0.13	0.00	0.00%	0.01	9.09%	0.10	3.30%	0.00	0.00%	0.00	0.00%
	1414*	0.06	0.10	2.96	11.64	0.14	0.06	0.10	2.93	11.64	0.13	0.00	0.00%	0.00	0.00%	0.03	1.01%	0.00	0.00%	0.01	7.14%
	1405*	0.07	0.11	3.15	11.55	0.12	0.06	0.10	2.96	11.54	0.13	0.01	14.29%	0.01	9.09%	0.19	6.03%	0.01	0.09%	-0.01	-8.33%
	1396*	0.12	0.19	4.13	11.54	0.05	0.11	0.18	3.98	11.53	0.05	0.01	8.33%	0.01	5.26%	0.15	3.63%	0.01	0.09%	0.00	0.00%
	1387*	0.20	0.28	4.70	11.54	0.03	0.18	0.27	4.63	11.53	0.03	0.02	10.00%	0.01	3.57%	0.07	1.49%	0.01	0.09%	0.00	0.00%
	1379*	0.27	0.37	5.16	11.54	0.02	0.26	0.36	5.10	11.52	0.02	0.01	3.70%	0.01	2.70%	0.06	1.16%	0.02	0.17%	0.00	0.00%
Reach 5	1370	0.35	0.47	5.59	11.54	0.01	0.33	0.45	5.53	11.52	0.01	0.02	5.71%	0.02	4.26%	0.06	1.07%	0.02	0.17%	0.00	0.00%
	1326*	0.32	0.44	5.06	11.54	0.02	0.31	0.42	4.99	11.52	0.01	0.01	3.13%	0.02	4.55%	0.07	1.38%	0.02	0.17%	0.01	50.00%
	1282*	0.30	0.41	4.53	11.54	0.02	0.29	0.40	4.46	11.52	0.02	0.01	3.33%	0.01	2.44%	0.07	1.55%	0.02	0.17%	0.00	0.00%
	1238*	0.27	0.39	4.00	11.54	0.02	0.26	0.37	3.92	11.52	0.02	0.01	3.70%	0.02	5.13%	0.08	2.00%	0.02	0.17%	0.00	0.00%
	1194*	0.24	0.36	3.48	11.53	0.03	0.24	0.34	3.38	11.52	0.03	0.00	0.00%	0.02	5.56%	0.10	2.87%	0.01	0.09%	0.00	0.00%
	1151*	0.21	0.33	2.96	11.53	0.04	0.20	0.31	2.86	11.51	0.04	0.01	4.76%	0.02	6.06%	0.10	3.38%	0.02	0.17%	0.00	0.00%
	1107*	0.16	0.29	2.61	11.52	0.06	0.17	0.27	2.30	11.50	0.06	-0.01	-6.25%	0.02	6.90%	0.31	11.88%	0.02	0.17%	0.00	0.00%
	1063	0.13	0.21	1.36	11.46	0.14	0.13	0.20	1.31	11.45	0.13	0.00	0.00%	0.01	4.76%	0.05	3.68%	0.01	0.09%	0.01	7.14%
	1029*	0.11	0.21	1.57	11.29	0.14	0.11	0.20	1.50	11.28	0.14	0.00	0.00%	0.01	4.76%	0.07	4.46%	0.01	0.09%	0.00	0.00%
	995*	0.14	0.29	2.14	11.21	0.08	0.14	0.28	2.04	11.19	0.08	0.00	0.00%	0.01	3.45%	0.10	4.67%	0.02	0.18%	0.00	0.00%
	961	0.17	0.45	4.21	11.19	0.03	0.16	0.43	4.09	11.18	0.03	0.01	5.88%	0.02	4.44%	0.12	2.85%	0.01	0.09%	0.00	0.00%
	913*	0.17	0.42	3.91	11.18	0.04	0.16	0.40	3.81	11.17	0.04	0.01	5.88%	0.02	4.76%	0.10	2.56%	0.01	0.09%	0.00	0.00%
	864*	0.16	0.39	3.67	11.17	0.04	0.16	0.37	3.47	11.16	0.04	0.00	0.00%	0.02	5.13%	0.20	5.45%	0.01	0.09%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		FEIS September—0.025 m^3/s					FEIS September—0.022 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 5 *(cont'd)*	816*	0.15	0.35	3.44	11.15	0.05	0.15	0.34	3.27	11.14	0.05	0.00	0.00%	0.01	2.86%	0.17	4.94%	0.01	0.09%	0.00	0.00%
	767*	0.14	0.30	3.13	11.12	0.06	0.13	0.29	3.01	11.11	0.06	0.01	7.14%	0.01	3.33%	0.12	3.83%	0.01	0.09%	0.00	0.00%
	719	0.10	0.21	2.45	11.05	0.10	0.09	0.20	2.34	11.04	0.10	0.01	10.00%	0.01	4.76%	0.11	4.49%	0.01	0.09%	0.00	0.00%
	689*	0.16	0.27	1.43	10.96	0.11	0.15	0.26	1.36	10.94	0.11	0.01	6.25%	0.01	3.70%	0.07	4.90%	0.02	0.18%	0.00	0.00%
	660	0.17	0.24	0.48	10.77	0.30	0.17	0.23	0.45	10.76	0.29	0.00	0.00%	0.01	4.17%	0.03	6.25%	0.01	0.09%	0.01	3.33%
	642	0.11	0.23	1.56	10.67	0.15	0.11	0.22	1.48	10.66	0.14	0.00	0.00%	0.01	4.35%	0.08	5.13%	0.01	0.09%	0.01	6.67%
	598*	0.11	0.29	1.52	10.57	0.14	0.10	0.28	1.50	10.56	0.14	0.01	9.09%	0.01	3.45%	0.02	1.32%	0.01	0.09%	0.00	0.00%
	555*	0.14	0.38	1.29	10.49	0.13	0.14	0.36	1.15	10.47	0.14	0.00	0.00%	0.02	5.26%	0.14	10.85%	0.02	0.19%	-0.01	-7.69%
	512*	0.19	0.48	1.17	10.42	0.12	0.18	0.46	1.06	10.40	0.11	0.01	5.26%	0.02	4.17%	0.11	9.40%	0.02	0.19%	0.01	8.33%
	468	0.22	0.55	0.92	10.33	0.12	0.22	0.53	0.84	10.31	0.12	0.00	0.00%	0.02	3.64%	0.08	8.70%	0.02	0.19%	0.00	0.00%
	447	0.16	0.24	1.25	10.21	0.13	0.15	0.22	1.20	10.19	0.12	0.01	6.25%	0.02	8.33%	0.05	4.00%	0.02	0.20%	0.01	7.69%
	419	0.04	0.07	0.89	9.64	0.67	0.04	0.06	0.88	9.63	0.63	0.00	0.00%	0.01	14.29%	0.01	1.12%	0.01	0.10%	0.04	5.97%
	396	0.26	0.29	0.38	9.47	0.25	0.25	0.27	0.38	9.46	0.24	0.01	3.85%	0.02	6.90%	0.00	0.00%	0.01	0.11%	0.01	4.00%
	373	0.29	0.39	0.91	9.44	0.10	0.28	0.38	0.88	9.43	0.09	0.01	3.45%	0.01	2.56%	0.03	3.30%	0.01	0.11%	0.01	10.00%
	340	0.17	0.27	1.61	9.39	0.09	0.16	0.26	1.59	9.38	0.09	0.01	5.88%	0.01	3.70%	0.02	1.24%	0.01	0.11%	0.00	0.00%
	300	0.10	0.16	3.14	9.30	0.08	0.09	0.15	3.07	9.29	0.08	0.01	10.00%	0.01	6.25%	0.07	2.23%	0.01	0.11%	0.00	0.00%
	284*	0.10	0.19	3.23	9.20	0.08	0.09	0.18	3.17	9.19	0.08	0.01	10.00%	0.01	5.26%	0.06	1.86%	0.01	0.11%	0.00	0.00%
	267*	0.09	0.21	3.06	9.09	0.09	0.09	0.19	2.84	9.08	0.09	0.00	0.00%	0.02	9.52%	0.22	7.19%	0.01	0.11%	0.00	0.00%
	251*	0.12	0.24	2.84	9.00	0.08	0.11	0.23	2.56	8.99	0.08	0.01	8.33%	0.01	4.17%	0.28	9.86%	0.01	0.11%	0.00	0.00%
	235*	0.16	0.35	3.92	8.98	0.04	0.15	0.33	3.77	8.96	0.04	0.01	6.25%	0.02	5.71%	0.15	3.83%	0.02	0.22%	0.00	0.00%
	218	0.22	0.46	4.73	8.96	0.02	0.21	0.44	4.60	8.95	0.02	0.01	4.55%	0.02	4.35%	0.13	2.75%	0.01	0.11%	0.00	0.00%
	178*	0.19	0.39	9.72	8.93	0.01	0.18	0.38	9.49	8.92	0.01	0.01	5.26%	0.01	2.56%	0.23	2.37%	0.01	0.11%	0.00	0.00%
	137*	0.16	0.34	15.09	8.91	0.01	0.16	0.33	14.79	8.90	0.01	0.00	0.00%	0.01	2.94%	0.30	1.99%	0.01	0.11%	0.00	0.00%
	97*	0.14	0.30	20.83	8.90	0.01	0.13	0.29	20.46	8.89	0.01	0.01	7.14%	0.01	3.33%	0.37	1.78%	0.01	0.11%	0.00	0.00%
	56*	0.11	0.25	27.60	8.89	0.01	0.11	0.25	26.72	8.88	0.01	0.00	0.00%	0.00	0.00%	0.88	3.19%	0.01	0.11%	0.00	0.00%
	16	0.09	0.20	34.17	8.87	0.01	0.09	0.20	32.30	8.86	0.01	0.00	0.00%	0.00	0.00%	1.87	5.47%	0.01	0.11%	0.00	0.00%
Average		**0.18**	**0.32**	**4.37**	**14.09**	**0.09**	**0.17**	**0.30**	**4.20**	**14.07**	**0.08**	**0.01**	**3.40%**	**0.01**	**4.54%**	**0.18**	**4.08%**	**0.01**	**0.10%**	**0.00**	**3.64%**

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment June—0.185 m^3/s					2024 Assessment June—0.156 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1	4241	0.44	0.70	35.92	18.10	0.01	0.41	0.67	35.61	18.08	0.01	0.03	6.82%	0.03	4.29%	0.31	0.86%	0.02	0.11%	0.00	0.00%
	4224*	0.39	0.69	35.46	18.10	0.01	0.37	0.66	34.94	18.07	0.01	0.02	5.13%	0.03	4.35%	0.52	1.47%	0.03	0.17%	0.00	0.00%
	4206*	0.35	0.67	35.22	18.10	0.02	0.33	0.64	34.55	18.07	0.01	0.02	5.71%	0.03	4.48%	0.67	1.90%	0.03	0.17%	0.01	50.00%
	4189*	0.31	0.66	34.92	18.10	0.02	0.29	0.63	34.34	18.07	0.02	0.02	6.45%	0.03	4.55%	0.58	1.66%	0.03	0.17%	0.00	0.00%
	4171*	0.28	0.64	34.61	18.09	0.02	0.25	0.61	34.17	18.06	0.02	0.03	10.71%	0.03	4.69%	0.44	1.27%	0.03	0.17%	0.00	0.00%
	4154*	0.24	0.62	34.29	18.08	0.03	0.22	0.59	33.81	18.06	0.03	0.02	8.33%	0.03	4.84%	0.48	1.40%	0.02	0.11%	0.00	0.00%
	4136*	0.21	0.59	33.89	18.07	0.04	0.19	0.57	33.37	18.04	0.03	0.02	9.52%	0.02	3.39%	0.52	1.53%	0.03	0.17%	0.01	25.00%
	4119	0.17	0.55	33.20	18.04	0.05	0.14	0.52	32.60	18.01	0.05	0.03	17.65%	0.03	5.45%	0.60	1.81%	0.03	0.17%	0.00	0.00%
	4095	0.25	0.54	17.76	18.02	0.05	0.23	0.51	17.01	17.99	0.04	0.02	8.00%	0.03	5.56%	0.75	4.22%	0.03	0.17%	0.01	20.00%
	4049*	0.27	0.55	16.41	18.00	0.04	0.27	0.52	15.14	17.97	0.04	0.00	0.00%	0.03	5.45%	1.27	7.74%	0.03	0.17%	0.00	0.00%
	4002*	0.31	0.56	15.53	17.99	0.04	0.29	0.53	15.14	17.96	0.04	0.02	6.45%	0.03	5.36%	0.39	2.51%	0.03	0.17%	0.00	0.00%
	3956	0.37	0.57	14.37	17.98	0.04	0.35	0.55	14.17	17.95	0.03	0.02	5.41%	0.02	3.51%	0.20	1.39%	0.03	0.17%	0.01	25.00%
	3906*	0.38	0.61	17.06	17.97	0.03	0.36	0.58	16.73	17.94	0.03	0.02	5.26%	0.03	4.92%	0.33	1.93%	0.03	0.17%	0.00	0.00%
	3857*	0.40	0.64	19.59	17.97	0.02	0.38	0.62	18.99	17.94	0.02	0.02	5.00%	0.02	3.13%	0.60	3.06%	0.03	0.17%	0.00	0.00%
	3807*	0.42	0.68	22.09	17.96	0.02	0.40	0.65	21.46	17.94	0.02	0.02	4.76%	0.03	4.41%	0.63	2.85%	0.02	0.11%	0.00	0.00%
	3757	0.44	0.72	24.76	17.96	0.02	0.42	0.69	24.09	17.94	0.02	0.02	4.55%	0.03	4.17%	0.67	2.71%	0.02	0.11%	0.00	0.00%
	3729	0.19	0.58	12.45	17.96	0.09	0.18	0.55	11.95	17.93	0.09	0.01	5.26%	0.03	5.17%	0.50	4.02%	0.03	0.17%	0.00	0.00%
	3717	0.24	0.43	5.71	17.93	0.14	0.22	0.40	5.71	17.90	0.14	0.02	8.33%	0.03	6.98%	0.00	0.00%	0.03	0.17%	0.00	0.00%
	3691*	0.22	0.49	6.23	17.81	0.15	0.20	0.46	5.91	17.78	0.15	0.02	9.09%	0.03	6.12%	0.32	5.14%	0.03	0.17%	0.00	0.00%
	3665	0.25	0.57	5.97	17.72	0.13	0.24	0.53	5.39	17.69	0.12	0.01	4.00%	0.04	7.02%	0.58	9.72%	0.03	0.17%	0.01	7.69%
	3643	0.31	0.67	5.36	17.66	0.13	0.28	0.64	5.24	17.63	0.12	0.03	9.68%	0.03	4.48%	0.12	2.24%	0.03	0.17%	0.01	7.69%
	3611	0.26	0.76	2.25	17.48	0.34	0.27	0.73	1.86	17.44	0.32	-0.01	-3.85%	0.03	3.95%	0.39	17.33%	0.04	0.23%	0.02	5.88%
	3565	0.29	0.56	14.32	17.43	0.05	0.26	0.52	14.00	17.39	0.05	0.03	10.34%	0.04	7.14%	0.32	2.23%	0.04	0.23%	0.00	0.00%
	3556*	0.31	0.58	13.21	17.42	0.05	0.28	0.54	12.90	17.39	0.05	0.03	9.68%	0.04	6.90%	0.31	2.35%	0.03	0.17%	0.00	0.00%
	3547*	0.32	0.59	12.09	17.42	0.05	0.29	0.56	11.80	17.39	0.05	0.03	9.38%	0.03	5.08%	0.29	2.40%	0.03	0.17%	0.00	0.00%
	3538*	0.33	0.61	10.95	17.42	0.06	0.30	0.57	10.69	17.38	0.05	0.03	9.09%	0.04	6.56%	0.26	2.37%	0.04	0.23%	0.01	16.67%
	3528*	0.34	0.62	9.79	17.41	0.06	0.32	0.59	9.56	17.38	0.05	0.02	5.88%	0.03	4.84%	0.23	2.35%	0.03	0.17%	0.01	16.67%
	3519*	0.35	0.64	8.61	17.41	0.07	0.33	0.60	8.41	17.37	0.06	0.02	5.71%	0.04	6.25%	0.20	2.32%	0.04	0.23%	0.01	14.29%
	3510*	0.36	0.65	7.40	17.40	0.07	0.34	0.62	7.25	17.37	0.07	0.02	5.56%	0.03	4.62%	0.15	2.03%	0.03	0.17%	0.00	0.00%
	3501*	0.37	0.67	6.19	17.40	0.08	0.34	0.63	6.08	17.36	0.08	0.03	8.11%	0.04	5.97%	0.11	1.78%	0.04	0.23%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment June—0.185 m^3/s					2024 Assessment June—0.156 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1 *(cont'd)*	3492*	0.37	0.68	4.97	17.39	0.10	0.34	0.64	4.88	17.35	0.10	0.03	8.11%	0.04	5.88%	0.09	1.81%	0.04	0.23%	0.00	0.00%
	3483	0.36	0.68	3.75	17.38	0.14	0.33	0.65	3.68	17.34	0.13	0.03	8.33%	0.03	4.41%	0.07	1.87%	0.04	0.23%	0.01	7.14%
	3474*	0.35	0.65	3.67	17.36	0.15	0.32	0.62	3.60	17.33	0.14	0.03	8.57%	0.03	4.62%	0.07	1.91%	0.03	0.17%	0.01	6.67%
	3464*	0.33	0.63	3.59	17.35	0.16	0.30	0.59	3.52	17.32	0.15	0.03	9.09%	0.04	6.35%	0.07	1.95%	0.03	0.17%	0.01	6.25%
	3455*	0.32	0.59	3.45	17.33	0.19	0.29	0.56	3.43	17.30	0.18	0.03	9.38%	0.03	5.08%	0.02	0.58%	0.03	0.17%	0.01	5.26%
	3446*	0.31	0.56	3.31	17.32	0.20	0.27	0.52	3.31	17.28	0.19	0.04	12.90%	0.04	7.14%	0.00	0.00%	0.04	0.23%	0.01	5.00%
Reach 2	3436	0.26	0.48	3.18	17.26	0.24	0.23	0.45	3.16	17.23	0.23	0.03	11.54%	0.03	6.25%	0.02	0.63%	0.03	0.17%	0.01	4.17%
	3429*	0.26	0.59	2.65	17.02	0.30	0.26	0.55	2.30	16.99	0.27	0.00	0.00%	0.04	6.78%	0.35	13.21%	0.03	0.18%	0.03	10.00%
	3422	0.35	0.91	3.11	17.01	0.18	0.33	0.88	3.07	16.98	0.16	0.02	5.71%	0.03	3.30%	0.04	1.29%	0.03	0.18%	0.02	11.11%
	3414*	0.32	0.82	3.13	17.00	0.19	0.29	0.79	3.08	16.97	0.18	0.03	9.38%	0.03	3.66%	0.05	1.60%	0.03	0.18%	0.01	5.26%
	3406*	0.28	0.73	3.14	17.00	0.22	0.26	0.70	3.08	16.96	0.20	0.02	7.14%	0.03	4.11%	0.06	1.91%	0.04	0.24%	0.02	9.09%
	3399*	0.24	0.64	3.16	16.98	0.31	0.22	0.60	2.94	16.95	0.29	0.02	8.33%	0.04	6.25%	0.22	6.96%	0.03	0.18%	0.02	6.45%
	3391	0.19	0.51	2.72	16.93	0.42	0.19	0.47	2.37	16.90	0.40	0.00	0.00%	0.04	7.84%	0.35	12.87%	0.03	0.18%	0.02	4.76%
	3390*	0.22	0.55	2.48	16.86	0.37	0.22	0.52	2.10	16.82	0.36	0.00	0.00%	0.03	5.45%	0.38	15.32%	0.04	0.24%	0.01	2.70%
	3389	0.25	0.61	2.32	16.79	0.33	0.26	0.57	1.92	16.75	0.32	-0.01	-4.00%	0.04	6.56%	0.40	17.24%	0.04	0.24%	0.01	3.03%
	3388*	0.28	0.68	2.37	16.73	0.28	0.29	0.64	1.98	16.69	0.27	-0.01	-3.57%	0.04	5.88%	0.39	16.46%	0.04	0.24%	0.01	3.57%
	3387*	0.31	0.77	2.61	16.69	0.24	0.31	0.72	2.20	16.65	0.23	0.00	0.00%	0.05	6.49%	0.41	15.71%	0.04	0.24%	0.01	4.17%
	3386*	0.33	0.87	2.95	16.67	0.19	0.33	0.82	2.51	16.62	0.19	0.00	0.00%	0.05	5.75%	0.44	14.92%	0.05	0.30%	0.00	0.00%
	3385*	0.35	0.98	3.37	16.65	0.16	0.35	0.93	2.92	16.60	0.15	0.00	0.00%	0.05	5.10%	0.45	13.35%	0.05	0.30%	0.01	6.25%
	3384*	0.37	1.09	3.84	16.64	0.13	0.37	1.04	3.39	16.59	0.12	0.00	0.00%	0.05	4.59%	0.45	11.72%	0.05	0.30%	0.01	7.69%
	3383	0.40	1.21	4.35	16.63	0.11	0.40	1.16	3.91	16.58	0.10	0.00	0.00%	0.05	4.13%	0.44	10.11%	0.05	0.30%	0.01	9.09%
	3337*	0.30	1.01	5.93	16.44	0.11	0.34	0.96	4.59	16.40	0.11	-0.04	-13.33%	0.05	4.95%	1.34	22.60%	0.04	0.24%	0.00	0.00%
	3290	0.32	0.90	8.34	16.35	0.08	0.30	0.87	8.10	16.31	0.08	0.02	6.25%	0.03	3.33%	0.24	2.88%	0.04	0.24%	0.00	0.00%
	3245*	0.30	0.96	7.28	16.30	0.10	0.29	0.93	6.92	16.27	0.09	0.01	3.33%	0.03	3.12%	0.36	4.95%	0.03	0.18%	0.01	10.00%
	3200	0.31	1.03	6.46	16.26	0.11	0.30	1.00	6.18	16.23	0.10	0.01	3.23%	0.03	2.91%	0.28	4.33%	0.03	0.18%	0.01	9.09%
	3160*	0.17	0.92	17.05	16.22	0.10	0.16	0.90	15.94	16.20	0.09	0.01	5.88%	0.02	2.17%	1.11	6.51%	0.02	0.12%	0.01	10.00%
	3119*	0.13	0.82	27.21	16.18	0.09	0.12	0.80	25.27	16.16	0.09	0.01	7.69%	0.02	2.44%	1.94	7.13%	0.02	0.12%	0.00	0.00%
	3079*	0.11	0.71	33.28	16.14	0.09	0.10	0.69	30.94	16.13	0.09	0.01	9.09%	0.02	2.82%	2.34	7.03%	0.01	0.06%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment June—0.185 m^3/s					2024 Assessment June—0.156 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 3	3038	0.06	0.56	32.25	16.06	0.17	0.05	0.54	29.65	16.04	0.17	0.01	16.67%	0.02	3.57%	2.60	8.06%	0.02	0.12%	0.00	0.00%
	2995	0.07	0.65	24.37	15.91	0.13	0.08	0.63	17.05	15.89	0.13	-0.01	-14.29%	0.02	3.08%	7.32	30.04%	0.02	0.13%	0.00	0.00%
	2951*	0.04	0.41	19.84	15.67	0.32	0.05	0.40	10.69	15.66	0.30	-0.01	-25.00%	0.01	2.44%	9.15	46.12%	0.01	0.06%	0.02	6.25%
	2907	0.09	0.24	29.86	15.50	0.09	0.08	0.22	28.81	15.49	0.09	0.01	11.11%	0.02	8.33%	1.05	3.52%	0.01	0.06%	0.00	0.00%
	2899*	0.06	0.35	27.67	15.48	0.16	0.05	0.34	25.38	15.46	0.19	0.01	16.67%	0.01	2.86%	2.29	8.28%	0.02	0.13%	-0.03	-18.75%
	2891*	0.13	0.44	6.08	15.42	0.23	0.14	0.42	5.03	15.40	0.23	-0.01	-7.69%	0.02	4.55%	1.05	17.27%	0.02	0.13%	0.00	0.00%
	2884*	0.10	0.51	9.42	15.36	0.19	0.15	0.49	5.77	15.34	0.18	-0.05	-50.00%	0.02	3.92%	3.65	38.75%	0.02	0.13%	0.01	5.26%
	2876	0.14	0.62	11.36	15.33	0.13	0.13	0.60	10.39	15.31	0.12	0.01	7.14%	0.02	3.23%	0.97	8.54%	0.02	0.13%	0.01	7.69%
	2830*	0.14	0.57	10.25	15.20	0.13	0.13	0.55	9.62	15.18	0.12	0.01	7.14%	0.02	3.51%	0.63	6.15%	0.02	0.13%	0.01	7.69%
	2783*	0.15	0.52	9.15	15.08	0.14	0.15	0.50	7.79	15.06	0.13	0.00	0.00%	0.02	3.85%	1.36	14.86%	0.02	0.13%	0.01	7.14%
	2737*	0.11	0.48	12.43	14.97	0.15	0.14	0.46	8.72	14.95	0.14	-0.03	-27.27%	0.02	4.17%	3.71	29.85%	0.02	0.13%	0.01	6.67%
	2691*	0.12	0.45	12.36	14.87	0.18	0.12	0.43	11.06	14.85	0.17	0.00	0.00%	0.02	4.44%	1.30	10.52%	0.02	0.13%	0.01	5.56%
	2645	0.13	0.39	8.02	14.74	0.23	0.12	0.37	7.62	14.72	0.21	0.01	7.69%	0.02	5.13%	0.40	4.99%	0.02	0.14%	0.02	8.70%
	2606*	0.10	0.40	14.71	14.61	0.17	0.09	0.38	13.84	14.60	0.16	0.01	10.00%	0.02	5.00%	0.87	5.91%	0.01	0.07%	0.01	5.88%
	2566*	0.08	0.40	20.23	14.48	0.17	0.07	0.39	19.20	14.47	0.16	0.01	12.50%	0.01	2.50%	1.03	5.09%	0.01	0.07%	0.01	5.88%
	2527*	0.08	0.44	28.02	14.38	0.13	0.07	0.42	25.88	14.36	0.13	0.01	12.50%	0.02	4.55%	2.14	7.64%	0.02	0.14%	0.00	0.00%
	2488	0.11	0.51	42.27	14.31	0.06	0.10	0.50	40.62	14.30	0.06	0.01	9.09%	0.01	1.96%	1.65	3.90%	0.01	0.07%	0.00	0.00%
	2440*	0.10	0.50	44.54	14.25	0.06	0.09	0.49	42.64	14.24	0.05	0.01	10.00%	0.01	2.00%	1.90	4.27%	0.01	0.07%	0.01	16.67%
	2392*	0.10	0.50	46.01	14.18	0.06	0.09	0.49	43.84	14.17	0.06	0.01	10.00%	0.01	2.00%	2.17	4.72%	0.01	0.07%	0.00	0.00%
	2344*	0.09	0.49	47.38	14.12	0.06	0.09	0.48	44.75	14.11	0.06	0.00	0.00%	0.01	2.04%	2.63	5.55%	0.01	0.07%	0.00	0.00%
	2296*	0.09	0.49	47.92	14.06	0.07	0.08	0.47	44.32	14.04	0.07	0.01	11.11%	0.02	4.08%	3.60	7.51%	0.02	0.14%	0.00	0.00%
	2248*	0.08	0.46	40.48	13.97	0.09	0.07	0.45	36.64	13.96	0.09	0.01	12.50%	0.01	2.17%	3.84	9.49%	0.01	0.07%	0.00	0.00%
	2200*	0.07	0.43	33.77	13.88	0.12	0.06	0.42	28.04	13.87	0.12	0.01	14.29%	0.01	2.33%	5.73	16.97%	0.01	0.07%	0.00	0.00%
	2152*	0.07	0.42	29.20	13.82	0.13	0.07	0.41	23.74	13.80	0.12	0.00	0.00%	0.01	2.38%	5.46	18.70%	0.02	0.14%	0.01	7.69%
Reach 4	2104	0.08	0.43	28.40	13.76	0.11	0.08	0.41	23.08	13.75	0.10	0.00	0.00%	0.02	4.65%	5.32	18.73%	0.01	0.07%	0.01	9.09%
	2077*	0.09	0.42	31.20	13.74	0.08	0.09	0.41	26.14	13.73	0.07	0.00	0.00%	0.01	2.38%	5.06	16.22%	0.01	0.07%	0.01	12.50%
	2050	0.07	0.41	40.50	13.72	0.07	0.07	0.40	37.77	13.71	0.07	0.00	0.00%	0.01	2.44%	2.73	6.74%	0.01	0.07%	0.00	0.00%
	2002*	0.06	0.55	55.40	13.68	0.08	0.05	0.54	52.90	13.67	0.07	0.01	16.67%	0.01	1.82%	2.50	4.51%	0.01	0.07%	0.01	12.50%
	1954	0.05	0.67	66.14	13.62	0.10	0.04	0.66	64.89	13.61	0.09	0.01	20.00%	0.01	1.49%	1.25	1.89%	0.01	0.07%	0.01	10.00%
	1911*	0.05	0.62	52.88	13.55	0.11	0.04	0.61	50.88	13.54	0.10	0.01	20.00%	0.01	1.61%	2.00	3.78%	0.01	0.07%	0.01	9.09%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment June—0.185 m^3/s					2024 Assessment June—0.156 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 4 *(cont'd)*	1868*	0.06	0.57	41.58	13.48	0.11	0.05	0.56	39.88	13.47	0.11	0.01	16.67%	0.01	1.75%	1.70	4.09%	0.01	0.07%	0.00	0.00%
	1825*	0.08	0.53	33.35	13.42	0.12	0.07	0.52	31.94	13.41	0.12	0.01	12.50%	0.01	1.89%	1.41	4.23%	0.01	0.07%	0.00	0.00%
	1783	0.07	0.47	22.85	13.33	0.19	0.06	0.46	21.80	13.32	0.18	0.01	14.29%	0.01	2.13%	1.05	4.60%	0.01	0.08%	0.01	5.26%
	1736*	0.07	0.50	22.05	13.16	0.21	0.06	0.48	18.76	13.14	0.20	0.01	14.29%	0.02	4.00%	3.29	14.92%	0.02	0.15%	0.01	4.76%
	1689*	0.07	0.52	20.08	12.98	0.21	0.07	0.51	17.12	12.96	0.21	0.00	0.00%	0.01	1.92%	2.96	14.74%	0.02	0.15%	0.00	0.00%
	1642*	0.07	0.55	21.08	12.80	0.20	0.07	0.54	18.31	12.78	0.19	0.00	0.00%	0.01	1.82%	2.77	13.14%	0.02	0.16%	0.01	5.00%
	1596	0.07	0.56	21.76	12.61	0.22	0.06	0.55	18.77	12.59	0.21	0.01	14.29%	0.01	1.79%	2.99	13.74%	0.02	0.16%	0.01	4.55%
	1555*	0.07	0.48	20.75	12.44	0.19	0.07	0.46	17.75	12.43	0.18	0.00	0.00%	0.02	4.17%	3.00	14.46%	0.01	0.08%	0.01	5.26%
	1514*	0.07	0.39	18.93	12.27	0.19	0.07	0.37	16.48	12.26	0.18	0.00	0.00%	0.02	5.13%	2.45	12.94%	0.01	0.08%	0.01	5.26%
	1472*	0.11	0.33	14.18	12.13	0.14	0.10	0.32	13.49	12.12	0.13	0.01	9.09%	0.01	3.03%	0.69	4.87%	0.01	0.08%	0.01	7.14%
	1431*	0.14	0.23	6.48	11.95	0.20	0.13	0.22	6.48	11.94	0.19	0.01	7.14%	0.01	4.35%	0.00	0.00%	0.01	0.08%	0.01	5.00%
	1432	0.13	0.25	6.28	11.88	0.24	0.12	0.23	5.75	11.86	0.23	0.01	7.69%	0.02	8.00%	0.53	8.44%	0.02	0.17%	0.01	4.17%
	1414*	0.17	0.28	5.24	11.81	0.21	0.16	0.25	4.74	11.79	0.20	0.01	5.88%	0.03	10.71%	0.50	9.54%	0.02	0.17%	0.01	4.76%
	1405*	0.22	0.34	5.18	11.78	0.16	0.21	0.31	4.92	11.76	0.15	0.01	4.55%	0.03	8.82%	0.26	5.02%	0.02	0.17%	0.01	6.25%
	1396*	0.28	0.42	5.55	11.77	0.12	0.27	0.39	5.36	11.74	0.11	0.01	3.57%	0.03	7.14%	0.19	3.42%	0.03	0.25%	0.01	8.33%
	1387*	0.35	0.50	5.97	11.76	0.09	0.34	0.48	5.82	11.74	0.08	0.01	2.86%	0.02	4.00%	0.15	2.51%	0.02	0.17%	0.01	11.11%
	1379*	0.41	0.59	6.39	11.76	0.07	0.40	0.57	6.25	11.74	0.06	0.01	2.44%	0.02	3.39%	0.14	2.19%	0.02	0.17%	0.01	14.29%
Reach 5	1370	0.47	0.68	6.95	11.76	0.06	0.47	0.66	6.67	11.73	0.05	0.00	0.00%	0.02	2.94%	0.28	4.03%	0.03	0.26%	0.01	16.67%
	1326*	0.29	0.65	9.86	11.75	0.07	0.33	0.63	8.18	11.73	0.06	-0.04	-13.79%	0.02	3.08%	1.68	17.04%	0.02	0.17%	0.01	14.29%
	1282*	0.17	0.61	15.74	11.74	0.08	0.19	0.59	13.08	11.72	0.07	-0.02	-11.76%	0.02	3.28%	2.66	16.90%	0.02	0.17%	0.01	12.50%
	1238*	0.12	0.57	23.41	11.72	0.08	0.12	0.56	20.17	11.71	0.08	0.00	0.00%	0.01	1.75%	3.24	13.84%	0.01	0.09%	0.00	0.00%
	1194*	0.10	0.53	31.66	11.71	0.10	0.09	0.51	28.10	11.69	0.09	0.01	10.00%	0.02	3.77%	3.56	11.24%	0.02	0.17%	0.01	10.00%
	1151*	0.09	0.48	39.60	11.68	0.10	0.08	0.47	35.97	11.67	0.10	0.01	11.11%	0.01	2.08%	3.63	9.17%	0.01	0.09%	0.00	0.00%
	1107*	0.08	0.42	45.80	11.65	0.11	0.07	0.41	42.18	11.64	0.10	0.01	12.50%	0.01	2.38%	3.62	7.90%	0.01	0.09%	0.01	9.09%
	1063	0.07	0.35	45.14	11.60	0.13	0.06	0.33	40.94	11.59	0.13	0.01	14.29%	0.02	5.71%	4.20	9.30%	0.01	0.09%	0.00	0.00%
	1029*	0.08	0.45	27.58	11.53	0.15	0.07	0.43	22.73	11.51	0.16	0.01	12.50%	0.02	4.44%	4.85	17.59%	0.02	0.17%	-0.01	-6.67%
	995*	0.11	0.57	19.31	11.49	0.12	0.11	0.55	15.28	11.46	0.12	0.00	0.00%	0.02	3.51%	4.03	20.87%	0.03	0.26%	0.00	0.00%
	961	0.18	0.72	15.47	11.47	0.08	0.18	0.70	13.27	11.44	0.08	0.00	0.00%	0.02	2.78%	2.20	14.22%	0.03	0.26%	0.00	0.00%
	913*	0.18	0.69	15.36	11.45	0.08	0.17	0.66	13.47	11.43	0.08	0.01	5.56%	0.03	4.35%	1.89	12.30%	0.02	0.17%	0.00	0.00%
	864*	0.17	0.65	14.70	11.43	0.09	0.17	0.62	13.10	11.41	0.08	0.00	0.00%	0.03	4.62%	1.60	10.88%	0.02	0.17%	0.01	11.11%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment June—0.185 m^3/s					2024 Assessment June—0.156 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 5 *(cont'd)*	816*	0.18	0.60	13.50	11.41	0.09	0.17	0.58	12.17	11.38	0.09	0.01	5.56%	0.02	3.33%	1.33	9.85%	0.03	0.26%	0.00	0.00%
	767*	0.17	0.55	11.61	11.37	0.11	0.17	0.53	10.54	11.35	0.10	0.00	0.00%	0.02	3.64%	1.07	9.22%	0.02	0.18%	0.01	9.09%
	719	0.17	0.47	8.83	11.31	0.15	0.16	0.45	7.95	11.28	0.14	0.01	5.88%	0.02	4.26%	0.88	9.97%	0.03	0.27%	0.01	6.67%
	689*	0.18	0.56	6.68	11.24	0.18	0.17	0.53	6.02	11.22	0.17	0.01	5.56%	0.03	5.36%	0.66	9.88%	0.02	0.18%	0.01	5.56%
	660	0.22	0.45	1.03	10.98	0.80	0.22	0.43	0.95	10.96	0.74	0.00	0.00%	0.02	4.44%	0.08	7.77%	0.02	0.18%	0.06	7.50%
	642	0.15	0.47	7.86	10.91	0.22	0.14	0.44	7.26	10.89	0.21	0.01	6.67%	0.03	6.38%	0.60	7.63%	0.02	0.18%	0.01	4.55%
	598*	0.16	0.59	7.25	10.87	0.20	0.15	0.56	6.61	10.84	0.20	0.01	6.25%	0.03	5.08%	0.64	8.83%	0.03	0.28%	0.00	0.00%
	555*	0.18	0.71	6.72	10.82	0.20	0.17	0.68	6.10	10.79	0.19	0.01	5.56%	0.03	4.23%	0.62	9.23%	0.03	0.28%	0.01	5.00%
	512*	0.19	0.83	6.23	10.78	0.19	0.18	0.80	5.63	10.75	0.19	0.01	5.26%	0.03	3.61%	0.60	9.63%	0.03	0.28%	0.00	0.00%
	468	0.19	0.91	4.70	10.68	0.26	0.19	0.87	3.97	10.65	0.24	0.00	0.00%	0.04	4.40%	0.73	15.53%	0.03	0.28%	0.02	7.69%
	447	0.18	0.29	1.47	10.26	0.72	0.18	0.27	1.37	10.24	0.65	0.00	0.00%	0.02	6.90%	0.10	6.80%	0.02	0.19%	0.07	9.72%
	419	0.15	0.39	4.94	9.96	0.32	0.14	0.36	4.24	9.93	0.31	0.01	6.67%	0.03	7.69%	0.70	14.17%	0.03	0.30%	0.01	3.13%
	396	0.12	0.64	2.99	9.83	0.65	0.13	0.62	2.15	9.80	0.62	-0.01	-8.33%	0.02	3.13%	0.84	28.09%	0.03	0.31%	0.03	4.62%
	373	0.22	0.71	5.62	9.76	0.20	0.20	0.68	5.47	9.73	0.19	0.02	9.09%	0.03	4.23%	0.15	2.67%	0.03	0.31%	0.01	5.00%
	340	0.25	0.54	3.77	9.67	0.23	0.23	0.51	3.59	9.64	0.21	0.02	8.00%	0.03	5.56%	0.18	4.77%	0.03	0.31%	0.02	8.70%
	300	0.19	0.38	7.21	9.52	0.15	0.17	0.35	6.66	9.49	0.14	0.02	10.53%	0.03	7.89%	0.55	7.63%	0.03	0.32%	0.01	6.67%
	284*	0.21	0.43	6.42	9.44	0.14	0.22	0.40	5.26	9.41	0.13	-0.01	-4.76%	0.03	6.98%	1.16	18.07%	0.03	0.32%	0.01	7.14%
	267*	0.26	0.49	6.04	9.38	0.12	0.24	0.45	5.56	9.34	0.12	0.02	7.69%	0.04	8.16%	0.48	7.95%	0.04	0.43%	0.00	0.00%
	251*	0.29	0.58	6.71	9.34	0.09	0.28	0.54	6.17	9.30	0.09	0.01	3.45%	0.04	6.90%	0.54	8.05%	0.04	0.43%	0.00	0.00%
	235*	0.33	0.69	7.63	9.32	0.07	0.32	0.65	7.03	9.28	0.07	0.01	3.03%	0.04	5.80%	0.60	7.86%	0.04	0.43%	0.00	0.00%
	218	0.37	0.79	8.42	9.29	0.06	0.36	0.75	7.81	9.25	0.06	0.01	2.70%	0.04	5.06%	0.61	7.24%	0.04	0.43%	0.00	0.00%
	178*	0.33	0.66	15.43	9.19	0.04	0.32	0.63	14.49	9.16	0.03	0.01	3.03%	0.03	4.55%	0.94	6.09%	0.03	0.33%	0.01	25.00%
	137*	0.31	0.58	22.45	9.15	0.03	0.30	0.55	21.14	9.12	0.03	0.01	3.23%	0.03	5.17%	1.31	5.84%	0.03	0.33%	0.00	0.00%
	97*	0.29	0.52	29.56	9.12	0.02	0.27	0.49	28.11	9.09	0.02	0.02	6.90%	0.03	5.77%	1.45	4.91%	0.03	0.33%	0.00	0.00%
	56*	0.27	0.46	36.75	9.09	0.02	0.25	0.43	35.15	9.06	0.02	0.02	7.41%	0.03	6.52%	1.60	4.35%	0.03	0.33%	0.00	0.00%
	16	0.25	0.41	43.96	9.07	0.02	0.23	0.38	42.21	9.04	0.02	0.02	8.00%	0.03	7.32%	1.75	3.98%	0.03	0.33%	0.00	0.00%
Average		**0.21**	**0.58**	**17.18**	**14.35**	**0.14**	**0.20**	**0.56**	**15.84**	**14.33**	**0.14**	**0.01**	**5%**	**0.03**	**4%**	**1.33**	**8%**	**0.03**	**0%**	**0.01**	**5%**

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment July—0.239 m^3/s					2024 Assessment July—0.222 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1	4241	0.48	0.75	36.42	18.15	0.01	0.47	0.74	36.29	18.14	0.01	0.01	2.08%	0.01	1.33%	0.13	0.36%	0.01	0.06%	0.00	0.00%
	4224*	0.43	0.74	36.08	18.15	0.02	0.42	0.72	35.95	18.14	0.02	0.01	2.33%	0.02	2.70%	0.13	0.36%	0.01	0.06%	0.00	0.00%
	4206*	0.39	0.72	35.82	18.15	0.02	0.38	0.71	35.65	18.13	0.02	0.01	2.56%	0.01	1.39%	0.17	0.47%	0.02	0.11%	0.00	0.00%
	4189*	0.35	0.70	35.47	18.14	0.02	0.34	0.69	35.40	18.13	0.02	0.01	2.86%	0.01	1.43%	0.07	0.20%	0.01	0.06%	0.00	0.00%
	4171*	0.32	0.69	35.12	18.14	0.03	0.31	0.67	35.12	18.12	0.02	0.01	3.13%	0.02	2.90%	0.00	0.00%	0.02	0.11%	0.01	33.33%
	4154*	0.29	0.67	34.77	18.13	0.03	0.27	0.65	34.77	18.12	0.03	0.02	6.90%	0.02	2.99%	0.00	0.00%	0.01	0.06%	0.00	0.00%
	4136*	0.25	0.64	34.42	18.12	0.04	0.24	0.63	34.42	18.10	0.04	0.01	4.00%	0.01	1.56%	0.00	0.00%	0.02	0.11%	0.00	0.00%
	4119	0.21	0.60	34.07	18.09	0.05	0.20	0.59	33.90	18.08	0.05	0.01	4.76%	0.01	1.67%	0.17	0.50%	0.01	0.06%	0.00	0.00%
	4095	0.29	0.59	18.43	18.07	0.05	0.28	0.58	18.23	18.06	0.05	0.01	3.45%	0.01	1.69%	0.20	1.09%	0.01	0.06%	0.00	0.00%
	4049*	0.30	0.60	18.10	18.05	0.05	0.28	0.58	18.10	18.04	0.04	0.02	6.67%	0.02	3.33%	0.00	0.00%	0.01	0.06%	0.01	20.00%
	4002*	0.35	0.61	16.19	18.04	0.05	0.34	0.59	15.99	18.02	0.04	0.01	2.86%	0.02	3.28%	0.20	1.24%	0.02	0.11%	0.01	20.00%
	3956	0.41	0.62	14.70	18.03	0.04	0.40	0.61	14.60	18.01	0.04	0.01	2.44%	0.01	1.61%	0.10	0.68%	0.02	0.11%	0.00	0.00%
	3906*	0.41	0.65	17.60	18.02	0.03	0.40	0.64	17.44	18.00	0.03	0.01	2.44%	0.01	1.54%	0.16	0.91%	0.02	0.11%	0.00	0.00%
	3857*	0.43	0.69	20.48	18.01	0.03	0.42	0.68	20.26	18.00	0.03	0.01	2.33%	0.01	1.45%	0.22	1.07%	0.01	0.06%	0.00	0.00%
	3807*	0.44	0.72	23.15	18.01	0.02	0.44	0.71	22.83	18.00	0.02	0.00	0.00%	0.01	1.39%	0.32	1.38%	0.01	0.06%	0.00	0.00%
	3757	0.46	0.76	25.88	18.01	0.02	0.46	0.75	25.54	17.99	0.02	0.00	0.00%	0.01	1.32%	0.34	1.31%	0.02	0.11%	0.00	0.00%
	3729	0.23	0.62	12.96	18.00	0.10	0.22	0.61	12.96	17.99	0.09	0.01	4.35%	0.01	1.61%	0.00	0.00%	0.01	0.06%	0.01	10.00%
	3717	0.29	0.48	5.71	17.97	0.16	0.28	0.46	5.71	17.96	0.15	0.01	3.45%	0.02	4.17%	0.00	0.00%	0.01	0.06%	0.01	6.25%
	3691*	0.27	0.54	6.23	17.86	0.16	0.26	0.52	6.23	17.85	0.16	0.01	3.70%	0.02	3.70%	0.00	0.00%	0.01	0.06%	0.00	0.00%
	3665	0.28	0.63	6.75	17.78	0.14	0.26	0.61	6.62	17.76	0.14	0.02	7.14%	0.02	3.17%	0.13	1.93%	0.02	0.11%	0.00	0.00%
	3643	0.36	0.73	5.46	17.72	0.14	0.35	0.72	5.43	17.71	0.14	0.01	2.78%	0.01	1.37%	0.03	0.55%	0.01	0.06%	0.00	0.00%
	3611	0.26	0.82	2.74	17.54	0.37	0.26	0.80	2.59	17.52	0.36	0.00	0.00%	0.02	2.44%	0.15	5.47%	0.02	0.11%	0.01	2.70%
	3565	0.34	0.62	14.82	17.49	0.05	0.33	0.60	14.70	17.47	0.05	0.01	2.94%	0.02	3.23%	0.12	0.81%	0.02	0.11%	0.00	0.00%
	3556*	0.36	0.64	13.66	17.48	0.06	0.34	0.62	13.56	17.47	0.05	0.02	5.56%	0.02	3.13%	0.10	0.73%	0.01	0.06%	0.01	16.67%
	3547*	0.37	0.65	12.44	17.48	0.06	0.35	0.63	12.41	17.46	0.06	0.02	5.41%	0.02	3.08%	0.03	0.24%	0.02	0.11%	0.00	0.00%
	3538*	0.38	0.67	11.21	17.48	0.06	0.37	0.65	11.20	17.46	0.06	0.01	2.63%	0.02	2.99%	0.01	0.09%	0.02	0.11%	0.00	0.00%
	3528*	0.40	0.68	9.99	17.47	0.06	0.38	0.67	9.99	17.46	0.06	0.02	5.00%	0.01	1.47%	0.00	0.00%	0.01	0.06%	0.00	0.00%
	3519*	0.41	0.70	8.76	17.47	0.07	0.39	0.68	8.76	17.45	0.07	0.02	4.88%	0.02	2.86%	0.00	0.00%	0.02	0.11%	0.00	0.00%
	3510*	0.42	0.71	7.54	17.46	0.08	0.40	0.70	7.54	17.45	0.08	0.02	4.76%	0.01	1.41%	0.00	0.00%	0.01	0.06%	0.00	0.00%
	3501*	0.42	0.73	6.31	17.46	0.09	0.40	0.71	6.31	17.44	0.09	0.02	4.76%	0.02	2.74%	0.00	0.00%	0.02	0.11%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment July—0.239 m^3/s					2024 Assessment July—0.222 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1 *(cont'd)*	3492*	0.42	0.73	5.08	17.45	0.12	0.40	0.72	5.07	17.43	0.11	0.02	4.76%	0.01	1.37%	0.01	0.20%	0.02	0.11%	0.01	8.33%
	3483	0.41	0.74	3.86	17.43	0.16	0.39	0.72	3.84	17.42	0.15	0.02	4.88%	0.02	2.70%	0.02	0.52%	0.01	0.06%	0.01	6.25%
	3474*	0.40	0.71	3.72	17.42	0.17	0.38	0.69	3.72	17.40	0.16	0.02	5.00%	0.02	2.82%	0.00	0.00%	0.02	0.11%	0.01	5.88%
	3464*	0.39	0.68	3.59	17.41	0.18	0.37	0.66	3.59	17.39	0.17	0.02	5.13%	0.02	2.94%	0.00	0.00%	0.02	0.11%	0.01	5.56%
	3455*	0.38	0.65	3.45	17.39	0.21	0.36	0.63	3.45	17.37	0.21	0.02	5.26%	0.02	3.08%	0.00	0.00%	0.02	0.12%	0.00	0.00%
	3446*	0.36	0.61	3.31	17.37	0.22	0.35	0.59	3.31	17.35	0.22	0.01	2.78%	0.02	3.28%	0.00	0.00%	0.02	0.12%	0.00	0.00%
Reach 2	3436	0.31	0.54	3.18	17.31	0.27	0.30	0.52	3.18	17.30	0.26	0.01	3.23%	0.02	3.70%	0.00	0.00%	0.01	0.06%	0.01	3.70%
	3429*	0.27	0.64	3.08	17.08	0.32	0.26	0.62	3.01	17.06	0.32	0.01	3.70%	0.02	3.13%	0.07	2.27%	0.02	0.12%	0.00	0.00%
	3422	0.40	0.96	3.17	17.06	0.20	0.39	0.95	3.15	17.05	0.19	0.01	2.50%	0.01	1.04%	0.02	0.63%	0.01	0.06%	0.01	5.00%
	3414*	0.36	0.88	3.20	17.06	0.22	0.35	0.86	3.18	17.04	0.21	0.01	2.78%	0.02	2.27%	0.02	0.63%	0.02	0.12%	0.01	4.55%
	3406*	0.32	0.78	3.24	17.05	0.24	0.31	0.77	3.21	17.03	0.23	0.01	3.13%	0.01	1.28%	0.03	0.93%	0.02	0.12%	0.01	4.17%
	3399*	0.28	0.69	3.31	17.03	0.33	0.27	0.67	3.27	17.02	0.32	0.01	3.57%	0.02	2.90%	0.04	1.21%	0.01	0.06%	0.01	3.03%
	3391	0.20	0.56	3.31	16.99	0.44	0.20	0.54	3.14	16.97	0.43	0.00	0.00%	0.02	3.57%	0.17	5.14%	0.02	0.12%	0.01	2.27%
	3390*	0.22	0.61	3.10	16.91	0.40	0.22	0.59	2.91	16.90	0.39	0.00	0.00%	0.02	3.28%	0.19	6.13%	0.01	0.06%	0.01	2.50%
	3389	0.25	0.67	2.97	16.85	0.35	0.25	0.65	2.78	16.83	0.35	0.00	0.00%	0.02	2.99%	0.19	6.40%	0.02	0.12%	0.00	0.00%
	3388*	0.28	0.75	3.06	16.80	0.30	0.27	0.73	2.85	16.78	0.30	0.01	3.57%	0.02	2.67%	0.21	6.86%	0.02	0.12%	0.00	0.00%
	3387*	0.30	0.84	3.32	16.76	0.25	0.30	0.82	3.11	16.74	0.25	0.00	0.00%	0.02	2.38%	0.21	6.33%	0.02	0.12%	0.00	0.00%
	3386*	0.33	0.94	3.67	16.74	0.21	0.33	0.92	3.45	16.72	0.20	0.00	0.00%	0.02	2.13%	0.22	5.99%	0.02	0.12%	0.01	4.76%
	3385*	0.36	1.05	4.08	16.72	0.17	0.35	1.03	3.87	16.70	0.17	0.01	2.78%	0.02	1.90%	0.21	5.15%	0.02	0.12%	0.00	0.00%
	3384*	0.39	1.17	4.54	16.71	0.14	0.38	1.14	4.33	16.69	0.14	0.01	2.56%	0.03	2.56%	0.21	4.63%	0.02	0.12%	0.00	0.00%
	3383	0.42	1.28	5.02	16.71	0.12	0.41	1.26	4.83	16.68	0.12	0.01	2.38%	0.02	1.56%	0.19	3.78%	0.03	0.18%	0.00	0.00%
	3337*	0.34	1.07	6.46	16.50	0.13	0.33	1.05	6.30	16.48	0.12	0.01	2.94%	0.02	1.87%	0.16	2.48%	0.02	0.12%	0.01	7.69%
	3290	0.36	0.96	8.74	16.40	0.09	0.35	0.94	8.62	16.39	0.09	0.01	2.78%	0.02	2.08%	0.12	1.37%	0.01	0.06%	0.00	0.00%
	3245*	0.33	1.01	7.80	16.35	0.11	0.32	1.00	7.68	16.33	0.11	0.01	3.03%	0.01	0.99%	0.12	1.54%	0.02	0.12%	0.00	0.00%
	3200	0.33	1.07	6.86	16.30	0.13	0.32	1.06	6.74	16.28	0.13	0.01	3.03%	0.01	0.93%	0.12	1.75%	0.02	0.12%	0.00	0.00%
	3160*	0.19	0.95	18.32	16.25	0.11	0.18	0.94	18.04	16.24	0.11	0.01	5.26%	0.01	1.05%	0.28	1.53%	0.01	0.06%	0.00	0.00%
	3119*	0.15	0.84	29.25	16.21	0.10	0.14	0.84	28.81	16.20	0.10	0.01	6.67%	0.00	0.00%	0.44	1.50%	0.01	0.06%	0.00	0.00%
	3079*	0.12	0.73	37.30	16.16	0.10	0.12	0.73	36.12	16.16	0.10	0.00	0.00%	0.00	0.00%	1.18	3.16%	0.00	0.00%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment July—0.239 m^3/s					2024 Assessment July—0.222 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 3	3038	0.07	0.58	35.16	16.08	0.18	0.07	0.57	34.39	16.07	0.17	0.00	0.00%	0.01	1.72%	0.77	2.19%	0.01	0.06%	0.01	5.56%
	2995	0.08	0.67	29.65	15.93	0.14	0.07	0.66	28.54	15.93	0.14	0.01	12.50%	0.01	1.49%	1.11	3.74%	0.00	0.00%	0.00	0.00%
	2951*	0.05	0.43	22.53	15.69	0.33	0.04	0.42	21.22	15.68	0.34	0.01	20.00%	0.01	2.33%	1.31	5.81%	0.01	0.06%	-0.01	-3.03%
	2907	0.11	0.26	31.60	15.52	0.09	0.10	0.25	31.11	15.51	0.09	0.01	9.09%	0.01	3.85%	0.49	1.55%	0.01	0.06%	0.00	0.00%
	2899*	0.07	0.38	33.34	15.50	0.14	0.07	0.37	30.02	15.49	0.15	0.00	0.00%	0.01	2.63%	3.32	9.96%	0.01	0.06%	-0.01	-7.14%
	2891*	0.05	0.46	22.56	15.45	0.23	0.06	0.46	17.13	15.44	0.23	-0.01	-20.00%	0.00	0.00%	5.43	24.07%	0.01	0.06%	0.00	0.00%
	2884*	0.11	0.54	11.27	15.38	0.20	0.11	0.53	10.67	15.38	0.20	0.00	0.00%	0.01	1.85%	0.60	5.32%	0.00	0.00%	0.00	0.00%
	2876	0.14	0.65	12.88	15.35	0.14	0.14	0.64	12.29	15.35	0.14	0.00	0.00%	0.01	1.54%	0.59	4.58%	0.00	0.00%	0.00	0.00%
	2830*	0.15	0.60	12.08	15.23	0.14	0.15	0.59	11.50	15.22	0.14	0.00	0.00%	0.01	1.67%	0.58	4.80%	0.01	0.07%	0.00	0.00%
	2783*	0.14	0.55	12.34	15.11	0.16	0.14	0.54	11.02	15.10	0.15	0.00	0.00%	0.01	1.82%	1.32	10.70%	0.01	0.07%	0.01	6.25%
	2737*	0.12	0.51	15.33	15.00	0.17	0.12	0.50	14.60	14.99	0.16	0.00	0.00%	0.01	1.96%	0.73	4.76%	0.01	0.07%	0.01	5.88%
	2691*	0.13	0.48	14.48	14.90	0.19	0.13	0.47	13.94	14.89	0.18	0.00	0.00%	0.01	2.08%	0.54	3.73%	0.01	0.07%	0.01	5.26%
	2645	0.15	0.42	8.67	14.77	0.25	0.14	0.41	8.49	14.76	0.24	0.01	6.67%	0.01	2.38%	0.18	2.08%	0.01	0.07%	0.01	4.00%
	2606*	0.11	0.42	15.66	14.63	0.19	0.11	0.41	15.38	14.62	0.18	0.00	0.00%	0.01	2.38%	0.28	1.79%	0.01	0.07%	0.01	5.26%
	2566*	0.09	0.42	21.90	14.50	0.18	0.08	0.42	21.38	14.49	0.18	0.01	11.11%	0.00	0.00%	0.52	2.37%	0.01	0.07%	0.00	0.00%
	2527*	0.09	0.45	30.73	14.39	0.14	0.08	0.45	29.95	14.39	0.14	0.01	11.11%	0.00	0.00%	0.78	2.54%	0.00	0.00%	0.00	0.00%
	2488	0.12	0.53	44.65	14.33	0.07	0.11	0.52	44.12	14.33	0.07	0.01	8.33%	0.01	1.89%	0.53	1.19%	0.00	0.00%	0.00	0.00%
	2440*	0.12	0.52	47.35	14.27	0.06	0.11	0.52	46.69	14.26	0.06	0.01	8.33%	0.00	0.00%	0.66	1.39%	0.01	0.07%	0.00	0.00%
	2392*	0.11	0.52	49.45	14.20	0.06	0.11	0.51	48.49	14.20	0.06	0.00	0.00%	0.01	1.92%	0.96	1.94%	0.00	0.00%	0.00	0.00%
	2344*	0.11	0.51	51.41	14.14	0.07	0.10	0.51	50.29	14.14	0.07	0.01	9.09%	0.00	0.00%	1.12	2.18%	0.00	0.00%	0.00	0.00%
	2296*	0.10	0.51	52.63	14.08	0.07	0.10	0.50	51.14	14.07	0.07	0.00	0.00%	0.01	1.96%	1.49	2.83%	0.01	0.07%	0.00	0.00%
	2248*	0.09	0.48	46.86	13.99	0.09	0.08	0.47	45.06	13.99	0.09	0.01	11.11%	0.01	2.08%	1.80	3.84%	0.00	0.00%	0.00	0.00%
	2200*	0.08	0.45	38.62	13.91	0.13	0.07	0.45	37.22	13.90	0.13	0.01	12.50%	0.00	0.00%	1.40	3.63%	0.01	0.07%	0.00	0.00%
	2152*	0.08	0.45	36.90	13.84	0.13	0.07	0.44	35.15	13.84	0.13	0.01	12.50%	0.01	2.22%	1.75	4.74%	0.00	0.00%	0.00	0.00%
Reach 4	2104	0.08	0.45	36.56	13.79	0.13	0.08	0.44	34.19	13.78	0.12	0.00	0.00%	0.01	2.22%	2.37	6.48%	0.01	0.07%	0.01	7.69%
	2077*	0.09	0.44	39.08	13.76	0.08	0.09	0.43	36.77	13.75	0.08	0.00	0.00%	0.01	2.27%	2.31	5.91%	0.01	0.07%	0.00	0.00%
	2050	0.08	0.43	44.78	13.74	0.08	0.08	0.43	43.52	13.73	0.08	0.00	0.00%	0.00	0.00%	1.26	2.81%	0.01	0.07%	0.00	0.00%
	2002*	0.07	0.56	59.35	13.69	0.08	0.07	0.56	58.18	13.69	0.08	0.00	0.00%	0.00	0.00%	1.17	1.97%	0.00	0.00%	0.00	0.00%
	1954	0.06	0.68	68.14	13.63	0.10	0.05	0.68	67.54	13.63	0.10	0.01	16.67%	0.00	0.00%	0.60	0.88%	0.00	0.00%	0.00	0.00%
	1911*	0.06	0.63	55.52	13.56	0.11	0.06	0.63	54.91	13.56	0.11	0.00	0.00%	0.00	0.00%	0.61	1.10%	0.00	0.00%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment July—0.239 m^3/s					2024 Assessment July—0.222 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 4 *(cont'd)*	1868*	0.08	0.59	44.28	13.50	0.12	0.07	0.58	43.48	13.49	0.12	0.01	12.50%	0.01	1.69%	0.80	1.81%	0.01	0.07%	0.00	0.00%
	1825*	0.09	0.55	35.56	13.44	0.13	0.09	0.55	34.91	13.43	0.13	0.00	0.00%	0.00	0.00%	0.65	1.83%	0.01	0.07%	0.00	0.00%
	1783	0.08	0.49	24.51	13.35	0.20	0.08	0.48	24.03	13.35	0.20	0.00	0.00%	0.01	2.04%	0.48	1.96%	0.00	0.00%	0.00	0.00%
	1736*	0.08	0.52	26.04	13.18	0.21	0.07	0.51	25.47	13.17	0.21	0.01	12.50%	0.01	1.92%	0.57	2.19%	0.01	0.08%	0.00	0.00%
	1689*	0.08	0.54	24.45	13.00	0.22	0.08	0.54	23.24	12.99	0.22	0.00	0.00%	0.00	0.00%	1.21	4.95%	0.01	0.08%	0.00	0.00%
	1642*	0.08	0.57	25.05	12.82	0.21	0.08	0.56	23.79	12.81	0.21	0.00	0.00%	0.01	1.75%	1.26	5.03%	0.01	0.08%	0.00	0.00%
	1596	0.07	0.59	26.85	12.63	0.22	0.07	0.58	25.49	12.62	0.22	0.00	0.00%	0.01	1.69%	1.36	5.07%	0.01	0.08%	0.00	0.00%
	1555*	0.07	0.50	25.21	12.46	0.21	0.07	0.49	23.91	12.45	0.20	0.00	0.00%	0.01	2.00%	1.30	5.16%	0.01	0.08%	0.01	4.76%
	1514*	0.09	0.41	19.90	12.29	0.19	0.08	0.40	19.61	12.28	0.19	0.01	11.11%	0.01	2.44%	0.29	1.46%	0.01	0.08%	0.00	0.00%
	1472*	0.13	0.36	14.70	12.16	0.15	0.13	0.35	14.70	12.15	0.15	0.00	0.00%	0.01	2.78%	0.00	0.00%	0.01	0.08%	0.00	0.00%
	1431*	0.17	0.26	6.48	11.98	0.22	0.16	0.25	6.48	11.97	0.21	0.01	5.88%	0.01	3.85%	0.00	0.00%	0.01	0.08%	0.01	4.55%
	1432	0.16	0.28	6.59	11.91	0.25	0.15	0.27	6.48	11.90	0.25	0.01	6.25%	0.01	3.57%	0.11	1.67%	0.01	0.08%	0.00	0.00%
	1414*	0.18	0.32	6.05	11.85	0.22	0.18	0.30	5.81	11.84	0.22	0.00	0.00%	0.02	6.25%	0.24	3.97%	0.01	0.08%	0.00	0.00%
	1405*	0.23	0.37	5.83	11.82	0.18	0.23	0.36	5.64	11.81	0.17	0.00	0.00%	0.01	2.70%	0.19	3.26%	0.01	0.08%	0.01	5.56%
	1396*	0.30	0.45	6.04	11.80	0.13	0.29	0.44	5.88	11.79	0.13	0.01	3.33%	0.01	2.22%	0.16	2.65%	0.01	0.08%	0.00	0.00%
	1387*	0.36	0.54	6.40	11.80	0.10	0.36	0.53	6.25	11.79	0.10	0.00	0.00%	0.01	1.85%	0.15	2.34%	0.01	0.08%	0.00	0.00%
	1379*	0.42	0.63	6.91	11.79	0.08	0.42	0.61	6.75	11.78	0.08	0.00	0.00%	0.02	3.17%	0.16	2.32%	0.01	0.08%	0.00	0.00%
Reach 5	1370	0.47	0.72	7.45	11.79	0.07	0.47	0.71	7.30	11.78	0.06	0.00	0.00%	0.01	1.39%	0.15	2.01%	0.01	0.08%	0.01	14.29%
	1326*	0.26	0.68	12.49	11.78	0.08	0.27	0.67	11.71	11.77	0.07	-0.01	-3.85%	0.01	1.47%	0.78	6.24%	0.01	0.08%	0.01	12.50%
	1282*	0.16	0.64	19.86	11.77	0.09	0.17	0.63	18.66	11.76	0.08	-0.01	-6.25%	0.01	1.56%	1.20	6.04%	0.01	0.08%	0.01	11.11%
	1238*	0.12	0.60	28.44	11.75	0.10	0.12	0.59	26.97	11.74	0.09	0.00	0.00%	0.01	1.67%	1.47	5.17%	0.01	0.09%	0.01	10.00%
	1194*	0.10	0.55	37.20	11.73	0.11	0.10	0.54	35.58	11.72	0.10	0.00	0.00%	0.01	1.82%	1.62	4.35%	0.01	0.09%	0.01	9.09%
	1151*	0.09	0.50	45.33	11.70	0.11	0.09	0.49	43.64	11.69	0.11	0.00	0.00%	0.01	2.00%	1.69	3.73%	0.01	0.09%	0.00	0.00%
	1107*	0.09	0.44	51.65	11.67	0.11	0.09	0.44	49.92	11.66	0.11	0.00	0.00%	0.00	0.00%	1.73	3.35%	0.01	0.09%	0.00	0.00%
	1063	0.08	0.37	52.25	11.62	0.13	0.07	0.36	50.08	11.61	0.13	0.01	12.50%	0.01	2.70%	2.17	4.15%	0.01	0.09%	0.00	0.00%
	1029*	0.09	0.48	35.32	11.57	0.14	0.08	0.47	33.02	11.56	0.15	0.01	11.11%	0.01	2.08%	2.30	6.51%	0.01	0.09%	-0.01	-7.14%
	995*	0.12	0.61	25.56	11.53	0.12	0.12	0.60	23.73	11.52	0.12	0.00	0.00%	0.01	1.64%	1.83	7.16%	0.01	0.09%	0.00	0.00%
	961	0.18	0.76	18.94	11.51	0.09	0.18	0.75	17.92	11.50	0.09	0.00	0.00%	0.01	1.32%	1.02	5.39%	0.01	0.09%	0.00	0.00%
	913*	0.18	0.73	18.36	11.49	0.09	0.18	0.71	17.48	11.48	0.09	0.00	0.00%	0.02	2.74%	0.88	4.79%	0.01	0.09%	0.00	0.00%
	864*	0.19	0.69	17.24	11.47	0.10	0.18	0.68	16.50	11.46	0.09	0.01	5.26%	0.01	1.45%	0.74	4.29%	0.01	0.09%	0.01	10.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment July—0.239 m^3/s					2024 Assessment July—0.222 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 5 *(cont'd)*	816*	0.19	0.64	15.61	11.44	0.10	0.18	0.63	14.99	11.43	0.10	0.01	5.26%	0.01	1.56%	0.62	3.97%	0.01	0.09%	0.00	0.00%
	767*	0.19	0.59	13.30	11.41	0.12	0.18	0.58	12.80	11.40	0.12	0.01	5.26%	0.01	1.69%	0.50	3.76%	0.01	0.09%	0.00	0.00%
	719	0.18	0.51	10.17	11.35	0.16	0.18	0.50	9.78	11.34	0.15	0.00	0.00%	0.01	1.96%	0.39	3.83%	0.01	0.09%	0.01	6.25%
	689*	0.19	0.60	7.72	11.29	0.20	0.19	0.59	7.43	11.27	0.19	0.00	0.00%	0.01	1.67%	0.29	3.76%	0.02	0.18%	0.01	5.00%
	660	0.19	0.48	1.40	11.01	0.90	0.21	0.47	1.25	11.00	0.87	-0.02	-10.53%	0.01	2.08%	0.15	10.71%	0.01	0.09%	0.03	3.33%
	642	0.18	0.51	8.24	10.95	0.23	0.17	0.49	8.13	10.94	0.22	0.01	5.56%	0.02	3.92%	0.11	1.33%	0.01	0.09%	0.01	4.35%
	598*	0.19	0.63	7.71	10.91	0.21	0.19	0.62	7.57	10.90	0.21	0.00	0.00%	0.01	1.59%	0.14	1.82%	0.01	0.09%	0.00	0.00%
	555*	0.21	0.75	7.11	10.87	0.21	0.20	0.74	7.10	10.85	0.20	0.01	4.76%	0.01	1.33%	0.01	0.14%	0.02	0.18%	0.01	4.76%
	512*	0.23	0.88	6.42	10.82	0.21	0.22	0.87	6.42	10.81	0.20	0.01	4.35%	0.01	1.14%	0.00	0.00%	0.01	0.09%	0.01	4.76%
	468	0.19	0.95	5.69	10.73	0.27	0.19	0.94	5.46	10.71	0.27	0.00	0.00%	0.01	1.05%	0.23	4.04%	0.02	0.19%	0.00	0.00%
	447	0.13	0.32	2.43	10.29	0.80	0.14	0.31	2.12	10.28	0.78	-0.01	-7.69%	0.01	3.13%	0.31	12.76%	0.01	0.10%	0.02	2.50%
	419	0.16	0.43	5.93	10.00	0.34	0.15	0.42	5.65	9.99	0.34	0.01	6.25%	0.01	2.33%	0.28	4.72%	0.01	0.10%	0.00	0.00%
	396	0.12	0.69	4.31	9.88	0.66	0.12	0.68	3.92	9.86	0.66	0.00	0.00%	0.01	1.45%	0.39	9.05%	0.02	0.20%	0.00	0.00%
	373	0.27	0.75	5.62	9.80	0.21	0.25	0.74	5.62	9.79	0.21	0.02	7.41%	0.01	1.33%	0.00	0.00%	0.01	0.10%	0.00	0.00%
	340	0.29	0.58	3.85	9.71	0.25	0.27	0.57	3.85	9.70	0.24	0.02	6.90%	0.01	1.72%	0.00	0.00%	0.01	0.10%	0.01	4.00%
	300	0.23	0.42	7.34	9.56	0.16	0.21	0.41	7.34	9.55	0.16	0.02	8.70%	0.01	2.38%	0.00	0.00%	0.01	0.10%	0.00	0.00%
	284*	0.21	0.48	8.18	9.49	0.14	0.21	0.47	7.82	9.48	0.14	0.00	0.00%	0.01	2.08%	0.36	4.40%	0.01	0.11%	0.00	0.00%
	267*	0.25	0.55	7.95	9.43	0.12	0.25	0.54	7.35	9.42	0.12	0.00	0.00%	0.01	1.82%	0.60	7.55%	0.01	0.11%	0.00	0.00%
	251*	0.29	0.64	8.33	9.40	0.10	0.29	0.62	7.72	9.38	0.10	0.00	0.00%	0.02	3.13%	0.61	7.32%	0.02	0.21%	0.00	0.00%
	235*	0.33	0.75	9.32	9.38	0.08	0.33	0.73	8.67	9.36	0.08	0.00	0.00%	0.02	2.67%	0.65	6.97%	0.02	0.21%	0.00	0.00%
	218	0.37	0.85	10.01	9.35	0.07	0.37	0.83	9.34	9.33	0.06	0.00	0.00%	0.02	2.35%	0.67	6.69%	0.02	0.21%	0.01	14.29%
	178*	0.36	0.71	16.88	9.25	0.04	0.35	0.70	16.44	9.23	0.04	0.01	2.78%	0.01	1.41%	0.44	2.61%	0.02	0.22%	0.00	0.00%
	137*	0.33	0.63	24.58	9.20	0.03	0.32	0.62	24.02	9.18	0.03	0.01	3.03%	0.01	1.59%	0.56	2.28%	0.02	0.22%	0.00	0.00%
	97*	0.31	0.57	32.48	9.17	0.03	0.30	0.55	31.80	9.15	0.03	0.01	3.23%	0.02	3.51%	0.68	2.09%	0.02	0.22%	0.00	0.00%
	56*	0.29	0.51	40.40	9.14	0.02	0.28	0.49	39.61	9.12	0.02	0.01	3.45%	0.02	3.92%	0.79	1.96%	0.02	0.22%	0.00	0.00%
	16	0.27	0.45	48.42	9.11	0.02	0.26	0.44	47.51	9.10	0.02	0.01	3.70%	0.01	2.22%	0.91	1.88%	0.01	0.11%	0.00	0.00%
Average		**0.23**	**0.62**	**19.12**	**14.39**	**0.15**	**0.22**	**0.61**	**18.56**	**14.38**	**0.15**	**0.01**	**3%**	**0.01**	**1.94%**	**0.56**	**2.91%**	**0.01**	**0.08%**	**0.00**	**2.04%**

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment August—0.132 m^3/s					2024 Assessment August—0.125 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1	4241	0.39	0.65	35.32	18.05	0.01	0.38	0.64	35.24	18.04	0.01	0.01	2.56%	0.01	1.54%	0.08	0.23%	0.01	0.06%	0.00	0.00%
	4224*	0.35	0.63	34.46	18.05	0.01	0.34	0.62	34.32	18.04	0.01	0.01	2.86%	0.01	1.59%	0.14	0.41%	0.01	0.06%	0.00	0.00%
	4206*	0.31	0.62	33.89	18.05	0.01	0.30	0.61	33.68	18.04	0.01	0.01	3.23%	0.01	1.61%	0.21	0.62%	0.01	0.06%	0.00	0.00%
	4189*	0.27	0.60	33.57	18.04	0.02	0.26	0.60	33.30	18.03	0.02	0.01	3.70%	0.00	0.00%	0.27	0.80%	0.01	0.06%	0.00	0.00%
	4171*	0.23	0.59	33.40	18.04	0.02	0.23	0.58	33.11	18.03	0.02	0.00	0.00%	0.01	1.69%	0.29	0.87%	0.01	0.06%	0.00	0.00%
	4154*	0.20	0.57	33.31	18.03	0.02	0.19	0.56	32.95	18.02	0.02	0.01	5.00%	0.01	1.75%	0.36	1.08%	0.01	0.06%	0.00	0.00%
	4136*	0.16	0.54	32.91	18.02	0.03	0.16	0.53	32.73	18.01	0.03	0.00	0.00%	0.01	1.85%	0.18	0.55%	0.01	0.06%	0.00	0.00%
	4119	0.12	0.50	31.83	17.98	0.05	0.11	0.49	31.11	17.98	0.05	0.01	8.33%	0.01	2.00%	0.72	2.26%	0.00	0.00%	0.00	0.00%
	4095	0.22	0.48	15.28	17.96	0.04	0.22	0.47	14.75	17.95	0.04	0.00	0.00%	0.01	2.08%	0.53	3.47%	0.01	0.06%	0.00	0.00%
	4049*	0.26	0.49	14.13	17.94	0.04	0.25	0.48	13.83	17.94	0.04	0.01	3.85%	0.01	2.04%	0.30	2.12%	0.00	0.00%	0.00	0.00%
	4002*	0.28	0.50	14.30	17.93	0.03	0.28	0.49	14.03	17.92	0.03	0.00	0.00%	0.01	2.00%	0.27	1.89%	0.01	0.06%	0.00	0.00%
	3956	0.33	0.52	13.99	17.92	0.03	0.32	0.51	13.93	17.92	0.03	0.01	3.03%	0.01	1.92%	0.06	0.43%	0.00	0.00%	0.00	0.00%
	3906*	0.34	0.55	16.27	17.92	0.02	0.34	0.55	16.10	17.91	0.02	0.00	0.00%	0.00	0.00%	0.17	1.04%	0.01	0.06%	0.00	0.00%
	3857*	0.37	0.59	18.44	17.91	0.02	0.36	0.58	18.28	17.91	0.02	0.01	2.70%	0.01	1.69%	0.16	0.87%	0.00	0.00%	0.00	0.00%
	3807*	0.39	0.63	20.89	17.91	0.02	0.39	0.62	20.71	17.90	0.02	0.00	0.00%	0.01	1.59%	0.18	0.86%	0.01	0.06%	0.00	0.00%
	3757	0.41	0.67	23.49	17.91	0.01	0.41	0.66	23.30	17.90	0.01	0.00	0.00%	0.01	1.49%	0.19	0.81%	0.01	0.06%	0.00	0.00%
	3729	0.16	0.53	11.10	17.91	0.08	0.16	0.52	10.73	17.90	0.08	0.00	0.00%	0.01	1.89%	0.37	3.33%	0.01	0.06%	0.00	0.00%
	3717	0.19	0.38	5.71	17.88	0.13	0.18	0.37	5.71	17.87	0.13	0.01	5.26%	0.01	2.63%	0.00	0.00%	0.01	0.06%	0.00	0.00%
	3691*	0.19	0.43	5.44	17.76	0.14	0.19	0.42	5.29	17.75	0.14	0.00	0.00%	0.01	2.33%	0.15	2.76%	0.01	0.06%	0.00	0.00%
	3665	0.23	0.50	4.85	17.65	0.12	0.23	0.49	4.69	17.65	0.12	0.00	0.00%	0.01	2.00%	0.16	3.30%	0.00	0.00%	0.00	0.00%
	3643	0.25	0.60	5.08	17.59	0.12	0.25	0.59	5.02	17.58	0.12	0.00	0.00%	0.01	1.67%	0.06	1.18%	0.01	0.06%	0.00	0.00%
	3611	0.31	0.69	1.47	17.41	0.30	0.33	0.68	1.35	17.40	0.29	-0.02	-6.45%	0.01	1.45%	0.12	8.16%	0.01	0.06%	0.01	3.33%
	3565	0.24	0.49	13.70	17.36	0.05	0.23	0.48	13.61	17.35	0.04	0.01	4.17%	0.01	2.04%	0.09	0.66%	0.01	0.06%	0.01	20.00%
	3556*	0.25	0.51	12.61	17.36	0.05	0.24	0.50	12.52	17.35	0.05	0.01	4.00%	0.01	1.96%	0.09	0.71%	0.01	0.06%	0.00	0.00%
	3547*	0.27	0.52	11.52	17.35	0.05	0.26	0.51	11.43	17.34	0.05	0.01	3.70%	0.01	1.92%	0.09	0.78%	0.01	0.06%	0.00	0.00%
	3538*	0.28	0.54	10.43	17.35	0.05	0.27	0.53	10.34	17.34	0.05	0.01	3.57%	0.01	1.85%	0.09	0.86%	0.01	0.06%	0.00	0.00%
	3528*	0.29	0.56	9.34	17.35	0.05	0.28	0.55	9.25	17.34	0.05	0.01	3.45%	0.01	1.79%	0.09	0.96%	0.01	0.06%	0.00	0.00%
	3519*	0.30	0.57	8.21	17.34	0.06	0.29	0.56	8.15	17.33	0.06	0.01	3.33%	0.01	1.75%	0.06	0.73%	0.01	0.06%	0.00	0.00%
	3510*	0.31	0.59	7.07	17.34	0.06	0.30	0.58	7.01	17.33	0.06	0.01	3.23%	0.01	1.69%	0.06	0.85%	0.01	0.06%	0.00	0.00%
	3501*	0.32	0.60	5.92	17.33	0.07	0.31	0.59	5.87	17.32	0.07	0.01	3.13%	0.01	1.67%	0.05	0.84%	0.01	0.06%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment August—0.132 m^3/s					2024 Assessment August—0.125 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1 *(cont'd)*	3492*	0.32	0.61	4.76	17.32	0.09	0.31	0.60	4.71	17.31	0.09	0.01	3.13%	0.01	1.64%	0.05	1.05%	0.01	0.06%	0.00	0.00%
	3483	0.31	0.62	3.59	17.31	0.12	0.30	0.61	3.56	17.30	0.12	0.01	3.23%	0.01	1.61%	0.03	0.84%	0.01	0.06%	0.00	0.00%
	3474*	0.29	0.59	3.53	17.30	0.13	0.29	0.58	3.50	17.29	0.13	0.00	0.00%	0.01	1.69%	0.03	0.85%	0.01	0.06%	0.00	0.00%
	3464*	0.28	0.56	3.45	17.29	0.14	0.27	0.55	3.43	17.28	0.14	0.01	3.57%	0.01	1.79%	0.02	0.58%	0.01	0.06%	0.00	0.00%
	3455*	0.26	0.53	3.37	17.27	0.17	0.26	0.52	3.35	17.26	0.16	0.00	0.00%	0.01	1.89%	0.02	0.59%	0.01	0.06%	0.01	5.88%
	3446*	0.25	0.49	3.27	17.25	0.18	0.24	0.48	3.25	17.24	0.18	0.01	4.00%	0.01	2.04%	0.02	0.61%	0.01	0.06%	0.00	0.00%
Reach 2	3436	0.21	0.42	3.00	17.20	0.22	0.20	0.41	2.93	17.19	0.22	0.01	4.76%	0.01	2.38%	0.07	2.33%	0.01	0.06%	0.00	0.00%
	3429*	0.26	0.52	2.08	16.96	0.26	0.26	0.51	2.00	16.95	0.25	0.00	0.00%	0.01	1.92%	0.08	3.85%	0.01	0.06%	0.01	3.85%
	3422	0.30	0.85	3.04	16.95	0.15	0.29	0.84	3.03	16.94	0.15	0.01	3.33%	0.01	1.18%	0.01	0.33%	0.01	0.06%	0.00	0.00%
	3414*	0.27	0.76	3.04	16.94	0.17	0.26	0.75	2.95	16.93	0.16	0.01	3.70%	0.01	1.32%	0.09	2.96%	0.01	0.06%	0.01	5.88%
	3406*	0.24	0.67	2.86	16.93	0.19	0.24	0.66	2.77	16.92	0.19	0.00	0.00%	0.01	1.49%	0.09	3.15%	0.01	0.06%	0.00	0.00%
	3399*	0.21	0.57	2.67	16.92	0.28	0.21	0.56	2.56	16.91	0.27	0.00	0.00%	0.01	1.75%	0.11	4.12%	0.01	0.06%	0.01	3.57%
	3391	0.19	0.44	2.02	16.87	0.38	0.19	0.43	1.91	16.86	0.38	0.00	0.00%	0.01	2.27%	0.11	5.45%	0.01	0.06%	0.00	0.00%
	3390*	0.23	0.48	1.71	16.79	0.34	0.24	0.47	1.59	16.78	0.34	-0.01	-4.35%	0.01	2.08%	0.12	7.02%	0.01	0.06%	0.00	0.00%
	3389	0.27	0.53	1.56	16.71	0.31	0.28	0.52	1.45	16.69	0.31	-0.01	-3.70%	0.01	1.89%	0.11	7.05%	0.02	0.12%	0.00	0.00%
	3388*	0.30	0.59	1.64	16.64	0.27	0.30	0.58	1.57	16.63	0.27	0.00	0.00%	0.01	1.69%	0.07	4.27%	0.01	0.06%	0.00	0.00%
	3387*	0.32	0.68	1.85	16.60	0.22	0.32	0.66	1.78	16.59	0.22	0.00	0.00%	0.02	2.94%	0.07	3.78%	0.01	0.06%	0.00	0.00%
	3386*	0.34	0.78	2.13	16.57	0.18	0.34	0.76	2.04	16.56	0.18	0.00	0.00%	0.02	2.56%	0.09	4.23%	0.01	0.06%	0.00	0.00%
	3385*	0.37	0.88	2.48	16.56	0.15	0.37	0.87	2.38	16.54	0.14	0.00	0.00%	0.01	1.14%	0.10	4.03%	0.02	0.12%	0.01	6.67%
	3384*	0.38	1.00	2.96	16.54	0.12	0.38	0.98	2.81	16.53	0.12	0.00	0.00%	0.02	2.00%	0.15	5.07%	0.01	0.06%	0.00	0.00%
	3383	0.39	1.12	3.50	16.54	0.10	0.40	1.10	3.35	16.52	0.09	-0.01	-2.56%	0.02	1.79%	0.15	4.29%	0.02	0.12%	0.01	10.00%
	3337*	0.38	0.92	3.64	16.36	0.10	0.41	0.91	3.31	16.35	0.09	-0.03	-7.89%	0.01	1.09%	0.33	9.07%	0.01	0.06%	0.01	10.00%
	3290	0.29	0.83	7.33	16.28	0.07	0.30	0.82	6.92	16.27	0.07	-0.01	-3.45%	0.01	1.20%	0.41	5.59%	0.01	0.06%	0.00	0.00%
	3245*	0.27	0.90	6.58	16.24	0.08	0.27	0.89	6.48	16.23	0.08	0.00	0.00%	0.01	1.11%	0.10	1.52%	0.01	0.06%	0.00	0.00%
	3200	0.29	0.98	5.76	16.21	0.09	0.29	0.97	5.62	16.20	0.09	0.00	0.00%	0.01	1.02%	0.14	2.43%	0.01	0.06%	0.00	0.00%
	3160*	0.15	0.88	15.21	16.18	0.08	0.15	0.88	14.96	16.17	0.08	0.00	0.00%	0.00	0.00%	0.25	1.64%	0.01	0.06%	0.00	0.00%
	3119*	0.11	0.78	23.28	16.15	0.08	0.11	0.78	22.65	16.14	0.08	0.00	0.00%	0.00	0.00%	0.63	2.71%	0.01	0.06%	0.00	0.00%
	3079*	0.09	0.68	29.19	16.11	0.09	0.09	0.67	28.62	16.11	0.09	0.00	0.00%	0.01	1.47%	0.57	1.95%	0.00	0.00%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment August—0.132 m^3/s					2024 Assessment August—0.125 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 3	3038	0.06	0.53	21.27	16.03	0.16	0.05	0.52	19.84	16.02	0.16	0.01	16.67%	0.01	1.89%	1.43	6.72%	0.01	0.06%	0.00	0.00%
	2995	0.14	0.61	7.44	15.87	0.12	0.15	0.60	6.77	15.87	0.12	-0.01	-7.14%	0.01	1.64%	0.67	9.01%	0.00	0.00%	0.00	0.00%
	2951*	0.15	0.39	3.31	15.65	0.27	0.16	0.39	2.88	15.65	0.26	-0.01	-6.67%	0.00	0.00%	0.43	12.99%	0.00	0.00%	0.01	3.70%
	2907	0.08	0.21	27.81	15.48	0.09	0.07	0.21	27.48	15.47	0.09	0.01	12.50%	0.00	0.00%	0.33	1.19%	0.01	0.06%	0.00	0.00%
	2899*	0.04	0.32	23.22	15.45	0.21	0.04	0.32	22.47	15.44	0.22	0.00	0.00%	0.00	0.00%	0.75	3.23%	0.01	0.06%	-0.01	-4.76%
	2891*	0.14	0.39	4.18	15.38	0.23	0.14	0.39	3.89	15.37	0.22	0.00	0.00%	0.00	0.00%	0.29	6.94%	0.01	0.07%	0.01	4.35%
	2884*	0.15	0.47	4.99	15.31	0.18	0.15	0.47	4.80	15.31	0.18	0.00	0.00%	0.00	0.00%	0.19	3.81%	0.00	0.00%	0.00	0.00%
	2876	0.12	0.58	9.36	15.29	0.12	0.12	0.58	8.74	15.28	0.12	0.00	0.00%	0.00	0.00%	0.62	6.62%	0.01	0.07%	0.00	0.00%
	2830*	0.13	0.54	8.71	15.17	0.12	0.13	0.53	8.50	15.16	0.11	0.00	0.00%	0.01	1.85%	0.21	2.41%	0.01	0.07%	0.01	8.33%
	2783*	0.14	0.48	7.29	15.04	0.13	0.14	0.47	7.17	15.03	0.12	0.00	0.00%	0.01	2.08%	0.12	1.65%	0.01	0.07%	0.01	7.69%
	2737*	0.15	0.44	6.79	14.93	0.13	0.16	0.44	6.38	14.93	0.13	-0.01	-6.67%	0.00	0.00%	0.41	6.04%	0.00	0.00%	0.00	0.00%
	2691*	0.11	0.41	10.09	14.84	0.16	0.11	0.41	9.78	14.83	0.16	0.00	0.00%	0.00	0.00%	0.31	3.07%	0.01	0.07%	0.00	0.00%
	2645	0.11	0.36	7.23	14.71	0.20	0.11	0.35	7.11	14.70	0.20	0.00	0.00%	0.01	2.78%	0.12	1.66%	0.01	0.07%	0.00	0.00%
	2606*	0.08	0.37	13.31	14.59	0.15	0.08	0.37	13.12	14.58	0.15	0.00	0.00%	0.00	0.00%	0.19	1.43%	0.01	0.07%	0.00	0.00%
	2566*	0.06	0.38	18.31	14.46	0.15	0.06	0.38	18.05	14.46	0.15	0.00	0.00%	0.00	0.00%	0.26	1.42%	0.00	0.00%	0.00	0.00%
	2527*	0.07	0.42	24.56	14.36	0.12	0.06	0.41	24.19	14.35	0.12	0.01	14.29%	0.01	2.38%	0.37	1.51%	0.01	0.07%	0.00	0.00%
	2488	0.09	0.49	39.43	14.29	0.06	0.09	0.48	38.99	14.29	0.06	0.00	0.00%	0.01	2.04%	0.44	1.12%	0.00	0.00%	0.00	0.00%
	2440*	0.09	0.48	40.91	14.22	0.05	0.08	0.48	40.37	14.22	0.05	0.01	11.11%	0.00	0.00%	0.54	1.32%	0.00	0.00%	0.00	0.00%
	2392*	0.08	0.47	41.73	14.16	0.06	0.08	0.47	40.73	14.16	0.05	0.00	0.00%	0.00	0.00%	1.00	2.40%	0.00	0.00%	0.01	16.67%
	2344*	0.08	0.47	41.54	14.10	0.06	0.08	0.47	40.43	14.09	0.06	0.00	0.00%	0.00	0.00%	1.11	2.67%	0.01	0.07%	0.00	0.00%
	2296*	0.08	0.46	40.53	14.03	0.06	0.08	0.46	39.40	14.03	0.06	0.00	0.00%	0.00	0.00%	1.13	2.79%	0.00	0.00%	0.00	0.00%
	2248*	0.06	0.43	34.40	13.95	0.09	0.06	0.43	33.62	13.94	0.09	0.00	0.00%	0.00	0.00%	0.78	2.27%	0.01	0.07%	0.00	0.00%
	2200*	0.05	0.40	23.25	13.85	0.12	0.08	0.39	14.46	13.84	0.12	-0.03	-60.00%	0.01	2.50%	8.79	37.81%	0.01	0.07%	0.00	0.00%
	2152*	0.11	0.39	11.58	13.78	0.11	0.13	0.38	9.09	13.78	0.11	-0.02	-18.18%	0.01	2.56%	2.49	21.50%	0.00	0.00%	0.00	0.00%
Reach 4	2104	0.09	0.40	17.90	13.74	0.10	0.09	0.39	16.21	13.73	0.09	0.00	0.00%	0.01	2.50%	1.69	9.44%	0.01	0.07%	0.01	10.00%
	2077*	0.10	0.40	21.21	13.72	0.06	0.11	0.39	19.63	13.71	0.06	-0.01	-10.00%	0.01	2.50%	1.58	7.45%	0.01	0.07%	0.00	0.00%
	2050	0.07	0.39	28.62	13.70	0.06	0.08	0.39	25.34	13.69	0.06	-0.01	-14.29%	0.00	0.00%	3.28	11.46%	0.01	0.07%	0.00	0.00%
	2002*	0.05	0.53	50.57	13.66	0.07	0.05	0.53	49.85	13.66	0.07	0.00	0.00%	0.00	0.00%	0.72	1.42%	0.00	0.00%	0.00	0.00%
	1954	0.03	0.65	63.68	13.61	0.09	0.03	0.65	63.30	13.60	0.09	0.00	0.00%	0.00	0.00%	0.38	0.60%	0.01	0.07%	0.00	0.00%
	1911*	0.04	0.60	49.05	13.53	0.10	0.03	0.60	48.41	13.53	0.10	0.01	25.00%	0.00	0.00%	0.64	1.30%	0.00	0.00%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment August—0.132 m^3/s					2024 Assessment August—0.125 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 4 *(cont'd)*	1868*	0.04	0.55	38.25	13.46	0.11	0.04	0.54	37.72	13.45	0.11	0.00	0.00%	0.01	1.82%	0.53	1.39%	0.01	0.07%	0.00	0.00%
	1825*	0.06	0.51	30.58	13.40	0.11	0.06	0.51	30.15	13.39	0.11	0.00	0.00%	0.00	0.00%	0.43	1.41%	0.01	0.07%	0.00	0.00%
	1783	0.05	0.45	20.73	13.31	0.18	0.05	0.44	20.41	13.31	0.18	0.00	0.00%	0.01	2.22%	0.32	1.54%	0.00	0.00%	0.00	0.00%
	1736*	0.06	0.47	15.34	13.13	0.19	0.06	0.47	14.22	13.13	0.19	0.00	0.00%	0.00	0.00%	1.12	7.30%	0.00	0.00%	0.00	0.00%
	1689*	0.07	0.49	14.13	12.95	0.20	0.07	0.49	13.23	12.94	0.19	0.00	0.00%	0.00	0.00%	0.90	6.37%	0.01	0.08%	0.01	5.00%
	1642*	0.07	0.52	15.56	12.77	0.18	0.07	0.52	14.59	12.77	0.18	0.00	0.00%	0.00	0.00%	0.97	6.23%	0.00	0.00%	0.00	0.00%
	1596	0.06	0.54	15.75	12.58	0.20	0.06	0.53	14.54	12.58	0.20	0.00	0.00%	0.01	1.85%	1.21	7.68%	0.00	0.00%	0.00	0.00%
	1555*	0.07	0.45	14.24	12.41	0.18	0.07	0.44	13.22	12.41	0.18	0.00	0.00%	0.01	2.22%	1.02	7.16%	0.00	0.00%	0.00	0.00%
	1514*	0.07	0.36	13.43	12.24	0.17	0.07	0.36	12.47	12.24	0.17	0.00	0.00%	0.00	0.00%	0.96	7.15%	0.00	0.00%	0.00	0.00%
	1472*	0.10	0.31	12.87	12.11	0.13	0.09	0.30	12.67	12.10	0.12	0.01	10.00%	0.01	3.23%	0.20	1.55%	0.01	0.08%	0.01	7.69%
	1431*	0.12	0.21	6.31	11.93	0.18	0.11	0.20	6.25	11.92	0.17	0.01	8.33%	0.01	4.76%	0.06	0.95%	0.01	0.08%	0.01	5.56%
	1432	0.12	0.21	5.28	11.84	0.22	0.11	0.21	5.14	11.84	0.22	0.01	8.33%	0.00	0.00%	0.14	2.65%	0.00	0.00%	0.00	0.00%
	1414*	0.15	0.23	4.43	11.77	0.20	0.15	0.23	4.36	11.76	0.20	0.00	0.00%	0.00	0.00%	0.07	1.58%	0.01	0.08%	0.00	0.00%
	1405*	0.20	0.29	4.71	11.73	0.14	0.19	0.28	4.65	11.73	0.14	0.01	5.00%	0.01	3.45%	0.06	1.27%	0.00	0.00%	0.00	0.00%
	1396*	0.26	0.37	5.19	11.72	0.10	0.25	0.36	5.14	11.72	0.10	0.01	3.85%	0.01	2.70%	0.05	0.96%	0.00	0.00%	0.00	0.00%
	1387*	0.32	0.46	5.67	11.72	0.07	0.32	0.45	5.62	11.71	0.07	0.00	0.00%	0.01	2.17%	0.05	0.88%	0.01	0.09%	0.00	0.00%
	1379*	0.39	0.55	6.13	11.72	0.06	0.39	0.54	6.08	11.71	0.05	0.00	0.00%	0.01	1.82%	0.05	0.82%	0.01	0.09%	0.01	16.67%
Reach 5	1370	0.46	0.64	6.56	11.72	0.04	0.45	0.63	6.52	11.71	0.04	0.01	2.17%	0.01	1.56%	0.04	0.61%	0.01	0.09%	0.00	0.00%
	1326*	0.39	0.61	6.63	11.71	0.05	0.41	0.60	6.26	11.70	0.05	-0.02	-5.13%	0.01	1.64%	0.37	5.58%	0.01	0.09%	0.00	0.00%
	1282*	0.21	0.58	10.58	11.70	0.06	0.23	0.57	9.77	11.70	0.06	-0.02	-9.52%	0.01	1.72%	0.81	7.66%	0.00	0.00%	0.00	0.00%
	1238*	0.13	0.54	17.08	11.69	0.07	0.13	0.54	16.08	11.69	0.07	0.00	0.00%	0.00	0.00%	1.00	5.85%	0.00	0.00%	0.00	0.00%
	1194*	0.09	0.50	24.74	11.68	0.08	0.09	0.50	23.64	11.67	0.08	0.00	0.00%	0.00	0.00%	1.10	4.45%	0.01	0.09%	0.00	0.00%
	1151*	0.08	0.46	32.60	11.66	0.09	0.08	0.45	31.48	11.65	0.09	0.00	0.00%	0.01	2.17%	1.12	3.44%	0.01	0.09%	0.00	0.00%
	1107*	0.07	0.40	39.00	11.63	0.10	0.07	0.40	37.91	11.63	0.10	0.00	0.00%	0.00	0.00%	1.09	2.79%	0.00	0.00%	0.00	0.00%
	1063	0.06	0.32	37.10	11.58	0.13	0.06	0.32	35.89	11.57	0.13	0.00	0.00%	0.00	0.00%	1.21	3.26%	0.01	0.09%	0.00	0.00%
	1029*	0.07	0.41	18.07	11.49	0.16	0.06	0.40	16.55	11.49	0.16	0.01	14.29%	0.01	2.44%	1.52	8.41%	0.00	0.00%	0.00	0.00%
	995*	0.12	0.52	11.43	11.44	0.11	0.12	0.51	10.19	11.43	0.11	0.00	0.00%	0.01	1.92%	1.24	10.85%	0.01	0.09%	0.00	0.00%
	961	0.19	0.67	11.17	11.42	0.07	0.19	0.66	10.51	11.41	0.07	0.00	0.00%	0.01	1.49%	0.66	5.91%	0.01	0.09%	0.00	0.00%
	913*	0.17	0.64	11.67	11.40	0.07	0.17	0.63	11.10	11.39	0.07	0.00	0.00%	0.01	1.56%	0.57	4.88%	0.01	0.09%	0.00	0.00%
	864*	0.17	0.60	11.58	11.38	0.08	0.17	0.59	11.10	11.37	0.08	0.00	0.00%	0.01	1.67%	0.48	4.15%	0.01	0.09%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment August—0.132 m^3/s					2024 Assessment August—0.125 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 5 *(cont'd)*	816*	0.16	0.55	10.92	11.36	0.08	0.16	0.55	10.52	11.35	0.08	0.00	0.00%	0.00	0.00%	0.40	3.66%	0.01	0.09%	0.00	0.00%
	767*	0.16	0.50	9.53	11.32	0.10	0.16	0.49	9.22	11.32	0.10	0.00	0.00%	0.01	2.00%	0.31	3.25%	0.00	0.00%	0.00	0.00%
	719	0.15	0.42	7.07	11.26	0.13	0.15	0.41	6.79	11.25	0.13	0.00	0.00%	0.01	2.38%	0.28	3.96%	0.01	0.09%	0.00	0.00%
	689*	0.17	0.51	5.39	11.19	0.17	0.16	0.50	5.19	11.19	0.16	0.01	5.88%	0.01	1.96%	0.20	3.71%	0.00	0.00%	0.01	5.88%
	660	0.22	0.41	0.86	10.94	0.69	0.22	0.40	0.84	10.93	0.67	0.00	0.00%	0.01	2.44%	0.02	2.33%	0.01	0.09%	0.02	2.90%
	642	0.13	0.42	6.42	10.87	0.21	0.13	0.41	6.15	10.86	0.21	0.00	0.00%	0.01	2.38%	0.27	4.21%	0.01	0.09%	0.00	0.00%
	598*	0.15	0.53	5.79	10.81	0.19	0.14	0.53	5.52	10.81	0.19	0.01	6.67%	0.00	0.00%	0.27	4.66%	0.00	0.00%	0.00	0.00%
	555*	0.16	0.65	5.30	10.77	0.18	0.16	0.64	5.04	10.76	0.18	0.00	0.00%	0.01	1.54%	0.26	4.91%	0.01	0.09%	0.00	0.00%
	512*	0.18	0.77	4.87	10.72	0.18	0.17	0.76	4.62	10.71	0.18	0.01	5.56%	0.01	1.30%	0.25	5.13%	0.01	0.09%	0.00	0.00%
	468	0.19	0.84	3.23	10.62	0.23	0.20	0.83	2.98	10.61	0.23	-0.01	-5.26%	0.01	1.19%	0.25	7.74%	0.01	0.09%	0.00	0.00%
	447	0.17	0.26	1.34	10.23	0.58	0.17	0.26	1.32	10.23	0.56	0.00	0.00%	0.00	0.00%	0.02	1.49%	0.00	0.00%	0.02	3.45%
	419	0.14	0.34	3.52	9.91	0.30	0.14	0.33	3.28	9.90	0.30	0.00	0.00%	0.01	2.94%	0.24	6.82%	0.01	0.10%	0.00	0.00%
	396	0.18	0.59	1.35	9.78	0.58	0.21	0.58	1.08	9.77	0.56	-0.03	-16.67%	0.01	1.69%	0.27	20.00%	0.01	0.10%	0.02	3.45%
	373	0.18	0.65	5.20	9.70	0.19	0.17	0.64	5.11	9.69	0.19	0.01	5.56%	0.01	1.54%	0.09	1.73%	0.01	0.10%	0.00	0.00%
	340	0.22	0.48	3.41	9.61	0.20	0.21	0.47	3.35	9.60	0.19	0.01	4.55%	0.01	2.08%	0.06	1.76%	0.01	0.10%	0.01	5.00%
	300	0.18	0.33	5.63	9.47	0.14	0.18	0.32	5.31	9.46	0.13	0.00	0.00%	0.01	3.03%	0.32	5.68%	0.01	0.11%	0.01	7.14%
	284*	0.21	0.37	4.88	9.38	0.13	0.20	0.36	4.78	9.37	0.13	0.01	4.76%	0.01	2.70%	0.10	2.05%	0.01	0.11%	0.00	0.00%
	267*	0.22	0.42	5.18	9.30	0.11	0.22	0.41	5.06	9.29	0.11	0.00	0.00%	0.01	2.38%	0.12	2.32%	0.01	0.11%	0.00	0.00%
	251*	0.26	0.50	5.74	9.26	0.09	0.25	0.49	5.60	9.25	0.09	0.01	3.85%	0.01	2.00%	0.14	2.44%	0.01	0.11%	0.00	0.00%
	235*	0.30	0.61	6.56	9.24	0.07	0.30	0.60	6.41	9.23	0.07	0.00	0.00%	0.01	1.64%	0.15	2.29%	0.01	0.11%	0.00	0.00%
	218	0.35	0.71	7.33	9.21	0.05	0.34	0.70	7.18	9.20	0.05	0.01	2.86%	0.01	1.41%	0.15	2.05%	0.01	0.11%	0.00	0.00%
	178*	0.31	0.60	13.75	9.13	0.03	0.30	0.59	13.59	9.12	0.03	0.01	3.23%	0.01	1.67%	0.16	1.16%	0.01	0.11%	0.00	0.00%
	137*	0.28	0.52	20.50	9.09	0.02	0.27	0.52	20.31	9.08	0.02	0.01	3.57%	0.00	0.00%	0.19	0.93%	0.01	0.11%	0.00	0.00%
	97*	0.26	0.46	27.41	9.06	0.02	0.25	0.46	27.19	9.06	0.02	0.01	3.85%	0.00	0.00%	0.22	0.80%	0.00	0.00%	0.00	0.00%
	56*	0.23	0.41	34.37	9.04	0.02	0.23	0.40	34.13	9.03	0.02	0.00	0.00%	0.01	2.44%	0.24	0.70%	0.01	0.11%	0.00	0.00%
	16	0.21	0.36	41.36	9.02	0.02	0.21	0.35	41.11	9.01	0.02	0.00	0.00%	0.01	2.78%	0.25	0.60%	0.01	0.11%	0.00	0.00%
Average		**0.20**	**0.53**	**14.47**	**14.31**	**0.13**	**0.20**	**0.53**	**14.01**	**14.30**	**0.13**	**0.00**	**0.74%**	**0.01**	**1.42%**	**0.45**	**3.14%**	**0.01**	**0.05%**	**0.00**	**1.46%**

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment September—0.089 m^3/s					2024 Assessment September—0.043 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1	4241	0.36	0.59	32.66	17.99	0.01	0.36	0.58	31.94	17.98	0.01	0.00	0.00%	0.01	1.69%	0.72	2.20%	0.01	0.06%	0.00	0.00%
	4224*	0.31	0.58	32.35	17.99	0.01	0.31	0.57	31.46	17.98	0.01	0.00	0.00%	0.01	1.72%	0.89	2.75%	0.01	0.06%	0.00	0.00%
	4206*	0.27	0.56	31.83	17.99	0.01	0.27	0.55	31.25	17.98	0.01	0.00	0.00%	0.01	1.79%	0.58	1.82%	0.01	0.06%	0.00	0.00%
	4189*	0.23	0.55	31.40	17.99	0.01	0.23	0.54	30.81	17.98	0.01	0.00	0.00%	0.01	1.82%	0.59	1.88%	0.01	0.06%	0.00	0.00%
	4171*	0.19	0.53	31.14	17.98	0.02	0.19	0.52	30.31	17.98	0.02	0.00	0.00%	0.01	1.89%	0.83	2.67%	0.00	0.00%	0.00	0.00%
	4154*	0.16	0.51	30.65	17.98	0.02	0.16	0.51	29.92	17.97	0.02	0.00	0.00%	0.00	0.00%	0.73	2.38%	0.01	0.06%	0.00	0.00%
	4136*	0.13	0.49	29.88	17.97	0.03	0.12	0.48	29.05	17.96	0.03	0.01	7.69%	0.01	2.04%	0.83	2.78%	0.01	0.06%	0.00	0.00%
	4119	0.08	0.44	25.79	17.93	0.06	0.08	0.43	22.48	17.92	0.06	0.00	0.00%	0.01	2.27%	3.31	12.83%	0.01	0.06%	0.00	0.00%
	4095	0.22	0.42	12.25	17.90	0.03	0.21	0.42	12.08	17.90	0.03	0.01	4.55%	0.00	0.00%	0.17	1.39%	0.00	0.00%	0.00	0.00%
	4049*	0.23	0.43	12.32	17.89	0.03	0.23	0.43	12.15	17.88	0.03	0.00	0.00%	0.00	0.00%	0.17	1.38%	0.01	0.06%	0.00	0.00%
	4002*	0.26	0.45	12.46	17.88	0.03	0.26	0.44	12.20	17.87	0.03	0.00	0.00%	0.01	2.22%	0.26	2.09%	0.01	0.06%	0.00	0.00%
	3956	0.28	0.47	13.52	17.87	0.02	0.28	0.46	13.33	17.86	0.02	0.00	0.00%	0.01	2.13%	0.19	1.41%	0.01	0.06%	0.00	0.00%
	3906*	0.32	0.50	15.18	17.87	0.02	0.31	0.49	15.00	17.86	0.02	0.01	3.13%	0.01	2.00%	0.18	1.19%	0.01	0.06%	0.00	0.00%
	3857*	0.34	0.54	17.34	17.86	0.02	0.34	0.53	17.17	17.86	0.01	0.00	0.00%	0.01	1.85%	0.17	0.98%	0.00	0.00%	0.01	50.00%
	3807*	0.36	0.58	19.74	17.86	0.01	0.36	0.57	19.55	17.85	0.01	0.00	0.00%	0.01	1.72%	0.19	0.96%	0.01	0.06%	0.00	0.00%
	3757	0.38	0.62	22.27	17.86	0.01	0.38	0.61	22.08	17.85	0.01	0.00	0.00%	0.01	1.61%	0.19	0.85%	0.01	0.06%	0.00	0.00%
	3729	0.16	0.48	8.65	17.86	0.07	0.15	0.47	8.25	17.85	0.07	0.01	6.25%	0.01	2.08%	0.40	4.62%	0.01	0.06%	0.00	0.00%
	3717	0.15	0.33	5.60	17.83	0.11	0.14	0.32	5.48	17.82	0.11	0.01	6.67%	0.01	3.03%	0.12	2.14%	0.01	0.06%	0.00	0.00%
	3691*	0.18	0.37	4.18	17.70	0.12	0.18	0.36	3.99	17.69	0.12	0.00	0.00%	0.01	2.70%	0.19	4.55%	0.01	0.06%	0.00	0.00%
	3665	0.22	0.44	3.89	17.59	0.11	0.21	0.42	3.76	17.58	0.10	0.01	4.55%	0.02	4.55%	0.13	3.34%	0.01	0.06%	0.01	9.09%
	3643	0.20	0.53	4.70	17.52	0.11	0.19	0.52	4.57	17.51	0.10	0.01	5.00%	0.01	1.89%	0.13	2.77%	0.01	0.06%	0.01	9.09%
	3611	0.39	0.63	0.97	17.35	0.24	0.39	0.62	0.94	17.34	0.23	0.00	0.00%	0.01	1.59%	0.03	3.09%	0.01	0.06%	0.01	4.17%
	3565	0.18	0.42	13.03	17.29	0.04	0.17	0.41	12.72	17.28	0.04	0.01	5.56%	0.01	2.38%	0.31	2.38%	0.01	0.06%	0.00	0.00%
	3556*	0.20	0.44	11.89	17.29	0.04	0.19	0.43	11.64	17.28	0.04	0.01	5.00%	0.01	2.27%	0.25	2.10%	0.01	0.06%	0.00	0.00%
	3547*	0.21	0.46	10.81	17.28	0.04	0.20	0.44	10.60	17.27	0.04	0.01	4.76%	0.02	4.35%	0.21	1.94%	0.01	0.06%	0.00	0.00%
	3538*	0.23	0.47	9.73	17.28	0.04	0.22	0.46	9.57	17.27	0.04	0.01	4.35%	0.01	2.13%	0.16	1.64%	0.01	0.06%	0.00	0.00%
	3528*	0.24	0.49	8.68	17.28	0.04	0.23	0.48	8.53	17.27	0.04	0.01	4.17%	0.01	2.04%	0.15	1.73%	0.01	0.06%	0.00	0.00%
	3519*	0.25	0.50	7.62	17.27	0.05	0.25	0.49	7.50	17.26	0.05	0.00	0.00%	0.01	2.00%	0.12	1.57%	0.01	0.06%	0.00	0.00%
	3510*	0.26	0.52	6.57	17.27	0.05	0.26	0.51	6.47	17.26	0.05	0.00	0.00%	0.01	1.92%	0.10	1.52%	0.01	0.06%	0.00	0.00%
	3501*	0.27	0.53	5.52	17.26	0.06	0.26	0.52	5.43	17.25	0.06	0.01	3.70%	0.01	1.89%	0.09	1.63%	0.01	0.06%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment September—0.089 m^3/s					2024 Assessment September—0.043 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1 *(cont'd)*	3492*	0.27	0.54	4.43	17.25	0.07	0.26	0.53	4.38	17.24	0.07	0.01	3.70%	0.01	1.85%	0.05	1.13%	0.01	0.06%	0.00	0.00%
	3483	0.26	0.55	3.34	17.24	0.10	0.25	0.54	3.30	17.23	0.10	0.01	3.85%	0.01	1.82%	0.04	1.20%	0.01	0.06%	0.00	0.00%
	3474*	0.25	0.52	3.27	17.23	0.11	0.24	0.51	3.22	17.22	0.11	0.01	4.00%	0.01	1.92%	0.05	1.53%	0.01	0.06%	0.00	0.00%
	3464*	0.23	0.49	3.19	17.22	0.12	0.23	0.48	3.12	17.21	0.12	0.00	0.00%	0.01	2.04%	0.07	2.19%	0.01	0.06%	0.00	0.00%
	3455*	0.22	0.46	3.07	17.21	0.14	0.22	0.45	2.99	17.19	0.14	0.00	0.00%	0.01	2.17%	0.08	2.61%	0.02	0.12%	0.00	0.00%
	3446*	0.21	0.43	2.93	17.19	0.15	0.20	0.42	2.84	17.18	0.15	0.01	4.76%	0.01	2.33%	0.09	3.07%	0.01	0.06%	0.00	0.00%
Reach 2	3436	0.19	0.36	2.36	17.13	0.20	0.19	0.35	2.19	17.12	0.20	0.00	0.00%	0.01	2.78%	0.17	7.20%	0.01	0.06%	0.00	0.00%
	3429*	0.27	0.45	1.47	16.89	0.22	0.28	0.44	1.40	16.87	0.22	-0.01	-3.70%	0.01	2.22%	0.07	4.76%	0.02	0.12%	0.00	0.00%
	3422	0.29	0.78	2.43	16.87	0.13	0.28	0.76	2.37	16.86	0.12	0.01	3.45%	0.02	2.56%	0.06	2.47%	0.01	0.06%	0.01	7.69%
	3414*	0.26	0.69	2.35	16.87	0.15	0.26	0.67	2.26	16.86	0.14	0.00	0.00%	0.02	2.90%	0.09	3.83%	0.01	0.06%	0.01	6.67%
	3406*	0.23	0.59	2.19	16.86	0.17	0.23	0.58	2.10	16.85	0.17	0.00	0.00%	0.01	1.69%	0.09	4.11%	0.01	0.06%	0.00	0.00%
	3399*	0.21	0.50	1.94	16.85	0.24	0.21	0.49	1.82	16.83	0.24	0.00	0.00%	0.01	2.00%	0.12	6.19%	0.02	0.12%	0.00	0.00%
	3391	0.21	0.37	1.22	16.80	0.35	0.22	0.36	1.13	16.79	0.34	-0.01	-4.76%	0.01	2.70%	0.09	7.38%	0.01	0.06%	0.01	2.86%
	3390*	0.25	0.40	1.12	16.71	0.32	0.24	0.39	1.09	16.69	0.31	0.01	4.00%	0.01	2.50%	0.03	2.68%	0.02	0.12%	0.01	3.13%
	3389	0.25	0.44	1.24	16.62	0.29	0.24	0.43	1.22	16.60	0.29	0.01	4.00%	0.01	2.27%	0.02	1.61%	0.02	0.12%	0.00	0.00%
	3388*	0.25	0.49	1.38	16.55	0.26	0.24	0.48	1.35	16.53	0.26	0.01	4.00%	0.01	2.04%	0.03	2.17%	0.02	0.12%	0.00	0.00%
	3387*	0.27	0.57	1.55	16.50	0.21	0.26	0.56	1.51	16.48	0.21	0.01	3.70%	0.01	1.75%	0.04	2.58%	0.02	0.12%	0.00	0.00%
	3386*	0.30	0.67	1.76	16.46	0.17	0.29	0.65	1.70	16.45	0.17	0.01	3.33%	0.02	2.99%	0.06	3.41%	0.01	0.06%	0.00	0.00%
	3385*	0.33	0.77	1.99	16.44	0.13	0.32	0.75	1.93	16.43	0.13	0.01	3.03%	0.02	2.60%	0.06	3.02%	0.01	0.06%	0.00	0.00%
	3384*	0.37	0.89	2.28	16.43	0.11	0.36	0.87	2.20	16.41	0.10	0.01	2.70%	0.02	2.25%	0.08	3.51%	0.02	0.12%	0.01	9.09%
	3383	0.40	1.01	2.62	16.43	0.08	0.40	0.99	2.52	16.41	0.08	0.00	0.00%	0.02	1.98%	0.10	3.82%	0.02	0.12%	0.00	0.00%
	3337*	0.39	0.83	2.84	16.27	0.08	0.38	0.82	2.79	16.25	0.08	0.01	2.56%	0.01	1.20%	0.05	1.76%	0.02	0.12%	0.00	0.00%
	3290	0.36	0.76	4.76	16.20	0.06	0.36	0.74	4.55	16.19	0.05	0.00	0.00%	0.02	2.63%	0.21	4.41%	0.01	0.06%	0.01	16.67%
	3245*	0.29	0.84	4.79	16.17	0.07	0.30	0.82	4.48	16.16	0.06	-0.01	-3.45%	0.02	2.38%	0.31	6.47%	0.01	0.06%	0.01	14.29%
	3200	0.29	0.92	4.75	16.15	0.07	0.29	0.91	4.52	16.14	0.07	0.00	0.00%	0.01	1.09%	0.23	4.84%	0.01	0.06%	0.00	0.00%
	3160*	0.17	0.83	9.98	16.13	0.07	0.17	0.82	8.95	16.12	0.07	0.00	0.00%	0.01	1.20%	1.03	10.32%	0.01	0.06%	0.00	0.00%
	3119*	0.10	0.74	17.65	16.10	0.07	0.11	0.73	14.63	16.09	0.07	-0.01	-10.00%	0.01	1.35%	3.02	17.11%	0.01	0.06%	0.00	0.00%
	3079*	0.07	0.64	23.23	16.07	0.08	0.06	0.62	20.49	16.05	0.09	0.01	14.29%	0.02	3.13%	2.74	11.80%	0.02	0.12%	-0.01	-12.50%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment September—0.089 m^3/s					2024 Assessment September—0.043 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 3	3038	0.13	0.48	4.61	15.98	0.15	0.21	0.45	2.36	15.95	0.17	-0.08	-61.54%	0.03	6.25%	2.25	48.81%	0.03	0.19%	-0.02	-13.33%
	2995	0.16	0.56	4.80	15.82	0.12	0.22	0.52	2.84	15.79	0.13	-0.06	-37.50%	0.04	7.14%	1.96	40.83%	0.03	0.19%	-0.01	-8.33%
	2951*	0.16	0.37	2.72	15.64	0.20	0.16	0.37	2.69	15.63	0.19	0.00	0.00%	0.00	0.00%	0.03	1.10%	0.01	0.06%	0.01	5.00%
	2907	0.06	0.19	25.49	15.45	0.10	0.05	0.18	25.19	15.45	0.10	0.01	16.67%	0.01	5.26%	0.30	1.18%	0.00	0.00%	0.00	0.00%
	2899*	0.07	0.29	7.36	15.41	0.22	0.07	0.28	6.71	15.40	0.22	0.00	0.00%	0.01	3.45%	0.65	8.83%	0.01	0.06%	0.00	0.00%
	2891*	0.13	0.34	2.95	15.32	0.22	0.13	0.33	2.78	15.31	0.23	0.00	0.00%	0.01	2.94%	0.17	5.76%	0.01	0.07%	-0.01	-4.55%
	2884*	0.15	0.41	3.25	15.26	0.18	0.16	0.40	3.00	15.25	0.18	-0.01	-6.67%	0.01	2.44%	0.25	7.69%	0.01	0.07%	0.00	0.00%
	2876	0.16	0.53	4.74	15.23	0.12	0.16	0.52	4.40	15.22	0.12	0.00	0.00%	0.01	1.89%	0.34	7.17%	0.01	0.07%	0.00	0.00%
	2830*	0.15	0.48	5.18	15.11	0.12	0.15	0.47	5.01	15.11	0.11	0.00	0.00%	0.01	2.08%	0.17	3.28%	0.00	0.00%	0.01	8.33%
	2783*	0.15	0.43	5.03	14.99	0.12	0.15	0.42	4.88	14.98	0.12	0.00	0.00%	0.01	2.33%	0.15	2.98%	0.01	0.07%	0.00	0.00%
	2737*	0.15	0.39	5.22	14.89	0.12	0.15	0.39	4.75	14.88	0.11	0.00	0.00%	0.00	0.00%	0.47	9.00%	0.01	0.07%	0.01	8.33%
	2691*	0.14	0.37	5.65	14.79	0.14	0.14	0.36	5.14	14.78	0.13	0.00	0.00%	0.01	2.70%	0.51	9.03%	0.01	0.07%	0.01	7.14%
	2645	0.10	0.33	6.07	14.68	0.17	0.10	0.32	5.91	14.67	0.16	0.00	0.00%	0.01	3.03%	0.16	2.64%	0.01	0.07%	0.01	5.88%
	2606*	0.07	0.35	11.55	14.56	0.14	0.06	0.34	11.20	14.56	0.13	0.01	14.29%	0.01	2.86%	0.35	3.03%	0.00	0.00%	0.01	7.14%
	2566*	0.05	0.37	16.77	14.44	0.13	0.05	0.36	16.21	14.44	0.13	0.00	0.00%	0.01	2.70%	0.56	3.34%	0.00	0.00%	0.00	0.00%
	2527*	0.05	0.39	22.65	14.33	0.12	0.04	0.39	22.06	14.33	0.12	0.01	20.00%	0.00	0.00%	0.59	2.60%	0.00	0.00%	0.00	0.00%
	2488	0.08	0.46	35.27	14.27	0.05	0.07	0.46	34.24	14.26	0.05	0.01	12.50%	0.00	0.00%	1.03	2.92%	0.01	0.07%	0.00	0.00%
	2440*	0.07	0.46	35.49	14.20	0.05	0.07	0.45	34.85	14.20	0.05	0.00	0.00%	0.01	2.17%	0.64	1.80%	0.00	0.00%	0.00	0.00%
	2392*	0.07	0.45	35.40	14.14	0.05	0.07	0.45	34.79	14.13	0.05	0.00	0.00%	0.00	0.00%	0.61	1.72%	0.01	0.07%	0.00	0.00%
	2344*	0.07	0.44	35.06	14.07	0.05	0.07	0.44	34.14	14.07	0.05	0.00	0.00%	0.00	0.00%	0.92	2.62%	0.00	0.00%	0.00	0.00%
	2296*	0.07	0.44	34.37	14.01	0.06	0.06	0.43	33.07	14.00	0.06	0.01	14.29%	0.01	2.27%	1.30	3.78%	0.01	0.07%	0.00	0.00%
	2248*	0.07	0.39	15.82	13.90	0.09	0.14	0.37	6.18	13.89	0.09	-0.07	-100.00%	0.02	5.13%	9.64	60.94%	0.01	0.07%	0.00	0.00%
	2200*	0.19	0.34	4.38	13.80	0.11	0.19	0.33	4.26	13.79	0.10	0.00	0.00%	0.01	2.94%	0.12	2.74%	0.01	0.07%	0.01	9.09%
	2152*	0.21	0.34	4.55	13.74	0.09	0.20	0.33	4.46	13.73	0.09	0.01	4.76%	0.01	2.94%	0.09	1.98%	0.01	0.07%	0.00	0.00%
Reach 4	2104	0.23	0.36	4.92	13.70	0.08	0.23	0.35	4.85	13.69	0.07	0.00	0.00%	0.01	2.78%	0.07	1.42%	0.01	0.07%	0.01	12.50%
	2077*	0.17	0.36	9.64	13.68	0.05	0.17	0.36	9.54	13.68	0.05	0.00	0.00%	0.00	0.00%	0.10	1.04%	0.00	0.00%	0.00	0.00%
	2050	0.11	0.36	14.23	13.67	0.06	0.11	0.36	14.10	13.66	0.05	0.00	0.00%	0.00	0.00%	0.13	0.91%	0.01	0.07%	0.01	16.67%
	2002*	0.10	0.51	15.53	13.63	0.06	0.13	0.50	11.44	13.63	0.06	-0.03	-30.00%	0.01	1.96%	4.09	26.34%	0.00	0.00%	0.00	0.00%
	1954	0.05	0.63	21.68	13.58	0.09	0.06	0.62	16.16	13.57	0.09	-0.01	-20.00%	0.01	1.59%	5.52	25.46%	0.01	0.07%	0.00	0.00%
	1911*	0.14	0.56	6.89	13.49	0.09	0.14	0.56	6.61	13.49	0.09	0.00	0.00%	0.00	0.00%	0.28	4.06%	0.00	0.00%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment September—0.089 m^3/s					2024 Assessment September—0.043 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 4 *(cont'd)*	1868*	0.13	0.52	7.07	13.42	0.10	0.16	0.51	5.67	13.42	0.09	-0.03	-23.08%	0.01	1.92%	1.40	19.80%	0.00	0.00%	0.01	10.00%
	1825*	0.05	0.48	19.46	13.37	0.10	0.07	0.47	13.46	13.36	0.10	-0.02	-40.00%	0.01	2.08%	6.00	30.83%	0.01	0.07%	0.00	0.00%
	1783	0.06	0.42	9.22	13.28	0.16	0.09	0.41	5.72	13.27	0.16	-0.03	-50.00%	0.01	2.38%	3.50	37.96%	0.01	0.08%	0.00	0.00%
	1736*	0.09	0.43	6.16	13.09	0.17	0.12	0.42	4.16	13.08	0.17	-0.03	-33.33%	0.01	2.33%	2.00	32.47%	0.01	0.08%	0.00	0.00%
	1689*	0.08	0.46	6.66	12.91	0.17	0.10	0.45	5.14	12.90	0.17	-0.02	-25.00%	0.01	2.17%	1.52	22.82%	0.01	0.08%	0.00	0.00%
	1642*	0.07	0.49	8.43	12.74	0.16	0.08	0.48	6.97	12.73	0.16	-0.01	-14.29%	0.01	2.04%	1.46	17.32%	0.01	0.08%	0.00	0.00%
	1596	0.07	0.50	7.23	12.54	0.18	0.09	0.49	5.40	12.54	0.18	-0.02	-28.57%	0.01	2.00%	1.83	25.31%	0.00	0.00%	0.00	0.00%
	1555*	0.10	0.41	6.10	12.37	0.16	0.12	0.41	4.72	12.37	0.15	-0.02	-20.00%	0.00	0.00%	1.38	22.62%	0.00	0.00%	0.01	6.25%
	1514*	0.09	0.33	6.73	12.21	0.15	0.10	0.32	5.59	12.21	0.14	-0.01	-11.11%	0.01	3.03%	1.14	16.94%	0.00	0.00%	0.01	6.67%
	1472*	0.08	0.28	11.67	12.08	0.11	0.07	0.27	11.61	12.08	0.11	0.01	12.50%	0.01	3.57%	0.06	0.51%	0.00	0.00%	0.00	0.00%
	1431*	0.10	0.18	5.91	11.90	0.16	0.09	0.17	5.83	11.89	0.16	0.01	10.00%	0.01	5.56%	0.08	1.35%	0.01	0.08%	0.00	0.00%
	1432	0.10	0.18	4.40	11.81	0.20	0.10	0.17	4.28	11.80	0.19	0.00	0.00%	0.01	5.56%	0.12	2.73%	0.01	0.08%	0.01	5.00%
	1414*	0.12	0.19	3.98	11.72	0.19	0.11	0.18	3.93	11.72	0.18	0.01	8.33%	0.01	5.26%	0.05	1.26%	0.00	0.00%	0.01	5.26%
	1405*	0.16	0.24	4.35	11.69	0.12	0.16	0.23	4.31	11.68	0.12	0.00	0.00%	0.01	4.17%	0.04	0.92%	0.01	0.09%	0.00	0.00%
	1396*	0.23	0.32	4.83	11.68	0.08	0.22	0.32	4.78	11.67	0.08	0.01	4.35%	0.00	0.00%	0.05	1.04%	0.01	0.09%	0.00	0.00%
	1387*	0.30	0.41	5.35	11.67	0.06	0.29	0.41	5.30	11.66	0.05	0.01	3.33%	0.00	0.00%	0.05	0.93%	0.01	0.09%	0.01	16.67%
	1379*	0.36	0.50	5.84	11.67	0.04	0.36	0.50	5.79	11.66	0.04	0.00	0.00%	0.00	0.00%	0.05	0.86%	0.01	0.09%	0.00	0.00%
Reach 5	1370	0.43	0.60	6.30	11.67	0.03	0.42	0.59	6.25	11.66	0.03	0.01	2.33%	0.01	1.67%	0.05	0.79%	0.01	0.09%	0.00	0.00%
	1326*	0.40	0.57	5.78	11.67	0.04	0.40	0.56	5.74	11.66	0.04	0.00	0.00%	0.01	1.75%	0.04	0.69%	0.01	0.09%	0.00	0.00%
	1282*	0.37	0.54	5.33	11.66	0.05	0.37	0.53	5.22	11.66	0.04	0.00	0.00%	0.01	1.85%	0.11	2.06%	0.00	0.00%	0.01	20.00%
	1238*	0.17	0.51	10.13	11.66	0.05	0.18	0.50	8.91	11.65	0.05	-0.01	-5.88%	0.01	1.96%	1.22	12.04%	0.01	0.09%	0.00	0.00%
	1194*	0.09	0.47	17.12	11.65	0.07	0.10	0.46	15.76	11.64	0.06	-0.01	-11.11%	0.01	2.13%	1.36	7.94%	0.01	0.09%	0.01	14.29%
	1151*	0.07	0.43	25.02	11.63	0.08	0.07	0.42	23.65	11.62	0.08	0.00	0.00%	0.01	2.33%	1.37	5.48%	0.01	0.09%	0.00	0.00%
	1107*	0.06	0.38	31.45	11.61	0.09	0.06	0.37	30.10	11.60	0.09	0.00	0.00%	0.01	2.63%	1.35	4.29%	0.01	0.09%	0.00	0.00%
	1063	0.05	0.30	28.38	11.55	0.14	0.04	0.30	26.70	11.55	0.14	0.01	20.00%	0.00	0.00%	1.68	5.92%	0.00	0.00%	0.00	0.00%
	1029*	0.08	0.37	7.11	11.45	0.16	0.10	0.36	5.25	11.44	0.16	-0.02	-25.00%	0.01	2.70%	1.86	26.16%	0.01	0.09%	0.00	0.00%
	995*	0.17	0.46	5.28	11.38	0.10	0.17	0.45	4.76	11.37	0.10	0.00	0.00%	0.01	2.17%	0.52	9.85%	0.01	0.09%	0.00	0.00%
	961	0.23	0.61	6.75	11.36	0.06	0.23	0.60	6.52	11.35	0.06	0.00	0.00%	0.01	1.64%	0.23	3.41%	0.01	0.09%	0.00	0.00%
	913*	0.19	0.58	7.65	11.35	0.06	0.20	0.57	6.99	11.34	0.06	-0.01	-5.26%	0.01	1.72%	0.66	8.63%	0.01	0.09%	0.00	0.00%
	864*	0.17	0.54	8.20	11.33	0.07	0.17	0.54	7.64	11.32	0.06	0.00	0.00%	0.00	0.00%	0.56	6.83%	0.01	0.09%	0.01	14.29%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment September—0.089 m^3/s					2024 Assessment September—0.043 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 5 *(cont'd)*	816*	0.16	0.50	8.11	11.31	0.07	0.16	0.49	7.65	11.30	0.07	0.00	0.00%	0.01	2.00%	0.46	5.67%	0.01	0.09%	0.00	0.00%
	767*	0.15	0.45	7.17	11.27	0.09	0.15	0.44	6.78	11.26	0.08	0.00	0.00%	0.01	2.22%	0.39	5.44%	0.01	0.09%	0.01	11.11%
	719	0.15	0.37	5.17	11.21	0.12	0.15	0.36	4.84	11.20	0.12	0.00	0.00%	0.01	2.70%	0.33	6.38%	0.01	0.09%	0.00	0.00%
	689*	0.16	0.45	3.98	11.14	0.15	0.16	0.44	3.70	11.13	0.14	0.00	0.00%	0.01	2.22%	0.28	7.04%	0.01	0.09%	0.01	6.67%
	660	0.21	0.36	0.74	10.89	0.57	0.21	0.35	0.73	10.88	0.55	0.00	0.00%	0.01	2.78%	0.01	1.35%	0.01	0.09%	0.02	3.51%
	642	0.12	0.37	4.53	10.81	0.19	0.12	0.36	4.22	10.80	0.19	0.00	0.00%	0.01	2.70%	0.31	6.84%	0.01	0.09%	0.00	0.00%
	598*	0.14	0.47	3.87	10.75	0.18	0.14	0.46	3.55	10.74	0.17	0.00	0.00%	0.01	2.13%	0.32	8.27%	0.01	0.09%	0.01	5.56%
	555*	0.17	0.59	3.41	10.70	0.17	0.17	0.57	3.09	10.69	0.16	0.00	0.00%	0.02	3.39%	0.32	9.38%	0.01	0.09%	0.01	5.88%
	512*	0.19	0.70	2.99	10.65	0.16	0.20	0.69	2.66	10.63	0.16	-0.01	-5.26%	0.01	1.43%	0.33	11.04%	0.02	0.19%	0.00	0.00%
	468	0.33	0.77	1.37	10.54	0.20	0.34	0.75	1.25	10.53	0.19	-0.01	-3.03%	0.02	2.60%	0.12	8.76%	0.01	0.09%	0.01	5.00%
	447	0.17	0.26	1.34	10.23	0.39	0.17	0.26	1.33	10.23	0.37	0.00	0.00%	0.00	0.00%	0.01	0.75%	0.00	0.00%	0.02	5.13%
	419	0.17	0.26	1.70	9.83	0.30	0.17	0.25	1.60	9.82	0.30	0.00	0.00%	0.01	3.85%	0.10	5.88%	0.01	0.10%	0.00	0.00%
	396	0.45	0.51	0.43	9.70	0.46	0.44	0.50	0.43	9.69	0.44	0.01	2.22%	0.01	1.96%	0.00	0.00%	0.01	0.10%	0.02	4.35%
	373	0.17	0.58	3.65	9.63	0.17	0.17	0.57	3.35	9.62	0.17	0.00	0.00%	0.01	1.72%	0.30	8.22%	0.01	0.10%	0.00	0.00%
	340	0.24	0.42	2.33	9.55	0.16	0.25	0.41	2.16	9.54	0.16	-0.01	-4.17%	0.01	2.38%	0.17	7.30%	0.01	0.10%	0.00	0.00%
	300	0.18	0.27	4.09	9.41	0.12	0.17	0.26	4.02	9.40	0.12	0.01	5.56%	0.01	3.70%	0.07	1.71%	0.01	0.11%	0.00	0.00%
	284*	0.17	0.30	4.28	9.32	0.12	0.17	0.30	4.19	9.31	0.12	0.00	0.00%	0.00	0.00%	0.09	2.10%	0.01	0.11%	0.00	0.00%
	267*	0.18	0.35	4.42	9.23	0.11	0.18	0.34	4.33	9.22	0.11	0.00	0.00%	0.01	2.86%	0.09	2.04%	0.01	0.11%	0.00	0.00%
	251*	0.22	0.42	4.90	9.18	0.08	0.21	0.41	4.79	9.17	0.08	0.01	4.55%	0.01	2.38%	0.11	2.24%	0.01	0.11%	0.00	0.00%
	235*	0.27	0.53	5.64	9.16	0.06	0.26	0.52	5.53	9.15	0.06	0.01	3.70%	0.01	1.89%	0.11	1.95%	0.01	0.11%	0.00	0.00%
	218	0.32	0.64	6.37	9.14	0.04	0.31	0.62	6.26	9.13	0.04	0.01	3.13%	0.02	3.13%	0.11	1.73%	0.01	0.11%	0.00	0.00%
	178*	0.27	0.54	12.69	9.07	0.03	0.27	0.53	12.51	9.06	0.03	0.00	0.00%	0.01	1.85%	0.18	1.42%	0.01	0.11%	0.00	0.00%
	137*	0.24	0.47	19.19	9.03	0.02	0.23	0.46	18.95	9.03	0.02	0.01	4.17%	0.01	2.13%	0.24	1.25%	0.00	0.00%	0.00	0.00%
	97*	0.22	0.41	25.96	9.01	0.02	0.21	0.40	25.68	9.00	0.02	0.01	4.55%	0.01	2.44%	0.28	1.08%	0.01	0.11%	0.00	0.00%
	56*	0.19	0.36	32.79	8.99	0.01	0.19	0.35	32.54	8.98	0.01	0.00	0.00%	0.01	2.78%	0.25	0.76%	0.01	0.11%	0.00	0.00%
	16	0.17	0.31	39.65	8.97	0.01	0.17	0.30	39.39	8.96	0.01	0.00	0.00%	0.01	3.23%	0.26	0.66%	0.01	0.11%	0.00	0.00%
Average		**0.19**	**0.48**	**10.38**	**14.25**	**0.11**	**0.20**	**0.47**	**9.74**	**14.24**	**0.11**	**0.00**	**-0.36%**	**0.01**	**2.08%**	**0.64**	**6.15%**	**0.01**	**0.07%**	**0.00**	**2.14%**

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment October—0.047 m^3/s					2024 Assessment October—0.043 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1	4241	0.38	0.50	24.96	17.91	0.00	0.37	0.49	24.64	17.90	0.00	0.01	2.63%	0.01	2.00%	0.32	1.28%	0.01	0.06%	0.00	0.00%
	4224*	0.35	0.49	22.45	17.91	0.01	0.35	0.48	22.14	17.90	0.01	0.00	0.00%	0.01	2.04%	0.31	1.38%	0.01	0.06%	0.00	0.00%
	4206*	0.33	0.48	19.89	17.91	0.01	0.32	0.47	19.60	17.89	0.01	0.01	3.03%	0.01	2.08%	0.29	1.46%	0.02	0.11%	0.00	0.00%
	4189*	0.30	0.47	17.31	17.91	0.01	0.30	0.45	17.00	17.89	0.01	0.00	0.00%	0.02	4.26%	0.31	1.79%	0.02	0.11%	0.00	0.00%
	4171*	0.27	0.45	15.00	17.90	0.01	0.27	0.44	14.39	17.89	0.01	0.00	0.00%	0.01	2.22%	0.61	4.07%	0.01	0.06%	0.00	0.00%
	4154*	0.22	0.43	13.52	17.90	0.02	0.23	0.42	12.31	17.89	0.02	-0.01	-4.55%	0.01	2.33%	1.21	8.95%	0.01	0.06%	0.00	0.00%
	4136*	0.16	0.41	11.99	17.89	0.02	0.18	0.40	10.29	17.88	0.02	-0.02	-12.50%	0.01	2.44%	1.70	14.18%	0.01	0.06%	0.00	0.00%
	4119	0.14	0.36	6.52	17.85	0.05	0.15	0.35	6.04	17.84	0.05	-0.01	-7.14%	0.01	2.78%	0.48	7.36%	0.01	0.06%	0.00	0.00%
	4095	0.19	0.35	9.70	17.83	0.03	0.18	0.34	9.50	17.82	0.03	0.01	5.26%	0.01	2.86%	0.20	2.06%	0.01	0.06%	0.00	0.00%
	4049*	0.19	0.36	10.91	17.81	0.02	0.18	0.35	10.76	17.80	0.02	0.01	5.26%	0.01	2.78%	0.15	1.37%	0.01	0.06%	0.00	0.00%
	4002*	0.22	0.38	11.12	17.81	0.02	0.21	0.37	10.98	17.80	0.02	0.01	4.55%	0.01	2.63%	0.14	1.26%	0.01	0.06%	0.00	0.00%
	3956	0.25	0.40	11.98	17.80	0.02	0.24	0.39	11.79	17.79	0.02	0.01	4.00%	0.01	2.50%	0.19	1.59%	0.01	0.06%	0.00	0.00%
	3906*	0.27	0.43	14.07	17.80	0.01	0.27	0.43	13.90	17.79	0.01	0.00	0.00%	0.00	0.00%	0.17	1.21%	0.01	0.06%	0.00	0.00%
	3857*	0.29	0.47	16.27	17.80	0.01	0.29	0.47	16.13	17.79	0.01	0.00	0.00%	0.00	0.00%	0.14	0.86%	0.01	0.06%	0.00	0.00%
	3807*	0.32	0.51	18.53	17.80	0.01	0.31	0.50	18.41	17.79	0.01	0.01	3.13%	0.01	1.96%	0.12	0.65%	0.01	0.06%	0.00	0.00%
	3757	0.34	0.55	20.82	17.80	0.01	0.34	0.54	20.71	17.79	0.01	0.00	0.00%	0.01	1.82%	0.11	0.53%	0.01	0.06%	0.00	0.00%
	3729	0.18	0.42	4.85	17.80	0.05	0.19	0.41	4.64	17.79	0.05	-0.01	-5.56%	0.01	2.38%	0.21	4.33%	0.01	0.06%	0.00	0.00%
	3717	0.11	0.27	4.75	17.77	0.09	0.11	0.27	4.56	17.76	0.09	0.00	0.00%	0.00	0.00%	0.19	4.00%	0.01	0.06%	0.00	0.00%
	3691*	0.13	0.28	3.19	17.61	0.11	0.12	0.27	3.07	17.60	0.11	0.01	7.69%	0.01	3.57%	0.12	3.76%	0.01	0.06%	0.00	0.00%
	3665	0.20	0.33	2.55	17.48	0.09	0.20	0.32	2.41	17.47	0.09	0.00	0.00%	0.01	3.03%	0.14	5.49%	0.01	0.06%	0.00	0.00%
	3643	0.18	0.42	2.91	17.41	0.09	0.17	0.41	2.71	17.40	0.09	0.01	5.56%	0.01	2.38%	0.20	6.87%	0.01	0.06%	0.00	0.00%
	3611	0.40	0.53	0.74	17.25	0.16	0.39	0.51	0.73	17.23	0.15	0.01	2.50%	0.02	3.77%	0.01	1.35%	0.02	0.12%	0.01	6.25%
	3565	0.19	0.32	6.86	17.19	0.04	0.19	0.31	6.43	17.18	0.04	0.00	0.00%	0.01	3.13%	0.43	6.27%	0.01	0.06%	0.00	0.00%
	3556*	0.20	0.34	6.86	17.19	0.04	0.19	0.32	6.50	17.17	0.03	0.01	5.00%	0.02	5.88%	0.36	5.25%	0.02	0.12%	0.01	25.00%
	3547*	0.18	0.35	7.35	17.18	0.03	0.20	0.34	6.35	17.17	0.03	-0.02	-11.11%	0.01	2.86%	1.00	13.61%	0.01	0.06%	0.00	0.00%
	3538*	0.20	0.37	6.89	17.18	0.04	0.19	0.36	6.57	17.17	0.03	0.01	5.00%	0.01	2.70%	0.32	4.64%	0.01	0.06%	0.01	25.00%
	3528*	0.21	0.39	6.33	17.18	0.04	0.20	0.37	6.04	17.16	0.03	0.01	4.76%	0.02	5.13%	0.29	4.58%	0.02	0.12%	0.01	25.00%
	3519*	0.22	0.40	5.72	17.17	0.04	0.21	0.39	5.46	17.16	0.04	0.01	4.55%	0.01	2.50%	0.26	4.55%	0.01	0.06%	0.00	0.00%
	3510*	0.22	0.42	5.05	17.17	0.04	0.22	0.40	4.83	17.15	0.04	0.00	0.00%	0.02	4.76%	0.22	4.36%	0.02	0.12%	0.00	0.00%
	3501*	0.23	0.43	4.30	17.16	0.05	0.23	0.42	4.12	17.15	0.05	0.00	0.00%	0.01	2.33%	0.18	4.19%	0.01	0.06%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment October—0.047 m^3/s					2024 Assessment October—0.043 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 1 *(cont'd)*	3492*	0.23	0.44	3.48	17.15	0.06	0.23	0.43	3.34	17.14	0.06	0.00	0.00%	0.01	2.27%	0.14	4.02%	0.01	0.06%	0.00	0.00%
	3483	0.22	0.45	2.62	17.15	0.08	0.22	0.44	2.51	17.13	0.08	0.00	0.00%	0.01	2.22%	0.11	4.20%	0.02	0.12%	0.00	0.00%
	3474*	0.21	0.43	2.52	17.14	0.09	0.21	0.42	2.41	17.12	0.09	0.00	0.00%	0.01	2.33%	0.11	4.37%	0.02	0.12%	0.00	0.00%
	3464*	0.20	0.40	2.39	17.13	0.10	0.20	0.39	2.28	17.11	0.09	0.00	0.00%	0.01	2.50%	0.11	4.60%	0.02	0.12%	0.01	10.00%
	3455*	0.19	0.37	2.23	17.11	0.11	0.19	0.36	2.10	17.10	0.11	0.00	0.00%	0.01	2.70%	0.13	5.83%	0.01	0.06%	0.00	0.00%
	3446*	0.20	0.34	1.95	17.10	0.12	0.20	0.32	1.82	17.08	0.12	0.00	0.00%	0.02	5.88%	0.13	6.67%	0.02	0.12%	0.00	0.00%
Reach 2	3436	0.16	0.26	1.70	17.04	0.17	0.15	0.25	1.65	17.03	0.17	0.01	6.25%	0.01	3.85%	0.05	2.94%	0.01	0.06%	0.00	0.00%
	3429*	0.22	0.33	1.18	16.77	0.18	0.21	0.32	1.15	16.76	0.18	0.01	4.55%	0.01	3.03%	0.03	2.54%	0.01	0.06%	0.00	0.00%
	3422	0.26	0.66	1.77	16.76	0.10	0.26	0.65	1.68	16.75	0.10	0.00	0.00%	0.01	1.52%	0.09	5.08%	0.01	0.06%	0.00	0.00%
	3414*	0.25	0.58	1.60	16.76	0.12	0.25	0.56	1.49	16.74	0.12	0.00	0.00%	0.02	3.45%	0.11	6.88%	0.02	0.12%	0.00	0.00%
	3406*	0.24	0.49	1.33	16.75	0.15	0.25	0.47	1.22	16.74	0.14	-0.01	-4.17%	0.02	4.08%	0.11	8.27%	0.01	0.06%	0.01	6.67%
	3399*	0.25	0.39	0.99	16.74	0.19	0.26	0.38	0.89	16.73	0.18	-0.01	-4.00%	0.01	2.56%	0.10	10.10%	0.01	0.06%	0.01	5.26%
	3391	0.20	0.27	0.83	16.70	0.29	0.19	0.26	0.81	16.69	0.28	0.01	5.00%	0.01	3.70%	0.02	2.41%	0.01	0.06%	0.01	3.45%
	3390*	0.19	0.30	0.96	16.61	0.26	0.18	0.29	0.94	16.59	0.25	0.01	5.26%	0.01	3.33%	0.02	2.08%	0.02	0.12%	0.01	3.85%
	3389	0.18	0.34	1.07	16.51	0.25	0.17	0.33	1.05	16.50	0.24	0.01	5.56%	0.01	2.94%	0.02	1.87%	0.01	0.06%	0.01	4.00%
	3388*	0.17	0.37	1.14	16.43	0.24	0.16	0.36	1.10	16.41	0.24	0.01	5.88%	0.01	2.70%	0.04	3.51%	0.02	0.12%	0.00	0.00%
	3387*	0.20	0.43	1.12	16.35	0.21	0.19	0.41	1.06	16.33	0.22	0.01	5.00%	0.02	4.65%	0.06	5.36%	0.02	0.12%	-0.01	-4.76%
	3386*	0.23	0.51	1.20	16.30	0.17	0.22	0.48	1.14	16.28	0.17	0.01	4.35%	0.03	5.88%	0.06	5.00%	0.02	0.12%	0.00	0.00%
	3385*	0.28	0.61	1.37	16.28	0.12	0.27	0.58	1.30	16.26	0.12	0.01	3.57%	0.03	4.92%	0.07	5.11%	0.02	0.12%	0.00	0.00%
	3384*	0.32	0.72	1.60	16.27	0.09	0.32	0.70	1.51	16.24	0.09	0.00	0.00%	0.02	2.78%	0.09	5.63%	0.03	0.18%	0.00	0.00%
	3383	0.37	0.84	1.84	16.26	0.07	0.37	0.82	1.76	16.24	0.07	0.00	0.00%	0.02	2.38%	0.08	4.35%	0.02	0.12%	0.00	0.00%
	3337*	0.30	0.68	2.39	16.12	0.06	0.29	0.66	2.32	16.10	0.06	0.01	3.33%	0.02	2.94%	0.07	2.93%	0.02	0.12%	0.00	0.00%
	3290	0.35	0.62	3.28	16.07	0.04	0.35	0.60	3.07	16.04	0.04	0.00	0.00%	0.02	3.23%	0.21	6.40%	0.03	0.19%	0.00	0.00%
	3245*	0.39	0.71	2.51	16.05	0.05	0.38	0.69	2.47	16.02	0.05	0.01	2.56%	0.02	2.82%	0.04	1.59%	0.03	0.19%	0.00	0.00%
	3200	0.40	0.80	2.37	16.03	0.05	0.43	0.78	2.06	16.01	0.05	-0.03	-7.50%	0.02	2.50%	0.31	13.08%	0.02	0.12%	0.00	0.00%
	3160*	0.33	0.72	2.65	16.01	0.05	0.38	0.70	2.12	15.99	0.05	-0.05	-15.15%	0.02	2.78%	0.53	20.00%	0.02	0.12%	0.00	0.00%
	3119*	0.29	0.63	2.60	15.99	0.06	0.33	0.61	2.14	15.97	0.06	-0.04	-13.79%	0.02	3.17%	0.46	17.69%	0.02	0.13%	0.00	0.00%
	3079*	0.27	0.52	2.21	15.95	0.08	0.26	0.50	2.09	15.93	0.08	0.01	3.70%	0.02	3.85%	0.12	5.43%	0.02	0.13%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment October—0.047 m^3/s					2024 Assessment October—0.043 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 3	3038	0.19	0.32	1.39	15.82	0.18	0.19	0.31	1.30	15.81	0.18	0.00	0.00%	0.01	3.13%	0.09	6.47%	0.01	0.06%	0.00	0.00%
	2995	0.23	0.43	1.81	15.69	0.11	0.23	0.41	1.72	15.68	0.11	0.00	0.00%	0.02	4.65%	0.09	4.97%	0.01	0.06%	0.00	0.00%
	2951*	0.16	0.32	2.05	15.59	0.15	0.16	0.32	1.95	15.58	0.14	0.00	0.00%	0.00	0.00%	0.10	4.88%	0.01	0.06%	0.01	6.67%
	2907	0.05	0.15	12.86	15.41	0.10	0.05	0.14	11.71	15.40	0.10	0.00	0.00%	0.01	6.67%	1.15	8.94%	0.01	0.06%	0.00	0.00%
	2899*	0.10	0.23	2.16	15.35	0.22	0.10	0.22	2.08	15.34	0.21	0.00	0.00%	0.01	4.35%	0.08	3.70%	0.01	0.07%	0.01	4.55%
	2891*	0.12	0.25	1.70	15.23	0.24	0.11	0.24	1.61	15.22	0.24	0.01	8.33%	0.01	4.00%	0.09	5.29%	0.01	0.07%	0.00	0.00%
	2884*	0.15	0.31	1.77	15.16	0.18	0.15	0.30	1.64	15.14	0.18	0.00	0.00%	0.01	3.23%	0.13	7.34%	0.02	0.13%	0.00	0.00%
	2876	0.19	0.43	2.31	15.14	0.11	0.19	0.42	2.19	15.12	0.10	0.00	0.00%	0.01	2.33%	0.12	5.19%	0.02	0.13%	0.01	9.09%
	2830*	0.13	0.41	3.42	15.04	0.10	0.14	0.40	3.07	15.03	0.10	-0.01	-7.69%	0.01	2.44%	0.35	10.23%	0.01	0.07%	0.00	0.00%
	2783*	0.12	0.36	3.84	14.93	0.10	0.12	0.36	3.72	14.92	0.10	0.00	0.00%	0.00	0.00%	0.12	3.12%	0.01	0.07%	0.00	0.00%
	2737*	0.13	0.32	3.56	14.81	0.10	0.12	0.31	3.46	14.80	0.10	0.01	7.69%	0.01	3.13%	0.10	2.81%	0.01	0.07%	0.00	0.00%
	2691*	0.15	0.28	2.87	14.70	0.11	0.15	0.27	2.79	14.69	0.11	0.00	0.00%	0.01	3.57%	0.08	2.79%	0.01	0.07%	0.00	0.00%
	2645	0.16	0.24	1.89	14.59	0.16	0.16	0.23	1.80	14.58	0.15	0.00	0.00%	0.01	4.17%	0.09	4.76%	0.01	0.07%	0.01	6.25%
	2606*	0.14	0.26	2.40	14.48	0.14	0.14	0.25	2.20	14.47	0.14	0.00	0.00%	0.01	3.85%	0.20	8.33%	0.01	0.07%	0.00	0.00%
	2566*	0.14	0.30	2.55	14.37	0.13	0.13	0.29	2.45	14.36	0.13	0.01	7.14%	0.01	3.33%	0.10	3.92%	0.01	0.07%	0.00	0.00%
	2527*	0.08	0.35	6.26	14.29	0.11	0.08	0.34	5.28	14.28	0.11	0.00	0.00%	0.01	2.86%	0.98	15.65%	0.01	0.07%	0.00	0.00%
	2488	0.05	0.43	29.68	14.23	0.05	0.05	0.43	28.58	14.23	0.04	0.00	0.00%	0.00	0.00%	1.10	3.71%	0.00	0.00%	0.01	20.00%
	2440*	0.05	0.43	30.22	14.17	0.04	0.05	0.42	27.92	14.16	0.04	0.00	0.00%	0.01	2.33%	2.30	7.61%	0.01	0.07%	0.00	0.00%
	2392*	0.05	0.41	29.48	14.10	0.05	0.06	0.40	17.90	14.08	0.06	-0.01	-20.00%	0.01	2.44%	11.58	39.28%	0.02	0.14%	-0.01	-20.00%
	2344*	0.07	0.39	12.62	14.02	0.06	0.08	0.38	9.51	14.00	0.06	-0.01	-14.29%	0.01	2.56%	3.11	24.64%	0.02	0.14%	0.00	0.00%
	2296*	0.15	0.36	4.61	13.93	0.07	0.17	0.35	3.97	13.92	0.07	-0.02	-13.33%	0.01	2.78%	0.64	13.88%	0.01	0.07%	0.00	0.00%
	2248*	0.16	0.30	3.64	13.81	0.08	0.16	0.29	3.52	13.80	0.08	0.00	0.00%	0.01	3.33%	0.12	3.30%	0.01	0.07%	0.00	0.00%
	2200*	0.15	0.26	3.50	13.72	0.09	0.14	0.25	3.43	13.71	0.09	0.01	6.67%	0.01	3.85%	0.07	2.00%	0.01	0.07%	0.00	0.00%
	2152*	0.17	0.27	3.81	13.66	0.07	0.16	0.26	3.71	13.65	0.07	0.01	5.88%	0.01	3.70%	0.10	2.62%	0.01	0.07%	0.00	0.00%
Reach 4	2104	0.20	0.30	4.34	13.64	0.05	0.20	0.29	4.26	13.63	0.05	0.00	0.00%	0.01	3.33%	0.08	1.84%	0.01	0.07%	0.00	0.00%
	2077*	0.13	0.31	8.72	13.63	0.04	0.13	0.30	8.60	13.62	0.04	0.00	0.00%	0.01	3.23%	0.12	1.38%	0.01	0.07%	0.00	0.00%
	2050	0.07	0.31	11.34	13.61	0.06	0.07	0.30	10.29	13.60	0.06	0.00	0.00%	0.01	3.23%	1.05	9.26%	0.01	0.07%	0.00	0.00%
	2002*	0.11	0.41	5.78	13.54	0.07	0.11	0.40	5.36	13.53	0.07	0.00	0.00%	0.01	2.44%	0.42	7.27%	0.01	0.07%	0.00	0.00%
	1954	0.22	0.53	2.30	13.48	0.09	0.21	0.52	2.22	13.47	0.09	0.01	4.55%	0.01	1.89%	0.08	3.48%	0.01	0.07%	0.00	0.00%
	1911*	0.13	0.49	4.28	13.42	0.09	0.13	0.48	3.90	13.41	0.09	0.00	0.00%	0.01	2.04%	0.38	8.88%	0.01	0.07%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment October—0.047 m^3/s					2024 Assessment October—0.043 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 4 *(cont'd)*	1868*	0.13	0.44	4.14	13.35	0.08	0.13	0.43	3.89	13.34	0.08	0.00	0.00%	0.01	2.27%	0.25	6.04%	0.01	0.07%	0.00	0.00%
	1825*	0.16	0.40	3.33	13.28	0.09	0.15	0.39	3.19	13.27	0.09	0.01	6.25%	0.01	2.50%	0.14	4.20%	0.01	0.08%	0.00	0.00%
	1783	0.16	0.32	1.96	13.19	0.15	0.15	0.31	1.89	13.18	0.15	0.01	6.25%	0.01	3.13%	0.07	3.57%	0.01	0.08%	0.00	0.00%
	1736*	0.17	0.34	1.83	13.00	0.15	0.16	0.33	1.75	12.99	0.15	0.01	5.88%	0.01	2.94%	0.08	4.37%	0.01	0.08%	0.00	0.00%
	1689*	0.18	0.36	1.70	12.81	0.15	0.18	0.34	1.56	12.80	0.16	0.00	0.00%	0.02	5.56%	0.14	8.24%	0.01	0.08%	-0.01	-6.67%
	1642*	0.19	0.37	1.48	12.62	0.16	0.21	0.35	1.27	12.60	0.16	-0.02	-10.53%	0.02	5.41%	0.21	14.19%	0.02	0.16%	0.00	0.00%
	1596	0.25	0.39	1.13	12.43	0.17	0.24	0.37	1.10	12.41	0.17	0.01	4.00%	0.02	5.13%	0.03	2.65%	0.02	0.16%	0.00	0.00%
	1555*	0.17	0.33	1.99	12.29	0.14	0.19	0.31	1.62	12.27	0.14	-0.02	-11.76%	0.02	6.06%	0.37	18.59%	0.02	0.16%	0.00	0.00%
	1514*	0.13	0.27	3.05	12.15	0.12	0.13	0.26	2.85	12.14	0.12	0.00	0.00%	0.01	3.70%	0.20	6.56%	0.01	0.08%	0.00	0.00%
	1472*	0.10	0.23	5.14	12.04	0.09	0.10	0.23	4.71	12.03	0.09	0.00	0.00%	0.00	0.00%	0.43	8.37%	0.01	0.08%	0.00	0.00%
	1431*	0.07	0.14	5.09	11.86	0.13	0.07	0.13	4.90	11.85	0.13	0.00	0.00%	0.01	7.14%	0.19	3.73%	0.01	0.08%	0.00	0.00%
	1432	0.08	0.14	3.57	11.77	0.16	0.08	0.13	3.47	11.76	0.16	0.00	0.00%	0.01	7.14%	0.10	2.80%	0.01	0.08%	0.00	0.00%
	1414*	0.08	0.13	3.40	11.67	0.17	0.08	0.13	3.33	11.66	0.17	0.00	0.00%	0.00	0.00%	0.07	2.06%	0.01	0.09%	0.00	0.00%
	1405*	0.11	0.17	3.91	11.62	0.11	0.10	0.17	3.82	11.61	0.11	0.01	9.09%	0.00	0.00%	0.09	2.30%	0.01	0.09%	0.00	0.00%
	1396*	0.18	0.26	4.49	11.61	0.06	0.17	0.25	4.45	11.60	0.06	0.01	5.56%	0.01	3.85%	0.04	0.89%	0.01	0.09%	0.00	0.00%
	1387*	0.25	0.35	4.97	11.61	0.04	0.24	0.34	4.93	11.60	0.04	0.01	4.00%	0.01	2.86%	0.04	0.80%	0.01	0.09%	0.00	0.00%
	1379*	0.32	0.44	5.44	11.61	0.03	0.32	0.43	5.39	11.60	0.03	0.00	0.00%	0.01	2.27%	0.05	0.92%	0.01	0.09%	0.00	0.00%
Reach 5	1370	0.39	0.53	5.92	11.61	0.02	0.38	0.52	5.87	11.60	0.02	0.01	2.56%	0.01	1.89%	0.05	0.84%	0.01	0.09%	0.00	0.00%
	1326*	0.36	0.50	5.41	11.60	0.02	0.36	0.50	5.36	11.60	0.02	0.00	0.00%	0.00	0.00%	0.05	0.92%	0.00	0.00%	0.00	0.00%
	1282*	0.34	0.48	4.90	11.60	0.03	0.33	0.47	4.85	11.59	0.03	0.01	2.94%	0.01	2.08%	0.05	1.02%	0.01	0.09%	0.00	0.00%
	1238*	0.31	0.45	4.38	11.60	0.03	0.30	0.44	4.34	11.59	0.03	0.01	3.23%	0.01	2.22%	0.04	0.91%	0.01	0.09%	0.00	0.00%
	1194*	0.23	0.42	4.75	11.59	0.04	0.27	0.41	3.82	11.59	0.04	-0.04	-17.39%	0.01	2.38%	0.93	19.58%	0.00	0.00%	0.00	0.00%
	1151*	0.08	0.38	12.38	11.59	0.06	0.08	0.38	10.51	11.58	0.05	0.00	0.00%	0.00	0.00%	1.87	15.11%	0.01	0.09%	0.01	16.67%
	1107*	0.05	0.34	19.13	11.57	0.07	0.05	0.33	17.27	11.56	0.07	0.00	0.00%	0.01	2.94%	1.86	9.72%	0.01	0.09%	0.00	0.00%
	1063	0.03	0.26	14.65	11.51	0.15	0.03	0.26	12.26	11.51	0.15	0.00	0.00%	0.00	0.00%	2.39	16.31%	0.00	0.00%	0.00	0.00%
	1029*	0.13	0.28	2.41	11.37	0.14	0.14	0.27	2.12	11.36	0.14	-0.01	-7.69%	0.01	3.57%	0.29	12.03%	0.01	0.09%	0.00	0.00%
	995*	0.16	0.37	3.38	11.29	0.09	0.15	0.36	3.28	11.27	0.09	0.01	6.25%	0.01	2.70%	0.10	2.96%	0.02	0.18%	0.00	0.00%
	961	0.22	0.52	4.82	11.27	0.04	0.21	0.51	4.72	11.26	0.04	0.01	4.55%	0.01	1.92%	0.10	2.07%	0.01	0.09%	0.00	0.00%
	913*	0.21	0.49	4.77	11.26	0.05	0.20	0.48	4.57	11.25	0.05	0.01	4.76%	0.01	2.04%	0.20	4.19%	0.01	0.09%	0.00	0.00%
	864*	0.20	0.46	4.58	11.24	0.05	0.19	0.45	4.42	11.23	0.05	0.01	5.00%	0.01	2.17%	0.16	3.49%	0.01	0.09%	0.00	0.00%

Reach	Cross-Section	HEC-RAS Output: Without Project Conditions					HEC-RAS Output: With Project Conditions					Change									
		2024 Assessment October—0.047 m^3/s					2024 Assessment October—0.043 m^3/s														
		Average Depth (m)[a]	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)[c]	Average Depth (m)	Maximum Depth (m)	Top Width (m)	WSEL[b] (m)	Average Velocity (m/s)	Average Depth (m)	Average Depth (%)	Maximum Depth (m)	Maximum Depth (%)	Top Width (m)	Top Width (%)	WSEL (m)	WSEL (%)	Average Velocity (m/s)	Average Velocity (%)
Reach 5 *(cont'd)*	816*	0.18	0.42	4.42	11.22	0.06	0.18	0.41	4.14	11.21	0.06	0.00	0.00%	0.01	2.38%	0.28	6.33%	0.01	0.09%	0.00	0.00%
	767*	0.17	0.37	4.00	11.19	0.07	0.17	0.36	3.74	11.18	0.07	0.00	0.00%	0.01	2.70%	0.26	6.50%	0.01	0.09%	0.00	0.00%
	719	0.14	0.29	3.15	11.13	0.11	0.13	0.28	3.04	11.11	0.11	0.01	7.14%	0.01	3.45%	0.11	3.49%	0.02	0.18%	0.00	0.00%
	689*	0.18	0.36	2.11	11.05	0.13	0.17	0.35	2.01	11.03	0.12	0.01	5.56%	0.01	2.78%	0.10	4.74%	0.02	0.18%	0.01	7.69%
	660	0.19	0.30	0.61	10.83	0.41	0.19	0.29	0.60	10.83	0.39	0.00	0.00%	0.01	3.33%	0.01	1.64%	0.00	0.00%	0.02	4.88%
	642	0.13	0.28	2.10	10.73	0.17	0.13	0.27	2.00	10.72	0.17	0.00	0.00%	0.01	3.57%	0.10	4.76%	0.01	0.09%	0.00	0.00%
	598*	0.17	0.37	1.65	10.65	0.16	0.16	0.35	1.62	10.63	0.16	0.01	5.88%	0.02	5.41%	0.03	1.82%	0.02	0.19%	0.00	0.00%
	555*	0.21	0.46	1.48	10.57	0.15	0.20	0.45	1.47	10.56	0.15	0.01	4.76%	0.01	2.17%	0.01	0.68%	0.01	0.09%	0.00	0.00%
	512*	0.25	0.57	1.34	10.52	0.14	0.24	0.56	1.33	10.50	0.13	0.01	4.00%	0.01	1.75%	0.01	0.75%	0.02	0.19%	0.01	7.14%
	468	0.26	0.65	1.17	10.42	0.16	0.24	0.63	1.16	10.41	0.15	0.02	7.69%	0.02	3.08%	0.01	0.85%	0.01	0.10%	0.01	6.25%
	447	0.18	0.27	1.36	10.24	0.20	0.17	0.27	1.35	10.23	0.19	0.01	5.56%	0.00	0.00%	0.01	0.74%	0.01	0.10%	0.01	5.00%
	419	0.10	0.14	1.23	9.71	0.39	0.09	0.13	1.17	9.70	0.41	0.01	10.00%	0.01	7.14%	0.06	4.88%	0.01	0.10%	-0.02	-5.13%
	396	0.35	0.39	0.40	9.58	0.33	0.34	0.38	0.40	9.56	0.32	0.01	2.86%	0.01	2.56%	0.00	0.00%	0.02	0.21%	0.01	3.03%
	373	0.23	0.48	1.53	9.53	0.14	0.27	0.47	1.23	9.51	0.13	-0.04	-17.39%	0.01	2.08%	0.30	19.61%	0.02	0.21%	0.01	7.14%
	340	0.22	0.33	1.75	9.46	0.12	0.21	0.32	1.73	9.45	0.12	0.01	4.55%	0.01	3.03%	0.02	1.14%	0.01	0.11%	0.00	0.00%
	300	0.13	0.20	3.54	9.34	0.10	0.13	0.20	3.48	9.34	0.10	0.00	0.00%	0.00	0.00%	0.06	1.69%	0.00	0.00%	0.00	0.00%
	284*	0.13	0.23	3.63	9.25	0.10	0.12	0.23	3.56	9.24	0.10	0.01	7.69%	0.00	0.00%	0.07	1.93%	0.01	0.11%	0.00	0.00%
	267*	0.13	0.26	3.67	9.15	0.10	0.12	0.25	3.58	9.14	0.10	0.01	7.69%	0.01	3.85%	0.09	2.45%	0.01	0.11%	0.00	0.00%
	251*	0.15	0.32	3.95	9.08	0.08	0.15	0.31	3.83	9.07	0.08	0.00	0.00%	0.01	3.13%	0.12	3.04%	0.01	0.11%	0.00	0.00%
	235*	0.21	0.43	4.70	9.06	0.05	0.20	0.42	4.58	9.04	0.05	0.01	4.76%	0.01	2.33%	0.12	2.55%	0.02	0.22%	0.00	0.00%
	218	0.26	0.54	5.46	9.04	0.03	0.25	0.52	5.35	9.02	0.03	0.01	3.85%	0.02	3.70%	0.11	2.01%	0.02	0.22%	0.00	0.00%
	178*	0.22	0.46	11.07	8.99	0.02	0.22	0.45	10.85	8.98	0.02	0.00	0.00%	0.01	2.17%	0.22	1.99%	0.01	0.11%	0.00	0.00%
	137*	0.19	0.40	17.10	8.96	0.01	0.19	0.39	16.76	8.95	0.01	0.00	0.00%	0.01	2.50%	0.34	1.99%	0.01	0.11%	0.00	0.00%
	97*	0.17	0.35	23.61	8.95	0.01	0.16	0.34	23.34	8.94	0.01	0.01	5.88%	0.01	2.86%	0.27	1.14%	0.01	0.11%	0.00	0.00%
	56*	0.15	0.30	30.30	8.93	0.01	0.14	0.29	30.00	8.92	0.01	0.01	6.67%	0.01	3.33%	0.30	0.99%	0.01	0.11%	0.00	0.00%
	16	0.12	0.25	37.02	8.91	0.01	0.12	0.24	36.69	8.90	0.01	0.00	0.00%	0.01	4.00%	0.33	0.89%	0.01	0.11%	0.00	0.00%
Average		**0.20**	**0.39**	**6.21**	**14.17**	**0.10**	**0.20**	**0.38**	**5.84**	**14.15**	**0.10**	**0.00**	**0.85%**	**0.01**	**2.81%**	**0.37**	**5.90%**	**0.01**	**0.09%**	**0.00**	**1.36%**

Notes:

* Interpolated cross-sections.

[a] m = metres.

[b] WSEL = water surface elevation.

[c] m/s = metres per second.

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MEMO

TO	Lisa Mah, Permitting Specialist - Water, Agnico Eagle Mines Limited Sam Gordon, Permitting Specialist – Aquatics, Agnico Eagle Mines Limited
FROM	Matt Friend, Managing Technical Consultant, ERM Consultants Canada Ltd. Cameron Evans, Managing Technical Consultant, ERM Consultants Canada Ltd. Kirby Ottenbreit, Principal Technical Consultant, ERM Consultants Canada Ltd. Kevin Murphy, Project Manager, ERM Consultants Canada Ltd. Craig Neufeld, Partner, ERM Consultants Canada Ltd.
DATE	8 July 2025
REFERENCE	0738135
SUBJECT	Analysis of Increased Water Withdrawals at Hope Bay

1. INTRODUCTION

ERM Consultants Canada Ltd. (ERM) understands that Agnico Eagle Mines Limited (Agnico Eagle) seeks to restart operations at the Hope Bay Mine (the Mine) in the near future using underground mining methods. Agnico Eagle anticipates water needs of 2,856,940 m^3/year, a volume that exceeds the currently permitted volume under Agnico Eagle's existing Water Licences. Three lakes have been identified as potential water sources; Doris Lake, Patch Lake, and Windy Lake. Each lake is located near the Mine area and Agnico Eagle has existing Water Licences associated with each lake. As Agnico Eagle prepares for the restart of operational activities at the Mine, Agnico Eagle seeks to understand additional water withdrawal capacity from Windy Lake, Patch Lake, and Doris Lake, and how those withdrawals would affect the hydrologic system and fish habitat of these three lakes and their outflows. Effects to other lakes and outflows have not been incorporated.

The intent of this memorandum is to assess how water withdrawals from Doris Lake, Patch Lake, and Windy Lake affect the hydrologic system by using a water balance and hydraulic models. Results of the hydrologic assessment are then used to assess how water withdrawals affect fish habitat using Fisheries and Oceans Canada (DFO) guidance and methods used during development of the Mine's Final Environmental Impact Statement (FEIS).

1.1 BACKGROUND

The Mine comprises the Doris North Mine and the Madrid-Boston project. The Mine is currently under Care and Maintenance. Miramar Resources Ltd. permitted Doris North in 2006 with Nunavut Impact Review Board (NIRB) Certificate 003 while TMAC Resources permitted Madrid-Boston in 2018 per NIRB Certificate 009. The Mine operates under a Framework Agreement with the Kitikmeot Inuit Association (KitIA) and Type A Water Licences, 2AM DOH1335 (for Doris and Madrid Developments), and 2AM BOS1835 (for Boston Development). In 2021, Agnico Eagle purchased the Mine. Approved water withdrawal volumes are provided in Table 1-1.

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TABLE 1-1 APPROVED WATER WITHDRAWALS

Source	Approved Amount (m^3/year)	Water Licence No.
Doris Lake	1,930,000	2AM-DOH1335
Patch Lake	103,000	2BB-MAE1727
Windy Lake	43,800	2AM-DOH1335
Total	2,076,800	NA

Water Licence No. 2AM-DOH1335 (Amendment No. 2) was issued to TMAC Resources Inc. Under this Water Licence, fresh water supplies from Windy Lake are permitted to be withdrawn at a volume not exceeding 43,800 cubic metres (m^3) per year, with water to be used for domestic camp use. Also permitted under this Water Licence are fresh water supplies withdrawn at a volume not exceeding 1,930,000 m^3 per year from Doris Lake for mining, milling, and associated industrial uses. Water Licence No. 2BB-MAE1727 (Amendment No. 2) allows for withdrawals of up to 103,000 m^3 per year from Patch Lake for industrial use, including drilling (surface, underground, quarry), dust suppression, and ice roads.

2. HYDROLOGY ANALYSIS

2.1 METHODOLOGY

2.1.1 WATER BALANCE

ERM developed a water balance model to assess how proposed water withdrawals from Doris Lake, Patch Lake, and Windy Lake affect the storage volume and water level of each lake, and how those changes affect discharge rates in the lake outflows. The water balance model was constructed using GoldSim 14.0 modelling software. It was run on a daily timestep using site baseline hydrometric data collected as part of the Mine's baseline and compliance monitoring programs.

To compare how the withdrawals affect the assessed hydrologic parameters, ERM developed a "without Mine" and a "with Mine" version of the model. The without Mine version incorporates components of the natural system, while the Mine version builds on the natural system with components introduced by Mine development, specifically direct water withdrawals and losses to the underground Mine through the talik system.

The model is based on the principle of mass balance. A body of water is modelled by the "reservoir" element in the model. Water quantity mass balance is maintained: the change in volume of the body of water is equal to the difference between the sum of the inflows to the body of water and the sum of the outflows from it (GoldSim Technology Group 2021).

The water balance model was built to represent an average year, where lake inflows and outflows are assumed to be in equilibrium. This allows the 10-years of cumulative hydrometric data from the outflow to also be used to determine average net lake inflows. The relationship between lake water levels and outflow streamflow rates was established using rating curves developed as part

of the Aquatic Effects Monitoring Program (AEMP) (ERM 2023). In addition to the lake outflows, for the With Mine scenario, additional outputs from the lakes include losses to the underground Mine through the talik system and the pumping withdrawals for the Mine.

2.1.1.1 DATA INPUTS

Bathymetry

Lake volumes and respective lake water elevations were used in the model to track impacts from the different water withdrawal scenarios. Lake volumes were determined using subsurface contours for the lakes, created from bathymetric survey information collected in 2006 and 2008 (ERM 2023). Bathymetric elevation data was tied to a geodetic datum from available surveyed water level benchmarks, at hydrometric monitoring station benchmarks, that were geodetic referenced from 2016 to 2020.

Storage Elevation Curves

Storage elevation curves were used to determine the volume of water in the lakes at a known elevation of water. A linear fit equation was used to gap fill the volume to water level relationship from August of 2006 and 2008, when the bathymetric surveys were completed, until freshet. Equations are listed below in Table 2-1. Results from the equations are listed below, in Table 2-2.

TABLE 2-1 STORAGE ELEVATION EQUATIONS

Lake	Linear Fit Equation
Patch Lake	y= 5.4246 ×-119.22 R^2=0.9997
Doris Lake	y = 3.2609 × - 43.865 R^2 = 0.9999
Windy Lake	y = 5.1995 × - 35.958 R^2 = 1

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TABLE 2-2 STORAGE ELEVATION CURVE GAP FILL RESULTS

Lake	Elevation (masl)	Volume (m^3)
Patch	26.60	25,074,360
	26.30	23,446,980
	26.05	22,090,830
	26.24	23,121,504
	26.50	24,531,900
	27.00	27,244,200
	27.50	29,956,500
	26.00	21,819,600
Doris	21.10	24,939,990
	21.40	25,918,260
	22.00	27,874,800
	22.50	29,505,250
	23.00	31,135,700
	23.50	32,766,150
Windy	18.13	58,308,935
	18.20	58,672,900
	18.28	59,088,860
	18.03	57,788,985
	18.15	58,397,327
	18.34	59,400,830
	18.50	60,232,750
	19.00	62,832,500
	19.50	65,432,250
	20.00	68,032,000
	20.50	70,631,750

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Rating Curve Equations

Site-specific rating curve equations were used to establish the relationship between lake water levels and outflow streamflow rates at each of the three lakes, and to model flow during the open water season. The rating curves for Windy Lake and Patch Lake were developed from historical monitoring data as part of the Mine's Hydrology Compliance Monitoring Program. This data were reported in the 2023 AEMP (Table 2-3; ERM 2023).

Unlike Windy Lake and Patch Lake, the outflow of Doris Lake is monitored by a separate hydrometric station and therefore a rating curve for Doris Lake itself was not available from historical monitoring data. Therefore, a linear regression between the elevation of Doris Lake and flow in Doris Creek (TL-2) was used to estimate the elevation-outflow relationship for Doris Lake.

TABLE 2-3 RATING CURVE EQUATIONS

Station	Rating Equation[1] $Q = C (h-a)^b$
Windy Outflow[1]	$Q = 5.322 (h - 18.147)^{1.869}$
Patch Outflow[1]	$Q = 2.261 (h - 25.998)^{1.765}$, when $h < 26.391$ $Q = 4.489 (h - 26.028)^{2.304}$, when $h > 26.391$
Doris Lake[2]	$Q=11.943*h -263.12$, when $h < 22.173$ $Q = 3.7129*h -80.632$, when $h > 22.173$

[1] Source: ERM 2023

[2] Regression between Doris Lake elevation and Doris Creek (TL-2) flow, with source data from ERM 2023.

Natural Inflow and Outflow

Outflow and assumed inflow streamflow data were calculated using historical data from hydrometric monitoring stations at the Doris, Patch and Windy Lake outflows (ERM 2023; Table 2-4). These data were used to develop mean daily discharges for each lake outflow, and are presented in Appendix A. Net daily inflows were calculated as the difference between the daily outflow volume and change in lake volume during baseline conditions. To mimic freeze-up conditions, natural inflows and outflows were stopped between January 01 to May 15 and November 01 to December 31.

TABLE 2-4 YEARS OF AVAILABLE MONITORED OUTFLOW DATA

Station	Years of Available data
Patch Lake Outflow	2009–2011, 2018–2023
Doris Lake Outflow	2009–2023
Windy Lake Outflow	2009–2010, 2012–2014, 2019–2023

Lake Loss to the Underground

Estimates for lake water losses through taliks were estimated as part of a hydrogeological characterization and modelling study (Gordon 2025). These estimates are included in Table 2-5.

TABLE 2-5 ESTIMATED WATER LOSSES FROM LAKE TO UNDERGROUND

Lake Name	Maximum Predicted Infiltration (m^3/year)	Maximum Predicted Infiltration (m^3/day)
Patch Lake	266,450	730
Windy Lake	3,431	9.4
Doris Lake	813,950	2,230

Source: Gordon 2025

2.1.1.2 WITHDRAWAL SCENARIOS

Agnico Eagle's anticipated water needs of 2,856,940 m^3/year represents an increase of 823,140 m^3/year above existing approved withdrawal volumes. To partition the increased water volume among Doris Lake, Patch Lake, and Windy Lake, ERM assessed multiple withdrawal scenarios using the water balance model in an iterative process. Withdrawal scenarios included different withdrawal rates using "constant-rate" year-round pumping that maximized the withdrawals from Doris Lake. This process was guided by several considerations, which were applied as applicable:

- Winter withdrawals do not exceed 10% of lake water volume; and
- Outflow streamflow rates do not decrease by more than 10%.

These considerations were not set as firm requirements, but with the understanding that exceeding them may require the need for more exhaustive assessments and/or fish habitat offsetting to obtain Water License amendments.

2.1.2 OUTFLOW MODELLING

To understand how streamflow rate changes affect hydrologic properties of the outflow, and therefore fish habitat indices, an existing HEC-RAS model was used. HEC-RAS is used to model the hydraulics of water flow through natural rivers and other channels (US ACE 2024). It can perform one-dimensional steady flow, one and two-dimensional unsteady flow calculations, sediment transport/mobile bed computations, and water temperature/water quality modelling. For this study, a one-dimension steady flow model was used.

Of the three lakes selected for proposed water withdrawals, Doris Lake and Patch Lake outflows have existing HEC-RAS models that were developed as part of the FEIS (ERM 2016a). Full details on the development of those models, including methodology and results, can be found in *Doris Lake, Doris Creek, and Little Roberts Outflow Fisheries Assessment – Hydraulic Modelling Results* (ERM 2015). Water withdrawals and other effects from the Mine were not anticipated at Windy Lake, therefore a HEC-RAS model was not developed for this location.

Based on updated water needs of the Mine, withdrawals from Doris Lake are proposed to increase, and new withdrawals from Windy Lake are proposed. Outflow modelling was performed using the results of the constant rate pumping scenario. A HEC-RAS model for the Windy Lake outflow was not developed for the FEIS, and there is insufficient data to develop one, therefore changes to hydrologic properties and fish habitat were not performed.

The existing HEC-RAS model for the Doris Lake outflow was updated with new steady flow data calculated in the water balance model. Mean monthly streamflows for the May through October open water season were input to the HEC-RAS model for baseline and constant rate, and a steady flow analysis was run for each streamflow value.

After the steady flow analyses were completed, a table of hydrologic properties required for the fish habitat assessment were extracted. These properties included wetted width, maximum water depth, and velocity, and were extracted for each transect in the model domain, and for each streamflow run through the model (i.e. mean monthly streamflow for baseline and constant rate).

2.2 RESULTS

Using total water requirements of the Mine, the iterative assessment of withdrawal volumes and pumping schemes ultimately resulted in withdrawal scenarios using constant rate schemes, as presented in Table 2-6.

The water balance model generated results for each of the three lakes included in this study (Doris Lake, Patch Lake, and Windy Lake), and for both without Mine (i.e. baseline) and with Mine (i.e. constant rate pumping) conditions. Results for modelled storage volume, water level, and outflow discharge rates were output and provided below.

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TABLE 2-6 DORIS LAKE MODELLED MEAN MONTHLY CONSTANT RATE PUMPING RATES

Month	Doris Lake (m^3/day)	Patch Lake (m^3/day)	Windy Lake (m^3/day)
January	7,225	164	438
February	7,225	164	438
March	7,225	164	438
April	7,225	164	438
May	7,225	164	438
June	7,225	164	438
July	7,225	164	438
August	7,225	164	438
September	7,225	164	438
October	7,225	164	438
November	7,225	164	438
December	7,225	164	438
Total Volume (m^3/year)	**2,637,125**	**59,860**	**159,870**
Approved Amount (m^3/year)	**1,930,000**	**103,000**	**43,800**
Additional Requirements (m^3/year)	**707,125**	**NA[1]**	**116,070**

Note:
[1] No change from approved amount.

2.2.1 CONSTANT RATE PUMPING

Results for the constant rate pumping scenario and can be found in Table 2-7 (Lake Volume Water Balance Results), Table 2-8 (Lake Water Level Water Balance Results), and Table 2-9 (Lake Outflow Discharge Rates Water Balance Results).

Winter lake water volume decreases were limited to less than 10% for all three lakes. Doris Lake experiences the largest decrease under the modelled scenario, where the maximum monthly volume

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decrease of 9.1% occurs in May. Annually, the stored water volume decreases by 2.7%. At both Patch Lake and Windy Lake, lake volume decreases are less than 1% for all months (Table 2-7).

The annual discharge at the Doris Lake outflow decreases by 31.5%. The largest monthly decrease of 43.8% occurs in June, and is caused by winter pumping from the lake decreasing water levels and delaying the start of water movement in the Doris Lake outflow. Once water starts moving in the outflow, the decrease in streamflow rate is quickly reduced to less than 10%, with July streamflow being 8.9% lower than baseline, then again progressively increases through the remaining open-water season (Table 2-8).

The annual discharge at the Patch Lake outflow decreases by 8.1%, with the largest monthly decrease of 11.9% occurring in June, while annual discharge at the Windy Lake outflow decreases by 9.0%, with the largest monthly decrease of 15.5% occurring in June. Similar to the Doris Lake outflow, this decrease is caused by winter pumping from the lake decreasing water levels and delaying the start out water movement in the outflow. For all remaining months in the open water season, streamflow reductions are modelled to be less than 10% (Table 2-9).

TABLE 2-7 CONSTANT RATE PUMPING: LAKE VOLUME WATER BALANCE RESULTS

Month	Doris Lake					Patch Lake					Windy Lake				
	Baseline (m^3)[1]	With Project (m^3)[1]	Absolute Change (m^3)	Relative Change (%)	Relative Change Under Ice (%)[2]	Baseline (m^3)[1]	With Project (m^3)[1]	Absolute Change (m^3)	Relative Change (%)	Relative Change Under Ice (%)[3]	Baseline (m^3)[1]	With Project (m^3)[1]	Absolute Change (m^3)	Relative Change (%)	Relative Change Under Ice (%)[4]
January	27,036,230	26,220,707	-815,523	-3.0	-4.0	21,839,560	21,727,078	-112,482	-0.5	-1.0	58,399,060	58,342,794	-56,266	-0.1	-0.1
February	27,036,230	25,937,058	-1,099,172	-4.1	-5.3	21,839,560	21,700,258	-139,302	-0.6	-1.2	58,399,060	58,329,203	-69,857	-0.1	-0.1
March	27,036,230	25,653,407	-1,382,823	-5.1	-6.7	21,839,560	21,673,438	-166,122	-0.8	-1.4	58,399,060	58,315,614	-83,446	-0.1	-0.2
April	27,036,230	25,365,030	-1,671,200	-6.2	-8.1	21,839,560	21,646,171	-193,389	-0.9	-1.7	58,399,060	58,301,797	-97,263	-0.2	-0.2
May	27,133,605	25,242,975	-1,890,629	-7.0	-9.1	22,188,825	21,974,182	-214,643	-1.0	-1.8	58,403,175	58,292,103	-111,072	-0.2	-0.2
June	28,245,475	27,402,800	-842,674	-3.0	NA	23,787,105	23,638,528	-148,577	-0.6	NA	59,159,988	59,063,201	-96,787	-0.2	NA
July	28,055,934	27,977,888	-78,046	-0.3	NA	24,056,891	24,011,764	-45,127	-0.2	NA	59,384,070	59,345,968	-38,102	-0.1	NA
August	27,393,584	27,291,965	-101,619	-0.4	NA	23,122,407	23,085,594	-36,814	-0.2	NA	59,112,999	59,091,220	-21,779	0.0	NA
September	27,344,801	27,241,373	-103,428	-0.4	NA	22,986,848	22,946,131	-40,716	-0.2	NA	58,978,080	58,958,681	-19,399	0.0	NA
October	27,247,721	27,142,964	-104,757	-0.4	NA	22,886,500	22,843,344	-43,157	-0.2	NA	58,804,130	58,783,774	-20,356	0.0	NA
November	27,051,598	26,808,103	-243,495	-0.9	-1.2	22,100,664	22,042,269	-58,395	-0.3	-0.5	58,471,237	58,442,381	-28,856	0.0	-0.1
December	27,036,230	26,504,357	-531,873	-2.0	-2.6	21,839,560	21,753,898	-85,662	-0.4	-0.7	58,399,060	58,356,384	-42,676	-0.1	-0.1
Average	**27,304,698**	**26,567,639**	**-737,058**	**-2.7**	**NA**	**22,529,358**	**22,422,537**	**-106,820**	**-0.5**	**NA**	**58,693,366**	**58,636,317**	**-57,048**	**-0.1**	**NA**

[1] Includes volume frozen as ice during the winter.
[2] Doris Lake assumed max ice volume is 6,438,000 m^3 which is excluded from under ice calculation.
[3] Patch Lake assumed max ice volume is 10,268,000 m^3 which is excluded from under ice calculation.
[4] Windy Lake assumed max ice volume is 10,343,000 m^3 which is excluded from under ice calculation.

TABLE 2-8 CONSTANT RATE PUMPING: LAKE WATER LEVEL WATER BALANCE RESULTS

Month	Doris Lake			Patch Lake			Windy Lake		
	Baseline (masl)	With Project (masl)	Absolute Change (m)	Baseline (masl)	With Project (masl)	Absolute Change (m)	Baseline (masl)	With Project (masl)	Absolute Change (m)
January	21.739	21.496	-0.243	26.004	25.983	-0.021	18.147	18.137	-0.011
February	21.739	21.411	-0.328	26.004	25.978	-0.026	18.147	18.134	-0.013
March	21.739	21.326	-0.413	26.004	25.973	-0.030	18.147	18.131	-0.016
April	21.739	21.239	-0.500	26.004	25.968	-0.035	18.147	18.129	-0.019
May	21.768	21.203	-0.566	26.068	26.029	-0.039	18.148	18.127	-0.021
June	22.113	21.856	-0.256	26.363	26.335	-0.027	18.294	18.275	-0.019
July	22.055	22.031	-0.024	26.412	26.404	-0.008	18.337	18.329	-0.007
August	21.848	21.816	-0.032	26.240	26.233	-0.007	18.285	18.280	-0.004
September	21.832	21.800	-0.032	26.215	26.208	-0.007	18.259	18.255	-0.004
October	21.802	21.771	-0.032	26.197	26.189	-0.008	18.225	18.221	-0.004
November	21.744	21.671	-0.072	26.052	26.041	-0.011	18.161	18.156	-0.006
December	21.739	21.581	-0.158	26.004	25.988	-0.016	18.147	18.139	-0.008
Average	**21.821**	**21.601**	**-0.221**	**26.131**	**26.111**	**-0.020**	**18.204**	**18.193**	**-0.011**

TABLE 2-9 CONSTANT RATE PUMPING: LAKE OUTFLOW DISCHARGE RATES WATER BALANCE RESULTS

Month	Doris Lake				Patch Lake				Windy Lake			
	Baseline (m^3/day)	With Project (m^3/day)	Absolute Change (m^3/day)	Relative Change (%)	Baseline (m^3/day)	With Project (m^3/day)	Absolute Change (m^3/day)	Relative Change (%)	Baseline (m^3/day)	With Project (m^3/day)	Absolute Change (m^3/day)	Relative Change (%)
January	0	0	0	NA	0	0	0	NA	0	0	0	NA
February	0	0	0	NA	0	0	0	NA	0	0	0	NA
March	0	0	0	NA	0	0	0	NA	0	0	0	NA
April	0	0	0	NA	0	0	0	NA	0	0	0	NA
May	13,710	0	-13,710	NA[1]	3,503	2,281	-1,222	NA[1]	4	0	-4	NA[1]
June	160,228	90,056	-70,172	-43.8	42,314	37,276	-5,038	-11.9	15,976	13,498	-2,478	-15.5
July	112,761	102,735	-10,026	-8.9	45,608	43,510	-2,098	-4.6	20,672	19,191	-1,481	-7.2
August	41,967	31,836	-10,131	-24.1	16,092	15,313	-780	-4.8	11,418	10,779	-638	-5.6
September	37,009	26,710	-10,299	-27.8	13,201	12,407	-794	-6.0	7,656	7,186	-470	-6.1
October	27,440	17,330	-10,110	-36.8	11,378	10,596	-782	-6.9	4,031	3,675	-356	-8.8
November	0	0	0	NA	0	0	0	NA	0	0	0	NA
December	0	0	0	NA	0	0	0	NA	0	0	0	NA
Average	**32,758**	**22,437**	**-10,321**	**-31.5**	**11,037**	**10,145**	**-892**	**-8.1**	**4,997**	**4,545**	**-452**	**-9.0**

Notes:
[1] For months of partial frozen conditions (i.e., May and November), monthly-averaged flow is misleading and therefore reported as NA.

2.2.2 DORIS OUTFLOW MODELLING

Mean monthly discharge values calculated in the water balance for the baseline and constant rate pumping scheme at Doris Outflow are presented in Table 2-9 (constant rate), and were used as the input to the HEC-RAS model. Hydrologic characteristic results of the HEC-RAS Doris Lake outflow model are included in Appendix B. These results include wetted width, average velocity, and maximum depth for each modelled cross-section in the model.

2.2.3 COMPARISON TO FINAL ENVIRONMENTAL IMPACT STATEMENT

Results of this current assessment were compared to the Mine's FEIS effects assessment to evaluate how proposed changes to water withdrawals deviate from those originally anticipated. The FEIS effects assessment was limited to examining outflow streamflow rates, while lake levels and volumes were not considered. A comparison of mean monthly and annual streamflow rates for the FEIS and the current assessment are provided in Table 2-10 for Doris Outflow, Table 2-11 for Patch Outflow, and Table 2-12 for Windy Outflow.

TABLE 2-10 DORIS LAKE OUTFLOW: COMPARISON TO FINAL ENVIRONMENTAL IMPACT STATEMENT

Month	Final Environmental Impact Statement			Current Assessment		
	Baseline (m^3/s)	With Project (m^3/s)	Relative Change (%)	Baseline (m^3/s)	With Project (m^3/s)	Relative Change (%)
January	0.000	0.000	NA	0.000	0.000	NA
February	0.000	0.000	NA	0.000	0.000	NA
March	0.000	0.000	NA	0.000	0.000	NA
April	0.000	0.000	NA	0.000	0.000	NA
May	0.000	0.000	NA	0.159	0.000	NA
June	1.943	1.204	-39.9	1.854	1.042	-43.8
July	0.638	0.509	-19.2	1.305	1.189	-8.9
August	0.344	0.281	-18.0	0.486	0.368	-24.1
September	0.345	0.283	-18.4	0.428	0.309	-27.8
October	0.196	0.130	-34.8	0.318	0.201	-36.8
November	0.005	0.006	NA[1]	0.000	0.000	NA
December	0.000	0.000	NA	0.000	0.000	NA
Average	**0.299**	**0.201**	**-31.9**	**0.379**	**0.260**	**-31.5**

Notes:
[1] For months of partial frozen conditions (i.e., May and November), monthly-averaged flow is misleading and therefore reported as NA.

TABLE 2-11 PATCH LAKE OUTFLOW: COMPARISON TO FINAL ENVIRONMENTAL IMPACT STATEMENT

Month	Final Environmental Impact Statement			Current Assessment		
	Baseline (m^3/s)	With Project (m^3/s)	Relative Change (%)	Baseline (m^3/s)	With Project (m^3/s)	Relative Change (%)
January	0.000	0.000	NA	0.000	0.000	NA
February	0.000	0.000	NA	0.000	0.000	NA
March	0.000	0.000	NA	0.000	0.000	NA
April	0.000	0.000	NA	0.000	0.000	NA
May	0.000	0.000	0.0	0.041	0.026	NA[1]
June	0.427	0.322	-28.4	0.490	0.431	-11.9
July	0.230	0.181	-19.9	0.528	0.504	-4.6
August	0.122	0.097	-18.9	0.186	0.177	-4.8
September	0.104	0.084	-18.4	0.153	0.144	-6.0
October	0.000	0.000	NA	0.132	0.123	-6.9
November	0.000	0.000	NA	0.000	0.000	NA
December	0.000	0.000	NA	0.000	0.000	NA
Average	**0.076**	**0.057**	**-23.8**	**0.128**	**0.117**	**-8.1**

Notes:
[1] For months of partial frozen conditions (i.e., May and November), monthly-averaged flow is misleading and therefore reported as NA.

At Doris Lake, the updated assessment calculated the mean annual discharge to be 27% higher than what was calculated for the FEIS, likely due to improved understanding of the Mine's hydrologic system from the availability of a much longer monitoring record. Similarly, mean annual discharge is 68% higher at Patch Outflow, and 122% higher at Windy Lake.

TABLE 2-12 WINDY LAKE OUTFLOW: COMPARISON TO FINAL ENVIRONMENTAL IMPACT STATEMENT

Month	Final Environmental Impact Statement			Current Assessment		
	Baseline (m^3/s)	With Project (m^3/s)	Relative Change (%)	Baseline (m^3/s)	With Project (m^3/s)	Relative Change (%)
January	0.000	0.000	NA	0.000	0.000	NA
February	0.000	0.000	NA	0.000	0.000	NA
March	0.000	0.000	NA	0.000	0.000	NA
April	0.000	0.000	NA	0.000	0.000	NA
May	0.000	0.000	NA	0.000	0.000	NA
June	0.183	0.178	-7.4	0.185	0.156	-15.5
July	0.079	0.072	-6.5	0.239	0.222	-7.2
August	0.027	0.023	-9.2	0.132	0.125	-5.6
September	0.025	0.022	-9.4	0.089	0.083	-6.1
October	0.000	0.000	NA	0.047	0.043	-8.8
November	0.000	0.000	NA	0.000	0.000	NA
December	0.000	0.000	NA	0.000	0.000	NA
Average	**0.026**	**0.024**	**-7.5**	**0.058**	**0.053**	**-9.0**

The percent decrease in mean annual discharge at Doris Outflow is essentially the same between the FEIS and current assessment, with mean annual streamflow modelled to decrease by 31.9% in the FEIS and 31.5% under the current assessment. Larger differences exist among mean monthly discharges, with June freshet flows modelled to be smaller under the current assessment, with additional variability in the other months with August, September and October predicted to have lower flows.

With reduced water withdrawals from Patch Lake in the current assessment, streamflow in the Patch Outflow is modelled to be larger. Mean annual discharge was modelled to decrease by 23.8% in the FEIS, while in the current assessment was modelled to decrease by 8.1%. The predicted reduction is similar to the FEIS during June, with modelled reductions of 28.3% in the current assessment and 28.4% modelled during the FEIS. The predicted mean monthly flow rates for the remainder of the open water season are higher than the FEIS.

At Windy Outflow, the current assessment results in similar decreases to streamflow as the FEIS, with the FEIS modelling decreases to mean annual discharge of 7.5%, and 9.0% for the current assessment. June and July have greater reductions in flow than the FEIS, and lower reductions for the rest of the open water season.

3. FISHERIES ANALYSIS

Impacts to fish habitat must be considered for water withdrawals in both winter and the open water seasons. During the winter frozen period, lake inputs and outputs do not occur. DFO has issued a *Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut* (DFO 2010). This protocol specifies that the "total water withdrawal from a single waterbody is not to exceed 10% of the available water volume" during one ice-covered season. This 10% allowable threshold has been applied to the stage-volume rating curve in this memo to determine allowable withdrawal volumes for each lake during the winter.

During the open water season there is no specific limit for determining allowable water withdrawals, however the impact to fish and aquatic life must be considered. The *Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada* (DFO 2013) recommends that a desktop hydrologic analysis is acceptable if water withdrawals do not reduce the instantaneous flow by more than 10%, or less than 30% of mean annual discharge (MAD). Reductions greater than this can be permitted but require a more rigorous assessment of impacts that can include hydraulic and habitat modelling.

3.1 LAKES

3.1.1 METHODS

Methods used to analyze the proposed increases in water withdrawals from Doris Lake and Windy Lake on fish habitat mirrored those used in the Madrid-Boston Project FEIS (ERM 2016a).
Two initial steps were applied using modelled changes in lake volume and modelled under ice lake surface level:

1. Where a modelled change in average annual lake volume was greater than 10% of average annual baseline volume, the change was considered to be outside of the range of natural variation and further assessment was required.
2. Where a modelled annual change in under ice lake surface level resulted in lake level changes 10 cm or greater than the maximum annual change during baseline, the area of unusable fish habitat under the ice was considered to be outside of the natural range of water level change and further assessment was required.

If further assessment was deemed necessary following the two initial steps, additional analyses focused on spawning habitat due to the potential effects of lake surface elevation reductions on eggs incubating over winter in substrates in the littoral zone. Unlike fish that are mobile and capable of moving to deeper water with changes in surface elevation, the relatively static nature of incubating eggs and larvae makes them more susceptible to environmental fluctuations.
The known presence and locations of high value spawning habitats were documented and compared with areas of potential habitat loss due to water withdrawal and use for the Mine.

3.1.2 RESULTS

3.1.2.1 WINDY LAKE

Lake Volume

Predicted changes in lake volume in Windy Lake were modelled using constant rate withdrawals of 438 m^3/day up to a maximum of 160,000 m^3 in a given year (see Section 2.2 above). Maximum modelled changes in lake volume at any stage are approximately 0.1 to 0.2% and therefore are lower than the $\leq$ 10% threshold (DFO 2010) indicating the predicted changes are within the range of natural variation. Consequently, no further assessment is recommended as a result of predicted changes in lake volume in Windy Lake considering the 160,000 m^3/year withdrawal scenario.

Lake Level

Predicted changes in lake level in Windy Lake were modelled using constant rate withdrawals of 438 m^3/day up to a maximum of 160,000 m^3 in a given year (see Section 2.2 above). Average modelled changes in lake level across all seasons is approximately 1 cm and the maximum modelled change is approximately 2.1 cm (Table 2-8). Modelled interannual change in lake is 20.2 cm as compared with 19.0 cm during modelled baseline conditions. The increase in interannual water level reduction of 1.2 cm is within the 10 cm threshold used in the FEIS as likely being within the natural range of water level variation, therefore the changes are considered within the range of natural variation in lake level and no further assessment is required.

3.1.2.2 DORIS LAKE

Lake Volume

Predicted changes in lake volume in Doris Lake were modelled using constant rate withdrawals of 7,225 m^3/day up to a maximum of 2,637,000 m^3 in a given year (see Section 2.2 above). Maximum modelled changes in under ice lake volume at any stage are approximately -9.1% in May, and therefore are lower than the $\leq$ 10% threshold indicating the predicted changes are within the range of natural variation. Consequently, the changes are considered within the range of natural variation in lake level and no further assessment is required.

Lake Level

Predicted changes in lake level in Doris Lake were modelled using constant rate withdrawals of 7,225 m^3/day up to a maximum of 2,637,125 m^3 in a given year (see Section 2.2 above). Average modelled changes in lake level across all seasons is approximately -22.1 cm, while the maximum modelled change is approximately -56.6 cm (Table 2-8). Modelled interannual change in lake level is 82.8 cm as compared with 37.4 cm during modelled baseline conditions. Similar to the FEIS, the predicted increase in interannual water level change exceeds the 10 cm threshold established in the FEIS, therefore changes are considered to be outside the range of natural variation in lake level and further assessment is required.

Additional Assessment

Modelling results from the current assessment predict that under constant rate pumping, water level variations with average ice conditions will isolate 2.59 m of lake depth, while water level variations with extreme ice conditions will isolate 2.83 m of lake depth (Table 3-1).

TABLE 3-1 MODELLED INTERANNUAL CHANGES IN WATER LEVELS IN DORIS LAKE

Water Level Variation	Final Environmental Impact Statement				Current Assessment	
	Baseline: Average[1]	Baseline: Maximum[1]	With Project: Average[1]	With Project: Maximum[1]	Baseline	Constant Rate
Interannual Change in Water Elevation (m)	0.53	0.74	0.93	1.14	0.37	0.83
Interannual Change + Avg. Ice thickness (1.76 m) (m)	2.29	2.50	2.69	2.90	2.13	2.59
Interannual Change + Max. Ice thickness (2.0 m) (m)	2.53	2.74	2.93	3.14	2.37	2.83

Notes:
1: Refers to an average or maximum variation in baseline interannual water level

Detailed information on the distribution of spawning habitats for Lake Trout, Lake Whitefish, and Cisco in Doris Lake was collected for the FEIS in 2015 (ERM 2016b). The known presence and locations of high value spawning habitats were surveyed and mapped and compared with the areas of potential habitat loss due to water withdrawal. All habitats shallower than 1.84 m were categorized as unsuitable for spawning because this is the minimum depth of baseline ice penetration. All habitats between 1.84 and 2.74 m depth were categorized as unsuitable or of low quality because they were within the natural range of ice and drawdown, and therefore isolate this lake depth from use as fish habitat. Between 2.74 m and 4 m depth high quality habitat for Lake Trout and Lake Whitefish spawning was identified in five of 47 habitat units and high-quality habitat for Cisco spawning was identified in seven of 47 habitat units. Further, deep-water transect surveys identified extensive good-quality spawning habitats for Lake Trout and Lake Whitefish at depths of up to 10 m. Surveys completed for the FEIS determined high value spawning habitats were not present in the areas predicted to be affected by lake surface reductions up to 2.69 m depth under average water level variation and ice thickness conditions. Under extreme water level variation and ice thickness conditions, lake surface elevation reductions up to 3.14 m modelled during the FEIS were predicted unlikely to result in adverse effects on spawning in Doris Lake because high value spawning habitats were not limited to the shallowest 3.14 m (ERM 2016b).

Results from current modelling predict the isolated lake depth under average and extreme ice conditions (2.59 m and 2.83 m, respectively) are less than the 3.14 m considered in the FEIS, and are unlikely to cause adverse effects on spawning in Doris Lake.

3.2 OUTLET STREAMS

3.2.1 METHODS

Methods used to analyze the proposed increases in water withdrawals from Doris Lake mirrored those used in the Madrid-Boston Project FEIS (ERM 2016a). Hydrological analyses used 43 transects in Doris Creek, divided between upper, middle, and lower Doris Creek to determine effects of withdrawals on flow, depths, and wetted width during the five months of the open water season. The fisheries analysis focused on the passibility of a shallow, riffle section marking the break between lower and middle Doris Creek referred to as the "boulder garden". This is a point of difficult passage for fish that becomes impassable in late summer during baseline conditions. Sufficient data were not collected during the FEIS to quantify loss of wetted usable area of fish habitat or to quantify changes in fish habitat quality for fish species present in the Doris Creek outflow.

There are no transect data for the Windy Lake outflow, therefore, hydrological modelling and analysis of potential effects on fish habitat could not be completed for that watercourse.

3.2.2 RESULTS

3.2.2.1 FISH PASSABILITY

The hydraulic assessment of the Doris Creek outflow modelled reductions in mean monthly discharge was 16% as compared with the predicted 13% in the FEIS (Table 3-2). The largest reductions in discharge are observed during freshet high flows (43%) when fish passage through the boulder garden would not be impeded (Table 3-2). Changes in discharge during the summer and fall open water months are smaller in magnitude (-5 to -13% of baseline discharge) and represent reductions in maximum depths of 1 to 3 cm and reductions in wetted width of 0.08 to 0.57 m. This is similar to the modelled changes of 1 to 2 cm reductions in maximum depth modelled in the FEIS (Table 3-2). The conclusions made in the FEIS regarding the effects of flow reductions on the passibility of the boulder garden to fish and the ultimate effects on fish in the Doris Creek outflow are as follows:

> "…there is no accessible overwintering habitat upstream of this location due to a large waterfall, so adult anadromous fish do not typically run up the creek in fall. The hydraulic model predicted that potential reductions in connectivity through the riffle/ boulder garden feature of Doris Creek will have little or no impact throughout a majority of the open water season" (ERM 2016a).

3.2.2.2 OPEN WATER TIMING AND WETTED CHANNEL AREA

Hydrology modelling predicted delays in the spring open water season in Doris Creek as well as reductions in wetted width in upper, middle, and lower Doris Creek. These factors were not considered in the FEIS, but these changes have implications for fish and fish habitat in Doris Creek.

Predicted timing of open water in Doris Creek is June 13 in the constant rate withdrawal scenario as compared with May 14 under baseline conditions. The delays represent a 20% reduction in the open water period and may have implications for the timing of fish movement into Doris Creek and fish use in lower and middle Doris Creek. This represents a temporal loss of habitat for fish species in Doris Creek that may need to be considered in offsetting for the additional withdrawals.

Estimated changes in loss of wetted area associated with reductions in predicted reductions in wetted width of Doris Creek are provided in Table 3-3. Wetted area reductions in Table 3-3 represent gross area estimates and do not consider baseline and modelled changes in parameters such as depths, velocities, and habitat quality indices. Additional survey data and analysis would be required to determine the net loss of wetted usable habitat, if any, for life-cycles stages and habitat use for fish species in Doris Creek.

TABLE 3-2 MODELLED CHANGES IN DORIS LAKE OUTFLOW DISCHARGE, DEPTH, AND WETTED WIDTH COMPARED WITH BASELINE IN THE FEIS AND WITH ADDITIONAL PROPOSED WITHDRAWALS (JUNE TO OCTOBER)

Baseline								Modelled Changes												
								FEIS							Current Assessment					
Reach	**Variable**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Mean Monthly**	**Variable**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Mean Monthly**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Mean Monthly**
Upper	Q (m^3/s)	1.85	1.31	0.49	0.43	0.32	0.88	Δ Q (m^3/s)	-0.30	-0.04	-0.04	-0.03	-0.02	-0.10	-0.95	-0.12	-0.12	-0.12	-0.12	-0.28
								Δ Q (%)	-16%	-3%	-8%	-7%	-6%	-10%	-51%	-9%	-24%	-28%	-37%	-32%
	Max Depth (m)	0.80	0.72	0.49	0.49	0.43	0.59	Δ Max Depth (m)	-0.07	-0.01	-0.01	-0.01	-0.01	-0.03	-0.17	-0.02	-0.04	-0.05	-0.06	-0.07
								Δ Max Depth (%)	-9%	-1%	-2%	-2%	-2%	-6%	-22%	-3%	-9%	-10%	-14%	-12%
	Top Width (m)	14.16	10.10	6.37	6.45	5.94	8.60	Δ Top Width (m)	-1.93	-0.29	-0.07	-0.07	-0.09	-0.51	-6.17	-1.07	-0.24	-0.35	-0.56	-1.68
								Δ Top Width (%)	-14%	-3%	-1%	-1%	-2%	-7%	-44%	-11%	-4%	-5%	-9%	-20%
Middle	Q (m^3/s)	1.85	1.31	0.49	0.43	0.32	0.88	Δ Q (m^3/s)	-0.30	-0.04	-0.04	-0.03	-0.02	-0.10	-0.95	-0.12	-0.12	-0.12	-0.12	-0.28
								Δ Q (%)	-16%	-3%	-8%	-7%	-6%	-10%	-51%	-9%	-24%	-28%	-37%	-32%
	Max Depth (m)	0.92	0.81	0.51	0.48	0.43	0.63	Δ Max Depth (m)	-0.07	-0.01	-0.02	-0.02	-0.01	-0.03	-0.23	-0.03	-0.06	-0.06	-0.07	-0.09
								Δ Max Depth (%)	-8%	-1%	-4%	-4%	-2%	-7%	-25%	-3%	-11%	-13%	-17%	-14%
	Top Width (m)	18.11	14.11	11.06	10.71	10.35	12.87	Δ Top Width (m)	-2.02	-0.24	-0.13	-0.17	-0.19	-0.58	-5.80	-0.70	-0.47	-0.54	-0.60	-1.62
								Δ Top Width (%)	-11%	-2%	-1%	-2%	-2%	-7%	-32%	-5%	-4%	-5%	-6%	-13%
Lower	Q (m^3/s)	1.85	1.31	0.49	0.43	0.32	0.88	Δ Q (m^3/s)	-0.30	-0.04	-0.04	-0.03	-0.02	-0.10	-0.95	-0.12	-0.12	-0.12	-0.12	-0.28
								Δ Q (%)	-16%	-3%	-8%	-7%	-6%	-10%	-51%	-9%	-24%	-28%	-37%	-32%
	Max Depth (m)	1.39	1.26	0.92	0.88	0.82	1.05	Δ Max Depth (m)	-0.09	-0.01	-0.02	-0.03	-0.01	-0.04	-0.27	-0.03	-0.07	-0.08	-0.08	-0.11
								Δ Max Depth (%)	-6%	-1%	-2%	-3%	-1%	-6%	-19%	-3%	-8%	-9%	-10%	-10%
	Top Width (m)	14.75	9.99	6.93	6.88	6.38	8.99	Δ Top Width (m)	-1.42	-0.15	-0.13	-0.12	-0.07	-0.40	-6.44	-0.67	-0.39	-0.39	-0.35	-1.65
								Δ Top Width (%)	-10%	-2%	-2%	-2%	-1%	-4%	-39%	-7%	-7%	-7%	-6%	-13%
Entire Length	Q (m^3/s)	1.85	1.31	0.49	0.43	0.32	0.88	Δ Q (m^3/s)	-0.30	-0.04	-0.04	-0.03	-0.02	-0.09	-0.95	-0.12	-0.12	-0.12	-0.12	-0.28
								Δ Q (%)	-16%	-3%	-8%	-7%	-6%	-10%	-51%	-9%	-24%	-28%	-37%	-32%
	Max Depth (m)	1.04	0.94	0.64	0.61	0.55	0.76	Δ Max Depth (m)	-0.08	-0.01	-0.02	-0.02	-0.01	-0.03	-0.22	-0.03	-0.06	-0.06	-0.07	-0.09
								Δ Max Depth (%)	-7%	-1%	-3%	-3%	-2%	-4%	-21%	-3%	-9%	-10%	-13%	-12%
	Top Width (m)	16.32	12.07	8.89	8.74	8.28	10.86	Δ Top Width (m)	-1.79	-0.23	-0.11	-0.12	-0.12	-0.50	-6.14	-0.81	-0.37	-0.43	-0.51	-1.65
								Δ Top Width (%)	-11%	-2%	-1%	-1%	-1%	-4%	-38%	-7%	-4%	-5%	-6%	-15%

TABLE 3-3 MODELLED CHANGES IN WETTED CHANNEL AREA IN DORIS CREEK

Reach	Length (m)	Modelled Mean Monthly Reduction in Wetted Area of Channel (m^2)						
		May	Jun	Jul	Aug	Sep	Oct	Mean Monthly
Upper Doris Creek	395	2,054	2,437	403	63	67	138	860
Middle Doris Creek	350	3,308	2,030	231	109	119	126	987
Lower Doris Creek	3,735	21,924	24,053	2,390	1,008	934	822	8,522
Totals	**4,480**	**27,286**	**28,521**	**3,024**	**1,180**	**1,120**	**1,086**	**10,369**

4. CONCLUSION

Using the constant rate water withdrawal scenario, winter lake water volume decreases were limited to less than 10%. Doris Lake experiences the largest annual decrease in water volume of 2.7%, while at both Patch Lake and Windy Lake volume decreases are less than 1%. The annual discharge at the Doris Lake outflow decreases by 31.5%, with the largest monthly decrease of 43.8% occurring in June due to a delayed start of water movement in the Doris Lake outflow. Once water starts moving in the outflow, the decrease in streamflow rate is reduced to 8.9% in July. Outflow discharges from Patch Lake and Windy Lake are limited to less than 10%, the annual discharge at the Patch Lake outflow decreases by 8.1%, with the largest monthly decrease of 11.9% occurring in June, while annual discharge at the Windy Lake outflow decreases by 9.0%, with the largest monthly decrease of 15.5% occurring in June.

Applying the same methods of analysis used in the FEIS to assess the effects of water withdrawals on fish and fish habitat, the current assessment water withdrawals presented in the hydrology section are not likely to have adverse effects on fish and the ability of them to utilize habitats in Windy and Doris Lake. The same can be said for predicted effects of the current assessment water withdrawals on fish passibility in the Doris Creek outflow. Analysis in the FEIS focused on the fish passibility of the boulder garden located at the boundary of upper and middle Doris Creek. Under the updated current assessment withdrawal scenario discussed above, there is no predicted change from the conclusions provided in the FEIS. Changes in the timing of flows in Doris Creek (i.e., modelled 4-week delay in the beginning of the open water season) may have implications for fish use in Doris Creek and represents a temporal loss of fish habitat. Additional survey data and analyses would be required to assess the effects of changes in open water timing and loss of wetted usable area in Doris Creek on fish.

The potential effects of the current assessment water withdrawals on fish and fish habitat could not be assessed for the Windy Lake outflow due to an absence of flow transect and fish habitat data. It is recommended that similar field surveys and hydrological analysis is completed for the Windy Lake outflow as was completed for Doris Creek downstream of Doris Lake.

5. REFERENCES

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APPENDIX A HISTORICAL MEAN DAILY DISCHARGE TABLES

TABLE A1 PATCH LAKE OUTFLOW, HISTORICAL MEAN DAILY DISCHARGE

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	0.123	0.715	0.229	0.145	0.159	0.053	-
2	-	-	-	-	-	0.134	0.721	0.223	0.141	0.164	0.041	-
3	-	-	-	-	-	0.140	0.709	0.219	0.139	0.160	0.032	-
4	-	-	-	-	-	0.151	0.689	0.211	0.138	0.159	0.025	-
5	-	-	-	-	-	0.163	0.663	0.205	0.142	0.156	0.020	-
6	-	-	-	-	-	0.164	0.636	0.200	0.143	0.157	0.016	-
7	-	-	-	-	-	0.178	0.611	0.197	0.149	0.154	0.013	-
8	-	-	-	-	-	0.183	0.590	0.195	0.154	0.156	0.010	-
9	-	-	-	-	-	0.185	0.568	0.191	0.158	0.154	0.008	-
10	-	-	-	-	-	0.196	0.545	0.192	0.161	0.147	0.007	-
11	-	-	-	-	-	0.197	0.534	0.187	0.161	0.141	0.006	-
12	-	-	-	-	-	0.245	0.516	0.188	0.161	0.139	0.004	-
13	-	-	-	-	-	0.362	0.489	0.186	0.162	0.131	0.003	-
14	-	-	-	-	-	0.642	0.473	0.183	0.163	0.129	0.003	-
15	-	-	-	-	-	0.630	0.450	0.176	0.164	0.129	0.003	-
16	-	-	-	-	-	0.772	0.434	0.173	0.161	0.131	0.003	-
17	-	-	-	-	0.017	0.851	0.418	0.170	0.161	0.124	0.002	-
18	-	-	-	-	0.048	0.927	0.401	0.170	0.161	0.122	0.002	-
19	-	-	-	-	0.137	0.960	0.386	0.164	0.162	0.115	0.002	-
20	-	-	-	-	0.141	0.975	0.372	0.160	0.161	0.110	-	-
21	-	-	-	-	0.142	0.945	0.356	0.156	0.160	0.103	-	-
22	-	-	-	-	0.138	0.935	0.340	0.157	0.162	0.101	-	-
23	-	-	-	-	0.127	0.914	0.327	0.150	0.166	0.098	-	-
24	-	-	-	-	0.130	0.895	0.311	0.150	0.167	0.094	-	-
25	-	-	-	-	0.121	0.871	0.299	0.147	0.165	0.091	-	-
26	-	-	-	-	0.127	0.842	0.293	0.147	0.162	0.087	-	-
27	-	-	-	-	0.108	0.809	0.279	0.146	0.164	0.082	-	-
28	-	-	-	-	0.133	0.780	0.263	0.149	0.164	0.078	-	-
29	-	-	-	-	0.133	0.745	0.253	0.147	0.161	0.077	-	-
30	-	-	-	-	0.135	0.727	0.246	0.145	0.159	0.069	-	-

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31	-	-	-	-	0.142	-	0.238	0.145	-	0.062	-	-
Mean	-	-	-	-	0.118	0.555	0.456	0.176	0.157	0.122	0.013	-
Max	-	-	-	-	0.142	0.975	0.721	0.229	0.167	0.164	0.053	-
Min		-	-	-	0.017	0.123	0.238	0.145	0.138	0.062	0.002	-

Note:
Mean daily discharge data used from 2009 through 2023

TABLE A2 DORIS LAKE OUTFLOW, HISTORICAL MEAN DAILY DISCHARGE

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	0.000	0.521	2.204	0.753	0.376	0.434	0.144	0.005
2	-	-	-	-	0.000	0.556	2.170	0.723	0.377	0.432	0.121	0.005
3	-	-	-	-	0.000	0.569	2.104	0.701	0.379	0.420	0.102	0.005
4	-	-	-	-	0.000	0.580	2.039	0.675	0.379	0.418	0.085	0.005
5	-	-	-	-	0.000	0.605	1.958	0.651	0.384	0.414	0.073	0.004
6	-	-	-	-	0.000	0.630	1.866	0.623	0.392	0.412	0.063	0.004
7	-	-	-	-	0.000	0.662	1.761	0.600	0.404	0.403	0.054	0.004
8	-	-	-	-	0.000	0.711	1.678	0.582	0.421	0.404	0.047	0.004
9	-	-	-	-	0.000	0.930	1.605	0.563	0.430	0.397	0.041	0.004
10	-	-	-	-	0.001	1.026	1.516	0.543	0.435	0.372	0.036	0.004
11	-	-	-	-	0.001	1.150	1.441	0.524	0.438	0.359	0.031	0.004
12	-	-	-	-	0.001	1.210	1.373	0.506	0.440	0.365	0.027	0.003
13	-	-	-	-	0.001	1.365	1.307	0.492	0.445	0.346	0.023	0.003
14	-	-	-	-	0.002	1.595	1.242	0.481	0.450	0.344	0.023	0.003
15	-	-	-	-	0.003	1.826	1.181	0.471	0.450	0.339	0.021	0.003
16	-	-	-	-	0.005	2.217	1.132	0.458	0.454	0.339	0.019	0.003
17	-	-	-	-	0.016	2.485	1.106	0.450	0.456	0.326	0.017	0.003
18	-	-	-	-	0.053	2.762	1.069	0.443	0.455	0.295	0.014	0.003
19	-	-	-	-	0.220	2.884	1.033	0.434	0.455	0.278	0.013	0.003
20	-	-	-	-	0.238	3.015	0.994	0.422	0.451	0.274	0.011	0.003
21	-	-	-	-	0.248	3.069	0.957	0.413	0.449	0.250	0.009	0.003
22	-	-	-	-	0.250	3.077	0.938	0.410	0.446	0.246	0.008	0.002
23	-	-	-	-	0.244	3.010	0.924	0.404	0.447	0.241	0.007	0.002

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
24	-	-	-	-	0.258	2.931	0.916	0.398	0.448	0.234	0.007	0.002
25	-	-	-	-	0.259	2.837	0.913	0.392	0.448	0.226	0.006	0.002
26	-	-	-	-	0.303	2.727	0.903	0.387	0.444	0.222	0.006	0.002
27	-	-	-	-	0.363	2.609	0.886	0.387	0.444	0.211	0.006	0.002
28	-	-	-	-	0.467	2.491	0.866	0.386	0.442	0.201	0.006	0.002
29	-	-	-	-	0.528	2.378	0.838	0.386	0.438	0.203	0.006	0.002
30	-	-	-	-	0.559	2.286	0.813	0.386	0.438	0.179	0.005	0.002
31	-	-	-	-	0.586	-	0.782	0.382	-	0.160	-	-
Mean	-	-	-	-	0.149	1.824	1.307	0.498	0.431	0.314	0.034	0.003
Max	-	-	-	-	0.586	3.077	2.204	0.753	0.456	0.434	0.144	0.005
Min	-	-	-	-	0.000	0.521	0.782	0.382	0.376	0.160	0.005	0.000

Note:
Mean daily discharge data used from 2009 through 2023

TABLE A3 WINDY LAKE OUTFLOW, HISTORICAL MEAN DAILY DISCHARGE

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	0.001	0.287	0.181	0.092	0.071	0.018	-
2	-	-	-	-	-	0.002	0.285	0.178	0.091	0.069	0.015	-
3	-	-	-	-	-	0.003	0.279	0.177	0.091	0.069	0.012	-
4	-	-	-	-	-	0.005	0.274	0.172	0.094	0.068	0.010	-
5	-	-	-	-	-	0.008	0.268	0.168	0.096	0.066	0.008	-
6	-	-	-	-	-	0.015	0.264	0.162	0.093	0.064	0.007	-
7	-	-	-	-	-	0.035	0.260	0.160	0.096	0.062	0.005	-
8	-	-	-	-	-	0.052	0.259	0.156	0.097	0.061	0.004	-
9	-	-	-	-	-	0.065	0.257	0.153	0.096	0.060	0.003	-
10	-	-	-	-	-	0.088	0.253	0.149	0.098	0.058	0.003	-
11	-	-	-	-	-	0.155	0.248	0.145	0.098	0.055	0.002	-
12	-	-	-	-	-	0.163	0.246	0.140	0.096	0.052	0.001	-
13	-	-	-	-	-	0.173	0.242	0.137	0.095	0.049	0.001	-
14	-	-	-	-	-	0.175	0.236	0.132	0.095	0.047	0.001	-
15	-	-	-	-	-	0.198	0.230	0.127	0.093	0.045	0.000	-
16	-	-	-	-	-	0.266	0.230	0.123	0.093	0.043	0.000	-

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
17	-	-	-	-	-	0.290	0.235	0.121	0.093	0.043	0.000	-
18	-	-	-	-	-	0.303	0.234	0.117	0.092	0.041	0.000	-
19	-	-	-	-	-	0.310	0.229	0.116	0.091	0.041	0.000	-
20	-	-	-	-	-	0.316	0.226	0.113	0.088	0.039	0.000	-
21	-	-	-	-	-	0.317	0.222	0.110	0.086	0.037	0.000	-
22	-	-	-	-	-	0.318	0.216	0.108	0.087	0.036	-	-
23	-	-	-	-	-	0.315	0.211	0.107	0.084	0.034	-	-
24	-	-	-	-	-	0.311	0.205	0.105	0.083	0.032	-	-
25	-	-	-	-	-	0.308	0.206	0.103	0.080	0.031	-	-
26	-	-	-	-	-	0.303	0.203	0.103	0.078	0.029	-	-
27	-	-	-	-	-	0.298	0.197	0.100	0.077	0.028	-	-
28	-	-	-	-	-	0.293	0.194	0.100	0.075	0.027	-	-
29	-	-	-	-	-	0.289	0.189	0.099	0.073	0.025	-	-
30	-	-	-	-	-	0.288	0.188	0.097	0.072	0.024	-	-
31	-	-	-	-	-		0.183	0.095		0.020	-	-
Mean	-	-	-	-	-	0.189	0.234	0.131	0.089	0.046	0.004	-
Max	-	-	-	-	-	0.318	0.287	0.181	0.098	0.071	0.018	-
Min	-	-	-	-	-	0.001	0.183	0.095	0.072	0.020	0.000	-

Note:
Mean daily discharge data used from 2009 through 2023

APPENDIX B DORIS LAKE OUTFLOW: CONSTANT RATE HYDROLOGIC PROPERTIES

TABLE B1 JUNE DORIS LAKE OUTFLOW: CONSTANT RATE HEC-RAS OUTPUT

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
43	1.854	0.19	27.52	0.65	1.042	0.15	19.01	0.52	-0.812	-44%	-0.04	-23%	-8.51	-31%	-0.13	-20%
42	1.854	0.31	25.01	0.74	1.042	0.25	11.90	0.61	-0.812	-44%	-0.06	-20%	-13.11	-52%	-0.13	-17%
41	1.854	0.31	12.40	0.83	1.042	0.23	11.47	0.70	-0.812	-44%	-0.08	-25%	-0.93	-7%	-0.13	-15%
40	1.854	0.35	17.06	0.63	1.042	0.31	14.28	0.51	-0.812	-44%	-0.04	-11%	-2.78	-16%	-0.13	-20%
39	1.854	0.35	12.43	0.91	1.042	0.28	11.29	0.78	-0.812	-44%	-0.07	-21%	-1.14	-9%	-0.13	-15%
38.5*	1.854	0.35	11.19	0.92	1.042	0.25	9.24	0.79	-0.812	-44%	-0.09	-27%	-1.95	-17%	-0.13	-14%
38	1.854	0.55	9.91	0.92	1.042	0.43	7.02	0.79	-0.812	-44%	-0.12	-22%	-2.89	-29%	-0.13	-14%
37	1.854	0.84	14.38	0.50	1.042	0.72	5.11	0.37	-0.812	-44%	-0.12	-14%	-9.28	-64%	-0.13	-26%
36	1.854	0.55	32.80	0.68	1.042	0.58	5.07	0.52	-0.812	-44%	0.03	6%	-27.73	-85%	-0.16	-23%
35	1.854	0.42	9.75	1.17	1.042	0.32	6.76	1.02	-0.812	-44%	-0.11	-25%	-2.99	-31%	-0.15	-13%
34	1.854	0.41	8.33	1.14	1.042	0.30	6.93	0.99	-0.812	-44%	-0.11	-27%	-1.40	-17%	-0.15	-13%
33	1.854	0.38	16.81	0.87	1.042	0.30	8.76	0.73	-0.812	-44%	-0.08	-22%	-8.05	-48%	-0.14	-16%
32	1.854	0.46	13.04	0.88	1.042	0.39	8.53	0.73	-0.812	-44%	-0.07	-14%	-4.51	-35%	-0.14	-16%
31.8333*	1.854	0.49	12.42	0.84	1.042	0.42	8.06	0.70	-0.812	-44%	-0.07	-14%	-4.36	-35%	-0.14	-17%
31.6666*	1.854	0.52	11.83	0.81	1.042	0.45	7.49	0.67	-0.812	-44%	-0.07	-14%	-4.34	-37%	-0.14	-18%
31.5*	1.854	0.57	11.25	0.78	1.042	0.49	6.83	0.64	-0.812	-44%	-0.08	-14%	-4.43	-39%	-0.15	-19%
31.3333*	1.854	0.63	10.60	0.76	1.042	0.56	6.01	0.62	-0.812	-44%	-0.08	-12%	-4.59	-43%	-0.15	-19%
31.1666*	1.854	0.77	9.17	0.72	1.042	0.69	4.86	0.57	-0.812	-44%	-0.08	-11%	-4.32	-47%	-0.15	-21%
31	1.854	1.80	3.11	0.47	1.042	1.53	2.86	0.35	-0.812	-44%	-0.27	-15%	-0.25	-8%	-0.12	-25%
30.8*	1.854	4.14	2.80	0.25	1.042	3.48	2.74	0.20	-0.812	-44%	-0.67	-16%	-0.06	-2%	-0.05	-21%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
30.6*	1.854	2.25	3.02	0.37	1.042	1.77	2.88	0.29	-0.812	-44%	-0.48	-21%	-0.13	-4%	-0.08	-22%
30.4*	1.854	3.12	2.92	0.27	1.042	2.72	2.82	0.20	-0.812	-44%	-0.40	-13%	-0.10	-3%	-0.07	-27%
30.2*	1.854	2.40	3.15	0.34	1.042	1.88	2.95	0.27	-0.812	-44%	-0.52	-22%	-0.20	-6%	-0.07	-21%
30	1.854	0.39	7.58	0.92	1.042	0.31	5.88	0.70	-0.812	-44%	-0.08	-21%	-1.70	-22%	-0.23	-25%
29	1.854	0.50	16.71	0.97	1.042	0.44	4.59	0.74	-0.812	-44%	-0.06	-13%	-12.12	-73%	-0.22	-23%
28.8*	1.854	0.51	8.27	0.97	1.042	0.43	4.67	0.75	-0.812	-44%	-0.08	-16%	-3.59	-43%	-0.23	-23%
28.6*	1.854	0.48	6.53	1.02	1.042	0.39	4.97	0.80	-0.812	-44%	-0.09	-19%	-1.56	-24%	-0.22	-22%
28.4*	1.854	0.41	7.48	1.12	1.042	0.32	5.40	0.91	-0.812	-44%	-0.10	-23%	-2.08	-28%	-0.21	-19%
28.2*	1.854	0.35	10.81	1.25	1.042	0.26	5.86	1.05	-0.812	-44%	-0.09	-26%	-4.95	-46%	-0.20	-16%
28	1.854	0.26	10.99	1.40	1.042	0.19	8.68	1.20	-0.812	-44%	-0.06	-25%	-2.31	-21%	-0.20	-14%
27	1.854	0.28	9.52	1.24	1.042	0.21	7.71	1.05	-0.812	-44%	-0.07	-26%	-1.82	-19%	-0.19	-16%
26	1.854	0.37	10.28	1.02	1.042	0.31	8.02	0.83	-0.812	-44%	-0.06	-16%	-2.27	-22%	-0.19	-19%
25	1.854	0.29	9.61	1.23	1.042	0.21	8.53	1.04	-0.812	-44%	-0.07	-25%	-1.09	-11%	-0.19	-15%
24.8333*	1.854	0.26	10.67	1.20	1.042	0.19	9.21	1.01	-0.812	-44%	-0.07	-26%	-1.46	-14%	-0.19	-16%
24.6666*	1.854	0.24	11.74	1.17	1.042	0.17	9.89	0.98	-0.812	-44%	-0.06	-26%	-1.84	-16%	-0.19	-16%
24.5*	1.854	0.22	13.02	1.13	1.042	0.16	10.58	0.95	-0.812	-44%	-0.06	-26%	-2.45	-19%	-0.19	-16%
24.3333*	1.854	0.20	14.71	1.10	1.042	0.15	11.26	0.91	-0.812	-44%	-0.05	-26%	-3.46	-23%	-0.19	-17%
24.1666*	1.854	0.19	17.40	1.06	1.042	0.14	11.94	0.88	-0.812	-44%	-0.05	-27%	-5.46	-31%	-0.18	-17%
24	1.854	0.18	22.70	1.03	1.042	0.13	12.59	0.84	-0.812	-44%	-0.05	-26%	-10.12	-45%	-0.18	-18%
23.8*	1.854	0.19	19.92	1.02	1.042	0.14	12.07	0.84	-0.812	-44%	-0.05	-27%	-7.85	-39%	-0.18	-18%
23.6*	1.854	0.19	17.92	1.01	1.042	0.14	11.53	0.83	-0.812	-44%	-0.05	-27%	-6.39	-36%	-0.18	-17%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
23.4*	1.854	0.20	16.75	1.00	1.042	0.15	10.98	0.83	-0.812	-44%	-0.06	-28%	-5.77	-34%	-0.17	-17%
23.2*	1.854	0.22	16.74	1.04	1.042	0.15	10.43	0.87	-0.812	-44%	-0.06	-28%	-6.31	-38%	-0.17	-16%
23	1.854	0.32	19.54	1.08	1.042	0.26	9.78	0.92	-0.812	-44%	-0.06	-19%	-9.77	-50%	-0.16	-15%
22.8*	1.854	0.30	20.67	1.03	1.042	0.26	11.17	0.85	-0.812	-44%	-0.04	-13%	-9.50	-46%	-0.18	-17%
22.6*	1.854	0.27	19.12	0.94	1.042	0.25	12.21	0.73	-0.812	-44%	-0.02	-7%	-6.91	-36%	-0.21	-22%
22.4*	1.854	0.33	15.43	0.80	1.042	0.31	13.10	0.58	-0.812	-44%	-0.02	-6%	-2.33	-15%	-0.22	-27%
22.2*	1.854	0.33	15.68	0.72	1.042	0.28	14.71	0.56	-0.812	-44%	-0.06	-17%	-0.98	-6%	-0.17	-23%
22	1.854	0.15	24.95	0.89	1.042	0.11	17.10	0.72	-0.812	-44%	-0.04	-26%	-7.85	-31%	-0.17	-19%
21.8*	1.854	0.16	24.21	0.88	1.042	0.12	16.76	0.71	-0.812	-44%	-0.04	-26%	-7.45	-31%	-0.17	-19%
21.6*	1.854	0.16	23.67	0.87	1.042	0.12	16.42	0.70	-0.812	-44%	-0.04	-25%	-7.25	-31%	-0.17	-19%
21.4*	1.854	0.17	23.22	0.85	1.042	0.13	16.08	0.69	-0.812	-44%	-0.04	-24%	-7.14	-31%	-0.17	-20%
21.2*	1.854	0.19	22.44	0.83	1.042	0.14	15.71	0.67	-0.812	-44%	-0.04	-23%	-6.73	-30%	-0.17	-20%
21	1.854	0.22	20.12	0.78	1.042	0.17	15.19	0.62	-0.812	-44%	-0.04	-20%	-4.93	-24%	-0.16	-21%
20.9*	1.854	0.23	21.06	0.79	1.042	0.19	16.06	0.62	-0.812	-44%	-0.04	-16%	-4.99	-24%	-0.17	-21%
20.8*	1.854	0.21	22.05	0.80	1.042	0.18	16.90	0.62	-0.812	-44%	-0.03	-14%	-5.15	-23%	-0.17	-22%
20.7*	1.854	0.21	22.93	0.81	1.042	0.19	17.68	0.61	-0.812	-44%	-0.02	-8%	-5.25	-23%	-0.19	-24%
20.6*	1.854	0.23	23.15	0.80	1.042	0.21	18.37	0.59	-0.812	-44%	-0.02	-8%	-4.77	-21%	-0.21	-26%
20.5*	1.854	0.22	22.95	0.78	1.042	0.18	19.14	0.59	-0.812	-44%	-0.04	-16%	-3.81	-17%	-0.19	-24%
20.4*	1.854	0.19	23.47	0.78	1.042	0.17	19.95	0.60	-0.812	-44%	-0.02	-11%	-3.51	-15%	-0.18	-23%
20.3*	1.854	0.17	24.76	0.80	1.042	0.15	20.75	0.62	-0.812	-44%	-0.02	-11%	-4.00	-16%	-0.19	-23%
20.2*	1.854	0.16	26.35	0.88	1.042	0.14	21.61	0.69	-0.812	-44%	-0.02	-12%	-4.74	-18%	-0.19	-21%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
20.1*	1.854	0.15	27.86	0.96	1.042	0.13	22.64	0.78	-0.812	-44%	-0.02	-15%	-5.22	-19%	-0.18	-19%
20	1.854	0.09	29.81	1.07	1.042	0.07	23.93	0.88	-0.812	-44%	-0.03	-27%	-5.88	-20%	-0.18	-17%
19.8333*	1.854	0.11	28.78	1.03	1.042	0.08	22.22	0.85	-0.812	-44%	-0.03	-25%	-6.55	-23%	-0.18	-18%
19.6666*	1.854	0.12	27.94	0.99	1.042	0.09	20.51	0.81	-0.812	-44%	-0.03	-25%	-7.43	-27%	-0.18	-18%
19.5*	1.854	0.14	27.46	0.95	1.042	0.11	18.77	0.77	-0.812	-44%	-0.03	-23%	-8.69	-32%	-0.18	-19%
19.3333*	1.854	0.16	27.72	0.92	1.042	0.12	17.00	0.74	-0.812	-44%	-0.04	-22%	-10.71	-39%	-0.18	-20%
19.1666*	1.854	0.19	30.08	0.87	1.042	0.15	15.16	0.69	-0.812	-44%	-0.04	-20%	-14.92	-50%	-0.18	-21%
19	1.854	0.22	37.08	0.82	1.042	0.18	12.87	0.64	-0.812	-44%	-0.04	-16%	-24.21	-65%	-0.18	-22%
18.98*	1.854	0.22	37.12	0.82	1.042	0.18	12.91	0.64	-0.812	-44%	-0.03	-16%	-24.21	-65%	-0.18	-22%
18.96*	1.854	0.23	35.99	0.79	1.042	0.20	12.30	0.61	-0.812	-44%	-0.04	-16%	-23.69	-66%	-0.18	-23%
18.94*	1.854	0.26	23.91	0.75	1.042	0.21	11.40	0.58	-0.812	-44%	-0.04	-17%	-12.51	-52%	-0.17	-23%
18.92*	1.854	0.27	18.25	0.73	1.042	0.21	11.40	0.58	-0.812	-44%	-0.06	-21%	-6.84	-38%	-0.15	-21%
18.9	1.854	0.23	35.99	0.79	1.042	0.18	13.30	0.64	-0.812	-44%	-0.05	-21%	-22.69	-63%	-0.15	-19%
18	1.854	0.65	13.33	1.01	1.042	0.65	4.07	0.79	-0.812	-44%	-0.01	-1%	-9.26	-69%	-0.22	-21%
17	1.854	0.23	16.71	1.68	1.042	0.20	12.02	1.46	-0.812	-44%	-0.03	-14%	-4.70	-28%	-0.22	-13%
16	1.854	0.24	17.20	1.74	1.042	0.20	11.08	1.53	-0.812	-44%	-0.04	-17%	-6.12	-36%	-0.22	-12%
15	1.854	0.42	9.86	1.31	1.042	0.33	5.32	1.09	-0.812	-44%	-0.09	-21%	-4.54	-46%	-0.21	-16%
14	1.854	0.82	8.51	0.97	1.042	0.78	3.37	0.76	-0.812	-44%	-0.04	-5%	-5.14	-60%	-0.22	-22%
13	1.854	0.11	21.60	2.36	1.042	0.08	15.63	2.14	-0.812	-44%	-0.03	-29%	-5.97	-28%	-0.21	-9%
12	1.854	0.14	15.76	1.90	1.042	0.10	13.32	1.69	-0.812	-44%	-0.04	-28%	-2.44	-15%	-0.21	-11%
11	1.854	0.52	8.14	1.25	1.042	0.41	4.64	1.04	-0.812	-44%	-0.11	-20%	-3.50	-43%	-0.21	-17%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
10.8333*	1.854	0.51	8.20	1.22	1.042	0.41	4.78	1.01	-0.812	-44%	-0.10	-20%	-3.42	-42%	-0.21	-17%
10.6666*	1.854	0.51	8.28	1.20	1.042	0.41	4.92	0.99	-0.812	-44%	-0.10	-20%	-3.37	-41%	-0.21	-17%
10.5*	1.854	0.51	8.36	1.17	1.042	0.41	5.05	0.96	-0.812	-44%	-0.09	-19%	-3.31	-40%	-0.21	-18%
10.3333*	1.854	0.52	8.37	1.13	1.042	0.43	5.16	0.92	-0.812	-44%	-0.09	-17%	-3.21	-38%	-0.21	-19%
10.1666*	1.854	0.54	8.32	1.10	1.042	0.46	5.24	0.88	-0.812	-44%	-0.07	-14%	-3.08	-37%	-0.21	-20%
10	1.854	0.57	7.88	1.04	1.042	0.53	5.25	0.82	-0.812	-44%	-0.04	-7%	-2.62	-33%	-0.23	-22%
9.8*	1.854	0.39	8.83	1.35	1.042	0.34	6.58	1.13	-0.812	-44%	-0.06	-15%	-2.25	-25%	-0.23	-17%
9.6*	1.854	0.31	9.97	1.66	1.042	0.26	7.94	1.44	-0.812	-44%	-0.05	-17%	-2.03	-20%	-0.23	-14%
9.4*	1.854	0.26	11.17	1.98	1.042	0.21	9.32	1.75	-0.812	-44%	-0.05	-18%	-1.86	-17%	-0.23	-12%
9.2*	1.854	0.22	12.41	2.29	1.042	0.18	10.71	2.06	-0.812	-44%	-0.04	-19%	-1.70	-14%	-0.23	-10%
9	1.854	0.16	13.65	2.60	1.042	0.12	12.11	2.37	-0.812	-44%	-0.04	-26%	-1.55	-11%	-0.23	-9%
8	1.854	0.18	15.05	2.60	1.042	0.14	12.91	2.37	-0.812	-44%	-0.04	-21%	-2.13	-14%	-0.23	-9%
7	1.854	0.20	16.04	2.23	1.042	0.16	11.84	2.01	-0.812	-44%	-0.04	-19%	-4.20	-26%	-0.23	-10%
6	1.854	0.39	8.54	1.09	1.042	0.34	6.95	0.86	-0.812	-44%	-0.05	-13%	-1.58	-19%	-0.23	-21%
5	1.854	0.47	9.08	1.07	1.042	0.40	4.86	0.83	-0.812	-44%	-0.08	-16%	-4.23	-47%	-0.24	-22%
4	1.854	0.33	9.47	1.06	1.042	0.29	7.89	0.81	-0.812	-44%	-0.03	-10%	-1.58	-17%	-0.25	-24%
3	1.854	0.35	10.74	1.09	1.042	0.32	6.76	0.84	-0.812	-44%	-0.04	-10%	-3.99	-37%	-0.26	-24%
2	1.854	0.14	22.42	1.26	1.042	0.11	13.77	1.00	-0.812	-44%	-0.03	-19%	-8.65	-39%	-0.26	-21%
1	1.854	0.27	13.01	1.31	1.042	0.22	7.70	1.05	-0.812	-44%	-0.05	-18%	-5.31	-41%	-0.26	-20%

TABLE B2 JULY DORIS LAKE OUTFLOW: CONSTANT RATE HEC-RAS OUTPUT

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
43	1.305	0.16	20.37	0.57	1.189	0.15	19.60	0.55	-0.116	-9%	-0.01	-4%	-0.77	-4%	-0.02	-4%
42	1.305	0.27	13.28	0.66	1.189	0.26	12.29	0.64	-0.116	-9%	-0.01	-4%	-0.99	-7%	-0.02	-3%
41	1.305	0.25	11.68	0.75	1.189	0.24	11.59	0.73	-0.116	-9%	-0.01	-5%	-0.09	-1%	-0.02	-3%
40	1.305	0.32	15.08	0.56	1.189	0.32	14.96	0.53	-0.116	-9%	-0.01	-2%	-0.12	-1%	-0.02	-4%
39	1.305	0.30	11.53	0.83	1.189	0.29	11.43	0.81	-0.116	-9%	-0.01	-3%	-0.10	-1%	-0.02	-3%
38.5*	1.305	0.28	9.48	0.84	1.189	0.27	9.34	0.82	-0.116	-9%	-0.01	-5%	-0.13	-1%	-0.02	-3%
38	1.305	0.47	7.37	0.84	1.189	0.45	7.17	0.82	-0.116	-9%	-0.02	-4%	-0.20	-3%	-0.02	-3%
37	1.305	0.75	7.49	0.43	1.189	0.73	5.25	0.41	-0.116	-9%	-0.02	-2%	-2.24	-30%	-0.02	-5%
36	1.305	0.61	17.23	0.59	1.189	0.60	6.93	0.56	-0.116	-9%	-0.01	-2%	-10.30	-60%	-0.02	-4%
35	1.305	0.35	7.39	1.08	1.189	0.34	7.03	1.06	-0.116	-9%	-0.02	-5%	-0.36	-5%	-0.02	-2%
34	1.305	0.33	7.36	1.05	1.189	0.32	7.14	1.03	-0.116	-9%	-0.02	-5%	-0.22	-3%	-0.02	-2%
33	1.305	0.32	9.37	0.79	1.189	0.31	9.13	0.77	-0.116	-9%	-0.01	-4%	-0.24	-3%	-0.02	-3%
32	1.305	0.41	10.42	0.79	1.189	0.40	9.60	0.77	-0.116	-9%	-0.01	-2%	-0.82	-8%	-0.02	-3%
31.8333*	1.305	0.43	9.90	0.76	1.189	0.42	9.04	0.74	-0.116	-9%	-0.01	-2%	-0.85	-9%	-0.02	-3%
31.6666*	1.305	0.46	9.28	0.73	1.189	0.45	8.37	0.70	-0.116	-9%	-0.01	-2%	-0.91	-10%	-0.02	-3%
31.5*	1.305	0.51	8.53	0.70	1.189	0.50	7.59	0.67	-0.116	-9%	-0.01	-2%	-0.95	-11%	-0.02	-3%
31.3333*	1.305	0.57	7.37	0.68	1.189	0.57	6.67	0.65	-0.116	-9%	-0.01	-1%	-0.70	-10%	-0.02	-4%
31.1666*	1.305	0.71	5.79	0.63	1.189	0.70	5.40	0.61	-0.116	-9%	-0.01	-2%	-0.39	-7%	-0.02	-4%
31	1.305	1.63	2.91	0.39	1.189	1.59	2.89	0.37	-0.116	-9%	-0.04	-3%	-0.02	-1%	-0.02	-4%
30.8*	1.305	3.77	2.76	0.22	1.189	3.66	2.75	0.21	-0.116	-9%	-0.11	-3%	-0.01	0%	-0.01	-3%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
30.6*	1.305	1.94	2.92	0.32	1.189	1.87	2.90	0.30	-0.116	-9%	-0.07	-4%	-0.02	-1%	-0.01	-4%
30.4*	1.305	2.88	2.85	0.23	1.189	2.82	2.84	0.22	-0.116	-9%	-0.06	-2%	-0.02	-1%	-0.01	-4%
30.2*	1.305	2.07	3.01	0.29	1.189	1.99	2.98	0.28	-0.116	-9%	-0.08	-4%	-0.03	-1%	-0.01	-4%
30	1.305	0.33	6.32	0.79	1.189	0.32	6.08	0.75	-0.116	-9%	-0.01	-4%	-0.24	-4%	-0.04	-4%
29	1.305	0.46	5.79	0.84	1.189	0.45	5.08	0.80	-0.116	-9%	-0.01	-3%	-0.71	-12%	-0.04	-4%
28.8*	1.305	0.46	5.10	0.84	1.189	0.45	4.92	0.80	-0.116	-9%	-0.01	-3%	-0.18	-3%	-0.04	-4%
28.6*	1.305	0.42	5.29	0.89	1.189	0.40	5.16	0.85	-0.116	-9%	-0.01	-3%	-0.13	-2%	-0.03	-4%
28.4*	1.305	0.35	5.68	0.99	1.189	0.33	5.56	0.96	-0.116	-9%	-0.02	-4%	-0.12	-2%	-0.03	-3%
28.2*	1.305	0.29	6.13	1.13	1.189	0.27	6.03	1.10	-0.116	-9%	-0.02	-5%	-0.10	-2%	-0.03	-3%
28	1.305	0.21	9.56	1.28	1.189	0.20	9.16	1.25	-0.116	-9%	-0.01	-4%	-0.40	-4%	-0.03	-2%
27	1.305	0.23	8.25	1.12	1.189	0.22	8.04	1.09	-0.116	-9%	-0.01	-5%	-0.21	-3%	-0.03	-3%
26	1.305	0.32	9.00	0.90	1.189	0.32	8.63	0.87	-0.116	-9%	-0.01	-3%	-0.37	-4%	-0.03	-3%
25	1.305	0.24	8.95	1.12	1.189	0.23	8.75	1.09	-0.116	-9%	-0.01	-5%	-0.20	-2%	-0.03	-3%
24.8333*	1.305	0.21	9.68	1.08	1.189	0.20	9.46	1.06	-0.116	-9%	-0.01	-5%	-0.23	-2%	-0.03	-3%
24.6666*	1.305	0.19	10.48	1.05	1.189	0.18	10.18	1.02	-0.116	-9%	-0.01	-5%	-0.29	-3%	-0.03	-3%
24.5*	1.305	0.18	11.35	1.02	1.189	0.17	10.94	0.99	-0.116	-9%	-0.01	-5%	-0.40	-4%	-0.03	-3%
24.3333*	1.305	0.17	12.35	0.99	1.189	0.16	11.76	0.96	-0.116	-9%	-0.01	-5%	-0.59	-5%	-0.03	-3%
24.1666*	1.305	0.16	13.66	0.95	1.189	0.15	12.70	0.92	-0.116	-9%	-0.01	-5%	-0.96	-7%	-0.03	-3%
24	1.305	0.15	15.76	0.91	1.189	0.14	13.82	0.89	-0.116	-9%	-0.01	-5%	-1.94	-12%	-0.03	-3%
23.8*	1.305	0.15	14.75	0.91	1.189	0.14	13.28	0.88	-0.116	-9%	-0.01	-5%	-1.47	-10%	-0.03	-3%
23.6*	1.305	0.16	13.70	0.90	1.189	0.15	12.54	0.87	-0.116	-9%	-0.01	-6%	-1.16	-8%	-0.03	-3%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
23.4*	1.305	0.17	12.89	0.89	1.189	0.16	11.91	0.87	-0.116	-9%	-0.01	-5%	-0.98	-8%	-0.03	-3%
23.2*	1.305	0.18	12.43	0.94	1.189	0.17	11.39	0.91	-0.116	-9%	-0.01	-6%	-1.04	-8%	-0.03	-3%
23	1.305	0.28	12.72	0.98	1.189	0.27	10.64	0.96	-0.116	-9%	-0.01	-4%	-2.08	-16%	-0.02	-2%
22.8*	1.305	0.27	14.24	0.93	1.189	0.26	12.64	0.91	-0.116	-9%	-0.01	-3%	-1.60	-11%	-0.02	-2%
22.6*	1.305	0.25	12.74	0.82	1.189	0.25	12.59	0.79	-0.116	-9%	-0.01	-3%	-0.15	-1%	-0.02	-3%
22.4*	1.305	0.33	13.45	0.64	1.189	0.32	13.30	0.62	-0.116	-9%	-0.01	-3%	-0.15	-1%	-0.03	-4%
22.2*	1.305	0.30	15.05	0.62	1.189	0.29	14.91	0.59	-0.116	-9%	-0.01	-3%	-0.15	-1%	-0.03	-4%
22	1.305	0.12	19.71	0.78	1.189	0.12	18.60	0.76	-0.116	-9%	-0.01	-5%	-1.12	-6%	-0.03	-3%
21.8*	1.305	0.13	19.31	0.77	1.189	0.12	18.19	0.75	-0.116	-9%	-0.01	-5%	-1.12	-6%	-0.03	-3%
21.6*	1.305	0.14	18.90	0.76	1.189	0.13	17.78	0.73	-0.116	-9%	-0.01	-5%	-1.12	-6%	-0.03	-3%
21.4*	1.305	0.15	18.45	0.75	1.189	0.14	17.31	0.72	-0.116	-9%	-0.01	-5%	-1.14	-6%	-0.03	-3%
21.2*	1.305	0.16	17.63	0.72	1.189	0.15	16.48	0.70	-0.116	-9%	-0.01	-4%	-1.15	-7%	-0.02	-3%
21	1.305	0.19	15.44	0.67	1.189	0.18	15.34	0.65	-0.116	-9%	-0.01	-4%	-0.10	-1%	-0.02	-4%
20.9*	1.305	0.20	16.33	0.68	1.189	0.20	16.22	0.66	-0.116	-9%	-0.01	-3%	-0.11	-1%	-0.02	-3%
20.8*	1.305	0.19	17.20	0.68	1.189	0.18	17.08	0.66	-0.116	-9%	-0.01	-3%	-0.12	-1%	-0.02	-4%
20.7*	1.305	0.20	18.04	0.68	1.189	0.19	17.90	0.66	-0.116	-9%	0.00	-2%	-0.13	-1%	-0.03	-4%
20.6*	1.305	0.22	18.81	0.67	1.189	0.21	18.66	0.64	-0.116	-9%	-0.01	-3%	-0.15	-1%	-0.03	-4%
20.5*	1.305	0.19	19.65	0.67	1.189	0.18	19.50	0.65	-0.116	-9%	-0.01	-4%	-0.16	-1%	-0.03	-4%
20.4*	1.305	0.17	20.51	0.68	1.189	0.17	20.33	0.66	-0.116	-9%	0.00	-2%	-0.17	-1%	-0.03	-4%
20.3*	1.305	0.15	21.40	0.70	1.189	0.15	21.19	0.67	-0.116	-9%	0.00	-2%	-0.21	-1%	-0.03	-4%
20.2*	1.305	0.14	22.35	0.77	1.189	0.14	22.10	0.74	-0.116	-9%	0.00	-2%	-0.25	-1%	-0.03	-4%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
20.1*	1.305	0.13	23.46	0.86	1.189	0.13	23.16	0.83	-0.116	-9%	0.00	-2%	-0.30	-1%	-0.03	-3%
20	1.305	0.08	26.90	0.96	1.189	0.07	25.24	0.93	-0.116	-9%	0.00	-4%	-1.66	-6%	-0.03	-3%
19.8333*	1.305	0.09	25.31	0.93	1.189	0.08	23.72	0.90	-0.116	-9%	0.00	-5%	-1.58	-6%	-0.03	-3%
19.6666*	1.305	0.10	23.74	0.89	1.189	0.10	22.20	0.86	-0.116	-9%	0.00	-4%	-1.55	-7%	-0.03	-3%
19.5*	1.305	0.12	22.24	0.85	1.189	0.11	20.66	0.82	-0.116	-9%	-0.01	-4%	-1.58	-7%	-0.03	-3%
19.3333*	1.305	0.13	20.81	0.81	1.189	0.13	19.13	0.79	-0.116	-9%	-0.01	-4%	-1.68	-8%	-0.03	-4%
19.1666*	1.305	0.16	19.29	0.77	1.189	0.15	17.43	0.74	-0.116	-9%	-0.01	-3%	-1.86	-10%	-0.03	-4%
19	1.305	0.19	17.13	0.72	1.189	0.19	14.70	0.69	-0.116	-9%	-0.01	-3%	-2.42	-14%	-0.03	-4%
18.98*	1.305	0.19	17.27	0.72	1.189	0.19	14.94	0.69	-0.116	-9%	-0.01	-3%	-2.33	-13%	-0.03	-4%
18.96*	1.305	0.20	15.50	0.69	1.189	0.20	13.61	0.66	-0.116	-9%	-0.01	-2%	-1.89	-12%	-0.03	-4%
18.94*	1.305	0.22	13.45	0.65	1.189	0.22	12.67	0.63	-0.116	-9%	-0.01	-3%	-0.79	-6%	-0.03	-4%
18.92*	1.305	0.23	13.25	0.64	1.189	0.22	12.58	0.62	-0.116	-9%	-0.01	-4%	-0.67	-5%	-0.02	-4%
18.9	1.305	0.20	16.75	0.71	1.189	0.19	15.15	0.69	-0.116	-9%	-0.01	-4%	-1.60	-10%	-0.02	-3%
18	1.305	0.66	5.50	0.87	1.189	0.65	4.47	0.84	-0.116	-9%	-0.01	-2%	-1.03	-19%	-0.03	-4%
17	1.305	0.20	13.43	1.55	1.189	0.20	12.59	1.51	-0.116	-9%	0.00	-2%	-0.84	-6%	-0.03	-2%
16	1.305	0.21	12.09	1.61	1.189	0.20	11.41	1.58	-0.116	-9%	-0.01	-3%	-0.67	-6%	-0.03	-2%
15	1.305	0.36	6.23	1.18	1.189	0.34	5.69	1.14	-0.116	-9%	-0.01	-4%	-0.54	-9%	-0.03	-3%
14	1.305	0.80	4.70	0.84	1.189	0.78	3.68	0.81	-0.116	-9%	-0.01	-1%	-1.02	-22%	-0.03	-4%
13	1.305	0.09	17.58	2.23	1.189	0.09	16.29	2.19	-0.116	-9%	-0.01	-5%	-1.29	-7%	-0.03	-1%
12	1.305	0.11	13.86	1.77	1.189	0.11	13.63	1.73	-0.116	-9%	-0.01	-5%	-0.23	-2%	-0.03	-2%
11	1.305	0.45	5.43	1.12	1.189	0.43	5.02	1.09	-0.116	-9%	-0.02	-4%	-0.42	-8%	-0.03	-3%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
10.8333*	1.305	0.44	5.57	1.09	1.189	0.43	5.14	1.06	-0.116	-9%	-0.02	-4%	-0.43	-8%	-0.03	-3%
10.6666*	1.305	0.44	5.70	1.07	1.189	0.43	5.25	1.03	-0.116	-9%	-0.02	-3%	-0.45	-8%	-0.03	-3%
10.5*	1.305	0.45	5.80	1.04	1.189	0.43	5.34	1.01	-0.116	-9%	-0.02	-3%	-0.46	-8%	-0.03	-3%
10.3333*	1.305	0.46	5.83	1.00	1.189	0.44	5.35	0.97	-0.116	-9%	-0.01	-3%	-0.48	-8%	-0.03	-3%
10.1666*	1.305	0.48	5.75	0.96	1.189	0.47	5.41	0.93	-0.116	-9%	-0.01	-2%	-0.34	-6%	-0.03	-3%
10	1.305	0.54	5.55	0.91	1.189	0.53	5.43	0.87	-0.116	-9%	-0.01	-1%	-0.12	-2%	-0.04	-4%
9.8*	1.305	0.35	6.94	1.22	1.189	0.34	6.80	1.18	-0.116	-9%	-0.01	-2%	-0.14	-2%	-0.04	-3%
9.6*	1.305	0.27	8.37	1.53	1.189	0.27	8.20	1.49	-0.116	-9%	-0.01	-3%	-0.17	-2%	-0.03	-2%
9.4*	1.305	0.23	9.82	1.84	1.189	0.22	9.61	1.80	-0.116	-9%	-0.01	-3%	-0.21	-2%	-0.04	-2%
9.2*	1.305	0.19	11.27	2.15	1.189	0.19	11.03	2.11	-0.116	-9%	-0.01	-3%	-0.24	-2%	-0.04	-2%
9	1.305	0.13	12.69	2.46	1.189	0.13	12.47	2.43	-0.116	-9%	-0.01	-5%	-0.23	-2%	-0.04	-1%
8	1.305	0.15	13.28	2.47	1.189	0.15	13.09	2.43	-0.116	-9%	-0.01	-3%	-0.19	-1%	-0.04	-1%
7	1.305	0.17	13.03	2.10	1.189	0.17	12.20	2.06	-0.116	-9%	-0.01	-3%	-0.83	-6%	-0.04	-2%
6	1.305	0.35	7.63	0.95	1.189	0.34	7.28	0.92	-0.116	-9%	-0.01	-2%	-0.35	-5%	-0.03	-4%
5	1.305	0.42	5.52	0.93	1.189	0.41	5.08	0.89	-0.116	-9%	-0.01	-3%	-0.44	-8%	-0.04	-4%
4	1.305	0.30	8.62	0.91	1.189	0.29	8.35	0.87	-0.116	-9%	-0.01	-2%	-0.27	-3%	-0.04	-4%
3	1.305	0.32	7.74	0.94	1.189	0.31	7.30	0.90	-0.116	-9%	-0.01	-2%	-0.44	-6%	-0.04	-4%
2	1.305	0.12	16.53	1.11	1.189	0.12	14.87	1.07	-0.116	-9%	0.00	-3%	-1.66	-10%	-0.04	-4%
1	1.305	0.23	8.91	1.16	1.189	0.23	8.36	1.12	-0.116	-9%	-0.01	-3%	-0.55	-6%	-0.04	-3%

TABLE B3 AUGUST DORIS LAKE OUTFLOW: CONSTANT RATE HEC-RAS OUTPUT

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
43	0.486	0.10	16.44	0.38	0.368	0.09	15.97	0.34	-0.118	-24%	-0.01	-14%	-0.47	-3%	-0.04	-10%
42	0.486	0.18	9.83	0.48	0.368	0.15	9.68	0.44	-0.118	-24%	-0.02	-13%	-0.16	-2%	-0.04	-8%
41	0.486	0.16	10.65	0.57	0.368	0.14	10.30	0.53	-0.118	-24%	-0.02	-13%	-0.35	-3%	-0.04	-7%
40	0.486	0.28	8.85	0.37	0.368	0.25	8.20	0.34	-0.118	-24%	-0.02	-8%	-0.64	-7%	-0.04	-10%
39	0.486	0.21	10.70	0.65	0.368	0.19	10.53	0.61	-0.118	-24%	-0.02	-8%	-0.18	-2%	-0.04	-6%
38.5*	0.486	0.16	8.79	0.66	0.368	0.14	8.66	0.62	-0.118	-24%	-0.02	-15%	-0.14	-2%	-0.04	-6%
38	0.486	0.30	6.40	0.67	0.368	0.26	5.88	0.63	-0.118	-24%	-0.04	-12%	-0.52	-8%	-0.04	-6%
37	0.486	0.78	4.41	0.20	0.368	0.77	4.27	0.16	-0.118	-24%	-0.01	-1%	-0.14	-3%	-0.03	-17%
36	0.486	0.55	3.29	0.30	0.368	0.53	3.10	0.24	-0.118	-24%	-0.03	-5%	-0.19	-6%	-0.06	-19%
35	0.486	0.25	5.24	0.80	0.368	0.22	4.95	0.74	-0.118	-24%	-0.03	-11%	-0.29	-5%	-0.06	-7%
34	0.486	0.23	5.74	0.77	0.368	0.21	5.44	0.72	-0.118	-24%	-0.03	-11%	-0.30	-5%	-0.06	-7%
33	0.486	0.25	5.35	0.51	0.368	0.22	5.12	0.46	-0.118	-24%	-0.03	-12%	-0.23	-4%	-0.05	-10%
32	0.486	0.33	4.02	0.53	0.368	0.29	3.76	0.48	-0.118	-24%	-0.04	-13%	-0.26	-7%	-0.05	-10%
31.8333*	0.486	0.36	4.14	0.50	0.368	0.31	3.81	0.45	-0.118	-24%	-0.04	-12%	-0.33	-8%	-0.05	-10%
31.6666*	0.486	0.38	3.97	0.47	0.368	0.34	3.84	0.42	-0.118	-24%	-0.04	-11%	-0.13	-3%	-0.05	-10%
31.5*	0.486	0.41	3.74	0.44	0.368	0.36	3.64	0.40	-0.118	-24%	-0.05	-11%	-0.10	-3%	-0.05	-10%
31.3333*	0.486	0.45	3.48	0.43	0.368	0.40	3.40	0.39	-0.118	-24%	-0.05	-12%	-0.08	-2%	-0.05	-10%
31.1666*	0.486	0.53	3.18	0.41	0.368	0.47	3.13	0.37	-0.118	-24%	-0.06	-12%	-0.06	-2%	-0.04	-10%
31	0.486	1.20	2.76	0.25	0.368	1.09	2.73	0.23	-0.118	-24%	-0.11	-9%	-0.03	-1%	-0.02	-10%
30.8*	0.486	2.63	2.66	0.16	0.368	2.39	2.64	0.15	-0.118	-24%	-0.24	-9%	-0.02	-1%	-0.01	-8%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
30.6*	0.486	1.30	2.79	0.21	0.368	1.16	2.77	0.19	-0.118	-24%	-0.14	-11%	-0.02	-1%	-0.02	-9%
30.4*	0.486	2.22	2.73	0.14	0.368	2.09	2.58	0.13	-0.118	-24%	-0.13	-6%	-0.15	-6%	-0.02	-11%
30.2*	0.486	1.35	2.83	0.20	0.368	1.20	2.79	0.18	-0.118	-24%	-0.15	-11%	-0.03	-1%	-0.02	-10%
30	0.486	0.25	5.15	0.44	0.368	0.22	4.97	0.38	-0.118	-24%	-0.02	-9%	-0.19	-4%	-0.07	-15%
29	0.486	0.35	3.44	0.49	0.368	0.32	3.37	0.42	-0.118	-24%	-0.03	-10%	-0.07	-2%	-0.07	-13%
28.8*	0.486	0.36	3.66	0.49	0.368	0.33	3.55	0.42	-0.118	-24%	-0.03	-8%	-0.11	-3%	-0.06	-13%
28.6*	0.486	0.35	4.10	0.52	0.368	0.33	3.83	0.44	-0.118	-24%	-0.02	-5%	-0.27	-7%	-0.07	-14%
28.4*	0.486	0.27	4.54	0.61	0.368	0.25	4.25	0.53	-0.118	-24%	-0.02	-7%	-0.29	-6%	-0.08	-13%
28.2*	0.486	0.20	4.99	0.75	0.368	0.18	4.70	0.67	-0.118	-24%	-0.02	-11%	-0.29	-6%	-0.08	-10%
28	0.486	0.15	5.76	0.90	0.368	0.13	5.15	0.83	-0.118	-24%	-0.02	-14%	-0.61	-11%	-0.08	-8%
27	0.486	0.16	6.14	0.75	0.368	0.14	5.85	0.68	-0.118	-24%	-0.02	-11%	-0.29	-5%	-0.07	-10%
26	0.486	0.29	4.32	0.53	0.368	0.26	3.90	0.46	-0.118	-24%	-0.02	-8%	-0.43	-10%	-0.07	-13%
25	0.486	0.18	5.73	0.75	0.368	0.16	5.46	0.68	-0.118	-24%	-0.02	-11%	-0.26	-5%	-0.07	-9%
24.8333*	0.486	0.16	7.31	0.72	0.368	0.15	6.26	0.65	-0.118	-24%	-0.02	-10%	-1.05	-14%	-0.07	-10%
24.6666*	0.486	0.15	8.47	0.68	0.368	0.14	7.77	0.62	-0.118	-24%	-0.01	-9%	-0.70	-8%	-0.07	-10%
24.5*	0.486	0.13	9.28	0.65	0.368	0.12	9.00	0.58	-0.118	-24%	-0.01	-8%	-0.29	-3%	-0.07	-11%
24.3333*	0.486	0.12	10.02	0.62	0.368	0.11	9.79	0.55	-0.118	-24%	-0.01	-8%	-0.23	-2%	-0.07	-11%
24.1666*	0.486	0.12	10.73	0.58	0.368	0.11	10.54	0.51	-0.118	-24%	-0.01	-9%	-0.20	-2%	-0.07	-12%
24	0.486	0.11	11.41	0.54	0.368	0.10	11.24	0.47	-0.118	-24%	-0.01	-8%	-0.17	-1%	-0.07	-13%
23.8*	0.486	0.11	10.83	0.53	0.368	0.10	10.66	0.46	-0.118	-24%	-0.01	-8%	-0.17	-2%	-0.07	-13%
23.6*	0.486	0.12	10.25	0.53	0.368	0.11	10.01	0.46	-0.118	-24%	-0.01	-9%	-0.23	-2%	-0.07	-13%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
23.4*	0.486	0.12	9.62	0.52	0.368	0.11	9.34	0.45	-0.118	-24%	-0.01	-9%	-0.29	-3%	-0.07	-14%
23.2*	0.486	0.13	8.99	0.56	0.368	0.12	8.76	0.49	-0.118	-24%	-0.01	-9%	-0.23	-3%	-0.07	-13%
23	0.486	0.24	8.39	0.61	0.368	0.22	8.21	0.54	-0.118	-24%	-0.02	-9%	-0.18	-2%	-0.07	-12%
22.8*	0.486	0.22	9.20	0.59	0.368	0.20	8.91	0.52	-0.118	-24%	-0.02	-10%	-0.29	-3%	-0.07	-11%
22.6*	0.486	0.20	10.20	0.53	0.368	0.18	9.81	0.47	-0.118	-24%	-0.02	-10%	-0.39	-4%	-0.06	-11%
22.4*	0.486	0.24	11.19	0.42	0.368	0.22	10.65	0.37	-0.118	-24%	-0.02	-9%	-0.54	-5%	-0.05	-11%
22.2*	0.486	0.24	13.06	0.37	0.368	0.22	12.43	0.33	-0.118	-24%	-0.02	-7%	-0.63	-5%	-0.05	-13%
22	0.486	0.07	16.10	0.54	0.368	0.06	15.84	0.49	-0.118	-24%	-0.01	-15%	-0.26	-2%	-0.05	-9%
21.8*	0.486	0.08	15.79	0.53	0.368	0.07	15.52	0.48	-0.118	-24%	-0.01	-15%	-0.27	-2%	-0.05	-9%
21.6*	0.486	0.09	15.50	0.52	0.368	0.08	15.24	0.47	-0.118	-24%	-0.01	-14%	-0.26	-2%	-0.05	-9%
21.4*	0.486	0.10	15.20	0.51	0.368	0.08	14.97	0.46	-0.118	-24%	-0.01	-13%	-0.23	-1%	-0.05	-9%
21.2*	0.486	0.11	14.88	0.49	0.368	0.10	14.67	0.44	-0.118	-24%	-0.01	-11%	-0.21	-1%	-0.05	-9%
21	0.486	0.14	14.40	0.44	0.368	0.14	13.62	0.39	-0.118	-24%	-0.01	-6%	-0.79	-5%	-0.05	-10%
20.9*	0.486	0.16	15.19	0.43	0.368	0.14	14.98	0.39	-0.118	-24%	-0.02	-9%	-0.21	-1%	-0.05	-11%
20.8*	0.486	0.16	15.99	0.43	0.368	0.14	15.67	0.39	-0.118	-24%	-0.02	-10%	-0.31	-2%	-0.05	-11%
20.7*	0.486	0.16	16.68	0.43	0.368	0.15	16.24	0.38	-0.118	-24%	-0.02	-9%	-0.44	-3%	-0.05	-11%
20.6*	0.486	0.17	17.06	0.41	0.368	0.16	16.58	0.36	-0.118	-24%	-0.01	-8%	-0.48	-3%	-0.05	-12%
20.5*	0.486	0.15	17.41	0.39	0.368	0.14	16.77	0.34	-0.118	-24%	-0.01	-6%	-0.64	-4%	-0.05	-14%
20.4*	0.486	0.15	17.77	0.38	0.368	0.14	16.62	0.32	-0.118	-24%	-0.01	-4%	-1.15	-6%	-0.06	-15%
20.3*	0.486	0.13	18.21	0.39	0.368	0.13	16.67	0.33	-0.118	-24%	-0.01	-5%	-1.54	-8%	-0.06	-16%
20.2*	0.486	0.12	18.78	0.46	0.368	0.11	17.14	0.41	-0.118	-24%	-0.01	-9%	-1.64	-9%	-0.06	-13%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
20.1*	0.486	0.10	19.88	0.56	0.368	0.09	18.08	0.50	-0.118	-24%	-0.01	-12%	-1.80	-9%	-0.06	-10%
20	0.486	0.05	21.04	0.66	0.368	0.04	19.57	0.61	-0.118	-24%	-0.01	-15%	-1.48	-7%	-0.06	-8%
19.8333*	0.486	0.06	19.18	0.63	0.368	0.05	17.78	0.57	-0.118	-24%	-0.01	-14%	-1.40	-7%	-0.06	-9%
19.6666*	0.486	0.07	16.84	0.59	0.368	0.06	16.23	0.53	-0.118	-24%	-0.01	-13%	-0.61	-4%	-0.05	-9%
19.5*	0.486	0.08	15.17	0.55	0.368	0.07	14.69	0.50	-0.118	-24%	-0.01	-13%	-0.48	-3%	-0.06	-10%
19.3333*	0.486	0.10	13.53	0.52	0.368	0.09	13.12	0.46	-0.118	-24%	-0.01	-11%	-0.41	-3%	-0.06	-11%
19.1666*	0.486	0.12	11.66	0.47	0.368	0.11	11.01	0.42	-0.118	-24%	-0.01	-11%	-0.65	-6%	-0.05	-11%
19	0.486	0.15	9.99	0.42	0.368	0.13	9.78	0.37	-0.118	-24%	-0.01	-10%	-0.20	-2%	-0.05	-13%
18.98*	0.486	0.15	10.01	0.43	0.368	0.13	9.81	0.38	-0.118	-24%	-0.02	-10%	-0.20	-2%	-0.05	-12%
18.96*	0.486	0.15	9.95	0.41	0.368	0.14	9.76	0.36	-0.118	-24%	-0.02	-11%	-0.18	-2%	-0.05	-12%
18.94*	0.486	0.17	9.81	0.38	0.368	0.15	9.64	0.33	-0.118	-24%	-0.02	-11%	-0.17	-2%	-0.05	-12%
18.92*	0.486	0.19	9.72	0.35	0.368	0.18	9.50	0.29	-0.118	-24%	-0.01	-4%	-0.22	-2%	-0.06	-16%
18.9	0.486	0.15	9.97	0.42	0.368	0.14	9.74	0.36	-0.118	-24%	-0.01	-7%	-0.23	-2%	-0.06	-14%
18	0.486	0.59	2.37	0.54	0.368	0.54	1.83	0.48	-0.118	-24%	-0.05	-9%	-0.53	-23%	-0.07	-12%
17	0.486	0.19	9.75	1.21	0.368	0.19	9.22	1.14	-0.118	-24%	0.00	2%	-0.52	-5%	-0.07	-6%
16	0.486	0.19	9.58	1.27	0.368	0.19	9.26	1.20	-0.118	-24%	0.01	3%	-0.32	-3%	-0.07	-6%
15	0.486	0.24	3.96	0.84	0.368	0.21	3.83	0.77	-0.118	-24%	-0.03	-12%	-0.13	-3%	-0.07	-9%
14	0.486	0.67	1.83	0.52	0.368	0.61	1.76	0.45	-0.118	-24%	-0.06	-9%	-0.07	-4%	-0.07	-13%
13	0.486	0.05	14.10	1.91	0.368	0.04	13.60	1.84	-0.118	-24%	-0.01	-16%	-0.49	-3%	-0.07	-4%
12	0.486	0.06	11.84	1.45	0.368	0.05	11.34	1.38	-0.118	-24%	-0.01	-16%	-0.50	-4%	-0.07	-5%
11	0.486	0.30	2.95	0.81	0.368	0.25	2.80	0.74	-0.118	-24%	-0.04	-15%	-0.14	-5%	-0.07	-8%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
10.8333*	0.486	0.30	3.09	0.79	0.368	0.26	2.98	0.72	-0.118	-24%	-0.04	-14%	-0.11	-4%	-0.07	-8%
10.6666*	0.486	0.31	3.48	0.76	0.368	0.27	3.14	0.70	-0.118	-24%	-0.04	-13%	-0.34	-10%	-0.06	-8%
10.5*	0.486	0.32	3.87	0.73	0.368	0.29	3.30	0.67	-0.118	-24%	-0.04	-11%	-0.57	-15%	-0.06	-9%
10.3333*	0.486	0.35	4.09	0.70	0.368	0.32	3.63	0.64	-0.118	-24%	-0.03	-8%	-0.46	-11%	-0.06	-9%
10.1666*	0.486	0.41	4.11	0.65	0.368	0.39	3.46	0.59	-0.118	-24%	-0.03	-6%	-0.65	-16%	-0.06	-9%
10	0.486	0.64	3.63	0.55	0.368	0.70	3.07	0.48	-0.118	-24%	0.06	10%	-0.56	-15%	-0.07	-13%
9.8*	0.486	0.33	5.28	0.85	0.368	0.33	4.69	0.78	-0.118	-24%	0.01	2%	-0.59	-11%	-0.08	-9%
9.6*	0.486	0.24	6.58	1.16	0.368	0.24	6.15	1.08	-0.118	-24%	0.00	0%	-0.44	-7%	-0.08	-7%
9.4*	0.486	0.19	7.96	1.47	0.368	0.19	7.49	1.39	-0.118	-24%	0.00	-1%	-0.46	-6%	-0.08	-5%
9.2*	0.486	0.16	9.29	1.78	0.368	0.16	8.88	1.70	-0.118	-24%	0.00	-1%	-0.40	-4%	-0.08	-4%
9	0.486	0.09	10.61	2.09	0.368	0.08	10.23	2.02	-0.118	-24%	-0.01	-10%	-0.38	-4%	-0.08	-4%
8	0.486	0.12	11.49	2.10	0.368	0.12	11.05	2.02	-0.118	-24%	0.00	-2%	-0.44	-4%	-0.08	-4%
7	0.486	0.14	9.82	1.73	0.368	0.14	9.57	1.65	-0.118	-24%	0.00	-3%	-0.25	-3%	-0.08	-5%
6	0.486	0.31	3.73	0.59	0.368	0.29	3.47	0.51	-0.118	-24%	-0.02	-7%	-0.26	-7%	-0.08	-13%
5	0.486	0.35	3.73	0.55	0.368	0.33	3.29	0.47	-0.118	-24%	-0.02	-6%	-0.43	-12%	-0.08	-14%
4	0.486	0.31	4.82	0.50	0.368	0.30	4.07	0.41	-0.118	-24%	-0.01	-2%	-0.76	-16%	-0.08	-17%
3	0.486	0.32	4.29	0.51	0.368	0.33	3.91	0.41	-0.118	-24%	0.01	2%	-0.38	-9%	-0.10	-19%
2	0.486	0.09	10.56	0.68	0.368	0.08	9.80	0.58	-0.118	-24%	-0.01	-8%	-0.76	-7%	-0.10	-14%
1	0.486	0.19	5.46	0.73	0.368	0.17	4.93	0.63	-0.118	-24%	-0.01	-7%	-0.54	-10%	-0.10	-13%

TABLE B4 SEPTEMBER DORIS LAKE OUTFLOW: CONSTANT RATE HEC-RAS OUTPUT

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
43	0.428	0.10	16.22	0.36	0.309	0.08	15.65	0.32	-0.119	-28%	-0.01	-14%	-0.58	-4%	-0.05	-13%
42	0.428	0.17	9.76	0.46	0.309	0.14	9.57	0.42	-0.119	-28%	-0.02	-13%	-0.19	-2%	-0.05	-10%
41	0.428	0.15	10.49	0.55	0.309	0.13	10.10	0.51	-0.119	-28%	-0.02	-14%	-0.39	-4%	-0.05	-8%
40	0.428	0.27	8.55	0.36	0.309	0.25	7.56	0.31	-0.119	-28%	-0.02	-6%	-0.99	-12%	-0.05	-13%
39	0.428	0.20	10.63	0.63	0.309	0.18	9.25	0.59	-0.119	-28%	-0.02	-8%	-1.38	-13%	-0.05	-7%
38.5*	0.428	0.15	8.73	0.64	0.309	0.13	8.57	0.60	-0.119	-28%	-0.03	-17%	-0.16	-2%	-0.05	-7%
38	0.428	0.28	6.17	0.65	0.309	0.24	5.56	0.61	-0.119	-28%	-0.04	-13%	-0.61	-10%	-0.04	-7%
37	0.428	0.78	4.34	0.18	0.309	0.75	4.07	0.15	-0.119	-28%	-0.04	-4%	-0.27	-6%	-0.03	-17%
36	0.428	0.54	3.16	0.27	0.309	0.52	3.04	0.21	-0.119	-28%	-0.02	-4%	-0.12	-4%	-0.06	-23%
35	0.428	0.24	5.08	0.77	0.309	0.20	4.81	0.71	-0.119	-28%	-0.03	-13%	-0.27	-5%	-0.06	-8%
34	0.428	0.22	5.60	0.75	0.309	0.19	5.27	0.69	-0.119	-28%	-0.03	-13%	-0.33	-6%	-0.06	-8%
33	0.428	0.24	5.25	0.49	0.309	0.20	4.99	0.43	-0.119	-28%	-0.03	-14%	-0.25	-5%	-0.06	-12%
32	0.428	0.32	3.89	0.50	0.309	0.27	3.61	0.45	-0.119	-28%	-0.05	-15%	-0.27	-7%	-0.06	-11%
31.8333*	0.428	0.34	4.05	0.47	0.309	0.29	3.61	0.42	-0.119	-28%	-0.05	-14%	-0.44	-11%	-0.05	-11%
31.6666*	0.428	0.36	3.91	0.45	0.309	0.31	3.77	0.39	-0.119	-28%	-0.05	-13%	-0.14	-4%	-0.05	-12%
31.5*	0.428	0.39	3.69	0.42	0.309	0.34	3.58	0.37	-0.119	-28%	-0.05	-13%	-0.11	-3%	-0.05	-12%
31.3333*	0.428	0.43	3.44	0.41	0.309	0.37	3.36	0.36	-0.119	-28%	-0.06	-14%	-0.08	-2%	-0.05	-12%
31.1666*	0.428	0.50	3.16	0.39	0.309	0.43	3.10	0.34	-0.119	-28%	-0.07	-14%	-0.06	-2%	-0.05	-12%
31	0.428	1.15	2.74	0.24	0.309	1.04	2.71	0.21	-0.119	-28%	-0.11	-10%	-0.04	-1%	-0.03	-12%
30.8*	0.428	2.53	2.65	0.15	0.309	2.16	2.63	0.14	-0.119	-28%	-0.37	-15%	-0.02	-1%	-0.01	-7%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
30.6*	0.428	1.23	2.78	0.20	0.309	1.09	2.75	0.18	-0.119	-28%	-0.14	-12%	-0.03	-1%	-0.02	-12%
30.4*	0.428	2.15	2.72	0.13	0.309	2.01	2.37	0.12	-0.119	-28%	-0.15	-7%	-0.36	-13%	-0.02	-13%
30.2*	0.428	1.28	2.81	0.19	0.309	1.13	2.78	0.17	-0.119	-28%	-0.15	-12%	-0.04	-1%	-0.02	-12%
30	0.428	0.24	5.06	0.41	0.309	0.21	4.87	0.34	-0.119	-28%	-0.03	-11%	-0.20	-4%	-0.07	-17%
29	0.428	0.33	3.41	0.45	0.309	0.30	3.34	0.39	-0.119	-28%	-0.04	-12%	-0.07	-2%	-0.07	-15%
28.8*	0.428	0.35	3.59	0.46	0.309	0.31	3.50	0.39	-0.119	-28%	-0.04	-10%	-0.09	-2%	-0.07	-15%
28.6*	0.428	0.34	3.97	0.48	0.309	0.32	3.63	0.40	-0.119	-28%	-0.02	-5%	-0.34	-9%	-0.08	-16%
28.4*	0.428	0.26	4.42	0.57	0.309	0.24	4.03	0.49	-0.119	-28%	-0.02	-8%	-0.39	-9%	-0.08	-14%
28.2*	0.428	0.19	4.86	0.71	0.309	0.16	4.51	0.63	-0.119	-28%	-0.02	-13%	-0.34	-7%	-0.08	-12%
28	0.428	0.14	5.41	0.87	0.309	0.12	4.99	0.79	-0.119	-28%	-0.02	-17%	-0.42	-8%	-0.08	-9%
27	0.428	0.15	6.00	0.72	0.309	0.13	5.69	0.64	-0.119	-28%	-0.02	-14%	-0.32	-5%	-0.08	-11%
26	0.428	0.28	4.11	0.50	0.309	0.25	3.75	0.42	-0.119	-28%	-0.03	-11%	-0.36	-9%	-0.08	-15%
25	0.428	0.17	5.60	0.72	0.309	0.15	5.32	0.64	-0.119	-28%	-0.02	-14%	-0.28	-5%	-0.07	-10%
24.8333*	0.428	0.16	6.81	0.68	0.309	0.14	6.06	0.61	-0.119	-28%	-0.02	-13%	-0.76	-11%	-0.07	-11%
24.6666*	0.428	0.14	8.25	0.65	0.309	0.13	7.26	0.58	-0.119	-28%	-0.02	-11%	-0.99	-12%	-0.07	-11%
24.5*	0.428	0.13	9.15	0.62	0.309	0.12	8.58	0.54	-0.119	-28%	-0.01	-10%	-0.57	-6%	-0.07	-12%
24.3333*	0.428	0.12	9.91	0.58	0.309	0.11	9.67	0.51	-0.119	-28%	-0.01	-9%	-0.25	-2%	-0.07	-13%
24.1666*	0.428	0.11	10.64	0.55	0.309	0.10	10.43	0.48	-0.119	-28%	-0.01	-9%	-0.21	-2%	-0.07	-13%
24	0.428	0.11	11.32	0.51	0.309	0.10	11.14	0.44	-0.119	-28%	-0.01	-8%	-0.18	-2%	-0.08	-15%
23.8*	0.428	0.11	10.75	0.50	0.309	0.10	10.57	0.43	-0.119	-28%	-0.01	-9%	-0.18	-2%	-0.08	-15%
23.6*	0.428	0.11	10.16	0.49	0.309	0.10	9.80	0.42	-0.119	-28%	-0.01	-9%	-0.36	-4%	-0.08	-15%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
23.4*	0.428	0.12	9.49	0.49	0.309	0.11	9.18	0.41	-0.119	-28%	-0.01	-10%	-0.31	-3%	-0.08	-16%
23.2*	0.428	0.12	8.88	0.53	0.309	0.11	8.64	0.45	-0.119	-28%	-0.01	-11%	-0.24	-3%	-0.08	-15%
23	0.428	0.23	8.31	0.58	0.309	0.21	8.11	0.50	-0.119	-28%	-0.03	-11%	-0.20	-2%	-0.08	-13%
22.8*	0.428	0.21	9.06	0.56	0.309	0.19	8.74	0.48	-0.119	-28%	-0.02	-11%	-0.32	-3%	-0.07	-13%
22.6*	0.428	0.19	10.00	0.50	0.309	0.17	9.56	0.44	-0.119	-28%	-0.02	-11%	-0.44	-4%	-0.07	-13%
22.4*	0.428	0.23	10.90	0.40	0.309	0.20	10.43	0.35	-0.119	-28%	-0.03	-11%	-0.48	-4%	-0.05	-13%
22.2*	0.428	0.23	12.77	0.35	0.309	0.21	12.02	0.30	-0.119	-28%	-0.02	-7%	-0.75	-6%	-0.05	-15%
22	0.428	0.07	15.98	0.52	0.309	0.06	15.68	0.47	-0.119	-28%	-0.01	-17%	-0.30	-2%	-0.05	-10%
21.8*	0.428	0.07	15.66	0.51	0.309	0.06	15.36	0.45	-0.119	-28%	-0.01	-15%	-0.31	-2%	-0.05	-11%
21.6*	0.428	0.08	15.38	0.50	0.309	0.07	15.07	0.44	-0.119	-28%	-0.01	-15%	-0.32	-2%	-0.05	-11%
21.4*	0.428	0.09	15.10	0.48	0.309	0.08	14.81	0.43	-0.119	-28%	-0.01	-13%	-0.28	-2%	-0.05	-11%
21.2*	0.428	0.10	14.79	0.47	0.309	0.09	14.54	0.41	-0.119	-28%	-0.01	-12%	-0.24	-2%	-0.05	-11%
21	0.428	0.14	14.31	0.41	0.309	0.13	11.72	0.36	-0.119	-28%	-0.01	-6%	-2.60	-18%	-0.05	-12%
20.9*	0.428	0.15	15.09	0.41	0.309	0.14	14.80	0.36	-0.119	-28%	-0.02	-11%	-0.29	-2%	-0.05	-12%
20.8*	0.428	0.15	15.88	0.41	0.309	0.13	15.45	0.36	-0.119	-28%	-0.02	-11%	-0.43	-3%	-0.05	-12%
20.7*	0.428	0.15	16.46	0.41	0.309	0.14	16.00	0.36	-0.119	-28%	-0.02	-11%	-0.46	-3%	-0.05	-12%
20.6*	0.428	0.16	16.84	0.39	0.309	0.15	16.31	0.33	-0.119	-28%	-0.02	-9%	-0.52	-3%	-0.05	-13%
20.5*	0.428	0.15	17.15	0.37	0.309	0.14	16.17	0.31	-0.119	-28%	-0.01	-6%	-0.98	-6%	-0.06	-16%
20.4*	0.428	0.15	17.35	0.35	0.309	0.14	15.85	0.29	-0.119	-28%	-0.01	-5%	-1.50	-9%	-0.07	-18%
20.3*	0.428	0.13	17.49	0.36	0.309	0.12	15.94	0.30	-0.119	-28%	-0.01	-8%	-1.55	-9%	-0.07	-18%
20.2*	0.428	0.11	18.00	0.44	0.309	0.10	16.71	0.37	-0.119	-28%	-0.01	-12%	-1.30	-7%	-0.06	-15%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
20.1*	0.428	0.09	19.04	0.53	0.309	0.08	17.57	0.47	-0.119	-28%	-0.01	-15%	-1.47	-8%	-0.06	-11%
20	0.428	0.04	20.70	0.63	0.309	0.04	18.44	0.57	-0.119	-28%	-0.01	-16%	-2.26	-11%	-0.06	-9%
19.8333*	0.428	0.05	18.27	0.60	0.309	0.04	17.27	0.54	-0.119	-28%	-0.01	-15%	-0.99	-5%	-0.06	-10%
19.6666*	0.428	0.06	16.55	0.56	0.309	0.05	15.89	0.50	-0.119	-28%	-0.01	-15%	-0.66	-4%	-0.06	-11%
19.5*	0.428	0.08	14.94	0.53	0.309	0.06	14.42	0.47	-0.119	-28%	-0.01	-15%	-0.52	-3%	-0.06	-11%
19.3333*	0.428	0.09	13.33	0.49	0.309	0.08	12.81	0.43	-0.119	-28%	-0.01	-13%	-0.53	-4%	-0.06	-12%
19.1666*	0.428	0.11	11.35	0.45	0.309	0.10	10.80	0.39	-0.119	-28%	-0.02	-13%	-0.55	-5%	-0.06	-13%
19	0.428	0.14	9.89	0.40	0.309	0.12	9.67	0.34	-0.119	-28%	-0.02	-12%	-0.22	-2%	-0.06	-14%
18.98*	0.428	0.14	9.91	0.40	0.309	0.12	9.70	0.35	-0.119	-28%	-0.02	-12%	-0.22	-2%	-0.06	-14%
18.96*	0.428	0.15	9.86	0.39	0.309	0.13	9.66	0.34	-0.119	-28%	-0.02	-13%	-0.20	-2%	-0.05	-13%
18.94*	0.428	0.16	9.73	0.35	0.309	0.14	9.55	0.31	-0.119	-28%	-0.02	-12%	-0.18	-2%	-0.05	-13%
18.92*	0.428	0.18	9.61	0.32	0.309	0.18	9.38	0.26	-0.119	-28%	-0.01	-4%	-0.24	-2%	-0.06	-19%
18.9	0.428	0.14	9.86	0.39	0.309	0.13	9.62	0.33	-0.119	-28%	-0.01	-9%	-0.25	-2%	-0.06	-16%
18	0.428	0.57	2.11	0.51	0.309	0.49	1.72	0.44	-0.119	-28%	-0.08	-13%	-0.40	-19%	-0.07	-13%
17	0.428	0.19	9.50	1.17	0.309	0.20	9.00	1.10	-0.119	-28%	0.01	5%	-0.50	-5%	-0.08	-6%
16	0.428	0.19	9.43	1.24	0.309	0.20	9.08	1.16	-0.119	-28%	0.01	8%	-0.35	-4%	-0.08	-7%
15	0.428	0.22	3.87	0.80	0.309	0.19	3.80	0.72	-0.119	-28%	-0.03	-14%	-0.07	-2%	-0.08	-10%
14	0.428	0.64	1.80	0.49	0.309	0.57	1.72	0.42	-0.119	-28%	-0.07	-10%	-0.08	-4%	-0.07	-15%
13	0.428	0.05	13.87	1.88	0.309	0.04	13.32	1.80	-0.119	-28%	-0.01	-19%	-0.54	-4%	-0.08	-4%
12	0.428	0.06	11.61	1.42	0.309	0.05	11.05	1.34	-0.119	-28%	-0.01	-17%	-0.56	-5%	-0.08	-5%
11	0.428	0.27	2.84	0.78	0.309	0.23	2.77	0.70	-0.119	-28%	-0.05	-17%	-0.07	-3%	-0.07	-10%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
10.8333*	0.428	0.28	3.02	0.76	0.309	0.24	2.93	0.68	-0.119	-28%	-0.04	-16%	-0.08	-3%	-0.07	-10%
10.6666*	0.428	0.29	3.21	0.73	0.309	0.25	3.10	0.66	-0.119	-28%	-0.04	-15%	-0.11	-4%	-0.07	-10%
10.5*	0.428	0.31	3.61	0.71	0.309	0.27	3.24	0.63	-0.119	-28%	-0.04	-13%	-0.37	-10%	-0.07	-10%
10.3333*	0.428	0.34	3.94	0.67	0.309	0.30	3.26	0.60	-0.119	-28%	-0.03	-10%	-0.68	-17%	-0.07	-10%
10.1666*	0.428	0.40	3.83	0.63	0.309	0.37	3.06	0.56	-0.119	-28%	-0.04	-9%	-0.77	-20%	-0.06	-10%
10	0.428	0.66	3.37	0.52	0.309	0.74	2.85	0.44	-0.119	-28%	0.08	11%	-0.51	-15%	-0.07	-14%
9.8*	0.428	0.33	5.02	0.82	0.309	0.34	4.36	0.74	-0.119	-28%	0.01	2%	-0.66	-13%	-0.08	-10%
9.6*	0.428	0.24	6.41	1.12	0.309	0.24	5.88	1.04	-0.119	-28%	0.00	0%	-0.52	-8%	-0.08	-7%
9.4*	0.428	0.19	7.76	1.44	0.309	0.19	7.22	1.35	-0.119	-28%	0.00	-1%	-0.54	-7%	-0.08	-6%
9.2*	0.428	0.16	9.11	1.75	0.309	0.16	8.61	1.66	-0.119	-28%	0.00	-1%	-0.50	-5%	-0.08	-5%
9	0.428	0.08	10.43	2.06	0.309	0.07	9.99	1.97	-0.119	-28%	-0.01	-15%	-0.44	-4%	-0.08	-4%
8	0.428	0.12	11.26	2.06	0.309	0.12	10.84	1.98	-0.119	-28%	0.00	-2%	-0.42	-4%	-0.08	-4%
7	0.428	0.14	9.68	1.69	0.309	0.14	9.46	1.61	-0.119	-28%	0.00	-2%	-0.23	-2%	-0.08	-5%
6	0.428	0.30	3.61	0.55	0.309	0.28	3.33	0.47	-0.119	-28%	-0.03	-9%	-0.28	-8%	-0.08	-15%
5	0.428	0.34	3.52	0.51	0.309	0.31	3.07	0.43	-0.119	-28%	-0.03	-8%	-0.45	-13%	-0.08	-16%
4	0.428	0.30	4.44	0.46	0.309	0.29	3.87	0.37	-0.119	-28%	-0.01	-4%	-0.57	-13%	-0.09	-19%
3	0.428	0.32	4.05	0.46	0.309	0.34	3.75	0.36	-0.119	-28%	0.01	4%	-0.29	-7%	-0.10	-22%
2	0.428	0.09	10.17	0.63	0.309	0.08	9.39	0.53	-0.119	-28%	-0.01	-9%	-0.79	-8%	-0.10	-16%
1	0.428	0.18	5.20	0.68	0.309	0.17	4.62	0.58	-0.119	-28%	-0.01	-8%	-0.58	-11%	-0.10	-15%

TABLE B5 OCTOBER DORIS LAKE OUTFLOW: CONSTANT RATE HEC-RAS OUTPUT

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
43	0.318	0.08	15.70	0.32	0.201	0.07	14.87	0.26	-0.117	-37%	-0.01	-13%	-0.83	-5%	-0.07	-20%
42	0.318	0.15	9.59	0.42	0.201	0.13	8.64	0.35	-0.117	-37%	-0.02	-12%	-0.95	-10%	-0.07	-16%
41	0.318	0.13	10.11	0.51	0.201	0.11	9.99	0.44	-0.117	-37%	-0.02	-14%	-0.12	-1%	-0.07	-13%
40	0.318	0.25	7.71	0.32	0.201	0.24	5.46	0.25	-0.117	-37%	-0.01	-4%	-2.26	-29%	-0.07	-21%
39	0.318	0.18	9.49	0.59	0.201	0.16	6.67	0.53	-0.117	-37%	-0.03	-15%	-2.82	-30%	-0.06	-10%
38.5*	0.318	0.13	8.59	0.60	0.201	0.10	8.38	0.55	-0.117	-37%	-0.03	-22%	-0.20	-2%	-0.06	-9%
38	0.318	0.25	5.61	0.61	0.201	0.20	5.14	0.56	-0.117	-37%	-0.05	-18%	-0.47	-8%	-0.05	-9%
37	0.318	0.75	4.11	0.15	0.201	0.65	3.64	0.12	-0.117	-37%	-0.10	-14%	-0.47	-11%	-0.03	-19%
36	0.318	0.52	3.05	0.22	0.201	0.52	2.91	0.14	-0.117	-37%	0.00	-1%	-0.15	-5%	-0.08	-35%
35	0.318	0.21	4.83	0.71	0.201	0.17	4.51	0.64	-0.117	-37%	-0.04	-19%	-0.33	-7%	-0.07	-10%
34	0.318	0.19	5.30	0.69	0.201	0.16	4.95	0.62	-0.117	-37%	-0.04	-19%	-0.35	-7%	-0.07	-10%
33	0.318	0.21	5.02	0.44	0.201	0.17	4.72	0.37	-0.117	-37%	-0.04	-20%	-0.30	-6%	-0.07	-16%
32	0.318	0.27	3.64	0.45	0.201	0.21	3.32	0.39	-0.117	-37%	-0.06	-22%	-0.32	-9%	-0.07	-14%
31.8333*	0.318	0.29	3.63	0.43	0.201	0.23	3.29	0.36	-0.117	-37%	-0.06	-21%	-0.34	-9%	-0.06	-15%
31.6666*	0.318	0.31	3.78	0.40	0.201	0.25	3.32	0.34	-0.117	-37%	-0.06	-19%	-0.46	-12%	-0.06	-15%
31.5*	0.318	0.34	3.60	0.38	0.201	0.28	3.47	0.32	-0.117	-37%	-0.06	-19%	-0.12	-3%	-0.06	-15%
31.3333*	0.318	0.37	3.37	0.37	0.201	0.30	3.27	0.31	-0.117	-37%	-0.07	-19%	-0.09	-3%	-0.06	-15%
31.1666*	0.318	0.44	3.10	0.35	0.201	0.35	3.04	0.30	-0.117	-37%	-0.08	-19%	-0.07	-2%	-0.05	-15%
31	0.318	1.06	2.71	0.21	0.201	0.90	2.66	0.19	-0.117	-37%	-0.15	-14%	-0.05	-2%	-0.03	-14%
30.8*	0.318	2.14	2.64	0.14	0.201	1.84	2.27	0.13	-0.117	-37%	-0.30	-14%	-0.37	-14%	-0.02	-10%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
30.6*	0.318	1.11	2.75	0.18	0.201	0.93	2.71	0.15	-0.117	-37%	-0.17	-16%	-0.04	-2%	-0.03	-15%
30.4*	0.318	1.99	2.43	0.12	0.201	1.94	1.56	0.09	-0.117	-37%	-0.04	-2%	-0.87	-36%	-0.03	-25%
30.2*	0.318	1.15	2.78	0.17	0.201	1.04	2.30	0.14	-0.117	-37%	-0.11	-10%	-0.48	-17%	-0.03	-19%
30	0.318	0.21	4.88	0.35	0.201	0.18	4.65	0.27	-0.117	-37%	-0.03	-15%	-0.23	-5%	-0.08	-23%
29	0.318	0.30	3.34	0.39	0.201	0.25	3.26	0.31	-0.117	-37%	-0.05	-16%	-0.08	-2%	-0.08	-20%
28.8*	0.318	0.32	3.51	0.39	0.201	0.27	3.41	0.32	-0.117	-37%	-0.05	-14%	-0.10	-3%	-0.08	-19%
28.6*	0.318	0.32	3.67	0.41	0.201	0.30	3.20	0.31	-0.117	-37%	-0.02	-6%	-0.47	-13%	-0.09	-23%
28.4*	0.318	0.24	4.07	0.50	0.201	0.22	3.51	0.40	-0.117	-37%	-0.03	-12%	-0.56	-14%	-0.10	-20%
28.2*	0.318	0.17	4.54	0.64	0.201	0.13	4.12	0.54	-0.117	-37%	-0.03	-19%	-0.42	-9%	-0.10	-15%
28	0.318	0.12	5.01	0.79	0.201	0.09	4.65	0.70	-0.117	-37%	-0.03	-24%	-0.36	-7%	-0.10	-12%
27	0.318	0.13	5.71	0.65	0.201	0.11	5.35	0.56	-0.117	-37%	-0.03	-20%	-0.37	-6%	-0.09	-14%
26	0.318	0.25	3.77	0.43	0.201	0.21	3.43	0.34	-0.117	-37%	-0.04	-16%	-0.34	-9%	-0.09	-21%
25	0.318	0.15	5.34	0.65	0.201	0.12	5.01	0.56	-0.117	-37%	-0.03	-20%	-0.33	-6%	-0.09	-13%
24.8333*	0.318	0.14	6.08	0.62	0.201	0.11	5.70	0.53	-0.117	-37%	-0.03	-19%	-0.38	-6%	-0.08	-14%
24.6666*	0.318	0.13	7.34	0.58	0.201	0.11	6.42	0.50	-0.117	-37%	-0.02	-18%	-0.92	-13%	-0.09	-15%
24.5*	0.318	0.12	8.65	0.55	0.201	0.10	7.57	0.47	-0.117	-37%	-0.02	-15%	-1.09	-13%	-0.09	-15%
24.3333*	0.318	0.11	9.69	0.52	0.201	0.09	8.77	0.43	-0.117	-37%	-0.01	-13%	-0.92	-9%	-0.08	-16%
24.1666*	0.318	0.10	10.44	0.48	0.201	0.09	9.89	0.40	-0.117	-37%	-0.01	-13%	-0.55	-5%	-0.09	-18%
24	0.318	0.10	11.16	0.44	0.201	0.09	10.83	0.36	-0.117	-37%	-0.01	-10%	-0.33	-3%	-0.09	-19%
23.8*	0.318	0.10	10.59	0.43	0.201	0.09	9.95	0.34	-0.117	-37%	-0.01	-12%	-0.63	-6%	-0.09	-20%
23.6*	0.318	0.10	9.84	0.42	0.201	0.09	9.37	0.34	-0.117	-37%	-0.01	-13%	-0.47	-5%	-0.09	-21%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
23.4*	0.318	0.11	9.20	0.42	0.201	0.09	8.85	0.33	-0.117	-37%	-0.02	-14%	-0.36	-4%	-0.09	-21%
23.2*	0.318	0.11	8.66	0.46	0.201	0.09	8.37	0.37	-0.117	-37%	-0.02	-15%	-0.28	-3%	-0.09	-20%
23	0.318	0.21	8.12	0.51	0.201	0.18	7.89	0.42	-0.117	-37%	-0.03	-15%	-0.23	-3%	-0.09	-18%
22.8*	0.318	0.19	8.77	0.49	0.201	0.16	8.39	0.40	-0.117	-37%	-0.03	-15%	-0.38	-4%	-0.09	-18%
22.6*	0.318	0.17	9.60	0.44	0.201	0.14	9.02	0.36	-0.117	-37%	-0.03	-15%	-0.58	-6%	-0.08	-18%
22.4*	0.318	0.20	10.48	0.35	0.201	0.17	9.69	0.29	-0.117	-37%	-0.03	-16%	-0.79	-8%	-0.06	-17%
22.2*	0.318	0.22	12.09	0.30	0.201	0.19	11.28	0.24	-0.117	-37%	-0.02	-10%	-0.81	-7%	-0.06	-21%
22	0.318	0.06	15.71	0.47	0.201	0.05	15.27	0.41	-0.117	-37%	-0.01	-22%	-0.44	-3%	-0.06	-13%
21.8*	0.318	0.06	15.38	0.46	0.201	0.05	14.97	0.40	-0.117	-37%	-0.01	-22%	-0.41	-3%	-0.06	-14%
21.6*	0.318	0.07	15.09	0.45	0.201	0.06	14.69	0.39	-0.117	-37%	-0.01	-20%	-0.40	-3%	-0.06	-14%
21.4*	0.318	0.08	14.84	0.44	0.201	0.06	14.44	0.37	-0.117	-37%	-0.01	-18%	-0.41	-3%	-0.06	-14%
21.2*	0.318	0.09	14.56	0.42	0.201	0.08	14.19	0.36	-0.117	-37%	-0.01	-15%	-0.38	-3%	-0.06	-15%
21	0.318	0.13	12.03	0.37	0.201	0.11	10.24	0.31	-0.117	-37%	-0.02	-14%	-1.79	-15%	-0.06	-17%
20.9*	0.318	0.14	14.83	0.37	0.201	0.12	11.43	0.31	-0.117	-37%	-0.02	-15%	-3.40	-23%	-0.06	-16%
20.8*	0.318	0.14	15.48	0.37	0.201	0.11	14.93	0.31	-0.117	-37%	-0.02	-16%	-0.56	-4%	-0.06	-16%
20.7*	0.318	0.14	16.03	0.36	0.201	0.12	15.49	0.30	-0.117	-37%	-0.02	-15%	-0.54	-3%	-0.06	-16%
20.6*	0.318	0.15	16.36	0.34	0.201	0.13	15.36	0.28	-0.117	-37%	-0.02	-13%	-0.99	-6%	-0.06	-18%
20.5*	0.318	0.14	16.28	0.31	0.201	0.13	14.84	0.25	-0.117	-37%	-0.02	-11%	-1.43	-9%	-0.06	-20%
20.4*	0.318	0.14	15.97	0.29	0.201	0.13	14.80	0.23	-0.117	-37%	-0.02	-11%	-1.17	-7%	-0.07	-23%
20.3*	0.318	0.12	15.97	0.30	0.201	0.11	15.44	0.23	-0.117	-37%	-0.02	-12%	-0.54	-3%	-0.07	-24%
20.2*	0.318	0.10	16.74	0.38	0.201	0.08	16.30	0.31	-0.117	-37%	-0.02	-18%	-0.43	-3%	-0.07	-19%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
20.1*	0.318	0.08	17.60	0.47	0.201	0.06	17.26	0.40	-0.117	-37%	-0.02	-23%	-0.34	-2%	-0.07	-15%
20	0.318	0.04	18.52	0.58	0.201	0.03	18.19	0.51	-0.117	-37%	-0.01	-24%	-0.33	-2%	-0.07	-12%
19.8333*	0.318	0.04	17.35	0.54	0.201	0.03	16.76	0.48	-0.117	-37%	-0.01	-23%	-0.59	-3%	-0.07	-13%
19.6666*	0.318	0.05	15.94	0.51	0.201	0.04	15.32	0.44	-0.117	-37%	-0.01	-23%	-0.62	-4%	-0.07	-14%
19.5*	0.318	0.07	14.47	0.47	0.201	0.05	13.87	0.40	-0.117	-37%	-0.01	-22%	-0.60	-4%	-0.07	-14%
19.3333*	0.318	0.08	12.88	0.44	0.201	0.06	11.79	0.37	-0.117	-37%	-0.02	-20%	-1.10	-9%	-0.07	-16%
19.1666*	0.318	0.10	10.82	0.40	0.201	0.08	10.45	0.33	-0.117	-37%	-0.02	-18%	-0.37	-3%	-0.07	-17%
19	0.318	0.13	9.69	0.34	0.201	0.11	9.44	0.28	-0.117	-37%	-0.02	-16%	-0.25	-3%	-0.07	-19%
18.98*	0.318	0.12	9.72	0.35	0.201	0.10	9.47	0.29	-0.117	-37%	-0.02	-17%	-0.25	-3%	-0.07	-19%
18.96*	0.318	0.13	9.67	0.34	0.201	0.11	9.44	0.28	-0.117	-37%	-0.02	-18%	-0.23	-2%	-0.06	-18%
18.94*	0.318	0.14	9.56	0.31	0.201	0.12	9.37	0.26	-0.117	-37%	-0.03	-20%	-0.19	-2%	-0.05	-15%
18.92*	0.318	0.18	9.40	0.27	0.201	0.17	9.13	0.20	-0.117	-37%	-0.01	-3%	-0.26	-3%	-0.07	-25%
18.9	0.318	0.13	9.64	0.33	0.201	0.12	9.36	0.26	-0.117	-37%	-0.02	-11%	-0.28	-3%	-0.07	-22%
18	0.318	0.50	1.72	0.45	0.201	0.38	1.67	0.39	-0.117	-37%	-0.12	-24%	-0.05	-3%	-0.06	-14%
17	0.318	0.20	9.04	1.10	0.201	0.20	8.62	1.03	-0.117	-37%	0.01	4%	-0.41	-5%	-0.07	-7%
16	0.318	0.20	9.11	1.16	0.201	0.25	8.84	1.07	-0.117	-37%	0.05	24%	-0.27	-3%	-0.09	-8%
15	0.318	0.20	3.81	0.73	0.201	0.16	3.73	0.64	-0.117	-37%	-0.04	-21%	-0.07	-2%	-0.09	-12%
14	0.318	0.58	1.72	0.42	0.201	0.48	1.64	0.34	-0.117	-37%	-0.10	-17%	-0.08	-5%	-0.08	-18%
13	0.318	0.04	13.37	1.81	0.201	0.03	12.85	1.73	-0.117	-37%	-0.01	-28%	-0.52	-4%	-0.08	-4%
12	0.318	0.05	11.10	1.35	0.201	0.04	10.57	1.27	-0.117	-37%	-0.01	-29%	-0.52	-5%	-0.08	-6%
11	0.318	0.23	2.77	0.71	0.201	0.17	2.70	0.63	-0.117	-37%	-0.06	-25%	-0.08	-3%	-0.08	-11%

River Station	HEC-RAS Output: Without Project Conditions				HEC-RAS Output: With Project Conditions				Change							
	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Average Velocity (m/s)	Top Width (m)	Maximum Depth (m)	Discharge (m^3/s)	Discharge (%)	Average Velocity (m/s)	Average Velocity (%)	Top Width (m)	Top Width (%)	Maximum Depth (m)	Maximum Depth (%)
10.8333*	0.318	0.24	2.94	0.69	0.201	0.18	2.86	0.61	-0.117	-37%	-0.06	-24%	-0.09	-3%	-0.08	-11%
10.6666*	0.318	0.25	3.10	0.67	0.201	0.19	3.00	0.59	-0.117	-37%	-0.06	-23%	-0.10	-3%	-0.07	-11%
10.5*	0.318	0.27	3.25	0.64	0.201	0.21	3.08	0.57	-0.117	-37%	-0.06	-21%	-0.18	-5%	-0.07	-11%
10.3333*	0.318	0.31	3.31	0.61	0.201	0.24	2.88	0.54	-0.117	-37%	-0.06	-21%	-0.43	-13%	-0.07	-11%
10.1666*	0.318	0.37	3.13	0.57	0.201	0.30	2.94	0.50	-0.117	-37%	-0.07	-19%	-0.19	-6%	-0.06	-11%
10	0.318	0.73	2.88	0.45	0.201	0.83	2.58	0.38	-0.117	-37%	0.10	14%	-0.30	-10%	-0.07	-16%
9.8*	0.318	0.34	4.41	0.74	0.201	0.33	3.76	0.66	-0.117	-37%	0.00	-1%	-0.65	-15%	-0.08	-11%
9.6*	0.318	0.24	5.93	1.05	0.201	0.24	5.35	0.96	-0.117	-37%	0.00	1%	-0.57	-10%	-0.09	-8%
9.4*	0.318	0.19	7.26	1.36	0.201	0.19	6.73	1.27	-0.117	-37%	0.00	2%	-0.52	-7%	-0.09	-7%
9.2*	0.318	0.16	8.65	1.67	0.201	0.16	8.03	1.58	-0.117	-37%	0.00	3%	-0.62	-7%	-0.09	-5%
9	0.318	0.07	10.04	1.98	0.201	0.06	9.45	1.89	-0.117	-37%	-0.02	-21%	-0.59	-6%	-0.09	-5%
8	0.318	0.12	10.87	1.99	0.201	0.12	10.42	1.89	-0.117	-37%	0.00	-1%	-0.46	-4%	-0.09	-5%
7	0.318	0.14	9.48	1.61	0.201	0.14	9.22	1.52	-0.117	-37%	0.00	1%	-0.25	-3%	-0.09	-6%
6	0.318	0.28	3.35	0.47	0.201	0.24	3.04	0.38	-0.117	-37%	-0.04	-14%	-0.31	-9%	-0.09	-20%
5	0.318	0.31	3.10	0.44	0.201	0.26	2.81	0.35	-0.117	-37%	-0.05	-16%	-0.29	-9%	-0.09	-20%
4	0.318	0.29	3.90	0.38	0.201	0.26	3.50	0.29	-0.117	-37%	-0.03	-11%	-0.40	-10%	-0.09	-23%
3	0.318	0.33	3.78	0.37	0.201	0.39	3.17	0.24	-0.117	-37%	0.06	17%	-0.61	-16%	-0.12	-34%
2	0.318	0.08	9.45	0.54	0.201	0.07	8.53	0.42	-0.117	-37%	-0.01	-12%	-0.92	-10%	-0.12	-23%
1	0.318	0.17	4.67	0.59	0.201	0.15	4.09	0.46	-0.117	-37%	-0.02	-12%	-0.58	-13%	-0.12	-21%

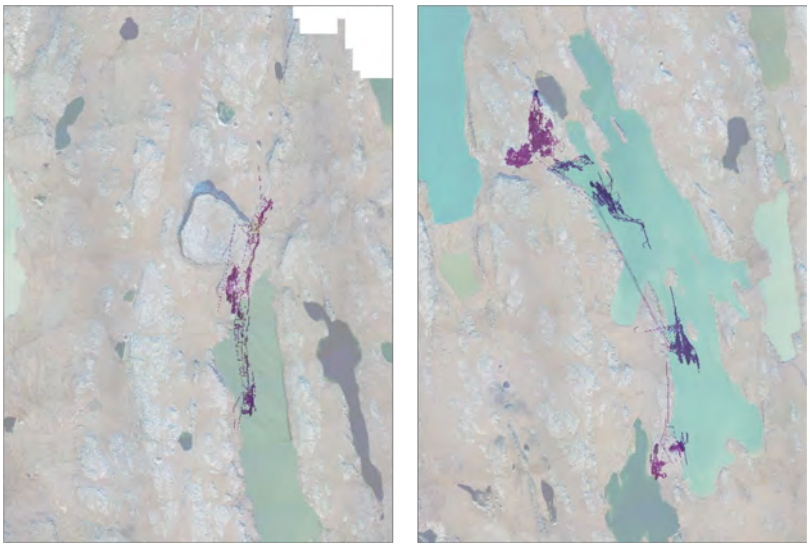
APPENDIX F
HYDROGEOLOGICAL MODEL REPORT

AGNICO EAGLE

2024 Hydrogeological Modeling Update

Prepared for

Agnico Eagle Mines Limited



Prepared by

srk consulting

SRK Consulting (Canada) Inc.
CAPR003296
January 2025

2024 Hydrogeological Modeling Update

January 2025

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srk consulting

Executive Summary

Agnico Eagle Mines Limited (Agnico Eagle) is planning to restart underground mining operations at the Hope Bay Project (the "Project"), in the Kitikmeot region of western Nunavut, Canada. SRK Consulting Ltd. (SRK) was retained to review the hydrogeological data and update the groundwater conceptual model and numerical model for the Project and estimate groundwater inflow and chloride concentration for an updated mine plan. This information will support the on-going environmental permitting process and serve as a basis to assess the effect of the mines to the groundwater environment and as inputs to the updated Project Water and Load Balance (SRK, 2024).

The Hope Bay greenstone belt hosts three known gold deposits (Doris, Madrid and Boston). Agnico Eagle proposes to expand the Doris mine developed by TMAC between 2017 and 2021 and develop a new underground mine at Madrid.

The Hope Bay belt drains directly into the Arctic Ocean. Numerous lakes and ponds are present, predominantly orientated along a north-south axis. Climate can be described as a sub-Arctic desert with limited rainfall, long dark winters and short bright summers. The Project is within Canada's continuous permafrost region, where permafrost (i.e., frozen ground) can extend to depths of 400 to 500 mbgs (meter below ground surface). Groundwater cannot flow in frozen ground; it can move in the active zone and in features called taliks, where rock is unfrozen. The active zone refers to the layer of ground that undergoes seasonal thawing and freezing. In most cases, taliks are formed by the heat of large water bodies such as lakes; an open talik is an unfrozen zone that penetrates completely and connects to sub-permafrost (i.e., the non-frozen ground below the permafrost).

The regional bedrock geology is composed of a greenstone belt dominated by mafic volcanic rocks. The overburden, up to 30 m in thickness, comprises locally and regionally derived tills and boulder tills with lacustrine and marine sediments and clay up to 15 m thick in the larger valleys. In lake bottoms, limnic sediments range in thickness between a few centimetres to as much as 2 m, under which is a consolidated layer of marine silty clay and clayey silts between 10 and 20 m thick.

Each site, Doris, Madrid, and Boston, has hydraulic conductivity, groundwater level, groundwater quality, and ground temperature data. During operations at Doris, groundwater flow and quality data were also recorded from underground locations.

The hydraulic conductivity (K) dataset includes a total of 190 test measurements in bedrock (i.e., excluding tests in permafrost). These were obtained from surface or underground drilling using slug tests, or short and long-duration packer injection tests. The K values are typically low, at Doris ranging between $<1x10^{-9}$ m/s and $4x10^{-6}$ m/s, with a geomean of $5x10^{-8}$ m/s, and at Madrid ranging between $< 1x10^{-9}$ and $1x10^{-6}$ m/s, with a geomean of $2x10^{-9}$ m/s. The spatial distribution of K values does not show a particular pattern. K values tend to decrease progressively with depth, which is interpreted to a result of reduction of fracture apertures with depth as lithostatic load increases. The probability of encountering higher K can increase in

areas with higher frequencies of fractures, but not always as shown by weak correlation coefficients. The Doris dataset includes fourteen tests, out of a total of 99 tests, that intercept structural features, from gouge-filled fractures to rubble zones; only eight had K greater than the geometric mean ($7x10^{-8}$ to $6x10^{-6}$ m/s). The Madrid dataset shows no evidence of higher K features associated with dyke contacts, major structures or faults, and/or the MDZ.

K measurements in soft lakebed sediments were obtained from 28 pressure dissipation tests conducted during cone penetrometer (CPT) drilling in sediments lining the base of Doris Lake, Patch Lake and Aimakatalok Lake (SRK 2009a) with a geomean of $1x10^{-8}$ m/s. CPT refusals were not associated with bedrock contact, but an indurated layer of lake sediment. Two samples were sent to a laboratory for consolidation testing and had hydraulic conductivity of $4.6x10^{-10}$ and $3.5x10^{-10}$ m/s, respectively (SRK 2009a).

Pre-mining groundwater level data consist of pressure profiles in two Westbay wells, two VWPs, and two drillholes. Groundwater pressure is converted to absolute elevations, but the water is saline and higher density affects the pressure, resulting in an accuracy of ±7 m, corresponding to a density variation of ±0.015 kg/m^3. Pre-mining groundwater levels were approximately at or near the lake levels, and the pressures in Westbay wells suggested a low vertical upward gradient. Additional groundwater pressures were measured during operations in the Doris underground mine and showed effects of mine dewatering, with pressures dropping below the level of Doris Lake as depressurization around the underground developments progressed.

Samples for groundwater quality were collected between 2010 and 2013, in 2022, and in 2023 at Doris, Madrid, and Boston. These samples were analyzed for standard parameters, major cations and anions, and total and dissolved metals. In the period 2010-2013, stable isotopes of oxygen and hydrogen were also analyzed to ensure quality assurance and control (QA/QC) and to assess variations in water source types. Baseline groundwater quality (i.e., 2010-2013) was compared to environmental guidelines[1] with concentrations of ammonia, boron, cadmium, chloride, fluoride, iron, manganese, nickel, selenium, and zinc exceeding guideline concentrations, making them potential constituents of concern. Groundwater samples collected during operations (i.e., 2022-2023) show a dilution of constituents and an increase of alkalinities interpreted to result from the dewatering of the Doris underground.

Ground temperatures have been measured with thermistors at Doris, Madrid and Boston. The active layer is generally less than 1 meter thick, with the depth of zero annual amplitude around 10 m. Freezing point depression based on measured groundwater salinity defined the -2°C isotherm as the boundary between taliks and permafrost.

The base of the permafrost (-2°C isotherm), away from lakes, is at approximately 447 mbgs. The vertical contacts between permafrost and open taliks are located near lake shorelines, at distances driven by thermal dynamics. The boundary slopes outward and downward as it

[1] Canadian Council of Ministers of the Environment (CCME) water quality guidelines for freshwater, irrigation, livestock, and marine (2024) and the Metal and Diamond Mining Effluent Regulations (MDMER) limits for harmful substances (2024)

extends deeper, and permafrost begins to dominate. In cross-section, it takes generally the shape of a parabola with its concave side oriented vertically beneath the lake.

A one-dimensional (1D) steady state analytical thermal model estimated the critical lake dimensions to sustain open taliks underneath water bodies: a) circular water bodies with a diameter greater than 224 m, b) elongated water bodies with a width of at least 104 m, and c) water bodies deeper than 1.3 m. Local 3D configurations of open taliks were estimated in Madrid and Boston areas using 2D thermal modeling in zones where distances between lakes were small and heat from lakes potentially interfering.

SRK reviewed the mine inflow rate and quality monitored during operations at Doris, and the inflows at individual drillholes (i.e., drilling records, packer test or axial velocity measurements), recorded between December 2020 and October 2022, from discrete locations or specific intervals or fractures intercepted by developments. The mine started encountering inflows in January 2018, at an elevation of about -120 masl, when it reached the boundary between permafrost and the Doris Lake open talik; the boundary was approximately vertically below the Doris Lake shoreline when projected downward. The initial concentrations of chloride (22,500 mg/L) were higher than observed prior to mining (6,060 to 14,200 mg/L at -198 masl). The total mine inflow increased progressively as the mine was developed and peaked in January 2020 at about 2,800 m3/day. Between 2020 and 2021 inflow rate plateaued at an average of 1,600 m^3/d.

Most groundwater inflows occurred primarily in the central area and originated from underground diamond drillholes, with flow rates typically within 10 to 50 m^3/d, and a very low percentage of individual holes with up to 2,180 m^3/day. It is uncertain whether inflows from individual features (i.e., drillholes or fractures) decreased over time, which is a behaviour that would be the expected for groundwater released from storage in the fractures rather than a direct connection with Doris Lake. Overall, inflows were highest as mining reached and occurred at its lowest elevations. This suggests the overall increase in inflows was primarily driven by the increase of hydraulic gradient between the mine and Doris Lake, rather than interception of specific geological structures, or exploration drillholes.

Inferences on cause of short-term fluctuations of mine inflow and/or quality that are observed to have occurred found that, 1. while not common, un-grouted surface exploration holes can lead to high inflows, such as during September 2018 when a flow of about 3,650 m^3/d was encountered from a drillhole (hole plugged in October 2018), and 2. the relationships between inflow peaks and structures remain uncertain except at the contact with, or in proximity of, the diabase dyke, which has been frequently reported to produce water. Peaks un-related to drillholes corresponded to short-term temporary increases of both inflow and chloride, suggesting that the features causing these peaks have a limited storage and are connected with deep saline groundwater.

The system is conceptualized as a low-flow, lake-dominated, confined flow system. The widespread, deep permafrost is essentially impermeable. Groundwater flow and connections between surface and deep bedrock groundwater systems occur exclusively in areas where lakes are associated with open taliks or in sub-permafrost zones. Groundwater systems in shallow

active zones have no or minimal influences on inflows to underground mining areas compared to the deeper flow dynamics within the open talik surrounding the underground mine.

K measurements for fractured rock and lake sediments fall within the bounds of published K values. Lake bottoms are draped with low K, fine sediments. At the small scale, bedrock K is fracture controlled, consisting of a low bulk K background intersected by distributed, potentially higher K fractures and geological structures. At the project scale, fractured rock is treated as a single unit, without differentiation between lithologies. This unit is characterized by relatively higher K at shallow depths, gradually decreasing with depth due to increasing confining pressure.

Groundwater is brackish to saline and can have elevated concentrations of major ions and metals. The concentrations of calcium, chloride and sodium show a general trend of increasing concentration with depth; other constituents can also have relatively high concentrations, but do not correlate with depth. Denser saline groundwater requires more energy to move. It tends to sink, move more slowly, and resist upward movement, while lighter freshwater flows more easily. This buoyancy effect can lead to stratification, greater resistance to downward vertical flow, and the formation of slow density-driven convection currents, where saline water sinks and freshwater rises.

During mining operations, the dewatering activities will alter groundwater flow gradients. Depressurization around parts of mines located within taliks or sub-permafrost will extend radially, drawing potentially upward and lateral saline flow from the talik, and downward freshwater flow from the lakes above. The low permeability fine lakebed sediments will limit downward infiltration. Initially, the salinity of the mine inflows will reflect the saline conditions of the surrounding groundwater system and become progressively less saline over time as the relative contribution from shallow freshwaters increases. As K in bedrock decreases with depth, groundwater inflows to the mine are expected to be more significant in shallower regions.

While the mine may intercept geological structures or fractures, historical observations of the Doris mine suggest they will have limited storage capacity and are more likely connected to deep saline groundwater rather than directly to the lakes above. At Doris specifically, the contacts with the diabase dykes are frequently reported to produce water and theorized to be associated with a more permeable contact zone. At Madrid, while no high K structures have been identified, the eastern contact of the MDZ, which typically hosts brittle faults parallel to it, could be theoretically associated with potentially higher K features.

Placement of CRF backfill in the underground will have some influence on mine inflows. Based on experience with similar materials on other projects, hydraulic conductivity of backfill is expected to be within or above the upper range of the shallow bedrock and therefore lead to a low to moderate reduction of inflow at shallow depth and no reduction at depth.

The heat circulated into the underground mines will generate a lateral thaw of the bedrock at distances of about 50 m from the workings. The heat will increase the volume of unfrozen ground around the mines, but it will not generate new open taliks that connect the ground surface to sub-permafrost.

At Closure, dewatering activities will stop. Re-flooding will result in a slow re-equilibration to baseline conditions, driven by the lakes' gradients and density gradients. Some parts of mine workings may continue to act as preferential pathways and may redistribute saline water from deeper zones into shallower regions or adjacent fractured zones. As water fills the mine, the heat will transfer to the surrounding permafrost and the underground areas will be expected to freeze-back where the minimum ground temperature is less than -2°C. It is possible that parts of the underground areas will not completely freeze back. The groundwater contained in unfrozen mined out areas may have its quality modified by the backfill and/or tailings deposited underground. It will become part of the regional groundwater system, and travel though the open taliks via the deep groundwater system. At Post-closure, the groundwater system will have returned to the same conditions as baseline with local influences on flow and groundwater quality immediately around the mines.

The numerical groundwater flow modeling was completed using the software FEFLOW 8.1. The model assumes media is saturated within a confined aquifer and density-dependent flow system. Bedrock is simulated as an equivalent porous media with homogeneous and isotropic hydraulic conductivity within overburden and fractured bedrock. Flow and transport processes are defined by Darcy's Law and advection-dispersion principles; mass transport is modeled using chloride as a conservative tracer; chemical reactions, attenuation processes, or biodegradation were not considered.

The model domain is 71 km^2 (i.e., approximately 18 x 4 km), with an upper surface defined by the topographical surface; the model base is a copy of the topographical surface set to a depth of 1,510 mbgs (between -1542 and -1354 masl), approximately twice the depth below ground of the lowest stopes (approx. 690 mbgs). The finite element mesh is constructed with 32 structured layers, and element width of about 20 m at tunnels and stopes, and 30 m along lake edges. The regional mesh elements are on the order of 30 m wide along lake edges and 100 m in areas away from features of interest. Vertically, the layer thickness ranges between 1 and 200 m.

The permafrost is represented by a selection of elements that matches the 3D geometries of the regional and local permafrost models. These elements are de-activated during simulations; no flow or transport happens through these elements.

The regional flow is simulated by applying constant head boundary conditions to the lakes supporting open taliks. Transport of chloride is simulated by applying an average chloride concentrations of 69 mg/L on the footprints of lakes supporting open taliks, and a vertical profile ranging between 69 and 22,500 mg/L on external borders. Mining is simulated with seepage boundary conditions (i.e., a constant head boundary with a flow constraint that only allows flow out of the model) associated with the mining schedule. The underground mines are represented by nodes aligned with the tunnels and stopes' overall 3D geometries but not explicitly incorporating the mine volume. Reduction in inflow due to grouting is not considered in the model. At the End-of-Mine, the mining boundary conditions are turned off.

The model calibration prioritized the mine inflow rates, and chloride concentrations observed during the 7-years of underground operations at Doris over pre-mining conditions. The pre-mining data, while valuable for the conceptual model, is inherently uncertain, while operational

data reflect the response of the groundwater system to the large stress imposed by mining activities. Calibration was an iterative process of varying the hydraulic conductivity profiles to match the transient observations of mine inflows and chloride concentration recorded between 2018 and 2024. The quality of calibration was rated visually by comparing the model results to observations.

The model replicated well the general trend of increasing and stabilizing mine inflows and the declining trend of chloride concentrations. It was not built to capture the short-term fluctuations, which may be due to episodic factors such as localized inflow with higher or lower salinity, changes in hydraulic connectivity, or interception of distinct water-bearing zones. A comparison between the modelled trend and observed short-term fluctuations showed future developments could potentially intercept additional contributions in the range of 100 to 610 m^3/d for a period of 2 to 8 months.

The base case model forecasts maximum inflows of 2,260 m^3/d in 2031 at Doris, and 750 m^3/d in 2039 at Madrid, and a progressive dilution over time of the chloride concentration with freshwater infiltrating from the lakes. At End-of-Mine, chloride concentrations were lowered to about 1,500 mg/L at Doris, and 9,500 mg/L at Madrid (i.e., equivalent TDS concentrations of 2,650 and 16,780 mg/L respectively). Lake infiltration was greatest for the lakes located directly above the mines, Doris Lake (2,230 m^3/d), Patch Lake (730 m^3/d), and Wolverine Lake (8 m^3/d). Time to reflood the mines at Closure were estimated to range between 4 and 52 years at Doris and Madrid respectively. At Post-closure, groundwater in contact with the Doris Mine will move towards Doris Lake, to the West and North (Roberts Bay), and groundwater in contact with the Madrid mine to Patch Lake, Windy Lake, and Wolverine Lake. Modelled travel times are long. After 1,000 years, no particles are predicted to have reached surface.

Additional scenarios were completed to assess the effects of parameter uncertainties on the calibration and forecasts of mine inflow, mine water quality, lake infiltrations, and reflood period at Closure. The sensitivity scenarios included variations to the permafrost, hydraulic conductivities, geological structures, storage compressibility, and density. The analysis of the model's sensitivity to parametrization showed model calibration and predictions were sensitive to changes in hydraulic conductivity of lakebed sediment or bedrock. These are considered sufficiently constrained by the field data and calibration to current conditions for Doris, but can affect predictions:

- Permafrost variations can influence the predicted leakages for Imniagut Lake and Wolverine Lake.
- Changes in K contrast between shallow and deep bedrock have limited effects on the predicted mine inflows but significant influence on chloride concentration at both Doris and Madrid, as well as leakage from lakes.
- Madrid has less K data than at Doris, but also a lower average than at Doris. Using the Doris K profile (which was calibrated to operational data) at Madrid resulted in significantly higher predicted inflow, but lower chloride concentration due to increased infiltration from Patch Lake.

- The “worst case” scenario combined the most conservative assumptions for the permafrost and hydraulic conductivity field in bedrock at Madrid. This model also resulted in increased flow at Madrid, a subsequent decrease in chloride concentration and a large increase in leakage from Imniagut and Wolverine lakes.
- Models did not explicitly assess the potential for mine inflow from unplugged surface drillholes, either as direct connection to lakes, or as small-scale, local connectors between fractures. Observations from Doris operations indicate an un-grouted surface exploration hole could produce an average flow of about 3,650 m^3/d. Predicting likelihood of any given drillhole to flow is difficult, but Operators were able to divert, manage and stop inflow from the hole within a relatively short time; capacity to manage such events should continue to be incorporated into contingency planning.

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Appendices

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Appendix B – Overburden Data

Appendix C – Hydraulic Conductivity Data

Appendix D – CPT Data

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Appendix H –2020-2022 Doris Inflow Data

List of Abbreviations

°C	degree Celsius
BC	boundary condition
CPT	cone penetrometer test
CRF	cemented rock fill
DDH	diamond drillhole
EOM	end of mine
K	hydraulic conductivity
km	kilometer
LTFT	long-term flow test
m	metre
m/s	metre per second
m^3/d	cubic metre per day
mah	meter along hole
masl	meter above see level
mbgs	meter below ground surface
MDZ	Madrid Deformation Zone
Mg/L	milligram per litre
ML/ARD	metal leaching and acid rock drainage
mm	millimetre
MN	Madrid North
MS	Madrid South
RQD	Rock Quality Designation
SP	Saline Pond
Sx	storage compressibility
STFT	short-term flow test
TIA	Tailings Impoundment Area
TDS	total dissolved solids
UG	underground
VFP	velocity flow profile
MDMER	Metal and Diamond Mining Effluent Regulations

1 Introduction

Agnico Eagle Mines Limited (Agnico Eagle) is planning to restart underground mining operations at its Doris and Madrid Deposits, located at the Hope Bay Project (the “Project”), in the Kitikmeot region of western Nunavut, Canada, approximately 685 km northeast of Yellowknife, Northwest Territories, and 125 km southwest of Cambridge Bay.

The Hope Bay greenstone belt hosts three known gold deposits (Doris, Madrid and Boston). Agnico Eagle proposes to expand the Doris mine developed by TMAC between 2017 and 2021 and develop a new underground mine as well as waste and water management facilities at Madrid. Exploration will continue at Boston, but its development is not planned at this stage.

Agnico Eagle retained SRK Consulting (Canada) Inc. (SRK) to review the hydrogeological data and update the groundwater conceptual model and numerical model of the Project. This information will support the on-going environmental permitting process and serve as a basis to assess the effect of the mines to the groundwater environment and as inputs to the updated Project Water and Load Balance (SRK, 2024).

1.1 Scope of Work

The scope of work consisted of:

- A review, compilation, and discussion of the project-wide hydrogeological data.
- The development of the hydrogeology conceptual site model.
- The development of a groundwater numerical model and calibration to current conditions.
- Simulations of the groundwater system for baseline to the post-closure periods.
- Predictions of mine inflows and effects to the groundwater system.
- An analysis of the sensitivity of the predictions to model parameters.
- Reporting

1.2 Report Layout

The report is organized as follows:

- Section 2: Site history, current land use, and proposed mine designs.
- Section 3: Summary of the hydrogeological studies.
- Section : Compilation of the hydrogeological data supporting the characterization of the groundwater system.
- Section 5: Groundwater conceptual model.
- Section 6: Technical presentation of the numerical groundwater model.
- Section 7: Model forecasts.
- Section 7: Conclusions of the study.

2 Background

2.1 Site History and Mine Plan

The Hope Bay Project (Figure 2-1) covers an area of 1,100 km², approximately 80 km by 20 km, in the Kitikmeot region of Nunavut, Canada, approximately 685 km northeast of Yellowknife and 125 km southwest of Cambridge Bay The Project is within Canada's continuous permafrost region, where permafrost (i.e., frozen ground) can extend to depths of 400 to 500 mbgs (meter below the ground surface) excepted under large water bodies where taliks (i.e., unfrozen ground) are present. At surface, the area is dominated by a tundra ecosystem, rugged terrain with a mix of low hills and flat, barren ground, and numerous lakes and rivers. The current land uses are hunting, fishing, and trapping from the local community in addition to mining activities.

TMAC Resources Inc. started the development of the Doris mine in early 2017. Agnico Eagle took over mining operations in February 2021 and focused on producing from developed stopes and bringing ore to surface until March 2022, at which point operations were scaled back and underground development focused on supporting exploration activities.

The proposed updated mine plan (Agnico, 2024) includes additional developments at the Doris Mine (BCN, and BCO, Figure 2-2), and a new underground mine at Madrid (Figure 2-3), approximately 17 km south of Roberts Bay. Most of the waste rock brought to surface will be used as backfill in the underground mines. At Doris, the backfill will include a mix of previously placed detoxified tailings and cemented rock Fill (CRF). At Madrid it will consist solely of CRF. Mining operations will begin in 2028 and conclude in 2045 after which there will be a 2-year closure period followed by a 3-year post-closure period following operations. At closure, the underground will be flooded and the backfill will be submerged.

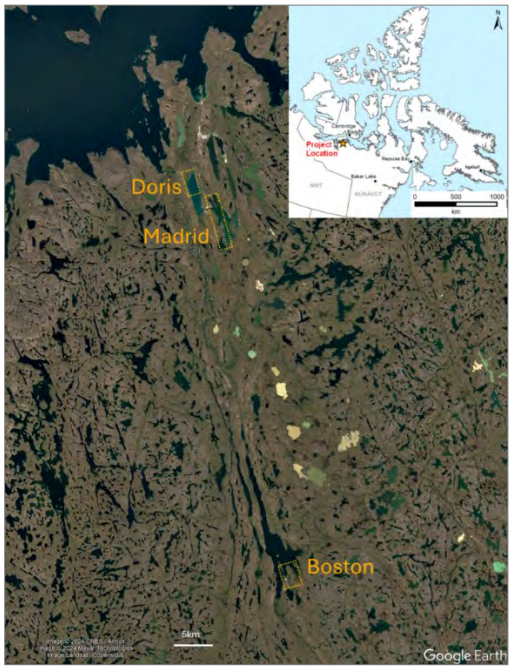


Figure 2-1: Project location

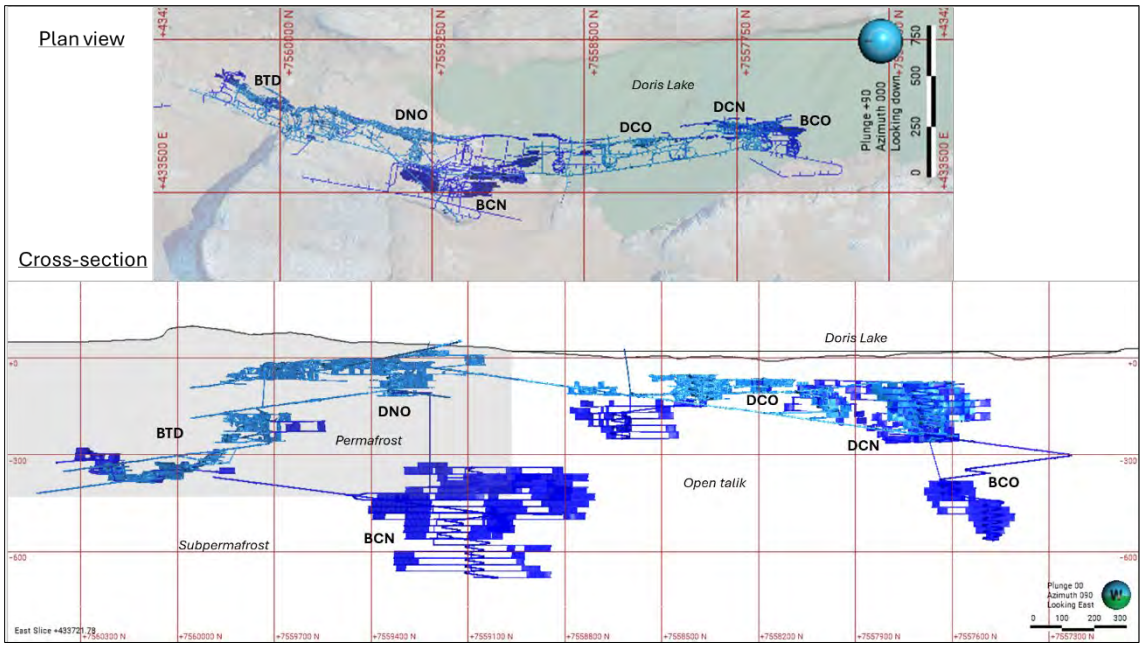


Figure 2-2: Plan view and cross-section view of Doris proposed underground developments

Source: fig_doris_cross-sections_mine,pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

Note: Permafrost contacts illustrated based on thermistor data but simplified with vertical wall at the shore of Doris Lake

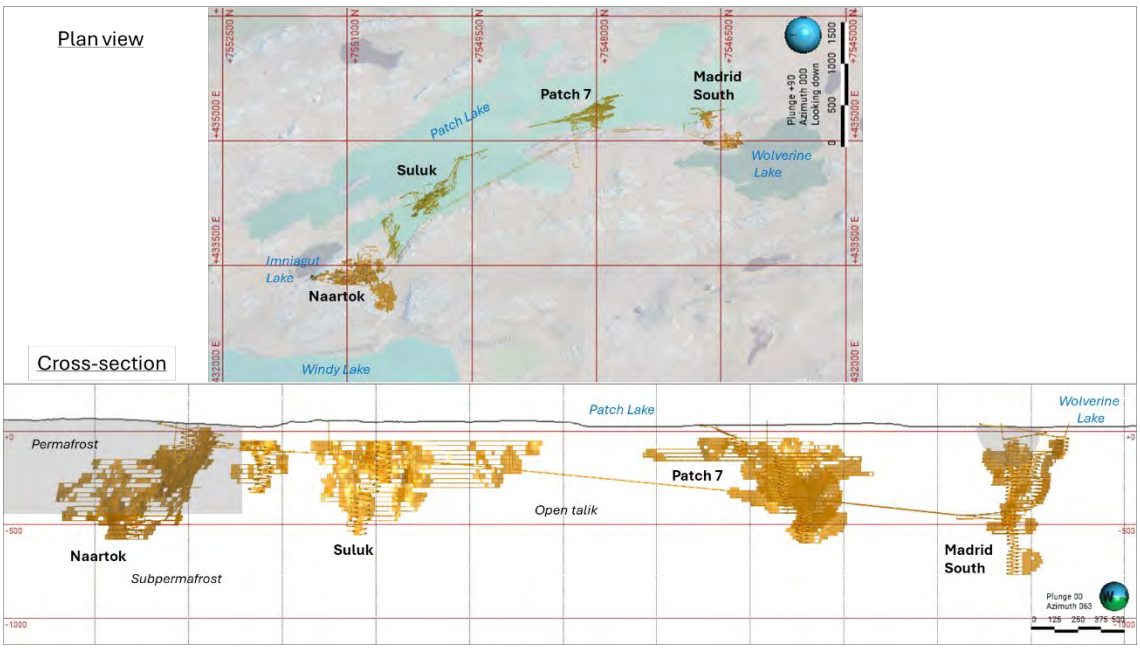


Figure 2-3: Plan view and cross-section view of Madrid proposed underground developments

Source: fig_madrid_cross-sections_mine_rev1.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

Note: Permafrost contacts illustrated based on thermistor data but simplified with vertical wall at the shore of Patch Lake

2.2 Studies Supporting the Characterisation of the Groundwater System

Table 2-1 summarizes hydrogeological studies used to support the Project. Complete references are provided in Section 8.

Table 2-1: Hydrogeological studies

Reference	Description
SRK, 2005	Installation of two thermistor strings at Doris; one in deep permafrost, the other in shallow permafrost.
SRK, 2009 a, b, c, d	Geotechnical and hydrogeological assessments for 1- an open pit at the Boston deposit, 2- an open pit and an underground mine at the Madrid deposit, and 3- an open pit and an underground mine at the Doris deposit. Assessments were based on field studies that included overburden characterisation, detailed structural review, hydrogeological investigations (including installations of additional thermistor), and geotechnical assessments.
SRK 2011a	Field program at Doris and Boston that included hydraulic testing, installation of Westbay multi-level monitoring wells, and groundwater quality sampling.
SRK 2011b	Summary of updated estimates of inflow rates and water quality for Doris, with assessment of potential flow from open exploration drill holes in talik.
SRK 2012	Summary of groundwater quality sampling and analysis results from the three existing Westbay wells: Doris North, Doris Central, and Boston.
SRK 2014	Review of Doris historical data and fieldwork, along with updates to the characterization of geotechnical and hydrogeological conditions. This information supported mine and infrastructure designs for an internal pre-feasibility study.
SRK 2014b	Summary of updated estimates of inflow rates and water quality for the Madrid South and Madrid North mines.
SRK, 2015a	Hydrogeological characterisation and groundwater numerical modeling of the Doris Mine; forecasts of groundwater inflow and quality to support a Type A Water Licence.
SRK, 2015b	Results of a site wide water and load balance for the Doris mine.
SRK, 2017a	Evaluation of the lake talik configurations: regional settings and local thermal modelling at Madrid and Boston.
SRK, 2017b	Hydrogeological characterisation and groundwater numerical modeling of the Madrid and Boston Mines; forecasts of groundwater inflow and quality to support the project site-wide water and load balance.
SRK, 2017c	Madrid-Boston project site-wide water and load balance.
TMAC, 2016	Groundwater management plan describing TMAC's management and work to minimize water that flows into the mine.
TMAC, 2020	Ground Control Management Plan describing TMAC's management and work to reduce the risk of uncontrolled ground failure.
HRI, 2020	Results of a 4-day investigation in the Doris underground, which included pressure measurements, and short- and long-term flow tests (STFT, LTFT) in existing underground open holes.
HRI, 2021	Results of two 14-day investigations in the Doris underground, which included pressure measurements and STFT, velocity flow profiles (VFP), packer tests, and chemical profiles (CP) (i.e., temperature, EC, salinity, and TDS) in existing underground open holes.
SRK, 2022a	Geomechanical design phase 1 review and gap analysis of the Madrid and Boston deposits for the preparation of prefeasibility Studies.

Reference	Description
Agnico, 2022	Groundwater monitoring package of data collected between Dec. 2020 and Oct. 2022. (i.e., mine water flow and quality at stations TL-12, TL-12A and 4926/North Ramp, as well as quantitative and qualitative observations of flows from drillholes or structures intercepted by the mine).
SRK, 2022b	Review of groundwater data collected between Dec. 2020 and May 2021 in the Doris underground mine, including mine water flow and quality, and observations of flows in open drillholes and at intercepted structures; comparisons to the 2015 numerical model predictions; estimation of long-term groundwater flow and chloride concentration with the 2021 as-built mine plan.
SRK, 2023a	Geotechnical and hydrogeological field program at the Madrid deposit. The hydrogeological investigation included hydraulic testing using inflatable packers and installations of thermistors and vibrating wire piezometers.
SRK, 2023b	Hydrogeological inspection of the underground workings of the Doris North mine.
Lorax, 2023a	Field program at Madrid, which included hydraulic testing of one exploration drillhole.
Lorax, 2023b	Results of the groundwater quality samples collected by Agnico in Oct 2022 and July 2023 at the Doris Westbay well 10WBW001.
Lorax, 2024 a,b,c,d	Field programs which included groundwater sampling of the Westbay Well 10WBW001 at Doris, and hydraulic testing of two drillholes at Madrid.

3 Baseline Data

3.1 Topography, Hydrology and Climate

The topography of the Project is typical of coastal lowland, ranging from undulating plains near the coast to massive Archean-age rocks rising to 300 m above sea level in the south. The Hope Bay belt drains directly into the Arctic Ocean and consists of three main watersheds: the Koignuk River (2,937 km^2), Windy-Glenn (48 km^2), and Doris-Roberts (194 km^2).

Numerous lakes and ponds are present along the bottom of elongated valleys separated by bedrock and glacial landforms. The shape of the basins is generally long and narrow and is predominantly orientated along the north-south axis. The main water bodies are the Doris Lake and Tail lakes in the Doris area; Patch, Imniagut, Wolverine, Windy, and Ogama lakes in the Madrid area, and Aimakatalok and Stickleback lakes in the Boston Area. The Tail Lake has been used as a Tailing Impoundment Area (TIA) for the Doris mine (see Section 2.1). Appendix A compiles available maps of the lakes' bathymetry.

Climate of the region can be described as a sub-Arctic desert with limited rainfall, long dark winters and short bright summers. The ground is covered in snow from approximately October to June most years. Extremely cold air temperatures and permafrost cause all rivers and creeks to freeze solid in winter, with ice reaching up to 2 m thick. Streams and rivers typically start flowing in late May or early June when snow and ice melt, peak in June, then decrease steadily until flow cease by October. Runoff occurs only briefly from June to October.

3.2 Permafrost

The Project is located within the zone of continuous permafrost, as delineated by the Geological Survey of Canada (NRCan, 2002). Groundwater cannot flow in frozen ground; it can move in the active zone and in features called taliks where rock is unfrozen.

The active zone refers to the layer of ground that undergoes seasonal thawing and freezing. It is located above the permanently frozen ground. Each year, during the warmer months, the active zone thaws, allowing for movement of water, before refreezing during the colder months. It acts as a dynamic layer where water can infiltrate, be stored, and move. During the thaw period, meltwater from snow and ice can percolate through this layer, potentially recharging shallow aquifers in the active zone. The presence of permafrost limits deeper infiltration, causing groundwater flow to be confined to the active zone.

A talik is defined as “a layer or body of unfrozen ground occurring in a permafrost area due to local anomalies in thermal, hydrological, hydrogeological or hydrochemical conditions” (Van Everdingen, 2005). In most cases, taliks are formed by lakes and other water bodies that cause a local departure in terrestrial ground temperature (Smith and Hwang, 1973; Burn, 2002). Taliks can be closed or open. A closed talik is an unfrozen zone beneath a water body that is enclosed at the base and the surrounding sides by permafrost. An open talik is an unfrozen zone beneath a water body that penetrates the permafrost completely and connects to supra-permafrost (i.e., the layer of ground above permafrost) and sub-permafrost (i.e., the non-frozen ground below the permafrost).

Key factors influencing configurations of taliks include water bottom temperature, lake dimensions, present and past ground thermal regime, and long-term changes to the landscape. Taliks are transient features. Present-day water bathymetry can affect talik configuration where shallow water allows for ice to seasonally freeze to the bottom (bottom-fast ice) and conduct heat from the ground (Burn, 2002, 2005; Stevens, 2010a,b). The long-term thermal and physical evolution of the landscape is a factor in the present-day configuration of taliks. Lunardini (1995) showed temperature at depths up to 600 mbgs can be influenced by surface temperatures as far back as 100,000 years. The boundaries of active zone, taliks, and subpermafrost are discussed in Section 3.10.

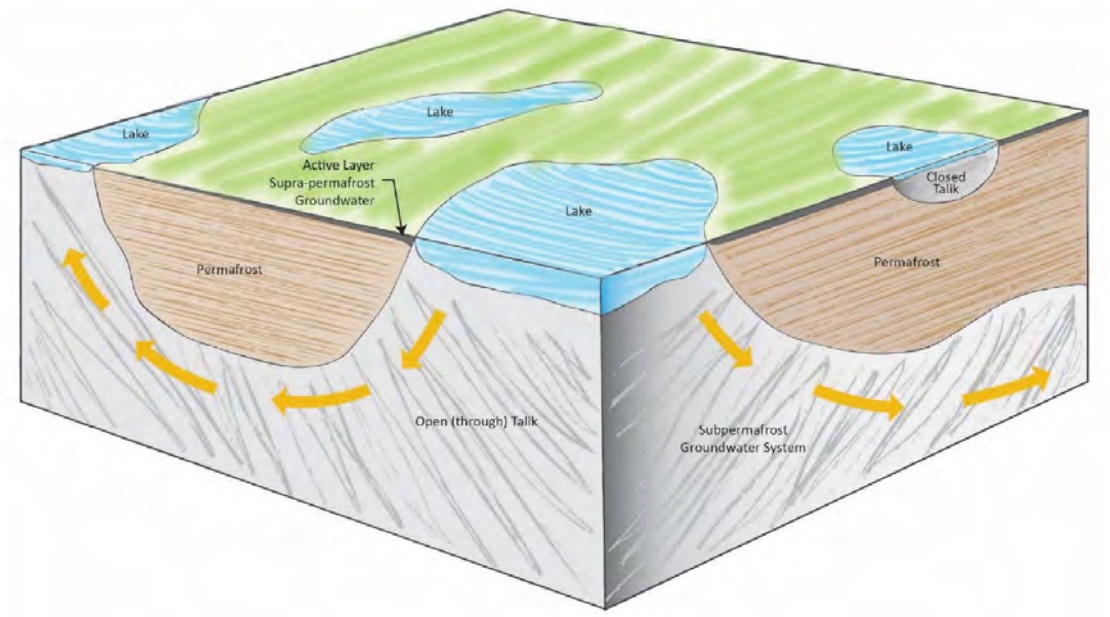


Figure 3-1: Conceptual drawing of open and closed taliks

Source: SRK, 2022a

Note: Orange arrows show potential direction of groundwater flow for illustrative purposes only.

3.3 Geology

3.3.1 Regional Geology

The Hope Bay Volcanic Belt is a greenstone belt located in the northeast portion of the Slave Structural Province (Figure 3-2). Dominated by mafic volcanic rocks, it features massive to pillowed tholeiitic flows interbedded with calc-alkaline felsic volcanic and volcanoclastic rocks, clastic sedimentary rocks, and rarely synvolcanic conglomerate and carbonates.

The Hope Bay area has been affected by successive Laurentide ice sheets during Quaternary ice ages. The last ice sheet began receding about 8,800 years ago (Dyke and Prest, 1986) leaving a blanket of basal till. After deglaciation, the Hope Bay region was submerged approximately 200 metres below present mean sea level (Dyke and Dredge, 1989). Fine sediments from meltwater (rock flour) were deposited as marine clays and silts onto the basal tills, with the greatest thicknesses accumulating in the deeper water zones, now represented by valleys.

Isostatic rebound after deglaciation led to emergent landforms and reworking of unconsolidated marine sediments and tills along the shoreface (EBA, 1996). Sediments were stripped from uplands and redeposited in valleys, forming relatively continuous north-northwest trending bedrock ridges and elongated lakes. The unconsolidated overburden, up to 30 m in thickness, comprises locally and regionally derived tills and boulder tills with lacustrine and marine sediments and clay up to 15 m thick in the larger valleys.

3.3.2 Doris Bedrock Geology and Structures

Gold mineralization is principally hosted by massive and pillowed metabasalt folded around a central coarse gabbroic metavolcanic. The main auriferous quartz vein has an anti-formal shape and appears to be associated with a zone of high strain a few metres wide, plunging 10° north at Doris North, and 25° south at Doris Central. All basaltic and gabbroic rocks are affected by a penetrative foliation, characterized by an alignment of chlorite, sericite, quartz, and carbonate minerals, striking north-south and dipping steeply to the west (i.e., At outcrops, the strike ranges between 175º to 205º and dip between vertical and 80º to the west) (SRK, 2014).

A diabase dyke complex crosscuts the gold mineralization, generally striking north-northeast and dipping both steeply and shallowly to the east. The complex has two distinct geometric features: a vertical dyke and a horizontal dyke. The vertical dyke runs along the west shore of Doris Lake and extends from surface to beyond permafrost maximum depths. The horizontal dyke is mapped between a depth of 339 and 488 mbgs (SRK 2014).

Two sets of sub-vertical dipping brittle faults transect the rock excepted for diabase dykes. The strike is generally northwest and northeast and the dip poorly constrained. All late structures in drill core are typically marked by rubble zones associated with sericitic alteration, slickensides, brecciation, and clay gouge.

3.3.3 Madrid Bedrock Geology and Structures

The stratigraphy of the Madrid area is composed of three major volcanic packages: the Wolverine Group basalts, the Patch Group basalts, and the pale green pillow basalts. Metasedimentary rocks often occur in the Patch Group metavolcanics. Gold mineralization occurs at proximity of a wide package of variably deformed and altered rocks collectively referred as the Madrid Deformation Zone (MDZ). It is not a single planar structure but an anastomosing feature with several splays and local pinch-and-swell textures. Its thickness is about 100 to 140 m and typically comprised of chlorite schist with a strong overprinting (regional) foliation. The eastern contact of the MDZ typically hosts brittle faults parallel to it (i.e., East-West faults at Naartok West and North-South faults at Suluk/Patch 7). Younger diabase dykes are present in the vicinity of Naartok. Apparent discontinuities in alteration, mineralization and lithological units generally define a set of northwest trending steep structures.

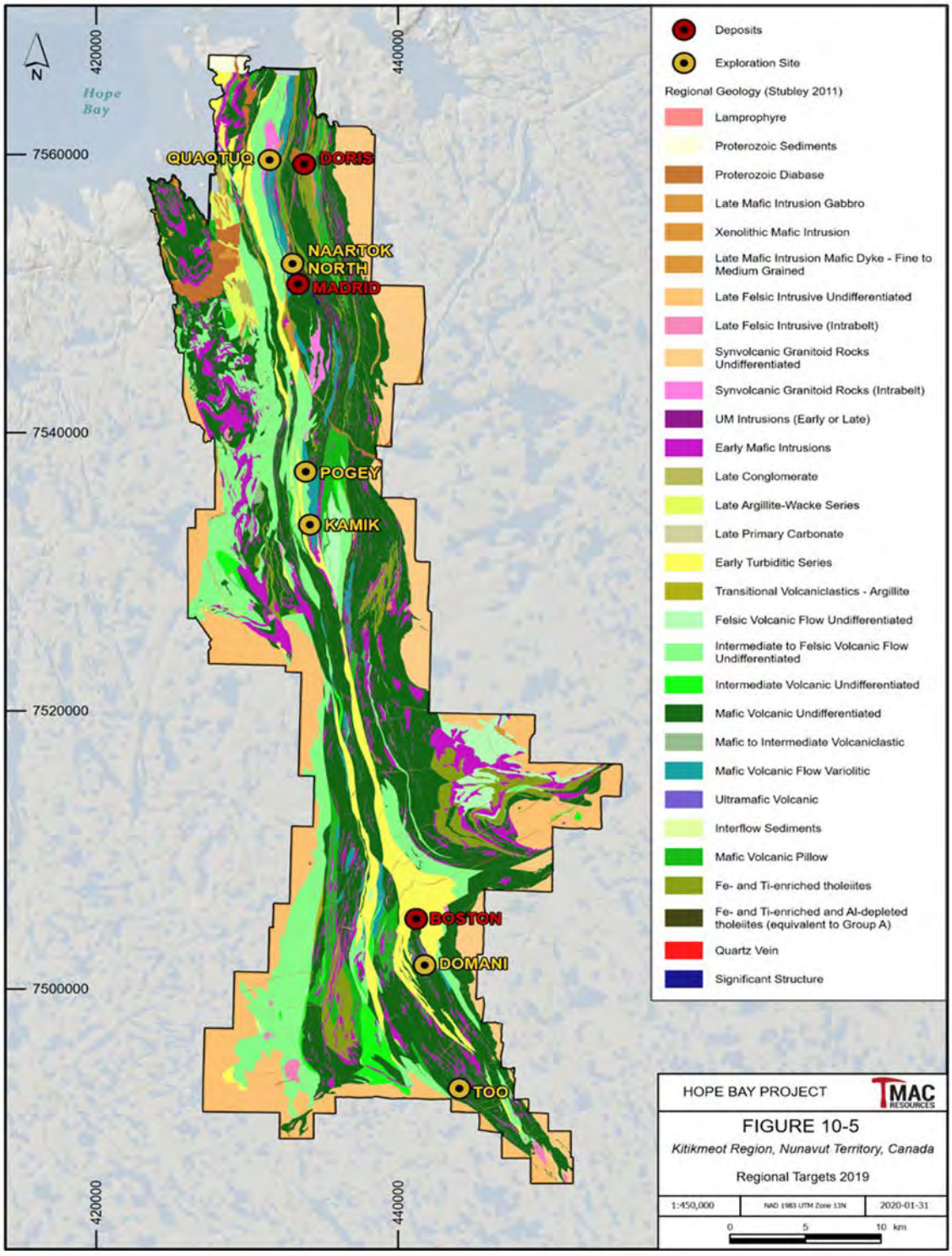


Figure 3-2: Geological map of the Kitikmeot Region, Nunavut Territory, Canada

Source: TMAC, 2020
(Projection: NAD83 / UTM zone 13N, unit: metre)

3.3.4 Boston Bedrock Geology and Structures

The Boston gold deposit is situated in an area dominated by mafic metavolcanics rocks, metasedimentary rock and minor amounts of felsic metavolcanics. The strata are folded and form a large south-plunging synformal anticline. The mafic metavolcanics form the interior of the fold, while synvolcanic metasediments flank the east and the west sides. The transition between the metasediment and metavolcanic packages is variable, with interbedded units of metasediments and metavolcanics.

Gold mineralization is associated primarily with steep deformed quartz veins at the contact between mafic metavolcanics and metasedimentary rocks. Four brittle faults have been modeled to crosscut the Boston area. Additional fault lineaments have been observed in airborne geophysics.

3.3.5 Surficial Geology

Thurber Engineering Limited conducted site-specific surficial geology mapping for the Doris North Project in July 2003. Their study covered an area of 45 km^2 and included air photo interpretation followed by ground reconnaissance. The study indicated that “the active zone earth materials include frost-churned mineral and organic soils mantled by a thin cover of tundra-heath vegetation. Patterned grounds, usually consisting of surface drainage rills, mask the underlying soils. Small, frost-heaved clay-silt polygons are very common. Linear frost cracks are noted in raised marine spit deposits. Ice wedge polygons are common in muskegs. There is evidence of naturally degrading permafrost along two creeks near Roberts Bay and at several other locations. Permafrost degradation is ascribed to past human activity just north of Roberts Lake in the northeast map area.

SRK conducted additional characterization programs on lake sediments and overburden (SRK 2009a, 2011c). Appendix B compiles a map of the locations and tables of sample descriptions. The overburden is described as ice-rich (10 to 30% by volume on average, but occasionally as high as 50%) marine silty clay and clayey silt. The onshore profile consists generally of a thin veneer of hummocky organic soil covered by tundra heath vegetation. Under this organic zone is a layer of marine clay (silty clay and clayey silt) typically between 5 and 20 m thick; however, since the terrain is glaciated with significant bedrock control, there are areas where overburden is less than 5 m thick as well as areas where the overburden exceeds 30 m in thickness. In areas where the overburden exceeds 20 m in thickness, it appears to be underlain by clayey morainal till, which contains moderate amounts of cobbles and boulders. Eskers occur but are not overly common. An esker is a ridge of sediment, generally well sorted sands and gravels, deposited by meltwater streams flowing beneath a glacier. As the glacier retreated, the sediment was left behind in a distinctive long and winding formation.

Onshore, the shallow active zone is disconnected from the deep subpermafrost groundwater system by the permafrost (Figure 3-1). Interactions between surface and groundwater occur only in the shallow active zone or at depths in taliks beneath lakes. For the later, the magnitude of interactions will depend on the type and thickness of lake bottom sediments, particularly fine-grained materials like clay. At lake bottoms, overburden is of the same characteristic as onshore

(i.e., silty clays and clayey silts). There is a layer of limnic sediments ranging in thickness between a few centimetres to as much as 2 m, under which is a consolidated layer of marine silty clay and clayey silts between 10 and 20 m thick (SRK, 2009a).

Minnow Environmental Inc. (2023) conducted baseline field studies in Patch Lake to supplement the existing baseline dataset reported by Rescan (2010). The study involved classifying substrates and preparing a bathymetric map. The shoreline and littoral substrates were visually characterized, sediment sampled from the bottom of Patch Lake was photographed and described, and a hydroacoustic survey was conducted. The visual assessments and sediment samples were used to identify and validate the following substrate types:

- Rock (cobble, boulder, and bedrock) for a high hardness category.
- Fines – Type 1 (sand, silt, and clay intermixed with rock and/or rock overlain with sand, silt, and clay) for a moderate hardness category.
- Fines – Type 2 (sand, silt, clay) for a low hardness category.

Figure 3-3 shows the resulting substrate classification map. Sediment grab sample descriptions, a map of the sample locations, and photos of the samples are included in Appendix B.

The substrate classification map indicated that Type 1 fines, consisting of sand, silt, and clay intermixed with cobble and boulder, were the dominant substrate type in the shallow, littoral areas of Patch Lake. Type 2 fines (sand, silt, and clay) were the second most common substrate type and were generally present in the deeper areas of the lake (typically greater than four metres depth). Rocky substrates (bedrock, boulder, and cobble) were present in shallow areas along the shorelines of islands, in shoals, and along the lake perimeter.

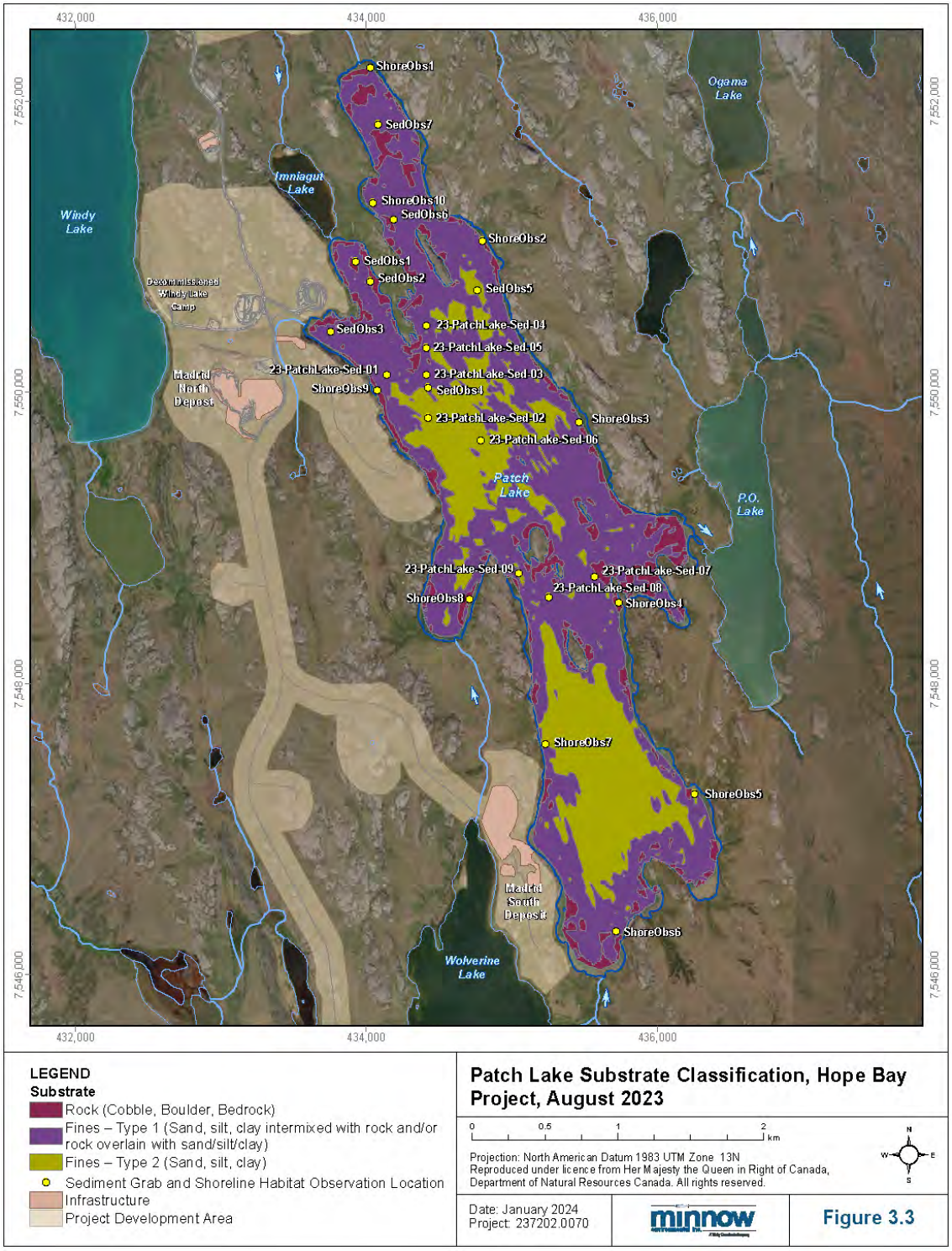


Figure 3-3: Patch Lake Substrate Classification, August 2023

Source: Minnow 2023

3.4 Doris Groundwater Monitoring Network

Figure 3-4 to Figure 3-9 are maps of the hydrogeological data locations at Doris.

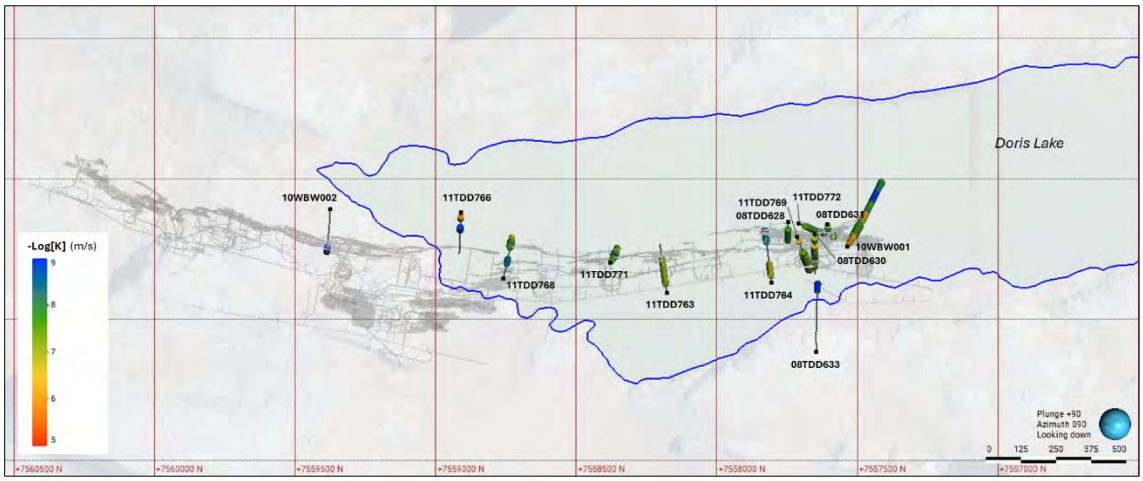


Figure 3-4: Map of hydraulic conductivities measured at Doris from surface drillholes

Source: fig_doris_K_data.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

Note: The map excludes tests in frozen intervals or rated as poor quality due to injection bypass or equipment issues. Variations of sizes for the cylinders representing tests intervals and transparencies are used to display overlapping test intervals; they do not correlate with influence radiuses.
The underground projected footprint corresponds to the proposed mine development.

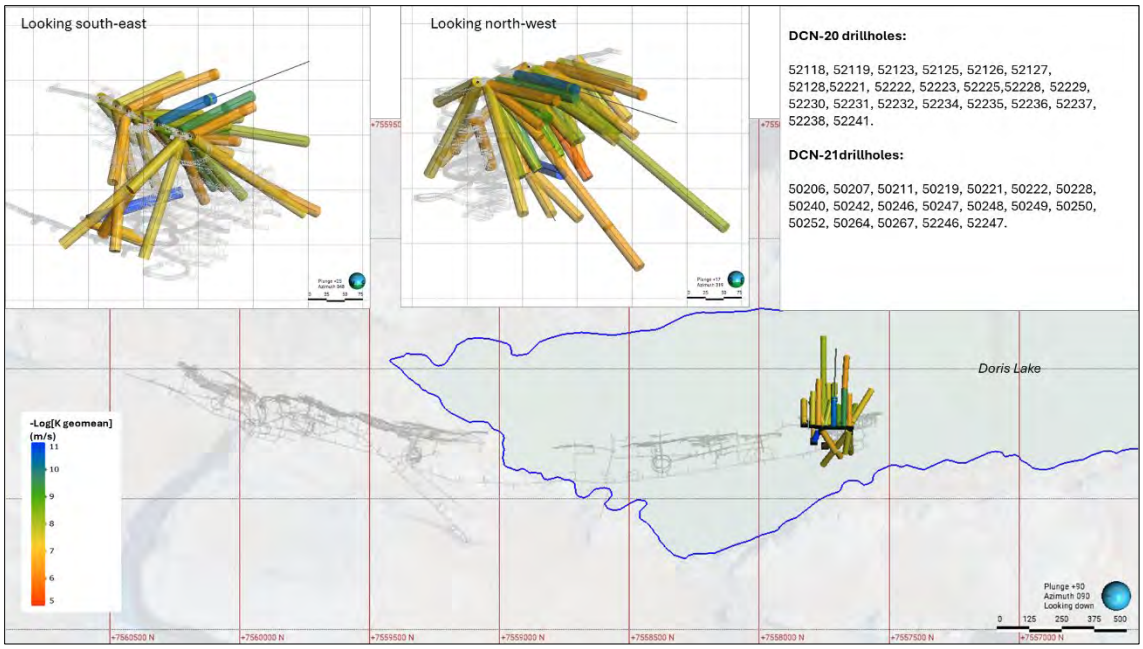


Figure 3-5: Map of hydraulic conductivities measured at Doris from underground drillholes

Source: fig_doris_K_data.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

Note: The underground projected footprint corresponds to the Doris mine developments as of 2022.

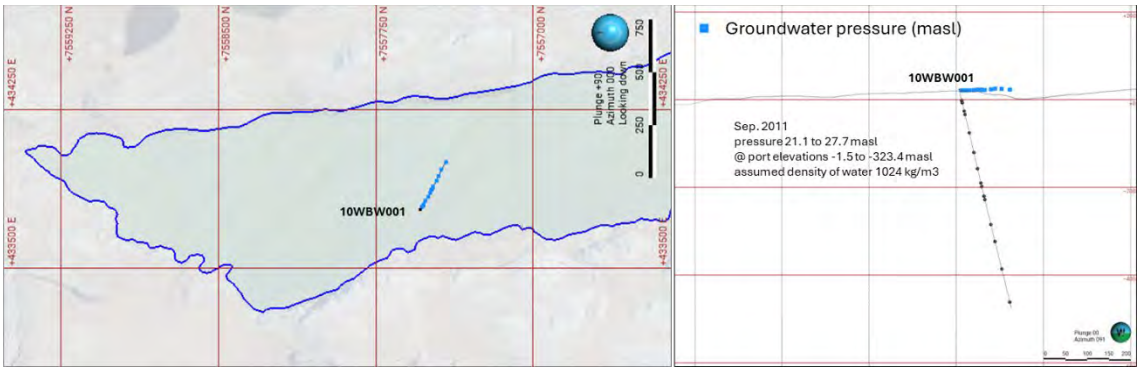


Figure 3-6: Map of groundwater pressure measured at Doris during pre-mining conditions

Source: fig_doris_gwPress_data.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

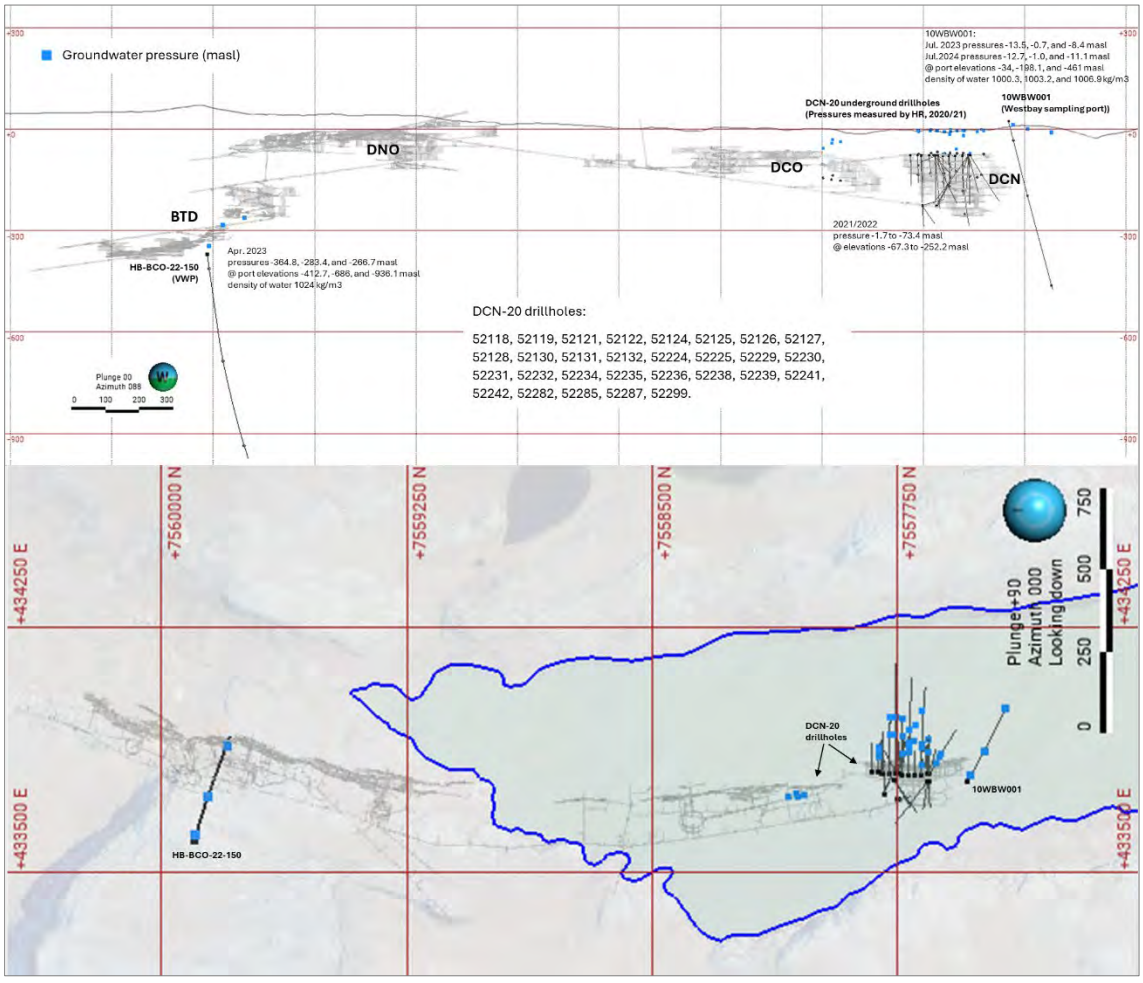


Figure 3-7: Map of groundwater pressures measured at Doris during mining

Source: fig_doris_gwPress_data.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

Note: The underground projected footprint corresponds to the Doris mine developments as of 2022.

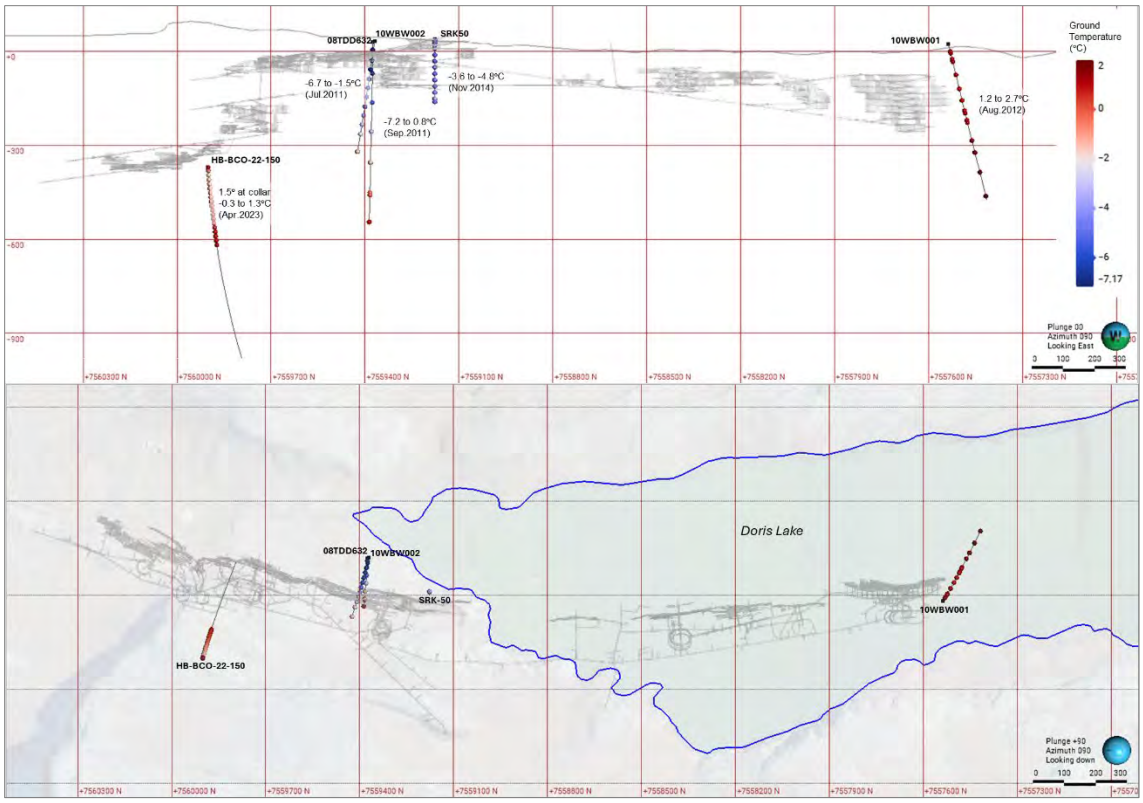


Figure 3-8: Map of ground temperatures measured at Doris

Source: fig_doris_therm_data.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

Note: The underground projected footprint corresponds to the proposed mine developments.

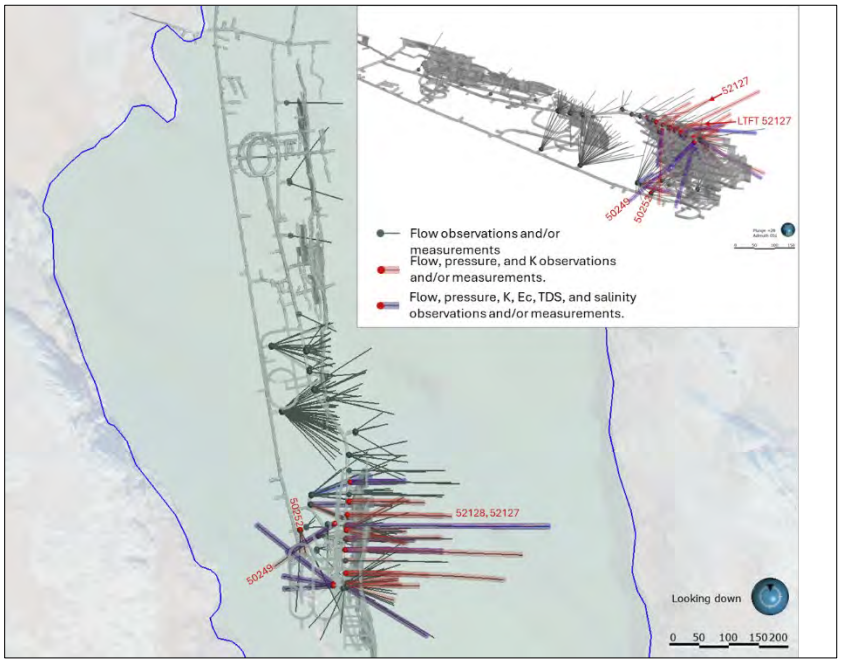


Figure 3-9: Map of flow measurements recorded in the Doris underground mine

Source: fig_doris_flow_data.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

3.5 Madrid Groundwater Monitoring Network

Figure 3-10 to Figure 3-14 are maps of the hydrogeological data locations at Madrid.

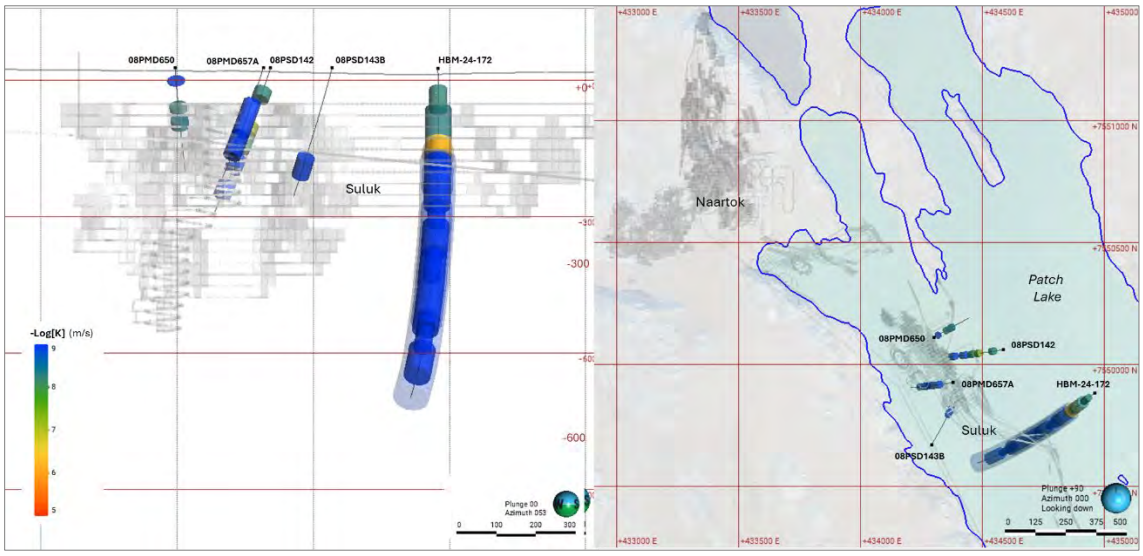


Figure 3-10: Map of hydraulic conductivities measured at Madrid (north area) from surface drillholes

Source: fig_madrid_K_data_rev1.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

Note: The map excludes tests in frozen intervals or rated as poor quality due to injection bypass or equipment issues. Variations of sizes for the cylinders representing tests intervals and transparencies are used to display overlapping test intervals; they do not correlate with influence radiuses.
The underground projected footprint corresponds to the proposed mine development.

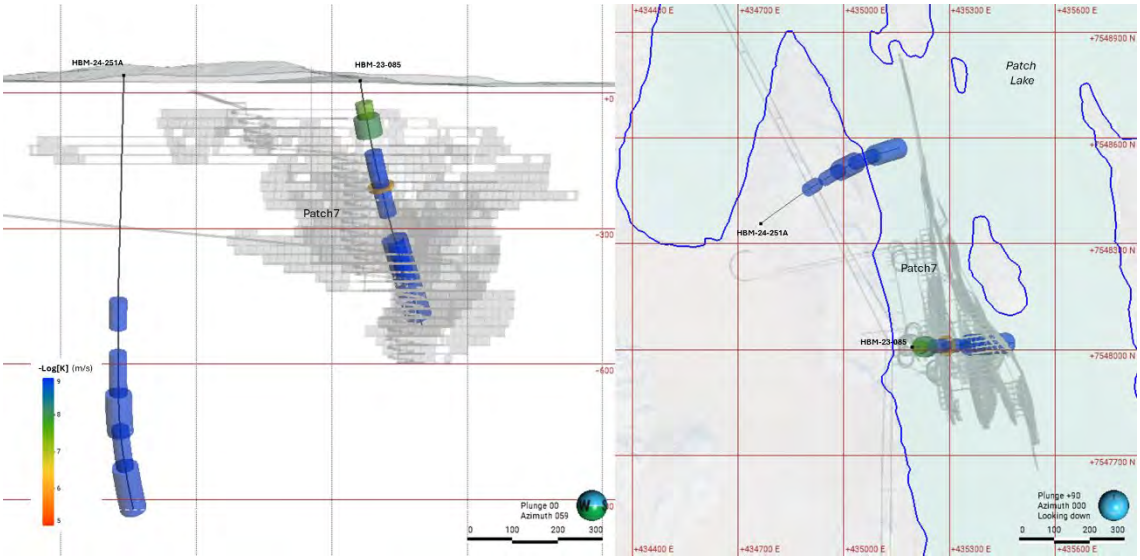


Figure 3-11: Map of hydraulic conductivities measured at Madrid (central area) from surface drillholes

Source: fig_madrid_K_data_rev1.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

Note: The map excludes tests in frozen intervals or rated as poor quality due to injection bypass or equipment issues. Variations of sizes for the cylinders representing tests intervals and transparencies are used to display overlapping test intervals; they do not correlate with influence radiuses.
The underground projected footprint corresponds to the proposed mine development.

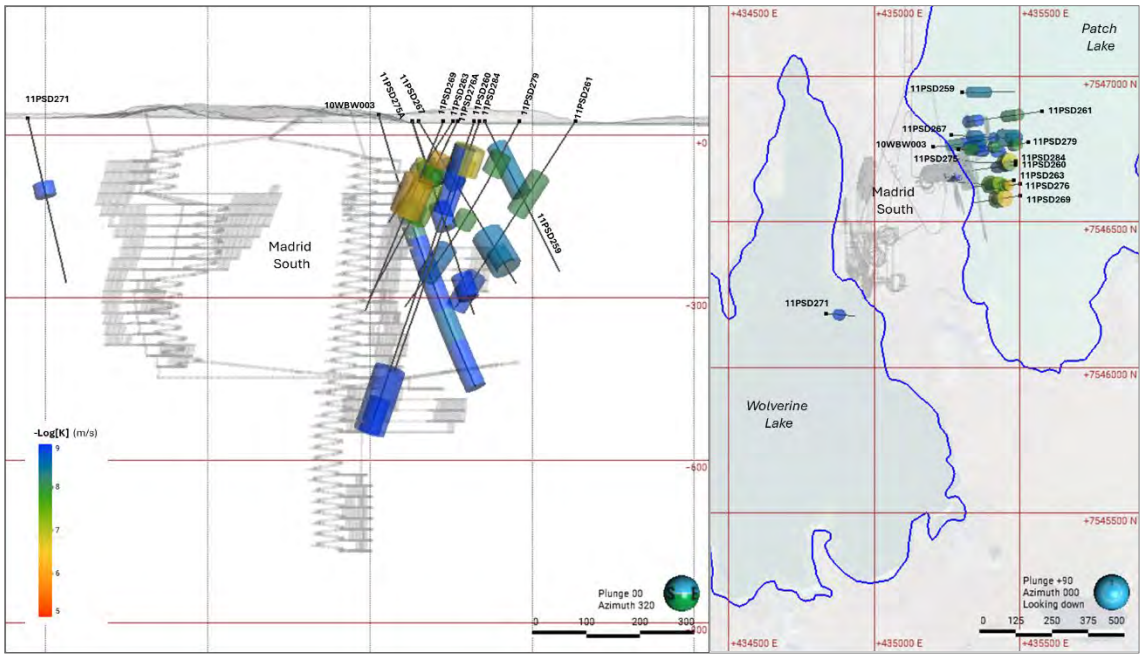


Figure 3-12: Map of hydraulic conductivities measured at Madrid (south area) from surface drillholes

Source: fig_madrid_K_data_rev1.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

Note: The map excludes tests in frozen intervals or rated as poor quality due to injection bypass or equipment issues. Variations of sizes for the cylinders representing tests intervals and transparencies are used to display overlapping test intervals; they do not correlate with influence radiuses.
The underground projected footprint corresponds to the proposed mine development.

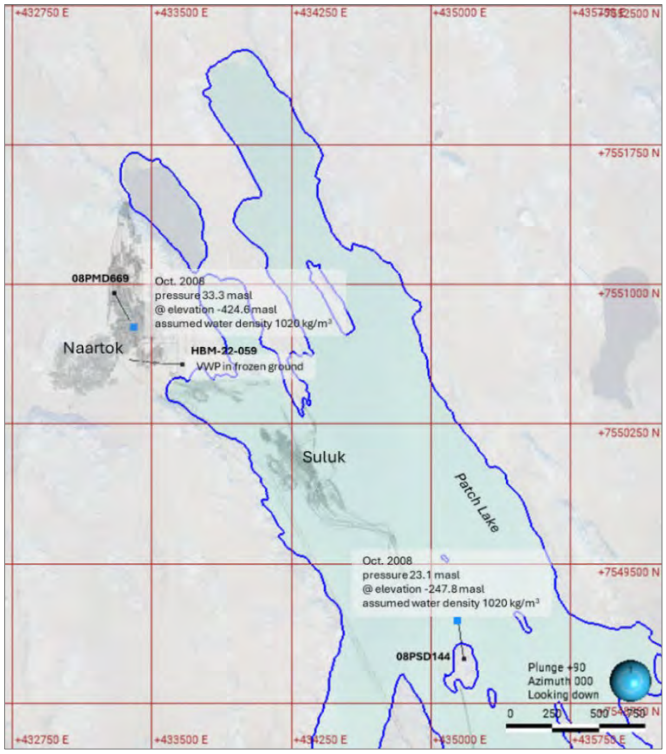


Figure 3-13: Map of groundwater pressures measured at Madrid

Source: fig_madrid_gwPress_data_rev1.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

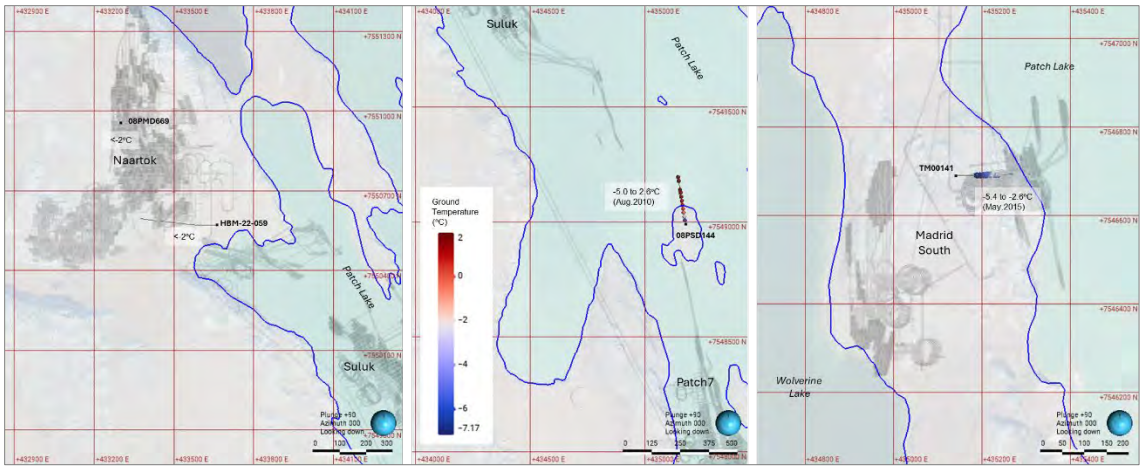


Figure 3-14: Map of ground temperatures measured at Madrid

Source: fig_madrid_therm_data_rev1.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

3.6 Boston Groundwater Monitoring Network

Figure 3-15 and Figure 3-16 show the hydrogeological data locations at the Boston exploration area, located on a peninsula on Aimakatalok Lake, immediately north of Stickleback Lake.

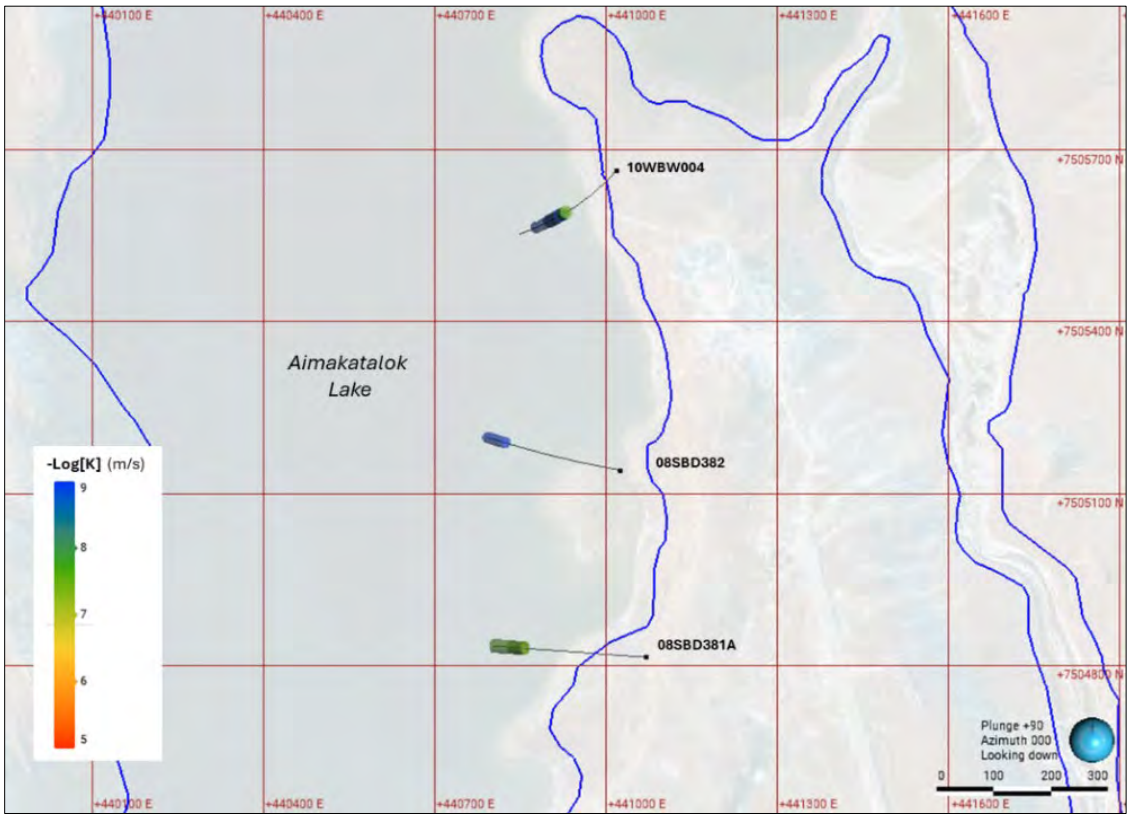


Figure 3-15: Hydraulic conductivity tests measured at Boston from surface drillhole

Source: fig_boston_K_data.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

Note: The map excludes tests in frozen intervals or rated as poor quality due to injection bypass or equipment issues.

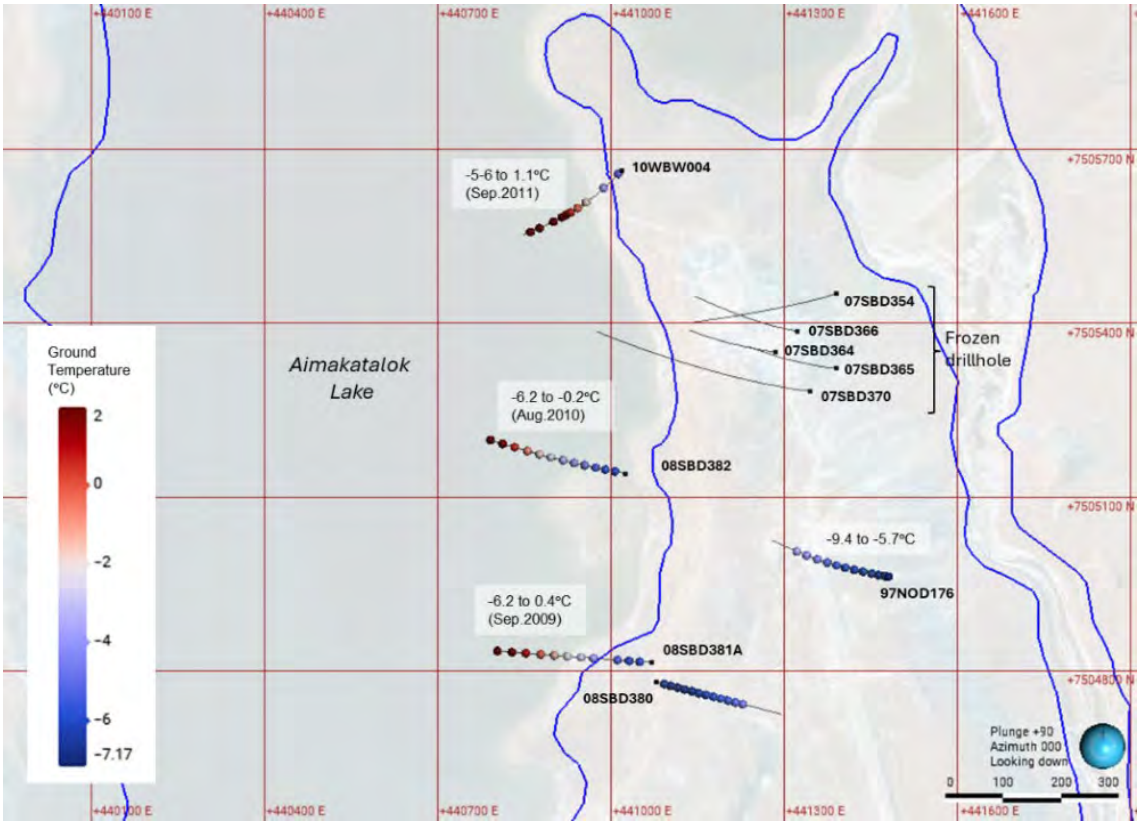


Figure 3-16: Map of ground temperatures measured at Boston

Source: fig_boston_them_data.pptx, Leapfrog model ID 12766
(Projection: NAD83 / UTM zone 13N, unit: metre)

3.7 Hydraulic Properties

The hydraulic conductivity (K) dataset includes a total of 184 test measurements at Doris (Figure 3-4 and Figure 3-5), Madrid (Figure 3-10 to Figure 3-9), and Boston (Figure 3-15), excluding tests in permafrost. These measurements were obtained from surface or underground drilling using slug tests, short and long-duration packer injection tests, pressure dissipation tests in cone penetration tests (CPT), and laboratory permeability measurements. Most tests included more than one lithological unit resulting in the averaging of the individual features or lithologies in the respective test intervals.

3.7.1 Bedrock

Table 3-1 compiles a statistical summary of the K values; individual test results are presented in Appendix C. The arithmetic mean, geometric mean, and harmonic mean are employed to capture different aspects of the hydraulic conductivity variability.

- The arithmetic mean provides a measure of the central tendency of the data. However, the arithmetic mean may not accurately represent the typical behavior in heterogeneous media as extreme values can significantly affect the average. It can be representative of the bulk K along preferential flow directions (i.e., along beddings or vertical fractures).
- The geometric mean is usually considered the best metrics for bulk K values because K is typically log-normally distributed. The geometric mean provides a better representation of the central tendency for log-normally distributed data, giving more weight to the geometrically central values.
- The harmonic mean gives more weight to lower values, making it sensitive to low K zones. In heterogeneous media, this statistic can better reflect the influence of rock with lower K on overall flow.

Table 3-1: Statistical summary of the hydraulic conductivity dataset

Unit	Count (-)	K min. (m/s)	K harm. (m/s)	K geo. (m/s)	K arith. (m/s)	K max. (m/s)
Doris bedrock	99	1.4E-11	5.0E-10	5.0E-08	3.0E-07	4.0E-06
Madrid bedrock	78	1.0E-11	2.4E-10	2.0E-09	5.7E-08	9.0E-07
Boston bedrock	7	1.1E-11	7.2E-11	3.4E-09	2.3E-08	7.0E-08

Source: HopeBay_MASTER_HydrProperties_gf_20250120.xlsx

Note: Min: Min., max: maximum, harm: harmonic mean, geo: geomean; arith: arithmetic mean, max: maximum.

The spatial distribution of K values does not show a particular pattern. Figure 3-17, Figure 3-18 and Figure 3-19 plot the K values versus depth, K values versus fracture frequency, and K values versus Rock Quality Designation (RQD), respectively. K values tend to decrease progressively with depth, which is interpreted to be a result of reduction of fracture apertures with depth as lithostatic load increases (Singhal and Gupta 2010); correlation coefficients between K and depths are weak to moderate. The probability of encountering higher K can increase in areas with higher fracture frequency.

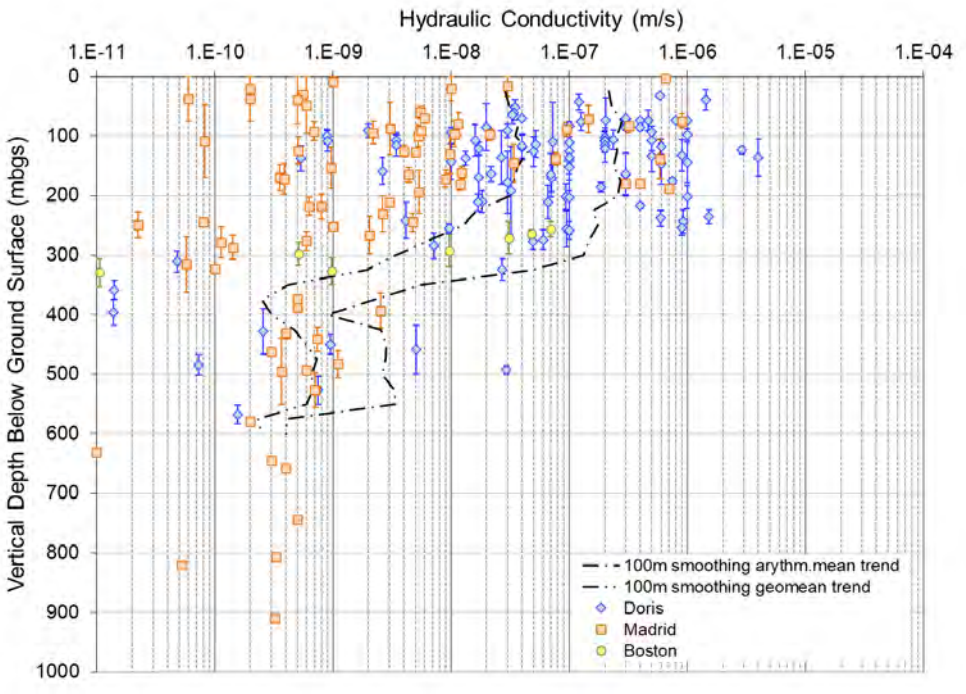


Figure 3-17: Hydraulic conductivity versus depth

Source: HopeBay_MASTER_HydrProperties_gf_20250120.xlsx

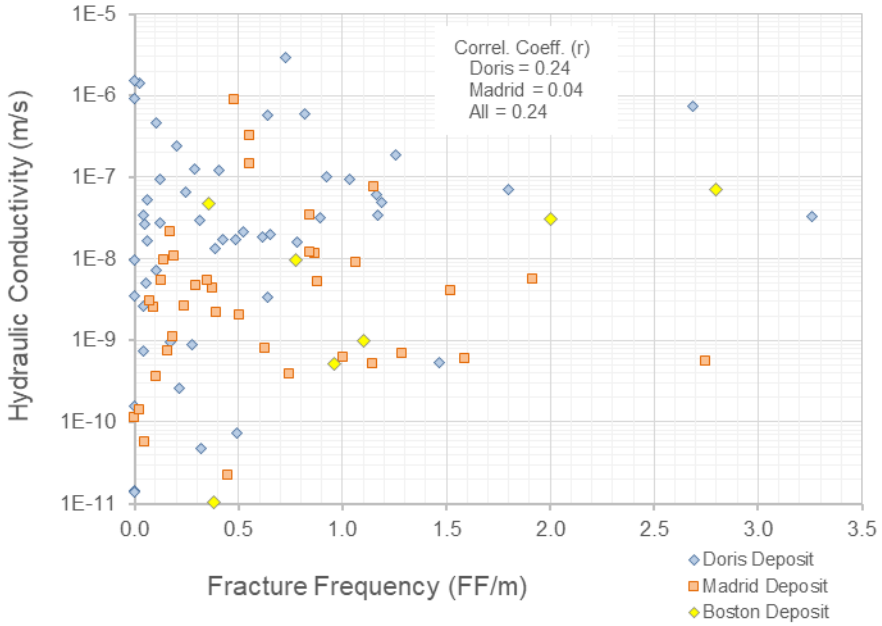


Figure 3-18: Hydraulic conductivity versus fracture frequency

Source: HopeBay_MASTER_HydrProperties_gf_20250120.xlsx

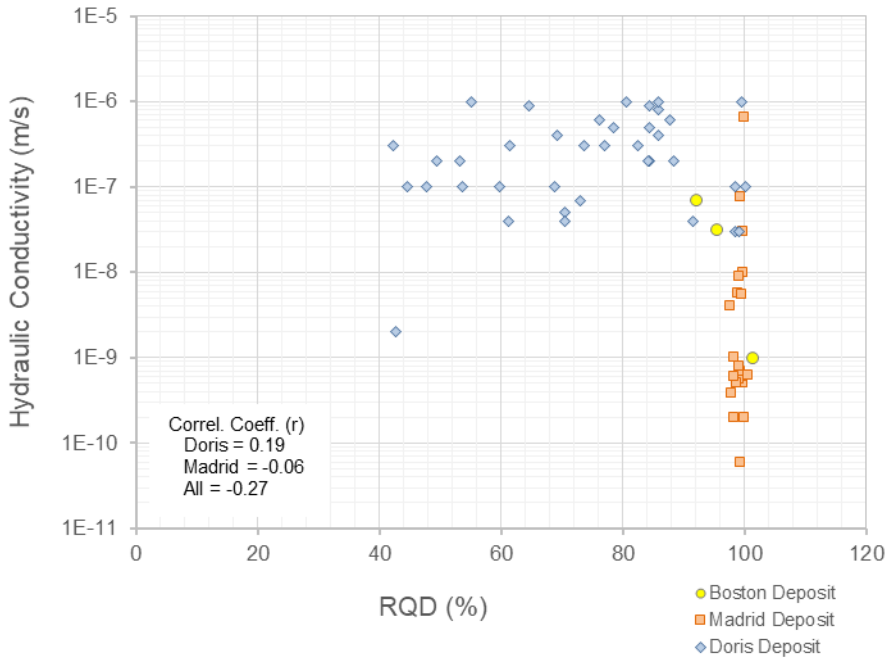


Figure 3-19: Hydraulic conductivity versus RQD

Source: HopeBay_MASTER_HydrProperties_gf_20250120.xlsx

Doris

The K tests performed at Doris (Figure 3-4 and Figure 3-5) show values are typically low, ranging between <1x10^{-9}m/s and 4x10^{-6} m/s, with a geomean of 5x10^{-8} m/s. The diabase dykes appear to have a low bulk rock hydraulic conductivity (1x10^{-11} m/s) but since only two tests were conducted exclusively within the diabase dykes, the statistical confidence remains low.

Out of fourteen hydraulic tests associated with intervals intercepting structural features, from gouge-filled fractures to rubble zones, only eight measurements are greater than the geometric mean.

- At 10WBW001, between 223.1 and 247 mbgs and between 223.1 and 263 mbgs, K was measured respectively as 1.5x10^{-6} m/s and 9.2x10^{-7} m/s. The test interval was described with basalt, quartz and dolomite veins with fractures (no recovery). Loss of pressure or drilling circulation were encountered during drilling.
- At 11TDD769, between 28.0 and 35.2 mbgs, K was measured as 5.9x10^{-7} m/s. The test interval was described as mafic volcanic pillow (foliated basalt) and included a 20 cm shear structure.
- At 11TDD769, between 117.3 and 129.8 mbgs, K was measured as 2.9x10^{-6} m/s. The test interval was described as mafic volcanic pillow (foliated basalt) and included major joints with gouge.
- At 11TDD769, between 170.2 and 179.9 mbgs, K was measured as 7.5x10^{-7} m/s. The test interval was described as mafic volcanic pillow (foliated basalt) with a rubble zone.

- At 11TDD771, between 148.0 and 193.7 mbgs and between 177.3 and 193.7 mbgs, K was measured respectively as $7.1x10^{-8}$ m/s and $1.9x10^{-7}$ m/s. The tests were described as primarily volcanic pillow with quartz, with the ore zone between 166-171m and a structure at the ore zone contact.
- At 11TDD772, between 256.8 and 291.1 mbgs, K was measured as $6.0x10^{-6}$ m/s. The test interval was described as mafic volcanic pillow (foliated basalt) with quartz (ore zone) and intercepted a fault labelled Force 1 in the 2012 structural model.

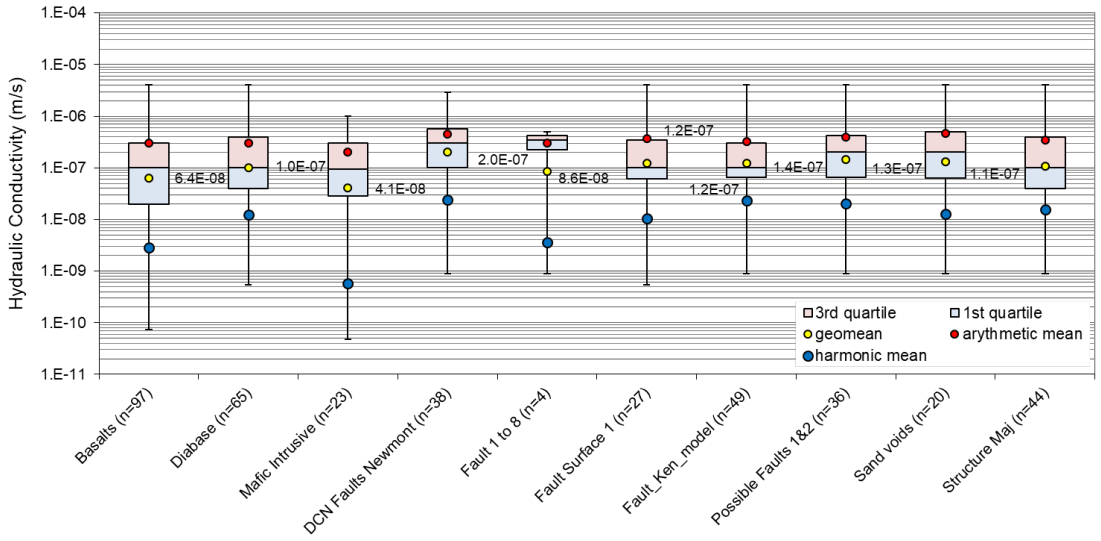


Figure 3-20: Box plot of the Doris K measurements by geology and structures

Source: HopeBay_MASTER_HydrProperties_gf_20250120.xlsx

Madrid

The tests performed at Madrid (Figure 3-10 and Figure 3-21) show K values are typically low, ranging between < $1x10^{-9}$ and $9x10^{-7}$ m/s, with a geomean of $2x10^{-9}$ m/s. The dataset shows no evidence of higher K features associated with dyke contacts, major structures, or faults, and/or the MDZ. The hydraulic tests intersecting geological structures at Madrid are listed in Table 4 3.

Four tests reported a K value above $1x10^{-7}$ m/s:

- At 11PSD269, between 105 and 150 mbgs, K was measured as 6x10-7 m/s. The drillers recorded a loss of return at 137 mah (meter along drillhole), and the geotechnical log indicates the presence of a shear zone at 138 mah.
- At 11PSD276, between 60 and 85 mbgs, K was measured as 9x10-7 m/s. The test interval showed no obvious weak zone; there were no major structures identified, and the number of joints and fractures was low (fracture frequency = 0.3 per m).
- 11PSD284 2, between 70 and 95 mbgs, K was measured as 3x10-7 m/s. The test interval showed no obvious weak zone; there was no major structure identified, and the number of joints and fractures was low (fracture frequency = 0.7 per m).

- HBM-23-085, between 229.7 and 236.6 mbgs, K was measured as 1x10-6 m/s. A zone of increased flow within the test zone was identified by loss of fluid pressure during drilling.

Table 3-2: Hydraulic tests intersecting MDZ or other geological structures at Madrid

ID	Test #	Test Interval (mbgs)	K (m/s)	Notes on the test interval
08PMD650	Test #1	27.7 to 31.2	$5.6x10^{-10}$	Basalt; shattered structure (possibly mechanical); graphite and sediments present.
08PMD650	Test #2	85.7 to 96.1	$5.6x10^{-9}$	Basalt; 4cm fault zone (no gouge).
08PMD657a	Test #1	75.5 to 107.3	$6.9x10^{-10}$	Deformation Zone (Foliated basalt with med-strong sericitic alteration).
08PMD657a	Test #2	100.9 to 146.6	$5.1x10^{-10}$	Deformation Zone (Foliated basalt with med-strong sericitic alteration).
08PMD657a	Test #3	146.8 to 197.4	$3.9x10^{-10}$	Deformation Zone (Foliated basalt with med-strong sericitic alteration).
08PSD142	Test #2	127.8 to 149.1	$6.5x10^{-8}$	Basalt, transition to PGP; set of joints with calcite crystals.
08PSD143B	Test #1	196.8 to 240.0	$8x10^{-10}$	Deformation zone with basalts.
10WBW003	Test #3	227.3 to 270.5	$2.3x10^{-11}$	Highly strained felsic and mafic metavolcanics. Some qtz/carbonate veining, some veins brecciated. Interval intercepted the alteration near the mineralized zone.
11PSD267	Test #1	75.1 to 113.0	$2.2x10^{-9}$	Mafic volcanic and felsic pillows with quartz (discontinuous ore zone 112-118m). Interval intercepted alteration near the mineralized zone, and modelled fault.

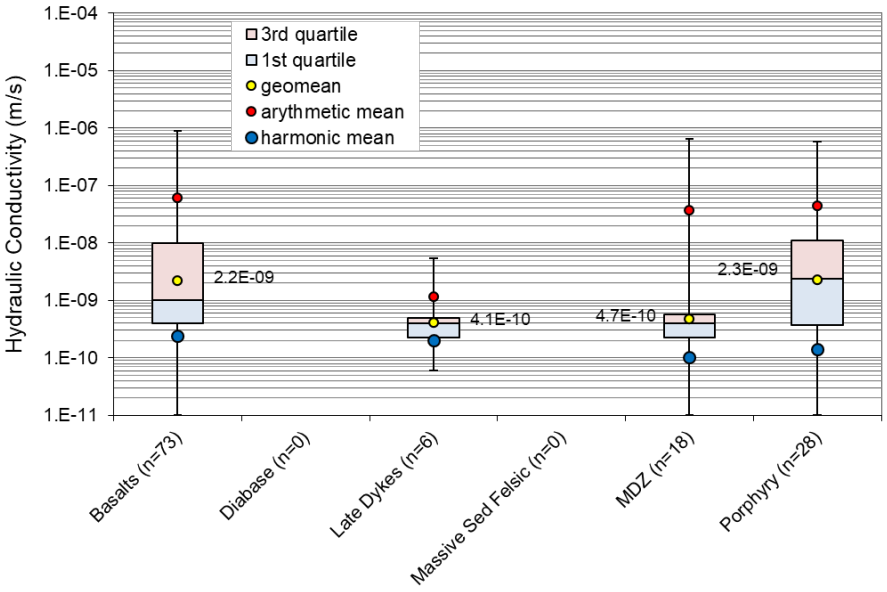


Figure 3-21: Box plot of the Madrid K measurements by geology and structures

Source: HopeBay_MASTER_HydrProperties_gf_20250120.xlsx

Boston

The tests performed at Boston (Figure 3-15) show K values are low, ranging between < $1x10^{-9}$ and $7x10^{-8}$ m/s, with a geomean of $3x10^{-9}$ m/s. The dataset shows no evidence of higher K features associated with geological structures.

3.7.2 Lake Sediments

Table 3-3 presents the estimated hydraulic conductivities of lakebed sediments.

Estimations for soft lakebed sediments were obtained from pressure dissipation tests conducted during CPT drilling in sediments lining the base of Doris Lake, Patch Lake and Aimakatalok Lake (SRK 2009a), and interpreted using the method of Parez and Fauriel (1988). Appendix D compiles the individual results.

CPT refusals were not associated with bedrock contact, but an indurated layer of lake sediment, which is estimated to be on average 3 m thick according to drillhole information. Two samples of the indurated lakebed sediment (SRK-OB-VS-14-S3 and SRK-OB-VS-31-S2) were sent to a laboratory for consolidation testing. The laboratory measured hydraulic conductivity of $4.6x10^{-10}$ and $3.5x10^{-10}$ m/s, respectively (SRK 2009a).

Table 3-3: Hydraulic Conductivity of Doris Lakebed Sediments

Type	Number of Tests	Average Thickness (m)	Hydraulic Conductivity Geometric Mean (m/s)
Soft lakebed sediments	28	17	$1x10^{-8}$
Indurated lakebed sediments	2	3	$4x10^{-10}$

3.7.3 Influence of Drillholes on Hydraulic Conductivity

There have been 1000's of drillholes completed into the different ore bodies over the years in support of exploration, geotechnical studies, etc. A large percentage of these drillholes have been grouted to some extent, but open drillholes can still present a risk for inflow if connected to an appropriate water source. Quantification of how these drillholes could affect the overall bulk K is difficult, if not impossible, but the potential for drillholes to potentially increase bulk K (locally at least) is a consideration.

3.8 Groundwater Levels

Pre-mining groundwater level data (Figure 3-6 and Figure 3-13) consist of pressure profiles in Westbay well 10WBW001 at Doris, groundwater level observations from two drillholes at Madrid, and pressure profiles in Westbay well 10WBW004 and two VWPs at Boston. The water levels collected during hydraulic conductivity tests were not considered representative of in-situ conditions because of influences from drilling. Groundwater pressure measurements are converted to absolute elevations, but as the water is saline, its higher density affects the pressure. To ensure accurate calculations, the pressure is adjusted to account for this increased density. The estimated degree of accuracy of the groundwater pressure measurements

expressed in levels is ±7 m, which corresponds to a variation in density of ±0.015 kg/m^3, as observed in laboratory measurements of Westbay well samples (min. 1.0 and max. 1.03 kg/m3).

Groundwater levels were approximately at or near the lake levels; between 21 and 28 masl at Doris (Doris Lake surface water elevation is ~22 masl), between 23 and 33 masl at Madrid (Patch Lake surface water elevation is ~26 masl), and 56 and 67 masl at Boston (Aimakatalok Lake surface water elevation is ~66 masl). The pressures in 10WBW001 and 10WBW004 suggest a low vertical upward gradient, however this interpretation is uncertain due to density corrections.

Additional groundwater pressures were measured during operations in the Doris underground mine. The dataset (Figure 3-7) includes pressures measured by HR (2020, 2021) in underground exploration drillholes, and pressures measured by Agnico in Westbay well 10WBW001 and VWP HB-BCO-22-150. The measurements show the effect of mine dewatering, with pressures dropping below the level of Doris Lake (-1 to -73.4 masl in the DCO and DCN areas, -266.7 to -364.8 masl in the BTD area) as depressurization around the underground developments progressed.

3.9 Groundwater Quality

Obtaining groundwater quality samples representative of true formation groundwater in low hydraulic conductivity fractured rock within a permafrost environment presents significant challenges. These difficulties arise due to several factors:

- Fractured rock systems with low hydraulic conductivity impede groundwater movement, leading to prolonged residence times and limited flow. This makes it challenging to extract samples that represent natural conditions rather than stagnant or mixed water from the borehole environment.
- Fractures are unevenly distributed and variably interconnected. Samples collected can reflect the water quality of only the more permeable fractures, skewing the representation of the overall system.
- During drilling and sampling, interactions between the borehole environment and surrounding formation water can lead to contamination. For instance, drilling fluids or disturbed fine particles may alter the chemical signature of the extracted groundwater.
- Freezing conditions above and the thermal gradient near the permafrost can alter the groundwater chemistry.

3.9.1 Regional Groundwater Quality Data

A dataset of groundwater Total Dissolved Solids (TDS) concentrations from the Canadian Shield is plotted against depth in Figure 3-22. This dataset includes data from Frape & Fritz (1987) and public data from the following mine projects: Back River (Rescan ERM, 2015), Lupin (Stotler et al., 2009), Meadow Bank (Cumberland Resources, 2005), Meliadine (Golder, 2013), Snap Lake (De Beers, 2002), Ekati (Golder, 2014), Gahcho Kue (De Beers, 2010), and Jay (Golder, 2014).

The distribution of TDS concentrations with depth shows brackish to hypersaline water is common in northern permafrost environments. Salinity, measured as TDS, generally increases with depth, with concentrations reaching up to tens of grams per liter at depths of 500 mbgs beneath continuous permafrost.

The presence of ancient brine water in various locations on the Canadian Precambrian Shield suggests that these deep flow systems are sluggish and slow-moving under natural (pre-mining) conditions (Frape & Fritz, 1987). Gascoyne (2003) reported several potential sources of salinity: (1) rock-water interactions, including reactions with rock matrix minerals and fracture-filling minerals, (2) soluble salts present at grain boundaries and in fluid inclusions, (3) residual saline hydrothermal fluids, and (4) ancient marine fluids or basinal brines that entered rock prior to glaciation. Additionally, in situ cryogenic concentration due to ice and methane hydrate formation may have concentrated the remaining fluids, as observed at the Lupin Mine (Stotler, 2009).

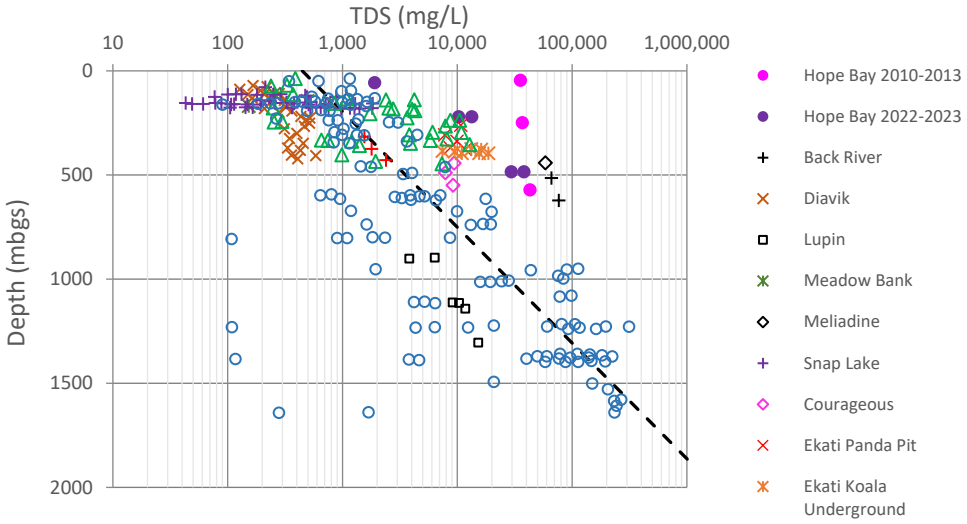


Figure 3-22: TDS concentrations with depth in Canada's North

Source: hopeBay_Compilation of TDS data versus Depth_20241205.GF.XLSX

3.9.2 Hope Bay Groundwater Quality Data

Groundwater samples were collected between 2010 and 2013 at Doris, Madrid, and Boston, and between 2022 and 2024 at Doris. Samples were analyzed for standard parameters, major cations and anions, and total and dissolved metals. In the period 2010-2013 and again in 2024, stable isotopes of oxygen and hydrogen were also analyzed to ensure quality assurance and control (QA/QC) and to assess variations in water source types.

Table 3-4 compiles the mean groundwater concentrations measured in each zone of the Westbay well 10WBW001; Appendix E compiles the individual groundwater quality results (SRK, 2015a, 2017b, c; Lorax 2023b, Lorax 2024c). Comparisons between mean concentrations in 10WBW001 and environmental guidelines[2] indicate that concentrations of ammonia, boron,

[2] Canadian Council of Ministers of the Environment (CCME) water quality guidelines for freshwater, irrigation, livestock, and marine (2024) and the Metal and Diamond Mining Effluent Regulations (MDMER) limits for harmful substances (2024)

cadmium, chloride, fluoride, iron, manganese, nickel, selenium, and zinc exceed the recommended levels, making them potential constituents of concern. Chloride is the only constituent of concern that shows a correlation with depth. Figure 3-23 plots the vertical depth profiles of chloride concentrations, and Figure 3-24 plots TDS Vs chloride concentrations.

The samples collected in 10WBW001 between 2010 and 2013 represent the pre-mining conditions. 10WBW001 underwent significant purging, and QA/QC analyzes concluded samples were representative of true formation groundwater. Although samples from 10WBW004 (Boston) showed comparable chemistry to 10WBW001, they were not considered as representative due to less effective purging. Samples from 10WBW002 (Doris) and 08PMD657a (Madrid) were also not considered representative due to limited purging. Specifically, 10WBW002 had low hydraulic conductivity, and 08PMD657a was a "grab" sample collected using a wireline swabbing method during drilling. The 2010-2013 groundwater quality in 10WBW001 confirmed groundwater was saline and chloride-dominated at all depths, with salinity varying by depth.

The samples collected in 10WBW001 between 2022 and 2024 represent the mining period influenced by the Doris underground operations. In comparison to the pre-mining period, the groundwater quality in Zone 1 (484.8 mbgs) remained the same except for decreases in pH and EC, whereas in Zone 6 and 10 (221 and 57.4 mbgs, respectively), constituents were largely diluted excepted for aluminum and uranium. Almost every major parameter (e.g. Ca, Li, Mg, Fe, SO4, Cl, NH4, Na, Sr) decreased by 60 to 70% in Zone 6 and by 90% in Zone 10. The alkalinity increased to over 200 mg/L in Zone 10 and 6, and from below detection to 14.7 mg/L in Zone 1.

This dilution of constituents and increase of alkalinities are interpreted to result from the dewatering of the Doris underground, which creates a depressurized zone at depth that draws in freshwater from Doris Lake and ultimately leads to an increase of carbonate solubility in the mixed waters. Potential mechanisms are:

- the reduced salinity of freshwater inputs affecting the activity of H+ and thus carbonate dissolution and pH;
- the dissolution of carbonate, specifically dolomite with minor calcite in the quartz veins at depth, by the mixing of surface water previously in equilibrium with the atmosphere (i.e. difference in pCO2) with groundwater;
- the release of groundwater pressures in underground workings and diamond drill holes; and
- various changes in solute concentrations leading to increases in carbonate solubility.

In terms of TDS versus Chloride (Figure 3-24), the increase in the slope from 0.4641 to 0.5662 suggests that chloride concentrations became a larger proportion of the TDS during the mining period. This could indicate that while overall TDS is diluted, chloride is less affected by dilution compared to other constituents. The slight decrease in R^2 from 0.9862 to 0.9823 indicates a minor reduction in the strength of the linear relationship, which could suggest some variability introduced by the mining activities.

Table 3-4: Mean baseline groundwater quality (Doris, 10WBW001)

Parameters		Units	Zone 1 2010-2013 (n = 8)	Zone 1 2022-2024 (n = 3)	Zone 6 2010-2013 (n = 12)	Zone 6 2022-2024 (n = 3)	Zone 10 2010-2013 (n = 9)	Zone 10 2022-2024 (n = 3)[z]	Doris Lake 2003-2016 (n = 8)	*MDMER and CCME Guidelines [mg/L]*
Field Parameters	pH	pH units	7.43	7.12	7.11	7.51	7.23	8.21	-	*6.0 – 9.5 [a2] 7.0 – 8.7 [c2]*
	EC *	µS/cm	52,650	44,431	52,300	17,197	45,050	3,512	-	*N/A*
	DO *	mg/L	11.37	10.27[Y]	10.13	N/A	8.31	8.46	-	*N/A*
	Salinity	%	3.27	2.8	15.1	1.0	15.3	0.2	-	*N/A*
	ORP *	mV	73	74	-66	22	-15	79	-	*N/A*
Lab Physical Parameters	EC *	µS/cm	47,000	47,200 (2022) 23,700 (2023)	45,500	14,600	44,000	3,400 (2023)	-	*N/A*
	Density	kg/m^3	1.03	N/A	1.02	N/A	1.02	N/A	-	*N/A*
	pH	pH units	7.47	6.74	7.48	7.99	7.49	8.23[Y] (2023)	7.62	*6.0 – 9.5 [a2] 7.0 – 8.7 [c2]*
	TDS * (gravimetric)	mg/L	40,700	38,100 (2022) 30,500 (2023/24)	34,400	13,400 (2022) 10,250 (2023/24)	33,700	1,920 (2023/24)	158	*500 – 3,500 [d], 3,000 [e]*
Anions and Nutrients	Alkalinity, Total (as $CaCO_3$)	mg/L	<2	15.3	57.2	288.3	97.5	243.5	29.5	*N/A*
	Ammonia as N	mg/L	0.06	0.01	3.2	2.6	3.6	0.67	<0.005	*1.04-15.3 [b2,F]*
	Chloride (Cl)	mg/L	19,000	19,270	18,000	5,840	17,400	1,000	62	*640 [b1], 120 [b2], 100-710 [d]*
	Fluoride (F)	mg/L	1.2	2.0	0.5	0.9	<0.75	0.8	0.055	*0.12 [b2], 1 [d], 2 [e]*
	Sulfate (SO_4)	mg/L	973	787	1,880	416	1,700	89	3	*1,000 [e]*
Dissolved Metals	Aluminum (Al)	mg/L	<0.005	0.06	<0.005	0.02	<0.005	0.0085	0.055	*0.005 – 0.1 [g]*
	Arsenic (As)	mg/L	<0.002	<0.005	0.033	<0.02	<0.017	0.00062	0.000295	*0.1 [a1], 0.2 [a2], 0.005 [de],*
	Boron (B)	mg/L	3.12	2.97	2.14	2.18	2.32	1.33	0.032	*29 [b1], 1.5 [b2], 0.5 [d], 5 [e]*
	Cadmium (Cd)	mg/L	0.00011	<0.00025	0.00007	<0.0001	0.00013	<0.00001	<0.000005	*0.0086-0.0124 [b1,A], 0.0020-0.0027 [b2,A], 0.00012 [c2], 0.0051 [d], 0.080 [e]*
	Calcium (Ca)	mg/L	4,780	4,630	1,460	310	1520	30	9	*N/A*
	Chromium (Cr)	mg/L	<0.00045	<0.025	0.00047	<0.005	<0.00046	<0.001	<0.0005	*0.001 to 0.0089 [B]*
	Cobalt (Co)	mg/L	0.00015	<0.005	0.00017	<0.002	0.0003	<0.00035	<0.00005	*0.05 [d], 1 [e]*
	Copper (Cu)	mg/L	0.00067	<0.01	<0.0005	0.002	0.00089	0.00071	0.0014	*0.1 [a1], 0.2 [a2], 0.002 [b2,C], 0.2-1.0 [d], 0.5-5.0 [e]*
	Iron (Fe)	mg/L	0.05	2.6	3.5	<0.15	4.7	0.2	0.14	*0.3 [b2], 5 [d]*
	Lead (Pb)	mg/L	0.0004	<0.025	<0.0003	<0.00`075	0.0004	0.0002	<0.00005	*0.08 [a1], 0.16 [a2], 0.001-0.0018 [b2,D], 0.2 [d], 0.1 [e]*
	Lithium (Li)	mg/L	0.38	0.34	0.22	0.064	0.17	0.017	0.004	*2.5 [d]*
	Magnesium (Mg)	mg/L	68	65	1,310	351	1160	36	6.5	*N/A*
	Manganese (Mn)	mg/L	0.72	0.9	1.6	0.3	1.47	0.037	0.02	*Variable [H], 0.2 [d]*
	Mercury (Hg)	mg/L	<0.00002	<0.000005	<0.00003	<0.000005	<0.00002	<0.000005	0.0000007	*0.000026 [b2]. 0.000016 [c2], 0.003 [e]*
	Molybdenum (Mo)	mg/L	0.012	0.01	0.02	<0.00075	0.0095	0.0024	0.0002	*0.073 [b2], 0.01 [d], 0.5 [e]*

Parameters		Units	Zone 1 2010-2013 (n = 8)	Zone 1 2022-2024 (n = 3)	Zone 6 2010-2013 (n = 12)	Zone 6 2022-2024 (n = 3)	Zone 10 2010-2013 (n = 9)	Zone 10 2022-2024 (n = 3)[z]	Doris Lake 2003-2016 (n = 8)	*MDMER and CCME Guidelines [mg/L]*
	Nickel (Ni)	mg/L	0.0017	0.06	0.001	<0.0075	0.0038	0.0015	0.0005	*0.25[a1], 0.5[a2], 0.025-0.150[b2,E], 0.2[d], 1[e]*
	Potassium (K)	mg/L	39	40	213	135	232	30	2.3	*N/A*
	Selenium (Se)	mg/L	<0.002	<0.0025	0.007	<0.00075	<0.002	0.00019	<0.0002	*0.001[b2], 0.02[d], 0.05[e]*
	Sodium (Na)	mg/L	7,000	6,710	8,300	3,060	8,100	680	32	*N/A*
	Strontium (Sr)	mg/L	56	58	19	4.1	16	0.33	-	*N/A*
	Uranium (U)	mg/L	<0.00013	<0.0005	0.00013	0.00021	0.00013	0.00021	0.000035	*0.033[b1], 0.015[b2], 0.01[d], 0.2[e]*
	Zinc (Zn)	mg/L	0.16	0.93	0.22	0.08	0.33	0.09	<0.003	*0.4[a1], Variable[b1b2,I], 5[d], 50[e]*

Source:https://srk.sharepoint.com/sites/FS208/Internal/!Project_Data%20(Not%20Job%20Specific)/04%20Groundwater%20Chemistry/!Master%20WQ%20Database/HopeBay_MASTER_GWQ-DB_jm_ja_spb%20Rev16_pb.xlsx?web=1

Notes:

"<" indicate that measurements were below detection; the average detection limit is the value present.

* EC, Electrical Conductivity; DO, Dissolved Oxygen; ORP, Oxidation-Reduction Potential; TDS, Total Dissolved Solids

1 n, count of values used to calculate statistics. Statistics assumed all values below detection limit were at the detection limit. Some samples taken early in the program with high detection limits were excluded from the statistical summary.

a1 MDMER Maximum authorized monthly mean concentration

a2 MDMER Maximum authorized in a grab sample

b1 CCME Freshwater (Short term)

b2 CCME Freshwater (Long term)

c1 CCME Marine (Short term)

c2 CCME Marine (Long term)

d CCME Irrigation

e CCME Livestock

A Cadmium short term guideline concentration = $10^{[1.016(\log[\text{hardness}])-1.71]}$ µg/L for hardness ≥5.3 and ≤360 mg/L and the long term guideline = $10^{[0.83(\log[\text{hardness}])-2.46]}$ µg/L for hardness ≥17 to ≤280 mg/L

B Chromium Hexavalent 0.001 mg/L and Chromium Trivalent 0.0089 mg/L

C Copper guideline concentration = $0.2*e^{\{0.8545[\ln(\text{hardness})]-1.465\}}$ µg/L for hardness ≥82 to ≤180 mg/L and for hardness <82 mg/L a concentration of 2 µg/L applies

D. Lead guideline concentration = $e^{\{1.273[\ln(\text{hardness})]+4.705\}}$ µg/L for hardness

E. Nickel guideline concentration = $e^{\{0.76[\ln(\text{hardness})]+1.06\}}$ µg/L for hardness >60 to ≤80 mg/L and for hardness ≤60 mg/L a concentration of 0.025 mg/L applies. At hardness >180 mg/L the guideline is 0.150 mg/L.

F Total ammonia guideline pH and temperature dependent

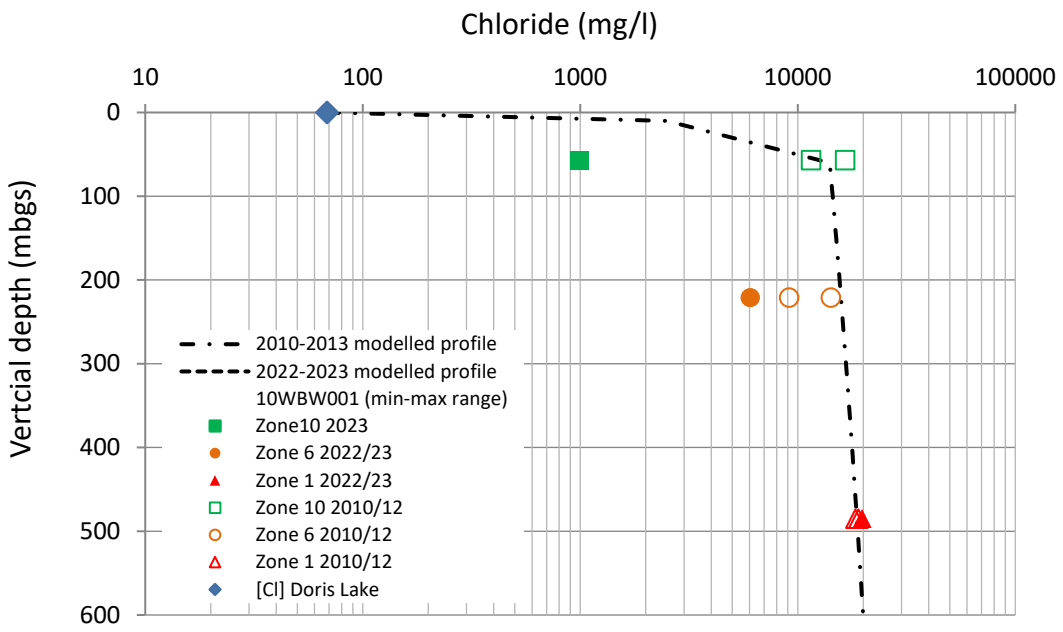
G Aluminum guideline concentrations 0.005 mg/L for pH <6.5 and 0.1 mg/L for pH >6.5

H Benchmark = exp(0.878[ln(hardness)] + 4.76) where the benchmark is expressed in dissolved manganese concentration (µg/L), and hardness is measured as CaCO3 equivalents in mg/L.

I Short-term benchmark is for dissolved zinc and calculated using Benchmark = exp(0.833[ln(hardness mg·L-1)] + 0.240[ln(DOC mg/L)] + 0.526). Long-term CWQG is for dissolved zinc and calculated using CWQG = exp(0.947[ln(hardness mg/L)] – 0.815[pH] + 0.398[ln(DOC mg/L)] + 4.625). Benchmark calculations are limited to a maximum of 250.5 mg/L and 399 mg/L hardness (as $CaCO_3$), for short and long-term concentrations respectfully.

Y Only one value for the date range, not a mean.

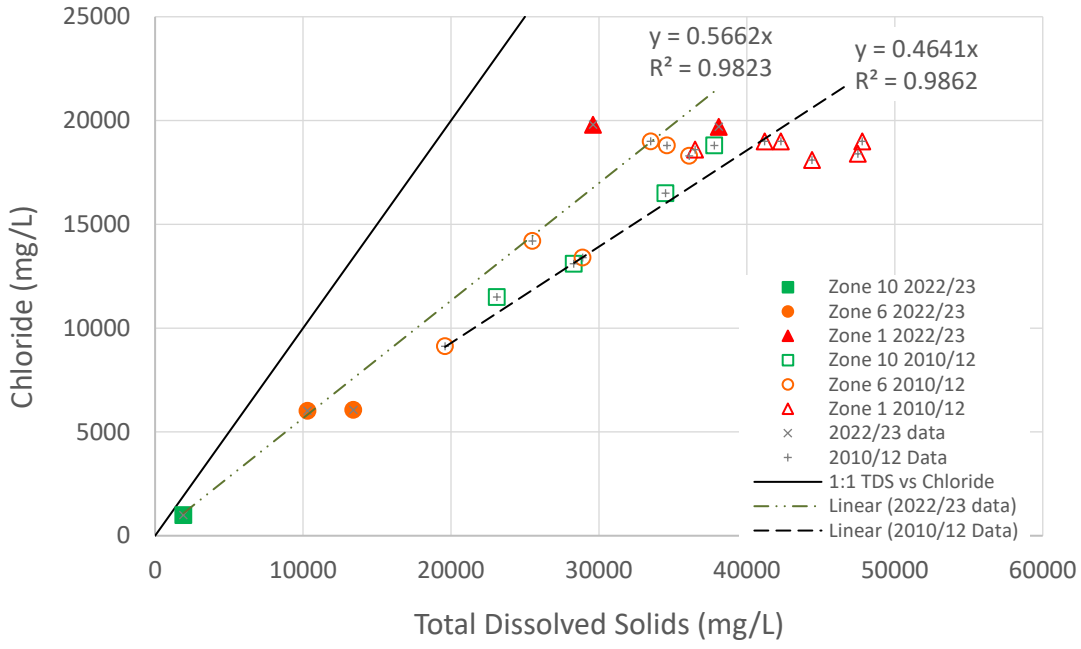
Z Some values were rescinded by the laboratory for improper preservation of sample; one of the sample bottles was acidified when it should not have been. Only parameters affected by this change were removed.



Source: HopeBay_1CT022.004_Chloride_Profile.xlsx

Figure 3-23: Chloride concentration versus depth

Note: Data from Lorax in 2024 was not available at the time of this analysis. The 2024 data in all zones is generally comparable to that of 2022 and 2023, with no significant variations in concentrations in 2024.



Source: HopeBay_MASTER_GWQ-DB_jm_ja_spb Rev16_pb.xlsx

Figure 3-24: TDS vs Chloride

Note: Data from Lorax in 2024 was not available at the time of this analysis. The 2024 data in all zones is generally comparable to that of 2022 and 2023, with no significant variations in concentrations in 2024.

3.9.3 Freezing Point Depression

Salinity lowers the freezing point of water through a process called freezing point depression. The particles of salt interfere with the water's ability to form a solid structure, requiring colder temperatures to freeze. The more salt present, the greater the freezing point depression. Freezing point depression is pertinent when considering the position at which groundwater inflow to a mine could occur, if the mine is advancing from frozen ground into a talik or occurring in the vicinity of a talik frozen-unfrozen boundary. Freezing point depression was calculated using equation (1).

(1) $\Delta T_f = i K_f m$

Where Tf , freezing point depression (ºC)
i, Van't Hoff factor (number of particles the solute dissociates into; for non-electrolytes, i = 1)
Kf, freezing point depression constant of the solvent (ºC.kg/mol)
m, molality of the solution (moles of solute per kilogram of solvent, mol/kg)

Theoretical freezing temperatures were calculated in Table 3-5 based on the 2010/2013 groundwater quality of 10WBW001, prior to mining. The results suggest groundwater freezes at a temperature of between -1°C to -2°C. A freezing point depression of -2°C was assumed for defining talik boundaries.

Table 3-5: Freezing point depression estimates

Parameter	Unit	10WBW001 Zone 1 (548 m)			10WBW001 Zone 6 (246 m)			10WBW001 Zone 10 (63 m)		
		2010/13	2022	2023	2010/13	2022	2023	2010/13	2022[1]	2023
Alkalinity	mg/L	2.0	14.4	15	44.2	260	289	49.7	(1)	229
Calcium	mg/L	4,960	4,400	4,750	749	298	335	1,010	26.9	26.7
Magnesium	mg/L	69.5	64	66.5	702	340	393	849	33.7	36
Potassium	mg/L	39	38.2	41.2	117	94.7	103	160	29.9	29.7
Sodium	mg/L	7,290	6,600	6,830	4,130	2,960	3,370	5,400	664	693
Chloride	mg/L	19,000	19,700	19,800	9,130	6,060	6,020	11,500	(1)	992
Sulphate	mg/L	981	964	476 (2)	940	403	440	1,160	(1)	85.9
Calculated Salinity	%	3.2	2.3 (L)	2.7	3.2	1.4	1.7	2.7	0.2	0.2
Freezing temperature (4)	ºC	-1.9			-0.9			-1.2		

Note: Data from Lorax in 2024 was not available at the time of this analysis. The 2024 data in all zones is generally comparable to that of 2022 and 2023, with no significant variations in concentrations in 2024.
Laboratory measurements affected by improper preservation were removed.
2. Significant variation between ICP-MS Sulfur and Sulfate (80% RPD), assumed to be a laboratory error in the measurement of sulphate.
3. Salinity calculated using linear regression developed in SRK 2022b: y = 0.0006x; with y = salinity in ppt and x the conductivity in µS/cm. 1 ppt = 0.1%.
L. Field conductivity is not available. lab conductivity is used instead. (2010-2013 Data uses mean conductivity - see Table 4-7).
4. Theoretical freezing point calculated based on the 2010/13 groundwater quality.

3.10 Permafrost Boundaries

3.10.1 Ground Temperatures

Ground temperatures have been measured with shallow and deep thermistors at Doris, Madrid and Boston.

At Doris (Figure 3-8, Appendix F):

- Thermistor 08TDD632 and 10WBW002 indicate the -2°C isotherm is between 361 and 366 masl (about 332 and 365 mbgs respectively). Both thermistors are located along the north shore of Doris Lake, which itself influences ground temperatures.
- Westbay well 10WBW001 confirms Doris Lake supports an open talik, with ground temperatures greater than -2°C.
- Thermistor HB-BCO-22-150 was installed from underground, in subpermafrost. It shows ground temperatures are greater than -2°C between 481 and 731 mbgs.

At Madrid (Figure 3-14, Appendix F):

- Thermistor 08PSD144 indicates -2°C isotherm is at 78 mbgs. It is shallow because equipment is located beneath an island centered within Patch Lake, and thus surrounded by heat from the lake.
- Thermistor 08PMD669 is instrumented in permafrost. Its maximum depth is 474 mbgs with temperatures remaining below -2°C.
- The lowermost thermistor sensor of TM00141 measures a ground temperature of -2.6°C at 225 mbgs, projecting a -2°C isotherm at about 346 mbgs. This installation is located between Patch Lake and Wolverine Lakes and influenced by their heat.

At Boston (Figure 3-16, Appendix F):

- At 08SBD382, 08SBD381A, and 10WBW004, the -2°C isotherm is respectively up to 115, 17, and 42 m from the shoreline of Aimakatalok Lake, at depths of 224, 202, and 209 mbgs. The offshore position of the -2°C isotherm cannot be explained by present-day lake configuration nor by lateral heat flow from the adjacent land. It is postulated that the permafrost beneath Aimakatalok Lake has been submerged by lake expansion.
- 08SBD380 and 97NOD176 are in permafrost, with temperature below -2°C down to depths of 241 mbgs and 247 mbgs respectively. The lowermost thermistor sensors indicate relatively cold permafrost temperatures (-5.1°C at 08SBD380 and -5.5°C at 97NOD176).

3.10.2 Regional Permafrost Model

Based on thermistor data, the active layer is generally less than 1 m thick, with the depth of zero annual amplitude around 10 m. The base of the permafrost (-2°C isotherm), away from lakes, is at approximately 447 mbgs. The vertical contacts between permafrost and open taliks are

located near lake shorelines, at distances driven by thermal dynamics. The boundary slopes outward and downward as it extends deeper, and permafrost begins to dominate. In cross-section, it takes generally the shape of a parabola with its concave side oriented vertically beneath the lake.

A one-dimensional (1D) steady state analytical thermal model (Appendix G) estimated the critical lake dimensions to sustain open taliks underneath water bodies.

The model estimated taliks would form under:

- Circular water bodies with a diameter greater than 224 m (radius >112 m); or
- Elongated water bodies with a width of at least 104 m (half-width >52 m); and
- Water bodies deeper than 1.3 m (two-thirds of the mean annual ice thickness).

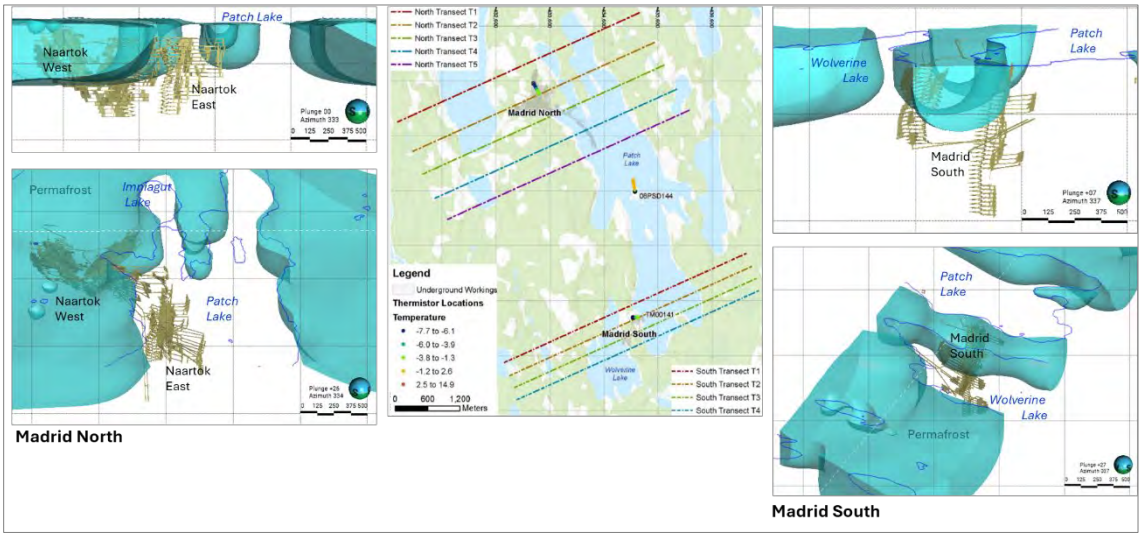
Figure 3-25 shows the potential open taliks in Doris and Madrid areas according to the above criteria. A default depth of 1.3 m was assumed where the bathymetry of lakes was unknown.

Figure 3-25: Potential open taliks in Doris and Madrid areas

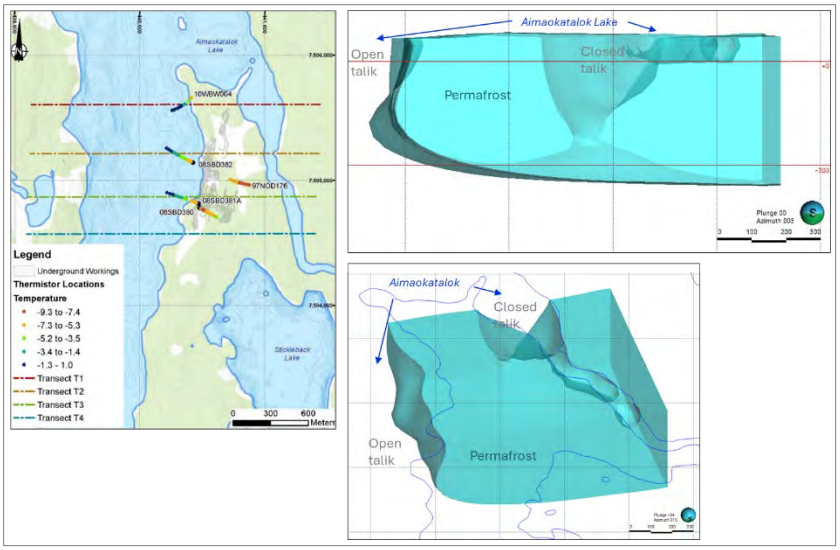
Source: fig_hopebay_potential_openTaliks.pptx

3.10.3 Local Permafrost Models

In 2017, local 3D configurations of the open taliks were estimated in Madrid and Boston areas using 2D thermal modeling (Appendix G) in zones where distances between lakes were small and heat from lakes potentially interfering. Figure 3-26 and Figure 3-27 illustrate the estimated permafrost local 3D-solids. Local 3D estimates were not made for the Doris area at the same time. Assumptions for the Doris area used in modeling are described in Section 6.3.3.



Source: fig_local_prmf_models.pptx



Source: fig_local_prmf_models.pptx

Figure 3-26: Madrid local permafrost model

3.11 Underground Inflow Data During Mine Operations

SRK reviewed the mine inflow rate and quality monitored during operations at Doris, and inflows at individual drillholes (i.e., drilling records, packer test or axial velocity measurements), recorded between Dec.2020 and Oct.2022, from discrete locations or specific intervals or fractures intercepted by developments (Appendix I).

The mine started observing groundwater inflows in January 2018, at an elevation of about -120 masl, when it reached the boundary between permafrost and the Doris Lake open talik; the boundary was approximately vertically below the Doris Lake shoreline when projected downward. The initial concentrations of chloride (22,500 mg/L) were higher than observed prior to mining (6,060 to 14,200 mg/L at -198 masl in 10WBW001 Zone 6). The total mine inflow (Figure 3-29) increased progressively as the mine was developed and peaked in January 2020 at about 2,800 m^3/day. Between 2020 and 2021 inflow rate plateaued at an average of 1,600 m^3/d, and then started decreasing in 2022 as a result of a grouting program.

Most groundwater inflows occurred primarily in the DCN area and originated from underground diamond drillholes (DDH), with flow rates typically within 10 to 50 m^3/d, and a very low percentage of individual DDH with up to 2,180 m^3/day (Figure 3-28). It is uncertain whether inflows from individual features (i.e., drillholes or fractures) decreased over time[(3)], which is a behaviour that would be expected for groundwater released from storage in the fractures rather than a direct connection with Doris Lake.

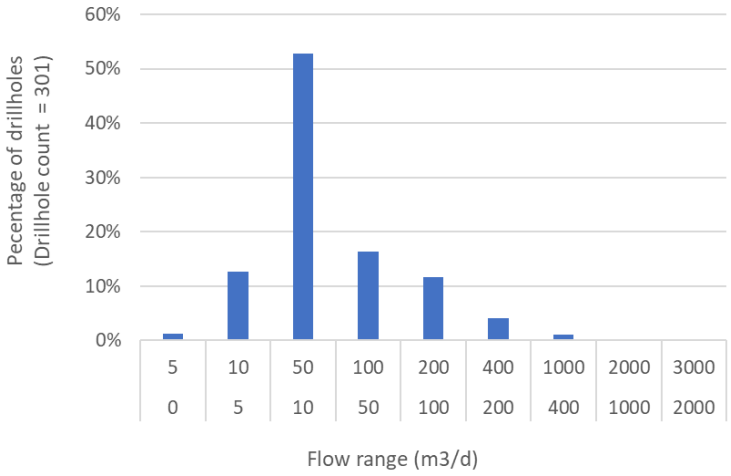
The Figure 3-29 compiles the time series of total mine inflow, chloride load, and chloride concentrations, and shows a cross-section of the Doris mine marked with numbers 1 to 8, corresponding to periodic increases in inflow or events. Overall, the inflows plateaued after the mine reached its lowest elevations, which suggests the overall increase in inflows was primarily driven by the increase of hydraulic gradient between the mine and Doris Lake, rather than interception of specific geological structures, or exploration drillholes.

Based on available information and communication with mine staff, the inferences on causes of the events identified in Figure 3-29 are discussed below:

1. In September 2018, mining at the 114 WLS area intercepted an un-grouted surface exploration hole (TM00083) connected to Doris Lake; the timing of this event is number 2 on Figure 3-29. The drillhole produced an inflow of about 3,650 m3/d and caused some flooding at the bottom part of the DCN decline (pers. Comm. Agnico Jan. 2023). Water was pumped to the North Ramp Sump and subsequently pumped out over time. The hole was plugged in Oct.2018. This event does not correlate with a particularly significant change in total water pumped from the mine, but did correlate with lower mine inflow chloride loads resulting from freshwater inputs.
2. The relationships between the inflow peaks numbered 3 to 8 and structures remain uncertain except at the contact with, or in proximity of, the diabase dyke, which has been frequently

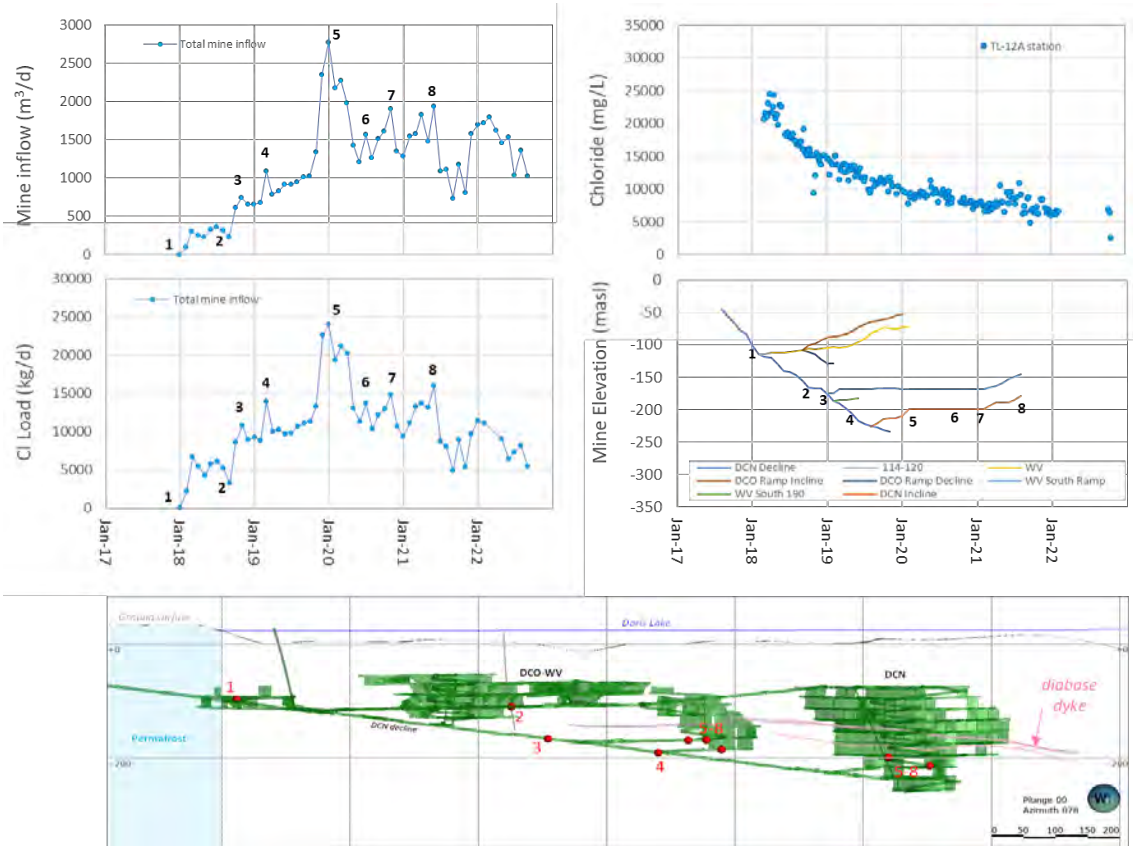
[3] TMAC did not maintain a master database of inflow records or groundwater quality from individual drillholes or fractures. The date and time of the measurements were generally not available, and dataset may contain duplicate records.

reported to produce water. Each peak corresponded to short-term temporary increases of both inflow and chloride, suggesting that the features causing these peaks have a limited storage and are connected with deep saline groundwater. None of these events were correlated with intersection of any specific drillholes.



Source: SRK 2022b

Figure 3-27: Distribution of flow observations from individual drillholes at the Doris mine

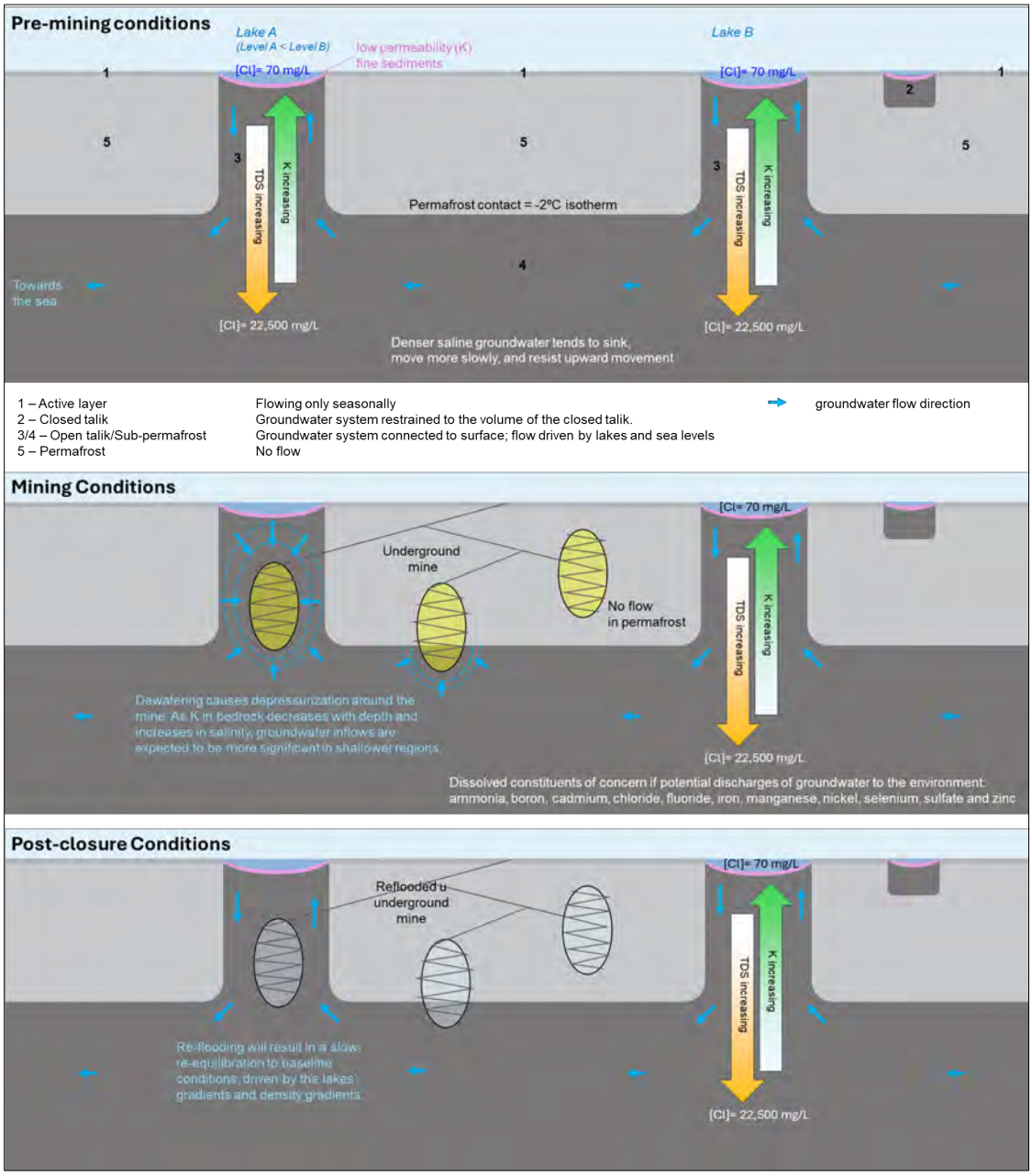


Source: HopeBay_MASTER_Comparison_MineWaterObs-2015Mdl_20221215

Figure 3-28: Mine water flow rates observed between 2017 and 2022

4 Conceptual Groundwater Model

Figure 4-1 illustrates the hydrogeological conceptual model.



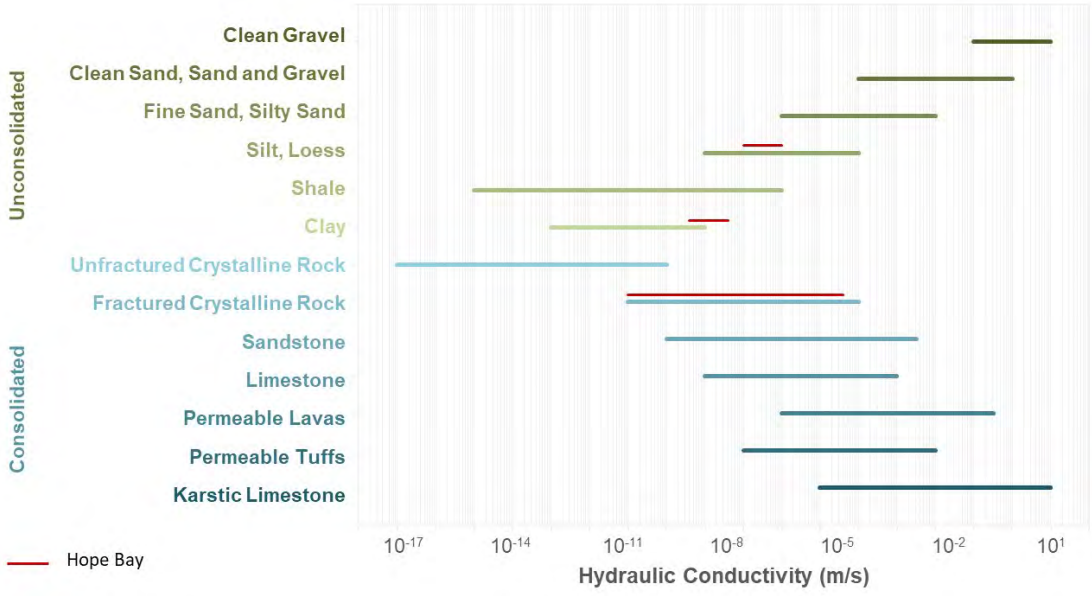
Source: fig_concept_model.pptx

Figure 4-1: Hydrogeological conceptual model

4.1 Baseline Conditions

The system is conceptualized as a low-flow, lake-dominated, confined flow system. The widespread, deep permafrost is essentially impermeable. Groundwater flow and connections between surface and deep bedrock groundwater systems occur exclusively in areas where lakes are associated with open taliks or in sub-permafrost zones. Groundwater systems in shallow active zones have no or minimal influences on inflows to underground mining areas compared to the deeper flow dynamics within the open talik surrounding the underground mine.

K measurements of the fractured rock and lake sediments fall within the bounds of published K values, as shown in Figure 4-2. Lake bottoms are draped with low K, fine sediments. At the small scale, bedrock K is fracture controlled. It consists of a low bulk K background intersected by distributed, potentially higher K fractures and geological structures. At the project scale, fractured rock is treated as a single unit, without differentiation between lithologies. This unit is characterized by relatively higher K at shallow depths, gradually decreasing with depth due to increasing confining pressure.



Source: Hydraulic conductivity ranges from Beale 2014.

Figure 4-2: Published K values Vs Hope Bay K measurements

Deep groundwater is connate, meaning ancient, or emplaced when sediments were originally deposited. Groundwater is brackish to saline, which is common in permafrost environments, and can have elevated concentrations of major ions and metals. The concentrations of calcium, chloride and sodium show a general trend of increasing concentration with depth; other constituents can also have relatively high concentrations, but do not correlate with depth. The dissolved constituents of concern, when looking at potential discharges of groundwater to the environment, are ammonia, boron, cadmium, chloride, fluoride, iron, manganese, nickel, selenium, sulfate and zinc.

Denser saline groundwater requires more energy to move. It tends to sink, move more slowly, and resist upward movement, while lighter freshwater flows more easily. This buoyancy effect can lead to stratification, greater resistance to downward vertical flow, and the formation of slow density-driven convection currents, where saline water sinks and freshwater rises.

As K decreases with depth, inflows are expected to be lower in deeper regions. Chloride concentrations will follow the flow patterns dictated by the hydraulic head and density variations, leading to higher concentrations at depth.

4.2 Mining Conditions

The dewatering activities during underground operations will alter groundwater flow gradients. Depressurization around parts of mines located within taliks or sub-permafrost will extend radially, drawing potential upward and lateral saline flow from the talik, and downward freshwater flow from the lakes above. The low permeability of the fine sediments present at the bottom of lakes will limit downward infiltrations. Table 4-1 lists percentages of mine volumes at the Doris and Madrid areas within and outside permafrost based on the modeled -2°C isotherm.

Table 4-1: Proposed Mine Volumes within and Outside Permafrost

Mine	Volume total	Volume within Permafrost		Volume outside Permafrost	
	m^3	m^3	%	m^3	%
Doris	2,900,000	1,460,000	50%	1,440,000	50%
Madrid	13,640,000	6,660,000	49%	6,980,000	51%

Density-driven flow is likely to slow, delay, and reduce the movement of saline water from depth into the mine. Brackish water at intermediate depths is expected to be mobilized more readily than saline brines at depth, since denser water remains more stagnant and does not mix as freely with fresher water.

Initially, the salinity of the mine inflows will reflect the saline conditions of the surrounding groundwater system. Over time, as the dewatering expands, more freshwater from shallower zones will be mobilized and inflows will become progressively less saline. As K in bedrock decreases with depth, groundwater inflows to the mine are expected to be more significant in shallower regions. Deeper regions, with lower K values, will contribute less water overall, limiting the influx of highly saline groundwater from depth.

While the mine may intercept geological structures or fractures, historical observations of inflow during the development of the Doris mine suggest they will have limited storage capacity and be more likely connected to deep saline groundwater rather than directly to the lakes above. At Doris specifically, the contacts with the diabase dykes are frequently reported to produce water and theorized to be associated with a more permeable contact zone. At Madrid, while no structures have been identified to promote high K, the eastern contact of the MDZ, which typically hosts brittle faults parallel to it, could be theoretically associated with potentially higher K features.

Placement of CRF backfill in the underground will have some influence on mine inflows. Influence is expected to depend on 1) the hydraulic properties of the fractured rock, 2) the type of backfill, and 3) the application methods. The bedrock K is typically low. At Doris, the average K in the top 100 mbgs is $9x10^{-8}$ m/s with some observations between $1x10^{-6}$ to 4×10^{-6} m/s; and at Madrid, it is $1x10^{-8}$ m/s with some observations between $1x10^{-7}$ to 1×10^{-6} m/s. Based on internal knowledge, the CRF backfill K is expected to be within or above the upper range of the shallow bedrock and therefore lead to a low to moderate reduction of inflow at shallow depth and no reduction at depth. In any case, voids left at the contact between backfill and underground walls could still constitute permeable flow pathways.

Effects of Heated Underground Mining

The heat circulated into the underground mines will generate a lateral thaw of the bedrock at some distance from the workings; this distance will be a function of the heated underground air temperature, the initial temperature of the bedrock at each depth, and the duration of time the heat source is applied.

Lateral thaw of permafrost from heated underground mining areas was estimated using a simplified one-dimensional analytical solution of temperature change for a given heat source and the bedrock thermal properties at the Project (SRK, 2017). Based on this analysis, the effects of underground heating on permafrost will be limited. The heat will increase the volume of unfrozen ground around the mines, but it will not generate new open taliks that connects the ground surface to subpermafrost.

The model assumed a constant heat source for the entire duration of mining operations and one-dimensional heat flow in the horizontal direction. Over time, the heat is transferred through the bedrock which contributes to thaw of the surrounding permafrost, with the rate of thaw decreasing with distance from the heat source. Figure 4-3 summarizes expected lateral thaw of the permafrost from underground areas heat over a 4, 12, and 17-year period. The initial bedrock temperatures of -8°C and -4°C represent reasonable end-member ground temperatures measured at the underground mining areas.

Figure 4-3: Lateral Permafrost Thaw from Heated Air in Underground Mining Areas

Heated Air Temperature (°C)	Initial Bedrock Temperature (°C)	Horizontal Thaw from Underground (m)		
		Year 4	Year 12	Year 17
10	-8	18	32	38
10	-4	28	47	57
5	-8	14	24	29
5	-4	23	40	48

Notes:
1. Horizontal thaw based on -2ºC isotherm, with a constant heat source
2. Initial bedrock temperature based on representative end-members measured at the Property

4.3 Closure Conditions

At Closure, dewatering activities will stop. Re-flooding will result in a slow re-equilibration to baseline conditions, driven by the lakes' gradients and density gradients. Some parts of mine workings may continue to act as preferential pathways and may redistribute saline water from deeper zones into shallower regions or adjacent fractured zones.

As water fills the mine, the heat will transfer to the surrounding permafrost and the underground areas will be expected to freeze-back where the minimum ground temperature is less than -2°C. It is possible that parts of the underground areas will not completely freeze back due to the large latent heat requirements combined with relatively warm permafrost temperatures at depth.

The groundwater contained in unfrozen mined out areas may have its quality modified by the backfill and/or tailings deposited underground. It will become part of the regional groundwater system, and travel though the open taliks via the deep groundwater system.

4.4 Post-Closure Conditions

At Post-closure, the groundwater system will have returned to the same conditions as baseline with local influences on flow and groundwater quality immediately around the mines.

5 Numerical Groundwater Model

5.1 Numerical Model Software

The groundwater numerical modeling was completed using FEFLOW 8.1 (DHI, Update 3, May 2024). FEFLOW is a professional software package for modeling fluid flow and transport of dissolved constituents and/or heat transport processes in the subsurface. This program is used extensively for groundwater mining projects around the world. The code is based on a finite element solution of the partial differential equations for flow and transport.

5.2 Numerical Model Assumptions

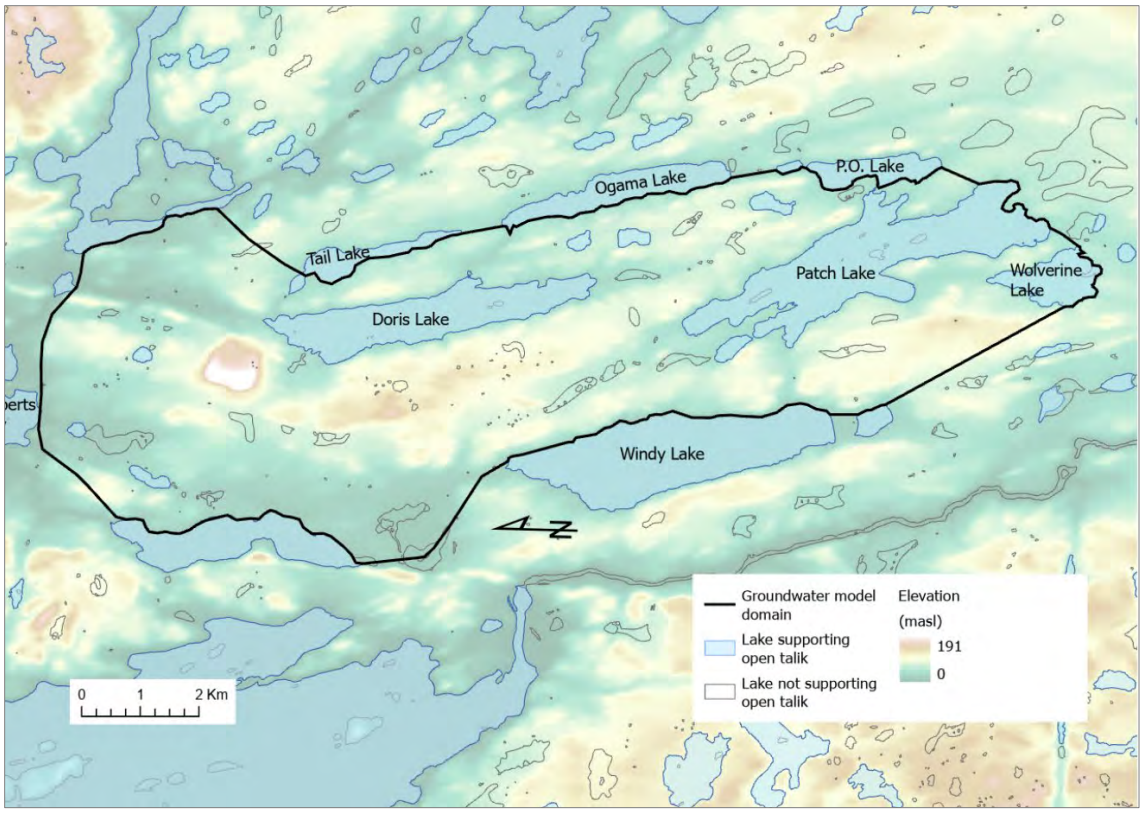
The numerical model assumptions are listed below:

- The media is saturated within a confined aquifer.
- The flow system is dependent on groundwater density.
- Bedrock is simulated as an equivalent porous media. Use of a fracture network model is not justified for a model of this scale and scope.
- The hydraulic conductivity fields within the respective units, overburden and fractured bedrock, are homogeneous and isotropic.
- Steady state or pseudo-steady states define the pre-mining initial conditions. Transient state provides forecasts of mine inflow rates and quality during operations and post-closure conditions.
- Groundwater flow and transport processes can be defined by Darcy's Law and advection-dispersion principles. Mass transport is modeled using chloride as a conservative tracer. The model does not simulate chemical reactions, attenuation processes, or biodegradation.
- The effects of temperature variations, gas migration, and multi-phase flow are not considered.

5.3 Numerical Model Setup

5.3.1 Domain

The model domain is shown on Figure 5-1 and is 71 km^2 (i.e., approximately 18 x 4 km). The upper surface of the model is defined by the topographical surfaces provided by Agnico, which were two high resolution topographical model focused on the Doris and Madrid areas and a topography covering the whole project. The lower surface of the groundwater model is a copy of the topographical surface set to a depth of 1510 mbgs (between -1542 and -1354 masl), approximately twice the depth below ground of the lowest stopes (approx. 690 mbgs).



Source: Hope_Bay_GW_2024.aprx

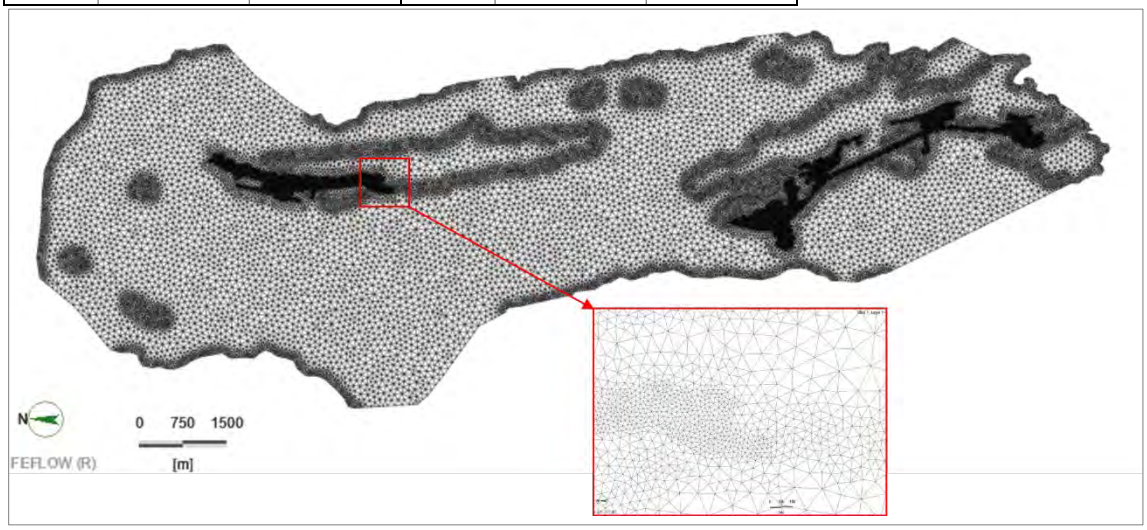
Figure 5-1: Numerical model domain

5.3.2 Mesh

The finite element mesh is shown on Figure 5-2 and has 32 structured layers with 24,312 nodes and 47,579 mesh elements per layer. Horizontally, the element sizes were optimized to obtain a local high resolution at, and immediately around, the Project and along lake edges, and a regional lower resolution near the external borders. The mesh elements are about 20 m wide at tunnels and stopes, and 30 m along lake edges. The regional mesh elements are on the order of 30 m wide along lake edges and 100 m in areas away from features of interest. Vertically, layer thickness increases progressively downwards (Table 5-1, Figure 5-2).

Table 5-1: Thicknesses of the model layers

Layer #	Top Elevation (masl)	Thickness (m)	Layer #	Top Elevation (masl)	Thickness (m)	Layer #	Top Elevation (masl)	Thickness (m)
1	-32 to 156	1	**12**	-262 to -74	40	**23**	-662 to -474	40
2	-33 to 155	3	**13**	-302 to -114	40	**24**	-702 to -514	40
3	-36 to 152	6	**14**	-342 to -154	40	**25**	-742 to -554	40
4	-42 to 146	10	**15**	-382 to -194	40	**26**	-782 to -594	40
5	-52 to 136	20	**16**	-422 to -234	40	**27**	-822 to -634	40
6	-72 to 116	30	**17**	-462 to -274	20	**28**	-862 to -674	80
7	-102 to 86	20	**18**	-482 to -294	20	**29**	-942 to -754	100
8	-122 to 66	20	**19**	-502 to -314	40	**30**	-1042 to -854	100
9	-142 to 46	40	**20**	-542 to -354	40	**31**	-1142 to -954	200
10	-182 to 6	40	**21**	-582 to -394	40	**32**	-1342 to -1154	200
11	-222 to -34	40	**22**	-622 to -434	40			



Source: fig_model_mesh.png

Figure 5-2: Model mesh

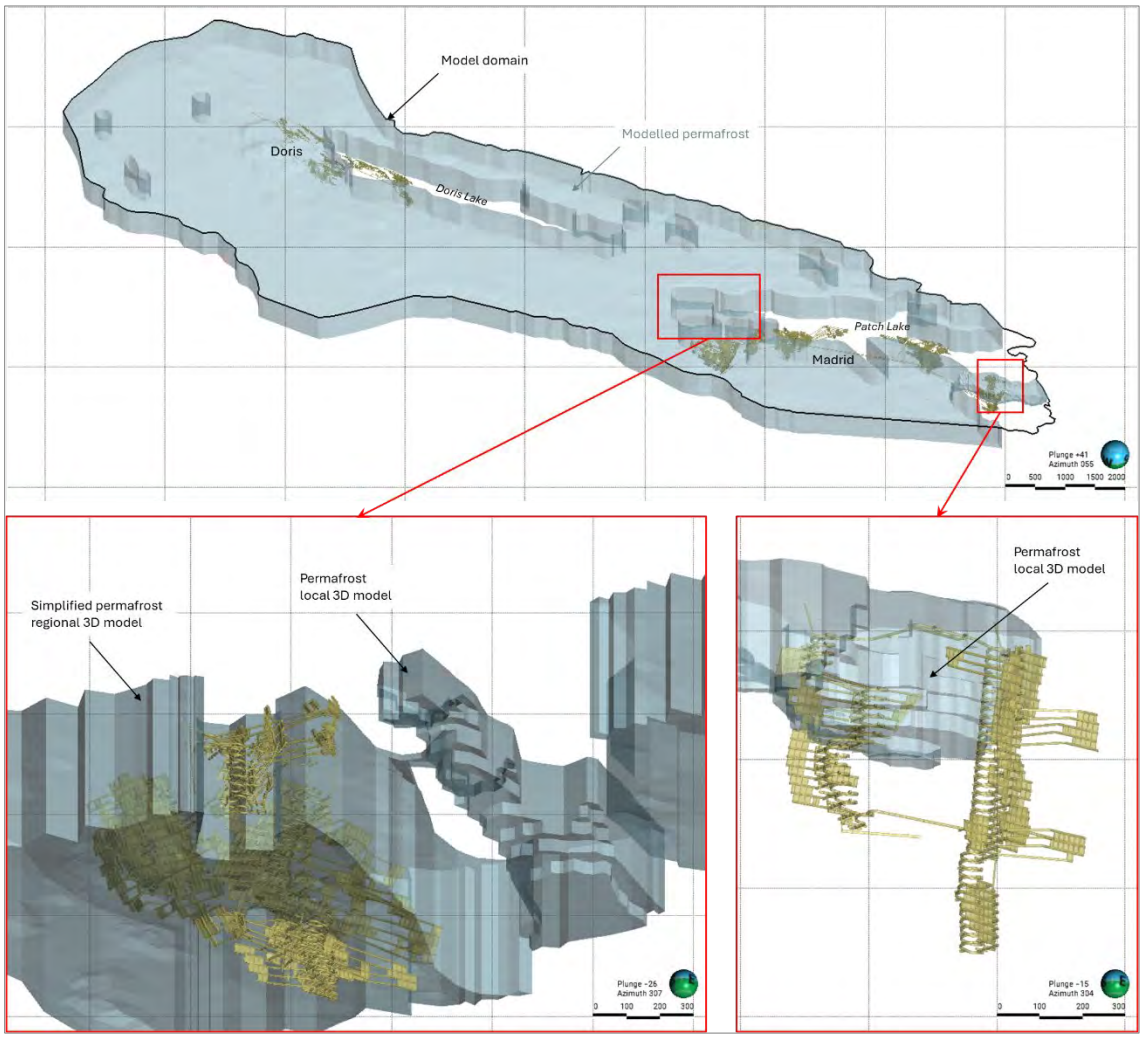
5.3.3 Permafrost

The permafrost is represented by a selection of elements that matches the 3D geometries of the regional and local permafrost models (Section 3.10.2 and 3.10.3). These elements are de-activated during simulations; no flow or transport happens through these elements.

A review of the updated mine plan against thermal data concluded the SRK 2017 3D permafrost models (See Section 3.10.3, Figure 3-26, and Appendix G) captured reasonably well the permafrost geometries in mine areas where ground temperatures are influenced by the heat from adjacent water bodies (i.e., Patch Lake and Imniagut Lake for Madrid North, and Patch Lake and Wolverine Lake for Madrid South). These were replicated in the groundwater numerical model.

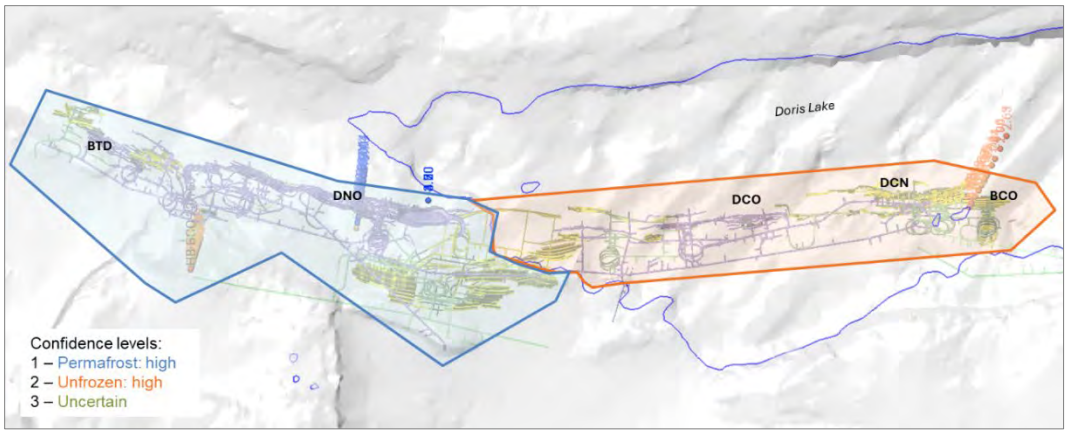
Elsewhere, the 3D geometry of permafrost was simplified: the boundaries between permafrost and open taliks were modeled as vertical and aligned with lake shorelines, while the sub-permafrost base was set at a depth of 450 mbgs.

The global permafrost model is illustrated in Figure 5-3. To evaluate how simplifications can affect inflow rate and quality predictions, mining zones were categorized into confidence levels related to potential interaction with permafrost (Figure 5-4, Figure 5-5, and Figure 5-6) and sensitivity scenarios defined to assess potential influence of model assumptions (Section 6.5). These simulations assessed a) the “uncertain” permafrost areas modeled as open taliks, b) a shallower permafrost base, and/or c) contacts with permafrost placed 100 m inland from the shoreline.



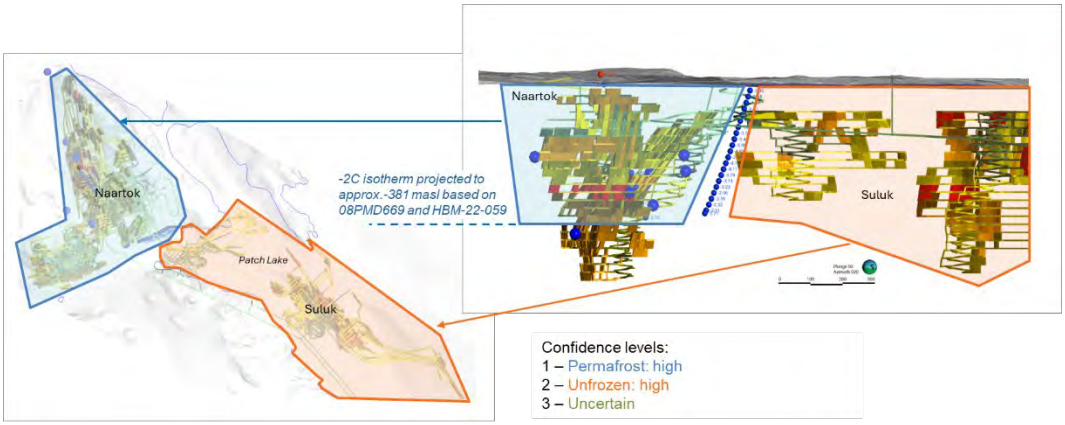
Source: fig_modelled_permafrost_rev1.pptx

Figure 5-3: Modelled permafrost



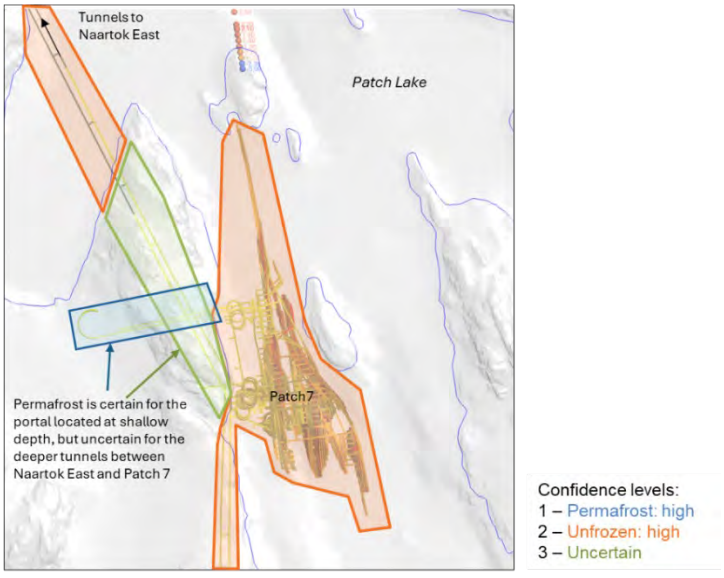
Source: fig_modelled_permafrost_rev1.pptx

Figure 5-4: Permafrost confidence levels at Doris



Source: fig_modelled_permafrost_rev1.pptx

Figure 5-5: Permafrost confidence levels at Madrid in the north area



Source: fig_modelled_permafrost_rev1.pptx

Figure 5-6: Permafrost confidence levels at Madrid in the central area

5.3.4 Boundary Conditions

Baseline Boundaries

- Constant head (i.e., Dirichlet) boundaries (Figure 5-7, Figure 5-8):
- Regional flow is simulated by applying constant head BCs to lakes supporting open taliks. Table 5-2 compiles the water elevations of the main water bodies.

Table 5-2: Average elevations of the lakes

Name	Water level (masl)	Name	Water level (masl)	Name	Water level (masl)
North border	0	Ogama Lake	23.1	Lake #9	42.7
Doris Lake	21.7	P.O. Lake	26.5	Lake #10	47.8
Tail Lake	28.2	Lake #1	20.2	Lake #11	11.4
Patch Lake	26.9	Lake #3	26.7	Lake #12	23.3
Imniagut Lake	28.0	Lake #6	6.3	Lake #14	41.2
Wolverine Lake	32.1	Lake #7	6.0	Lake #15	45.6
Windy Lake	19.0	Lake #8	10.8		

Mass transport:

- Transport of chloride is simulated by applying a constant mass BC of 69 mg/L on the footprints of lakes supporting open taliks, and on external borders constant mass BCs of 69 mg/L for slice 1 to 4, 300 mg/L for slice 3, 2,500 mg/L for slice 4, and 22,500 mg/L for slice 5 to 33.
- No flow (i.e., zero-flux) boundaries:
- All nodes at the top, bottom or external borders other than lakes supporting open taliks.

Mine Boundaries

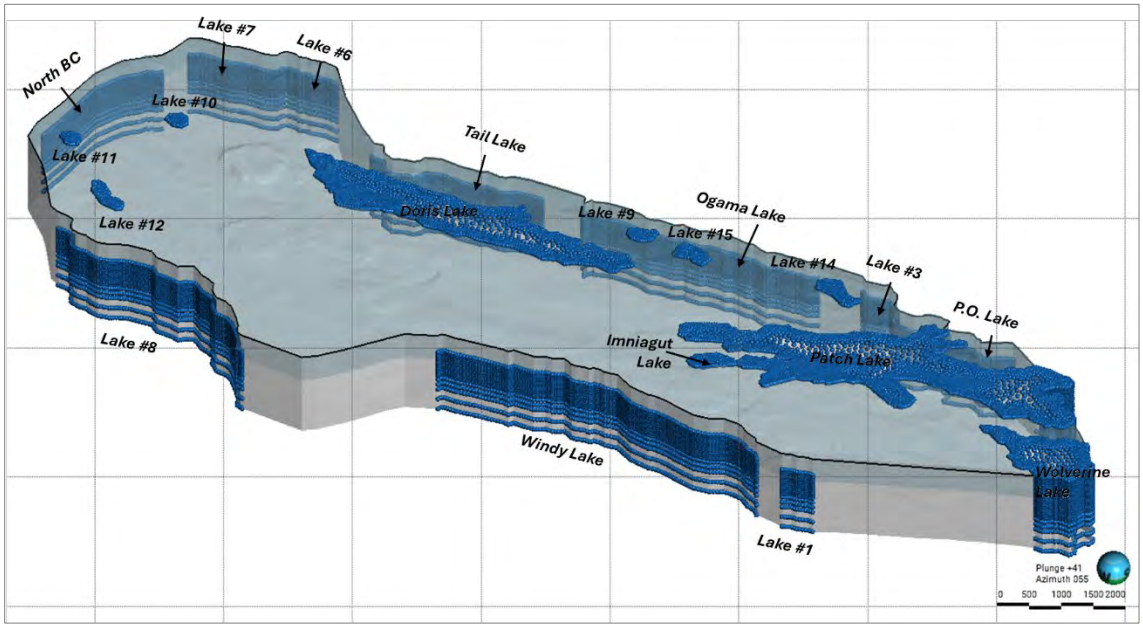
- Boundary conditions are the same as for the baseline model, except for the mining area itself:
- Seepage[4] (i.e., flux constrained Dirichlet) boundaries (Figure 5-9):
- The underground mines are represented by nodes aligned with the tunnels and stopes' 3D geometries that correspond to where water can enter the mine; this method allows for unconstrained flow into the mine where the mathematical solution determines it could occur, allowing assessment of potential impacts on groundwater levels and flow patterns without complex modeling of actual mine volumes.

[4] A seepage boundary is a constant head boundary with a flow constraint that only allows flow out of the model. This represents the fact that undergrounds are exclusively discharge locations.

Each seepage node is associated with a time schedule that matches the proposed progression of the mine. Figure 5-10 illustrates how the minimum elevations in each underground mine progresses over time.

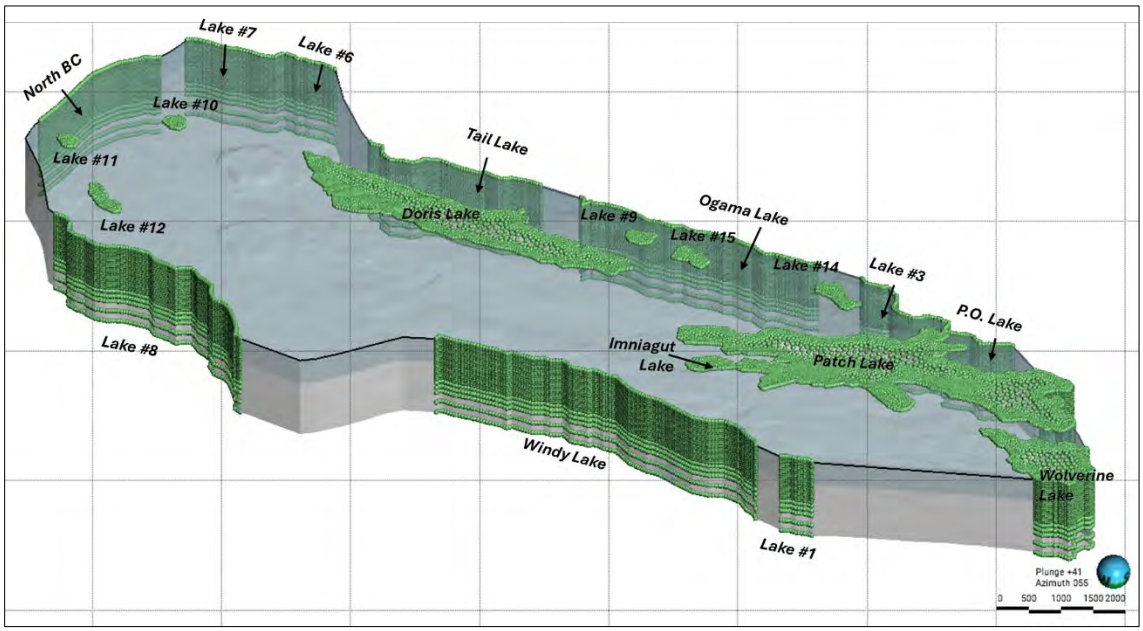
Post-closure Boundaries

At the EOM, the mining boundary conditions are turned off. Boundary conditions are the same as in baseline.



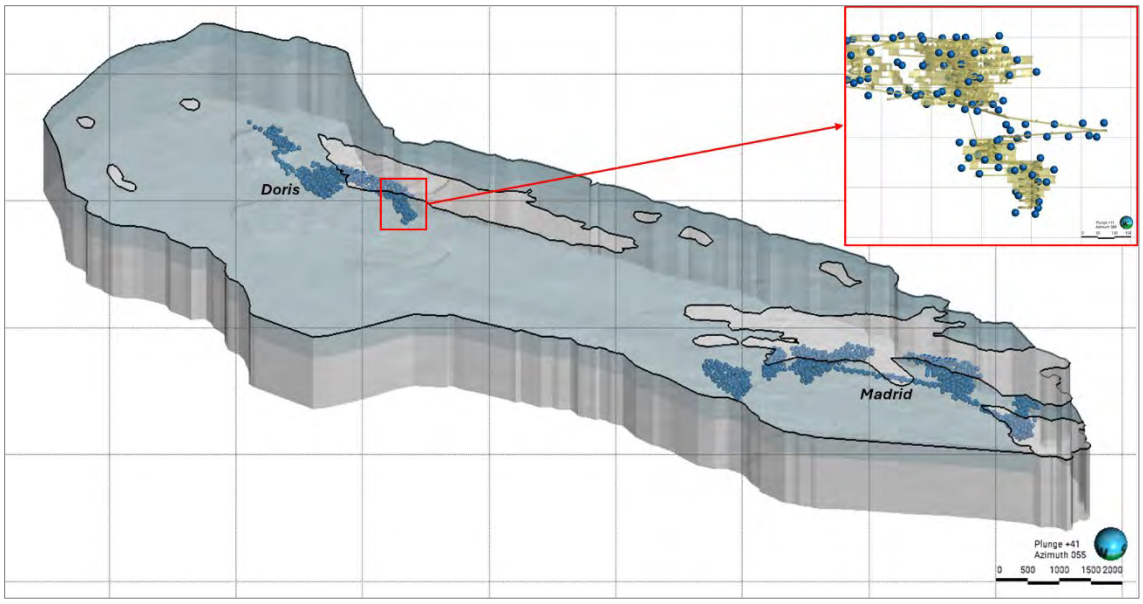
Source: fig_baseline_BC.pptx

Figure 5-7: Baseline head boundary conditions



Source: fig_baseline_BC.pptx

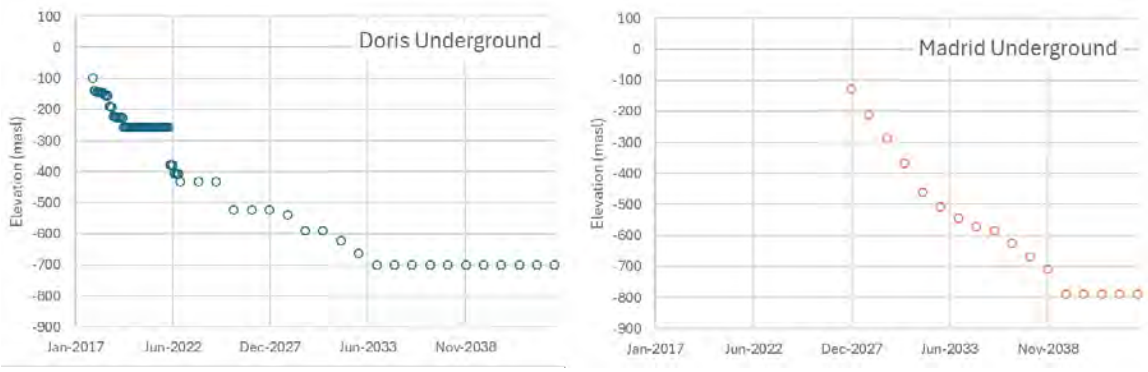
Figure 5-8: Baseline mass boundary conditions



Source: fig_mining_BC_rev1.pptx

Figure 5-9: Mining head boundary conditions

Note: Head boundary conditions assigned to lakes during mining conditions are the same as during baseline. They are hidden to distinguish the seepage nodes assigned to the underground mines.



Source: HB2024_1-ModelSetup_rev1.xlsx

Figure 5-10: Underground mines' bottom elevations versus time

Note: Nodes associated with both underground and permafrost are excluded from the plots.

5.3.5 Water Density

The model was set with a single, uniform density ratio value based on the maximum and minimum densities observed at the Project. This approach simplified the model setup but does not account for local density variability due to infiltration from relatively lower density freshwater lakes. Such infiltration is suspected to occur but not well characterized by monitoring data.

5.3.6 Initial Flow and Mass Conditions

The initial flow field was defined based on steady-state flow predictions under baseline conditions.

The initial mass was set to pseudo-steady state predictions under baseline conditions, with a simulation time of 1,000 years.

5.4 Numerical Model Calibration

5.4.1 Approach

The primary objective of the model is to simulate the hydrogeological behavior of the system under mining conditions, including water inflow rates and solute transport. These outputs will be used to guide mine water management, inform environmental impact assessments, and regulatory compliance.

The model calibration prioritized the mine inflow rates, and chloride concentrations observed during the 7-years of underground operations at Doris over pre-mining conditions. The pre-mining data, while valuable for the conceptual model, is inherently uncertain, while operational data reflect the response of the groundwater system to the large stress imposed by mining activities. Calibrating the model to replicate operational data ensures that the model is fit-for-purpose and enables reliable predictions for ongoing and future mine development scenarios.

The permafrost environment, salinity, and low-permeability fractured bedrock present significant challenges for data collection and interpretation. These complexities exacerbate the uncertainties in pre-mining data, particularly with respect to groundwater flow dynamics and solute distribution. The pre-mining groundwater pressures converted to absolute elevations are uncertain due to assumptions about water density, and the fact that chloride concentrations were significantly greater when the Doris mine intercepted the open talik suggest a limitation in capturing true hydrogeological conditions before operations. Even with its limitations, this data provided a valuable understanding of groundwater pressures, flow patterns, and baseline chloride concentrations, and established a starting point for interpreting deviations observed during mining operations.

5.4.2 Transient Calibration

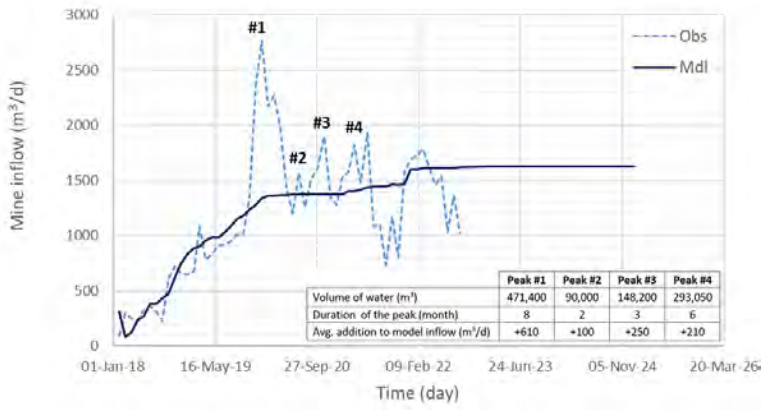
The transient calibration was an iterative process that consisted of varying the hydraulic conductivity profiles to match the transient observations of mine inflows and chloride concentration ([Cl]) recorded between 2018 and 2024 (i.e., year 2017 was not included because the mine was in permafrost and not yet intercepted inflows). The quality of calibration was rated visually by comparing observed and modelled inflow rates and [Cl].

Initially, the model was configured with two hydraulic conductivity profiles (Figure 5-13) defined using K geomeans and expert judgment. One profile was assigned to the Doris area based on the Doris K dataset, and the other to the Madrid area using the Madrid K dataset. A transition zone of approximately 2 km allowed for a gradual shift in hydraulic conductivities between the two areas. During calibration, adjustments to hydraulic properties were applied uniformly across the entire model.

Figure 5-11 and Figure 5-12 show calibration results. The results were considered reliable for predicting the average mine inflows and long-term chloride trends but limited in resolving short-term variabilities.

The model replicated well the general trend of increasing and stabilizing mine inflows but not the sharp peaks and variabilities. These are interpreted as temporary increases caused by local interception of structural bedrock features with limited storage capacity, leading to temporary inflow events. The model does not attempt to replicate the discrete fracture network, focusing instead on capturing the overall trend of mine inflows, but the comparison between the global average trend and the observed peaks provides insights into the potential additional volumes of inflow that may be intercepted occasionally and temporarily by the future developments. The analysis of water volumes associated with peaks shows additional contributions to the overall model inflows could range between 100 to 610 m^3/d for a period of 2 to 8 months.

The model replicated well the overall declining trend of chloride concentrations which reflects the gradual dilution of chloride in mine inflows over time. The model did not reproduce the short-term fluctuations, which may be due to episodic factors such as localized inflow with higher or lower salinity, changes in hydraulic connectivity, or interception of distinct water-bearing zones.



Source: HB2024_2-ModelResultsCalib.xlsx

Figure 5-11: Modelled versus observed underground inflow rates

Source: HB2024_2-ModelResultsCalib.xlsx

Figure 5-12: Modelled versus observed chloride concentration of underground inflows

5.4.3 Calibrated Properties

Table 5-3 compiles the properties of the calibrated numerical model. Figure 5-14 shows the modelled calibrated file of hydraulic conductivities. All the parameters fall within the range of the field observations and, if not measured, within the range of literature values.

Table 5-3: Groundwater model properties

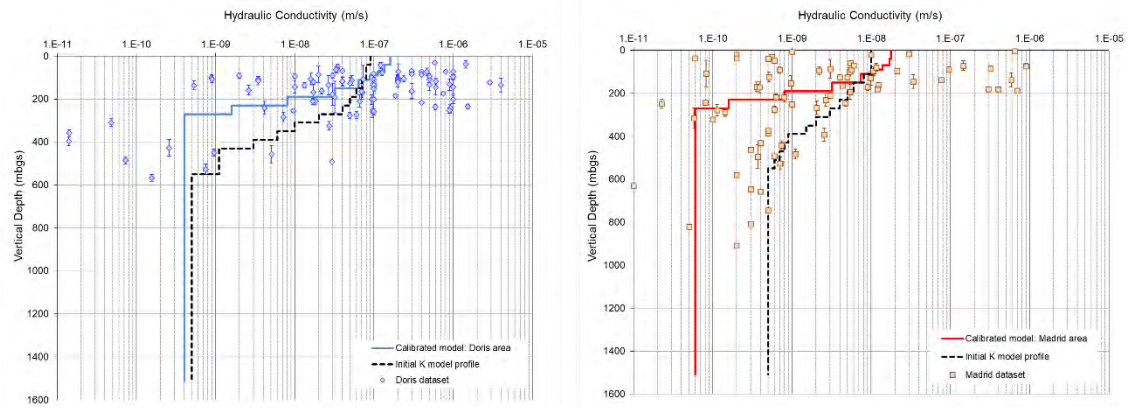
Unit	K_{xyz} (m/s)	S_x [1] (-)	Porosity (-)	Density ratio (-)
Lake sediments [layer 1 to 4]	$1x10^{-8}$	$1.0x10^{-5}$	0.2	0
Fractured bedrock [layer 1 to 32]	*See Figure 5-13*	$3.0x10^{-7}$	0.03	$8.1418x10^{-3}$

Note:

The modelled thickness of lake sediments (Figure 5-15) vary between 0.5 and 20 mbgs, with shallow thickness at the edges, and a gradual decrease towards the center of the lakes.

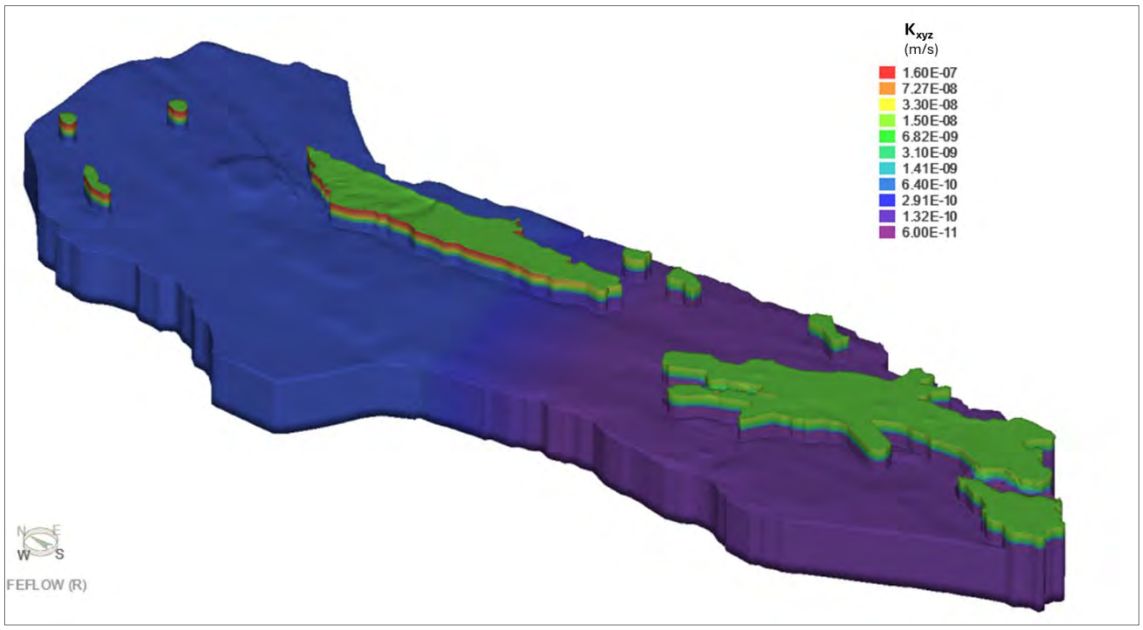
1 Storativity (or specific storage), influences the "drainability" of surficial material. There are no site-specific overburden storativity value measurements. A value of $1x10^{-5}$ m^{-1} was assumed based on scientific literature (Singhal and Gupta, 2010).

Density ratio estimates based on minimum density calculated for a chloride concentration of 69 mg/L and a maximum chloride concentration of 22,056 mg/L.



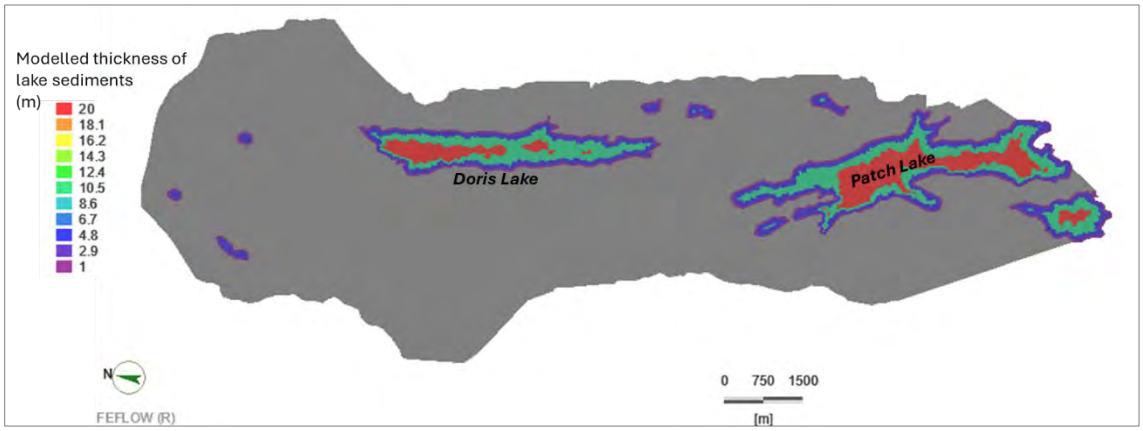
Source: HopeBay_MASTER_HydrProperties_gf_20250120.xlsx

Figure 5-13: Calibrated K versus observed



Source: fig_model_K_rev1.pptx

Figure 5-14: Modelled calibrated K



Source: fig_model_thickn_sedimLakes.pptx

Figure 5-15: Modelled thicknesses of lake sediments

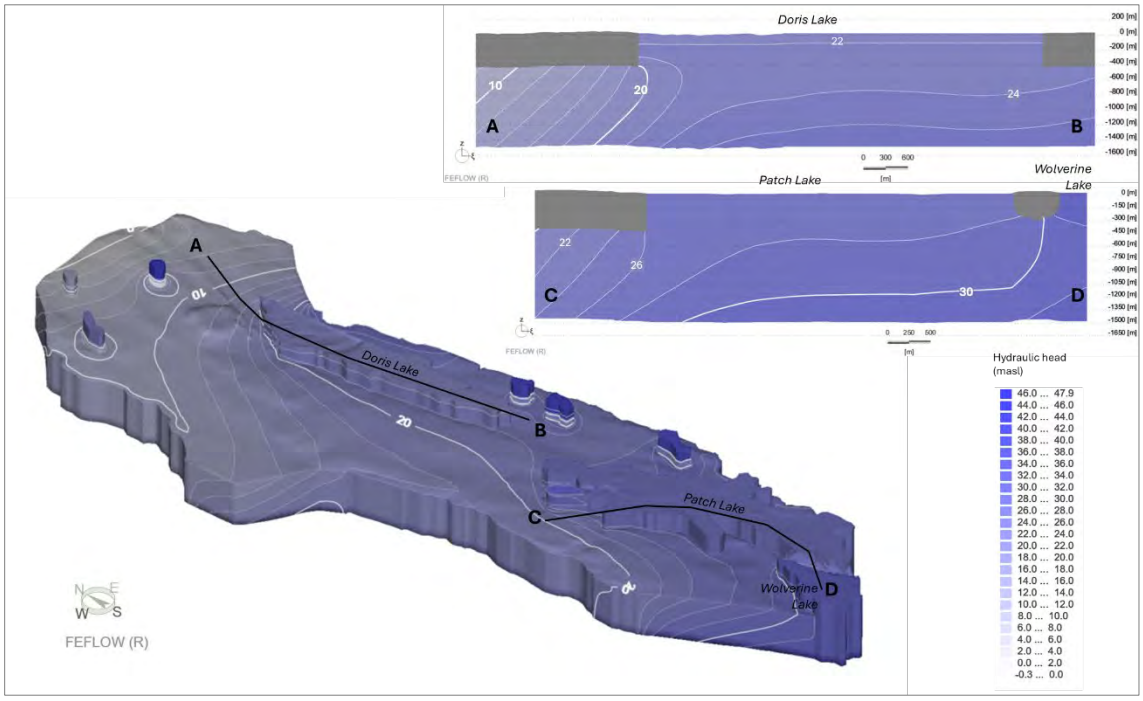
6 Numerical Model Results

The base case modeling scenario consists of a single model run, set to the calibrated properties presented in Section 5.4.3 and simulating the full mining development schedule, from 2018 to 2043, and a 500-year post-closure period. The permafrost model corresponds to the model illustrated in Figure 5-3, with the mining areas rated with an “uncertain” permafrost confidence levels simulated as frozen. The predictions were used to estimate the average annual mine inflows and support the evaluation of Project’s potential impacts on the environment. Particle tracking was used to estimate the flow paths of contact water and their potential discharge points and contribution to lakes.

Section 6 will present alternative scenarios with the most conservative permafrost settings and parameter variabilities.

6.1 Baseline Conditions

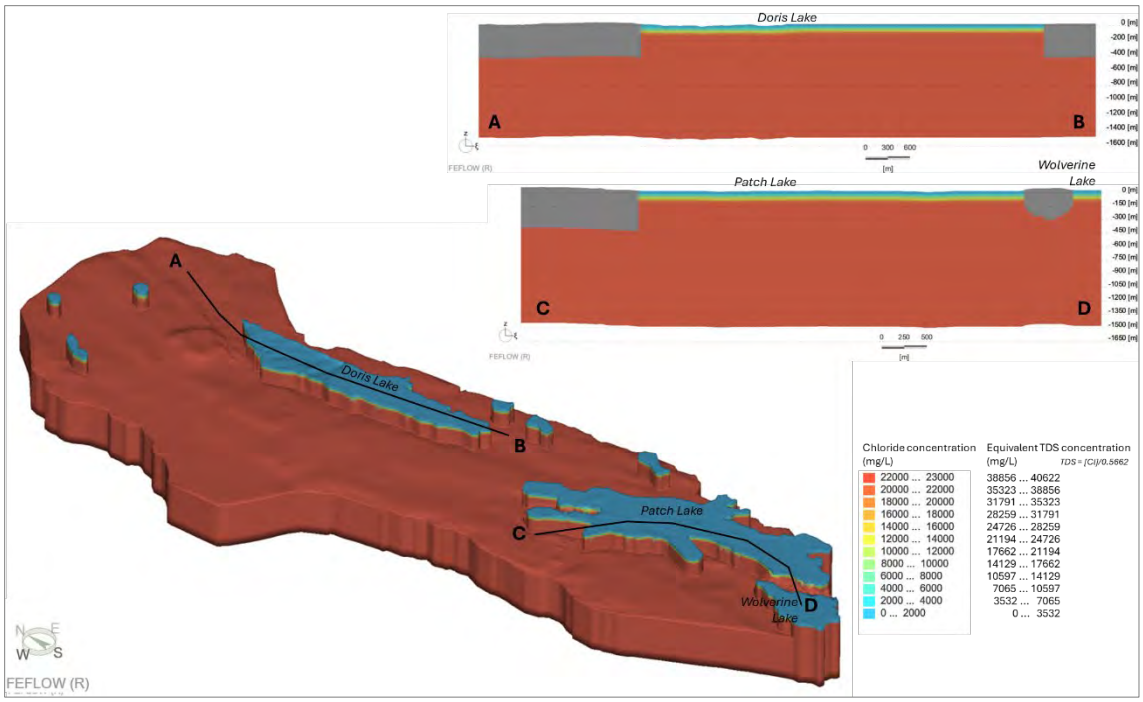
Figure 6-1 and Figure 6-2 present the modelled hydraulic heads and chloride concentrations for baseline conditions. Groundwater flow and mass balances were good (<0.1% and 0.9% respectively), and the predictions consistent with the groundwater conceptual model. Modelled groundwater flows from the south to the north, towards the coast, at a slow rate (Table 6-1). The chloride concentration in groundwater is increasing with depth as shown in the vertical profile (Figure 6-3).



Source: fig_mdl_baseline_head_rev1.pptx, HB2024_3DgwMdl_03-00_rev2_[InitHeadMass]_trsnt1000yr.dac

Figure 6-1: Modelled groundwater heads for baseline conditions

Note: Permafrost elements are not shown in the 3D view.



Source: fig_mdl_baseline_mass_rev1.pptx, HB2024_3DgwMdl_03-00_rev2_[InitHeadMass]_trsnt1000yr.dac

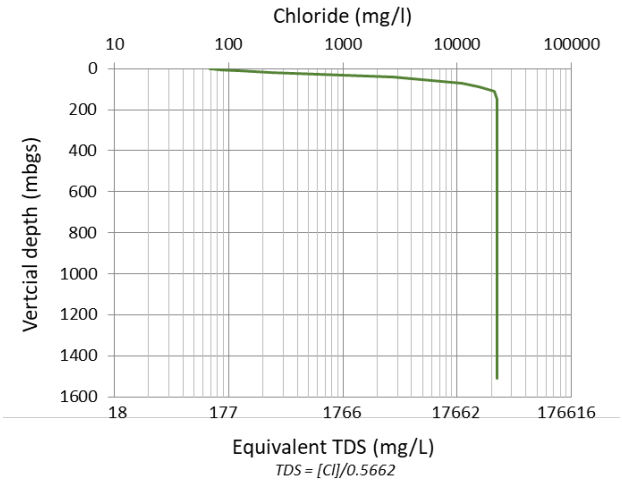
Figure 6-2: Modelled chloride concentrations for baseline conditions

Note: Permafrost elements are not shown in the 3D view.

Table 6-1: Predicted flow rates for baseline conditions

Name	**Outflow Rate** (*Discharge*) (m^3/d)	**Inflow Rate** (*Infiltration*) (m^3/d)	**Name**	**Outflow Rate** (*Discharge*) (m^3/d)	**Inflow Rate** (*Infiltration*) (m^3/d)
Model domain	4.3	4.3	Lake #1	<0.1	<0.1
North border	0.8	<0.1	Lake #3	<0.1	<0.1
Doris Lake	0.3	0.8	Lake #6	0.2	<0.1
Imniagut Lake	0.0	0.2	Lake #7	0.2	<0.1
Patch Lake	0.8	0.9	Lake #8	0.7	0.1
P.O. Lake	<0.1	<0.1	Lake #9	0.0	<0.1
Ogama Lake	0.3	<0.1	Lake #10	0.0	0.3
Tail Lake	<0.1	0.8	Lake #11	0.0	<0.1
Wolverine Lake	0.5	0.5	Lake #12	0.0	0.2
Windy Lake	0.4	<0.1	Lake #14	0.0	<0.1
			Lake #15	0	0.1

Source: HB2024_3DgwMdl_03-00_rev2_[InitHeadMass]_trsnt1000yr.fem

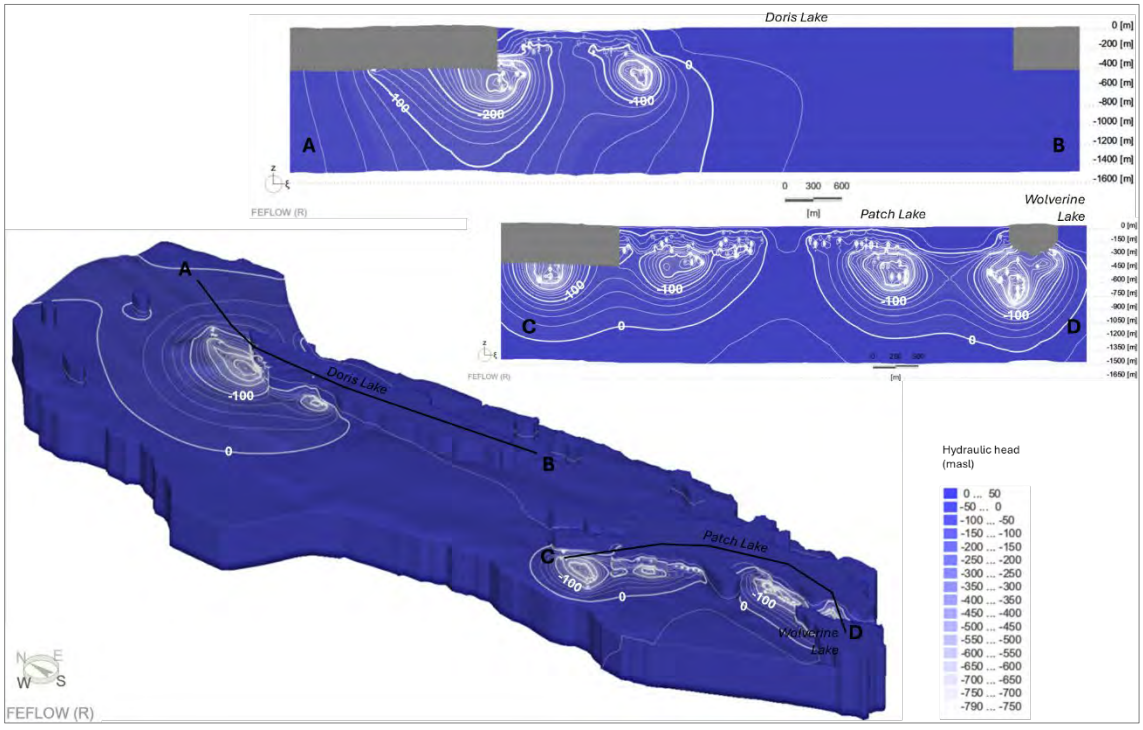


Source: HB2024_2-ModelResultsCalib.xlsx

Figure 6-3: Modelled vertical profile of chloride concentrations for baseline conditions

6.2 Mining Conditions

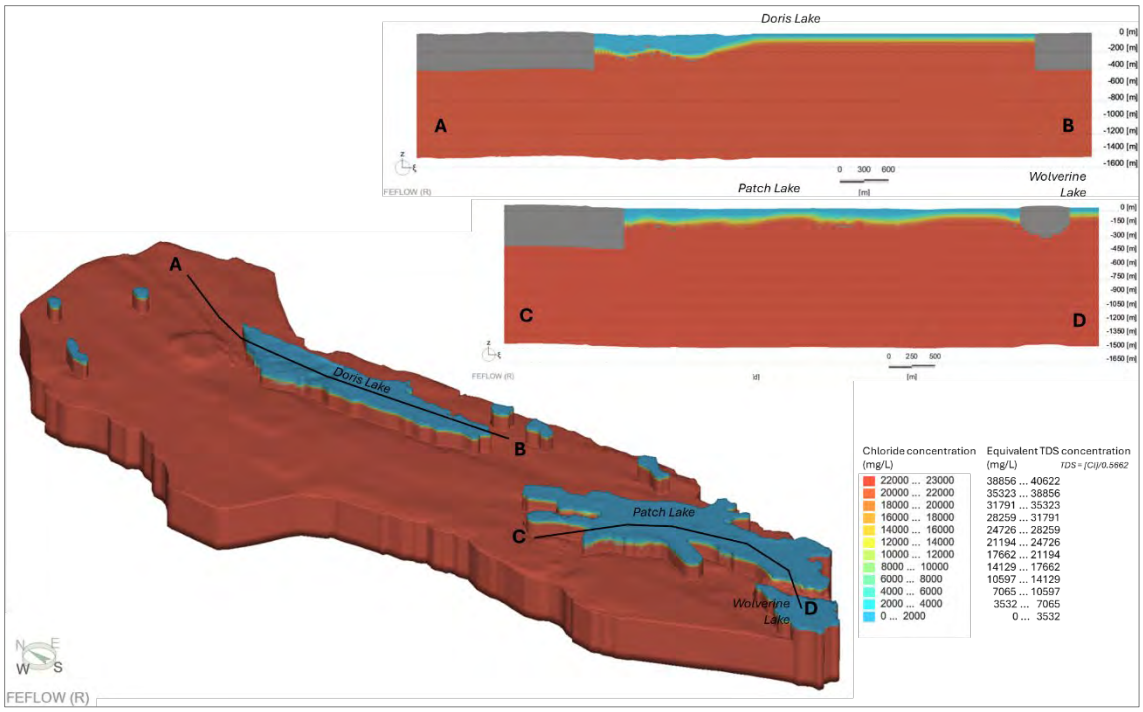
Figure 6-4 and Figure 6-5 show the modelled hydraulic heads and chloride concentrations at the end of mine (i.e., end of year 2043). Groundwater flow and mass balance of the simulation were reasonable; flow imbalance <0.1% and mass <10% until mid-2020, then 10 to 15% except for the period 2024-2029 between 16 and 23% and 2044-2046 between 16 and 17%. Some oscillations occurred at distance from the mine dewatering areas, but predictions remained stable.



Source: fig_mdl_eom_head_rev1.pptx, HB2024_3DgwMdl_04-01m_rev3_histFutrMng_[03-27m_rev1]_trsnt.dac

Figure 6-4: Modelled groundwater heads at end of mine

Note: Permafrost elements are not shown in the 3D view.



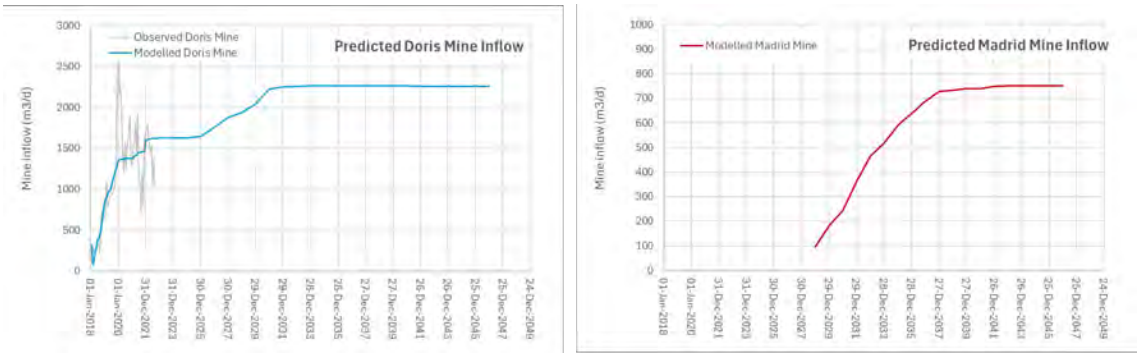
Source: fig_mdl_eom_head_rev1.pptx, HB2024_3DgwMdl_04-01m_rev3_histFutrMng_[03-27m_rev1]_trsnt.dac

Figure 6-5: Modelled chloride concentrations at end of mine

Note: Permafrost elements are not shown in the 3D view.

6.2.1 Mine Inflows

Figure 6-6 plots the modelled average inflow rates during operations. The model forecasts a maximum inflow of 2,260 m^3/d in 2031 at Doris, and 750 m^3/d in 2039 at Madrid. As discussed in Section 5.4.1, the model captures the overall trend of mine inflows and not suitable to predict temporary inflow events from discrete structures. Based on history of inflows at Doris, additional inflows between 100 m^3/d to 600 m^3/d could occur for periods of 2 to 8 months.



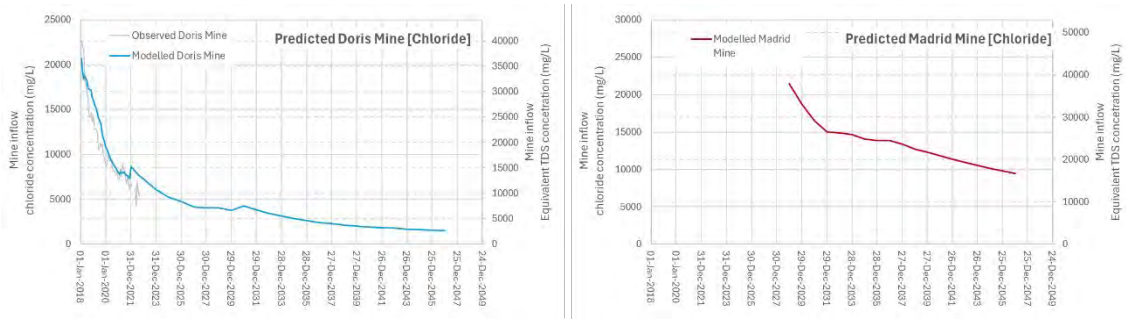
Source: HB2024_3-ModelResultsPredictions_04-01m_rev3.xlsx

Figure 6-6: Modelled mine inflows during operations

6.2.2 Mine Inflow Quality

Figure 6-7 plots the modelled chloride concentrations during operations. The model forecasts a progressive dilution of the chloride concentration with freshwater infiltration from the lakes. At

end of mining, chloride concentrations are lowered to about 1,500 mg/L at Doris, and 9,500 mg/L at Madrid (i.e., equivalent TDS concentrations of 2,650 and 16,780 mg/L respectively).

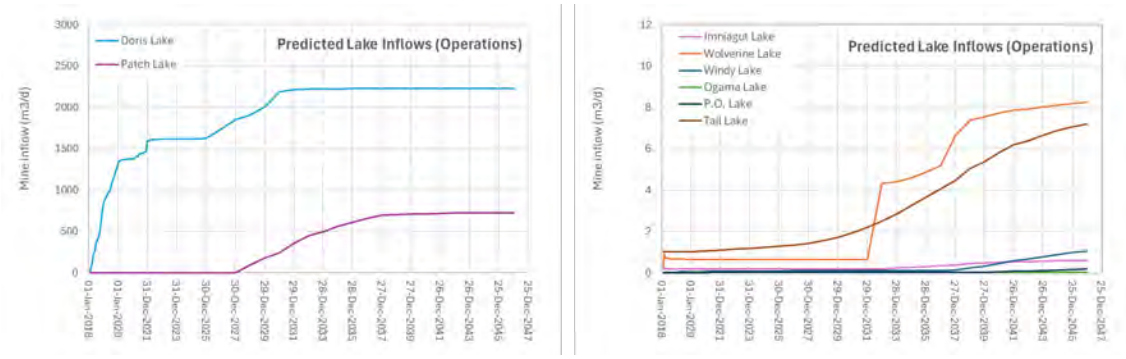


Source: HB2024_3-ModelResultsPredictions_04-01m_rev3.xlsx

Figure 6-7: Modelled chloride concentrations during operations

6.2.3 Lake Infiltrations

Figure 6-8 plots the modelled infiltration rates from the main lakes. The model forecasts a progressive increase of freshwater infiltration from the lakes over time. Changes to lake infiltration are greater for the lakes located directly above the mines: Doris Lake, Patch Lake, and Wolverine Lake.



Source: HB2024_3-ModelResultsPredictions_04-01m_rev3.xlsx

Figure 6-8: Modelled lake infiltration during operations

6.3 Closure Conditions

Mine Reflood Time Estimation

At Closure, mine dewatering will be deactivated and the mine areas allowed to flood. The duration of the reflood period will be a function of inflow rate, the volume of the mine void and equilibration of pressures to a state similar to pre-mining conditions in the surrounding rock mass. Time to re-flood incorporating the mine void were estimated using an exponential decay function, the predicted mine inflow rates, and the void volumes of the mine workings including backfill; equation (2):

(2) $\Delta h_r(t) = \Delta h_{eom}\, e^{-t\frac{Q_{eom}}{V_{mine}}}$

Where $\Delta h_r(t)$, final reflood time to the reflood level (calculation in days, then converted to years)
Δh_{eom}, drawdown at end of mining (maximum mine depth; meters)
Q_{eom}, inflow rate at the end of mining (m^3/d)
V_{mine}, effective mine volume to reflood (total void minus backfill; m^3)
t, time since end of dewatering (days)

Effective volume of the mine at the end of operations (V_{mine}) was estimated based on the proposed mine plan and backfill volumes. Mine volumes were estimated from annual mine plans using MineSight 3D and Rhino 3D. Backfill volumetric quantities were based on the LOM plan assuming a bulk density of 1,990 kg/m^3. Estimated volumes rounded to the nearest 1,000 m^3 are listed in Table 6-2.

Table 6-2: Mine volumes used for reflood estimates

Component	Unit	Doris	Madrid
Total Mine Void	m^3	2,824,000	13,973,000
Backfill Volume	m^3	1,671,000	9,325,000
Unfilled Volume	m^3	1,153,000	4,648,000
Unfilled Volume	% of Total	41%	33%

Source: CAPR003296_DorisMadrid-reflood_calculations_REV01.xlsx

Table 6-3 compiles the input parameters and reflood time estimations for the proposed mine areas based on Base Case calibrated model. The significant difference in reflood time between the Doris and Madrid areas reflects the significantly larger open mine volume at Madrid, combined with significantly lower inflow rate compared to Doris.

Table 6-3: Base Case reflood time estimations

Parameters	Unit	Doris	Madrid
V_{mine}	m^3	1,153,000	4,648,000
Δh_r[1]	mbgs	50	30
Δh_{eom}	mbgs	680	635
(Q_{eom})	m^3/d	2,260	750
t_1 reflood	year	4	52

Source: CAPR003296_DorisMadrid-reflood_calculations_REV01.xlsx

Note:
[1] Reflood level defined as top of mine void, thus values reflect crown pillar thickness below lake level.

6.4 Post-Closure Conditions

Final Receptors

Once the mine voids are reflooded and groundwater conditions have re-equilibrated, the groundwater flow system will return to a state similar to pre-mining conditions. Water in contact with mine areas will move in a down gradient direction.

At Doris, the model forecasts groundwater will flow towards Doris Lake, towards lake #8 to the west, and towards Roberts Bay to the north. At Madrid, the model forecasts groundwater will flow towards Patch Lake, as well as westwards towards Windy Lake and Wolverine Lake. While flow directions are towards lakes, the travel times are very long. Assuming parameters used in the Base Case calibrated model, no particles are predicted to have reached these lakes after 1,000 years.

6.5 Sensitivity to Model Parameters

Additional scenarios were completed to assess the effects of parameter uncertainties on the calibration and forecasts of mine inflow, mine water quality, lake infiltrations, and reflood period at Closure. The goal was to evaluate the impact of key parameters, providing a basis for understanding the robustness and limitations of the groundwater flow model under different conditions. This information is important for decision-making and model refinement, ensuring the model accurately represents the hydrogeological system.

6.5.1 Sensitivity Scenarios

Sensitivity scenarios are listed below by category:

Permafrost Model (P)

- P1: The depth of the sub-permafrost is raised by about 90 m.
- P2: The depth of the sub-permafrost is raised by about 180 m.
- P3: Mining zones where permafrost has been rated as "uncertain" are assumed part of the open taliks (unfrozen).
- P4: The permafrost model is modified to place the contacts between permafrost and open taliks approximately 100 m inland from shorelines.

Permeable Structures (S)

- S: Hypothetical permeable ($K=1x10^{-6}$ m/s) geological structures, approximately five-metre-thick, intercept the Doris and Madrid mines (Figure 6-9). At Doris, the structure is hypothesised to match the upper diabase dyke. At Madrid, the structure is hypothesised to match the MDZ eastern wall.

Hydraulic Conductivities (K)

- K1: Hydraulic conductivity is increased by one order of magnitude in the overburden unit (K_{ovb} = 1x10^{-7} m/s).
- K2: Hydraulic conductivity is decreased by one order of magnitude in the overburden unit (K_{ovb} = 1x10^{-9} m/s).
- K3: Hydraulic conductivity is increased globally by one order of magnitude in bedrock.
- K4: The contrast of hydraulic conductivity between the upper and lower bedrock is increased by 50% (Figure 6-10).
- K5: The contrast of hydraulic conductivity between upper and lower bedrock is decreased by 50% (Figure 6-11).
- K6: The hydraulic conductivity profile is cutoff with a low value of 1x10^{-9} m/s (i.e., typical limit of testing equipment, Figure 6-12).
- K7: The hydraulic conductivity profile applied at Doris is applied to Madrid.

Storage Compressibility (Sx)

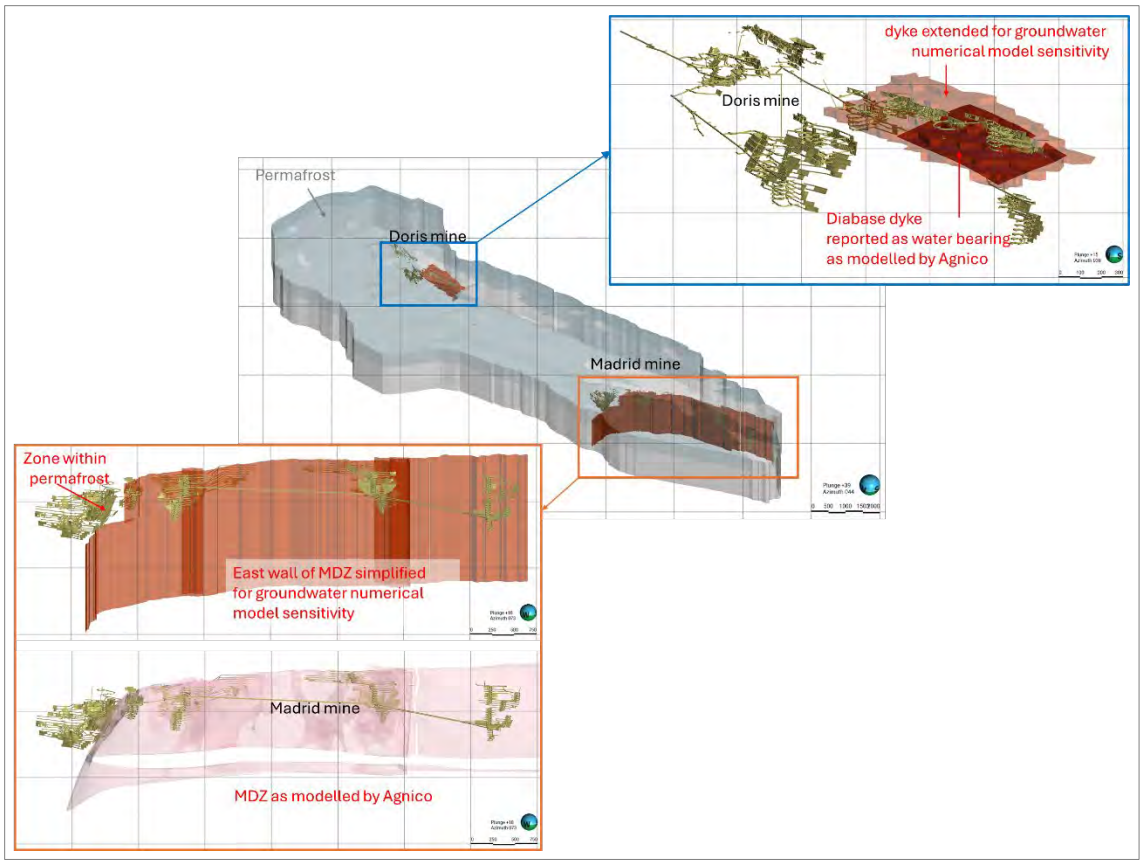
- Sx1: Storage compressibility is increased by one order of magnitude in overburden (Sx_{ovb} = 1x10^{-4} m/s).
- Sx2: Storage compressibility is decreased by one order of magnitude in overburden (Sx_{ovb} = 1x10^{-6} m/s).
- Sx3: Storage compressibility is increased by one order of magnitude in bedrock. (Sx_{bdr} = 3x10^{-6} m/s).
- Sx3: Storage compressibility is decreased by one order of magnitude in bedrock. (Sx_{bdr} = 3x10^{-8} m/s).

Density Dependent Flow Assumption (D)

- D1: Water density is not accounted for (density ratio = 0)
- D2: Higher density ratio based on 69 mg/L at surface and 35,000 mg/L at depth.

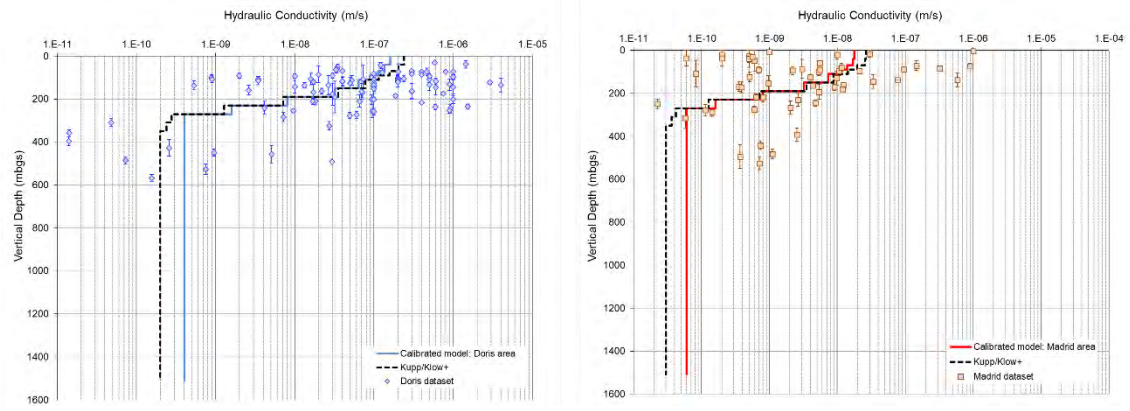
Worst Case Scenario (W)

- W: The hydraulic conductivity profile applied at Doris is applied at Madrid; mining zones where permafrost has been rated as "uncertain" are assumed part of the open taliks (unfrozen); the permafrost model assumes contacts between permafrost and open taliks are approximately 100 m inland from shorelines; and the calibrated hydraulic conductivities are cutoff to a lower limit of 1x10^{-9} m/s.



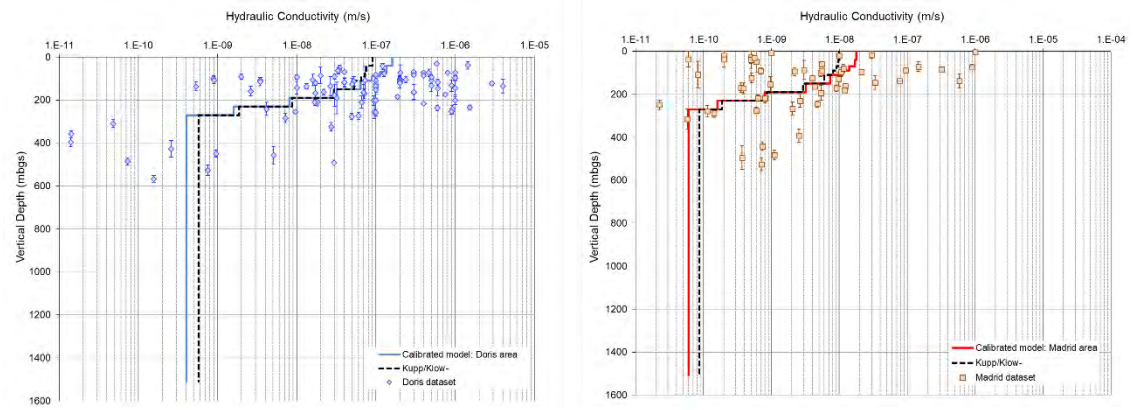
Source: fig_mdl_svy_structure.pptx

Figure 6-9: Modelled structures



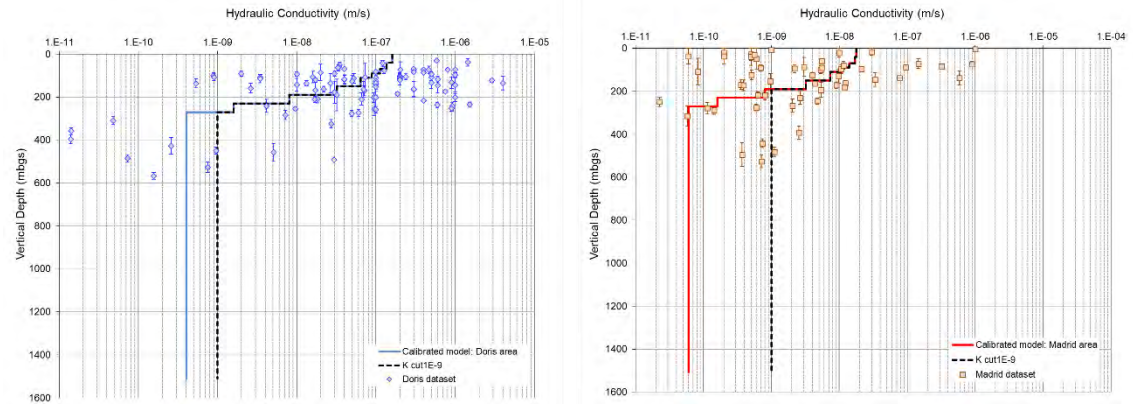
Source: HopeBay_MASTER_HydrProperties_gf_20241120.xlsx

Figure 6-10: Sensitivity K profiles: higher contrast between upper and lower bedrock



Source: HopeBay_MASTER_HydrProperties_gf_20241120.xlsx

Figure 6-11: Sensitivity K profiles: lower contrast between upper and lower bedrock



Source: HopeBay_MASTER_HydrProperties_gf_20241120.xlsx

Figure 6-12: Sensitivity K profiles: 1x10^{-9} m/s cutoff value

6.5.2 Sensitivity Ratings

The sensitivity of each scenario was rated as either significant or not significant according to the thresholds defined in Table 6-4, then classified into sensitivity types as defined by Brown (1996) and presented below.

Type I: There are no significant effects for both model calibration and predictive model results. In other words, within a reasonable range of parameter values, the model outcomes are not significantly affected. This parameter type does not need further data collection or monitoring. Type I sensitivities are of little concern because the impact on predictions is insignificant.

Type II: There is a significant effect on model calibration, but no significant effect on predictive model results (relative to modelling objectives). The model calibration is affected so the parameter has an effect on the calibration goodness of fit. However, the results of the predictive model are still insensitive to this parameter. Type II sensitivities are of little concern because the impact on predictions is insignificant.

Type III: There are significant effects on both model calibration and model prediction results. The parameter has an effect on the calibration goodness of fit and a corresponding effect on the predictive model results. Type III sensitivity is of concern only for an uncalibrated model, or where a wide range of calibrations are possible, and proper calibration of this parameter is the solution. The sensitivity is important, but it is known and can be avoided by model calibration.

Type IV: There is no significant effect on model calibration, but a significant effect on predictive model results. The model calibration is not affected and does not help constrain this parameter value, while the results of the predictive model are sensitive to this parameter. Type IV sensitivity is cause for concern because of the non-uniqueness. The model input may allow for a range of valid calibrations, but the choice of value significantly impacts model prediction. It is important to determine the actual value of this parameter and not rely on model calibration to estimate this parameter. It should be measured with robust data.

Table 6-4: Definitions and significance thresholds for sensitivity models

Definition	Calibration	Predictions
Information evaluated	• Mine inflow rate at the end of year 2022. • Mine inflow chloride concentration at the end of year 2022.	• Average annual mine inflow rate at EOM (2046). • Average annual mine inflow chloride concentration at EOM (2046) • Infiltrations for the Doris Lake, Patch Lake, and Wolverine Lake at EOM (2046). • Mine closure reflood time.
Significant Change	• +/- 300 m^3/d variations to mine inflows compared to observed (i.e., approximately 10% of the modelled base case total inflows for the Project). • +/- 20% variations to chloride concentrations compared to observed.	• +/- 300 m^3/d variations compared to modelled base case (i.e., approximately 10% of the modelled base case total inflows for the Project). • +/- 20% variations to mine inflow chloride concentration compared to modelled base case. • +/- 10% and greater than 0.5 m^3/d variations to lake infiltration rates compared to modelled base case. • +/- 5-year variations to reflood time compared to modelled base case.

6.5.3 Results

Table 6-5 lists results from sensitivity model runs categorized into sensitivity type III and IV. Some parameters were either not sensitive to both calibration and predictions (Type I), sensitive to both calibration and predictions (Type III), or not sensitive to calibration but sensitive to predictions (Type IV). Parameters showing significant effects on both calibration and prediction results (Type III) or prediction alone (Type IV) require careful consideration.

Key observations are:

Type I sensitivities: Models in this category had changes to both calibration and predictions but less than the defined significance thresholds.

- P1, P3 included a change to depth of the base of permafrost. Since most of the future mining occurs within the Doris Lake or Patch Lake taliks, permafrost boundaries at distance from the mines would not be expected to have a significant effect on flow; results also indicate minimal effect on chloride concentration.
- Sx1 and Sx2 changed storage compressibility in the lakebed sediment. Results suggest that pressure changes from dewatering (thus water release from overburden storage) do not extend significantly into the lakebed (this does not mean leakage does not occur, just that it is not sensitive to storage compressibility).
- Sx4 simulated a decreased storage compressibility in bedrock. Results show predictions are not particularly sensitive to lower storage compressibility in bedrock.
- D1 and D2 related to water density. Results show predictions are not particularly sensitive to density. Changes to chloride concentrations were minimal, likely because the flow system was not significantly affected.

Type II sensitivities: There were no models in this category, with significant effect on calibration but not predictions.

Type III sensitivities: Models in this category have significant effects on both model calibration and model prediction.

- Scenarios K1, K2, K3 and K4 fall in this category, and all reflect changes in hydraulic conductivity, of lakebed sediment or bedrock. Significant sensitivities are seen for both flow and chloride concentration. The largest changes in flow occurred for K1 and K3, both of which reflect increases in K, for lakebed sediment and bedrock, respectively; K3 shows the most significant increase in flow for any sensitivity run and reflects that model results are most sensitive to this assumption. Chloride concentrations responded inversely to flow, decreasing for sensitivity runs that indicate increase in flow and increasing for sensitivity runs that indicate decrease in flow. This relationship is a function of increased flow from shallower, lower concentration waters when K is higher and higher leakage from overlying lakes. The uncertainty on K assumptions is reduced by the fact that modelled hydraulic conductivity fields are well aligned with Project data and calibrated to the historical records of mine inflows and chloride concentrations at Doris.
- The structures simulating hypothetical permeable conduits in the Scenario S influence both the model calibration and predictions. At End-Of-Mine, the inflows are increased to 2,780 m^3/d at Doris and 2,810 m^3/d at Madrid. Chloride concentrations respond inversely to flow at Madrid, decreasing to 4,560 mg/L. Concentrations at Doris are not affected significantly.

Type IV sensitivities: Models in this category have no significant effect on model calibration, but a significant effect on model prediction; these sensitivities are considered the most important because the parameter variation cannot be constrained by model calibration and accurate input is data is needed.

- Scenarios related to permafrost, P2 and P4 only showed changes for leakage from Imniagut Lake and Wolverine Lake, suggesting permafrost assumptions influenced predictive outcomes for these lakes.
- Scenarios K5, K6 and K7 reflect changes in K contrast between shallow and deep bedrock, a low K cutoff of $1x10^{-9}$ m/s (testing instrument limits) or the relatively high calibrated K for Doris applied to Madrid. With the exception of K7 (calibrated K for Doris applied to Madrid) change to flow was not significant but change to inflow chloride concentration was, at both Doris and Madrid areas. These models also had significant changes on leakage from lakes.
- Scenario K7 highlights the potential effect of higher K at Madrid. K in the Base Case model was set to match Madrid data, which has on average lower K than Doris; increasing K at Madrid to match the average at Doris has a significant effect on predicted inflow.
- Scenarios Sx3 (storage compressibility in bedrock) affected leakage from Wolverine Lake, but not to the same degree as models K5, K6 and K7.
- Scenario W is a “worst case” scenario combining changes to the most conservative assumptions for the permafrost and bedrock hydraulic conductivity field at Madrid. It resulted in increased flow at Madrid, a subsequent decrease in chloride concentration (significantly greater leakage from Patch Lake) and also large increases in leakage from Imniagut and Wolverine lakes. Results again indicate sensitivity to K, but not in a way that would affect model calibration; K in the Madrid area is not as well constrained as in the Doris area.

Reflooding durations in Doris were not sensitive to parameter changes. Sensitivity K3 (global increase in K by one order of magnitude) does decrease the time to reflood Doris by a factor of five, but not technically within the selected sensitivity threshold. The reflood duration for the Base Case is significantly longer for Madrid (50 years) than Doris (4 years) due to a larger open area and lower inflow. Increasing K, thus increasing inflow can significantly shorten the time to reflood (K3, K7 and W), as expected.

Sensitivity results clearly indicate that model calibration and predictions are affected by K assumption, and subsequently have an effect on predicted chloride concentrations. Such K changes can be in either bedrock or lakebed sediments, or by the assumed location of the boundary with permafrost (though not as significantly as bedrock K in general). This is generally consistent with results of modelling for many other projects and can be particularly important at Hope Bay when considering that mining occurs underneath lakes.

There was no specific sensitivity model run to address the potential for flow from drillholes, as this is generally more uncertain than other parameters, but this is discussed in Section 6.6.

Table 6-5: Sensitivity Results

ID	Description	Calibration		Predictions												Sensitivity Ratings		
		End of 2022 Mine Inflow		End of Mine 2046 Mine Inflow			End of Mine 2046 UG [Cl]			End of Mine 2046 Lake Infiltrations				Closure		Ratings		Type
		Flow (m^3/d)	[Cl] *(TDS)* [a] (mg/L)	Total inflow (m^3/d)	Doris inflow (m^3/d)	Madrid inflow (m^3/d)	Total [Cl] *(TDS)* [a] (mg/L)	Doris [Cl] *(TDS)* [a] (mg/L)	Madrid [Cl] *(TDS)* [a] (mg/L)	Doris Lake (m^3/d)	Patch Lake (m^3/d)	Imniagut Lake (m^3/d)	Wolverine Lake (m^3/d)	UG reflood Doris (year)	UG reflood Madrid (year)	Calibration (S/NS)	Prediction (S/NS)	
-	Base case model	1621	7644 *(13501)*	3014	2262	752	3492 *(6167)*	1509 *(2665)*	9457 *(16703)*	2231	727	0.6	7.8	3.6	51.6	-	-	-
P2	Depth of subpermafrost raised by about 180m	1639	7796 *(13769)*	3047	2287	760	3658 *(6461)*	1729 *(3054)*	9465 *(16717)*	2246	730	**1.7**	8.3	3.6	51.1	NS	**S**	IV
P4	Contacts between permafrost and open taliks approx. 100 m inland from shorelines.	1714	7685 *(13573)*	3211	2383	827	3750 *(6623)*	1726 *(3048)*	9581 *(16922)*	2354	795	**2.1**	**14.1**	3.5	47.0	NS	**S**	IV
S	Structures intercepting the mines x simulated as potential conduits	**2184**	7694 *(13589)*	**5595**	**2782**	**2812**	3038 *(5366)*	1499 *(2647)*	**4561** ***(8055)***	**2749**	**2765**	0.4	**8.6**	3.8	**6.9**	**S**	**S**	III
K1	Hydraulic conductivity increased in overburden (K_{ovb} = 1x10^{-7} m/s)	**2220**	**5240** ***(9255)***	**4030**	**3217**	813	**2490** ***(4398)***	**949** ***(1676)***	8586 *(15164)*	**3187**	788	0.6	7.8	2.6	47.8	**S**	**S**	III
K2	Hydraulic conductivity decreased in overburden (K_{ovb} = 1x10^{-9} m/s)	**966**	**12488** ***(22056)***	**1847**	**1273**	574	**6140** ***(10844)***	**3302** ***(5832)***	**12434** ***(21960)***	**1238**	**546**	0.6	7.4	6.5	**67.7**	**S**	**S**	III
K3	Hydraulic conductivity increased globally by one order of magnitude in bedrock	**9608**	**2818** ***(4977)***	**18329**	**12656**	**5673**	**1650** ***(2914)***	**1013** ***(1789)***	**3070** ***(5422)***	**12399**	**5501**	**8.0**	**81.7**	0.7	**6.8**	**S**	**S**	III
K4	Contrast of hydraulic conductivity between the upper and lower bedrock increased by 50%	**1995**	6497 *(11475)*	**3709**	**2740**	970	2856 *(5044)*	**1078** ***(1904)***	7881 *(13919)*	**2717**	**926**	0.7	**9.5**	3.0	**40.1**	**S**	**S**	III
K5	Contrast of hydraulic conductivity between the upper and lower bedrock decreased by 50%	1474	8453 *(14929)*	2899	2106	793	**4992** ***(8817)***	**2243** ***(3961)***	**12292** ***(21710)***	2042	690	**1.5**	**10.8**	3.9	49.0	NS	**S**	IV
K6	hydraulic conductivity profile is cutoff with a low value of 1x10^{-9} m/s	1631	7736 *(13663)*	**3350**	2329	1021	**5451** ***(9627)***	**2135** ***(3771)***	**13015** ***(22987)***	2261	**894**	**5.7**	**30.9**	3.5	**38.0**	NS	**S**	IV
K7	hydraulic conductivity profile applied at Doris applied to Madrid	1621	7644 *(13501)*	**7223**	2262	**4960**	**2402** ***(4242)***	1513 *(2672)*	**2808** ***(4959)***	2231	**4857**	**4.4**	**60.2**	3.6	**7.8**	NS	**S**	IV
Sx3	Storage compressibility is increased in bedrock (Sx_{bdr} = 3x10^{-6} m/s)	1625	7644 *(13501)*	3037	2273	763	3583 *(6328)*	1588 *(2805)*	9521 *(16816)*	2226	720	0.3	**6.6**	3.6	50.9	NS	**S**	IV
W	Worst case: combination of scenarios P3, P4, K6 and K7	1724	7771 *(13725)*	**8295**	2465	**5830**	3259 *(5756)*	**2432** ***(4295)***	**3609** ***(6374)***	2402	**5599**	**25.1**	**133.7**	3.3	**6.7**	NS	**S**	IV

Source: HB2024_4-ModelResultsSummaryReport.xlsx

Note:

[a] Equivalent TDS concetration calculated using equation [TDS] = [Cl] / 0.5662 (See Section 3.9.2)

A value in bold red font indicates the modelled result is above the criteria listed in Table 6-4.

GWL, groundwater level; UG, underground

NS, Not Significant; S, Significant.

6.6 Sensitivity to Flow from Exploration Drillholes

As noted previously, there are a significant number (>1000) of drillholes into the ore bodies that represent potential flow conduits. Uncertainties exist regarding flow potential, either as direct connections between the lake and the mine, or as small-scale, local connectors between fractures that can influence bulk K. Most surface holes should have been plugged using a method that involved setting a Van Ruth–type plug approximately 35 m into bedrock and then emplacing cement on top of the plug, but a certain number are also known to have not been cemented or have no written records of methods for cementing; nor are there as-built-type descriptions of what was actually done. In 2017, SRK had estimated that the Madrid prefeasibility mine layouts had a more than 50% probability to intercept old open exploration holes in the north area (Naartok East), and a low probability in the south area.

Predicting likelihood of any given drillhole to act as a connector to surface (or a lake) is difficult and can be best addressed through management planning for such events. Observations from mining at Doris suggest the likelihood for such an event is low but possible. The scale of inflow that could be encountered is indicated by the September 2018 inflow event at Doris, when workings intercepted an un-grouted surface exploration hole producing an averaged flow on the order of 3,650 m^3/d until it was plugged in Oct.2018. While this event happened despite efforts to proactively identify zones where such intercepts can occur, it showed Operators were able to divert, manage and stop the inflow from that hole within a relatively short time.

7 Conclusions

This study reviewed hydrogeological data to update the groundwater conceptual model and refine estimates of groundwater inflow and chloride concentrations in alignment with the updated Hope Bay mine plan. The objective was to support the ongoing environmental permitting process, provide a basis for assessing the mine's effects on the groundwater environment, and supply inputs to the updated Project Water and Load Balance. The level of detail, methods, and quality of the hydrogeological data supporting the conceptual and numerical models were deemed adequate for these purposes.

The system is conceptualized as a low-flow, lake-dominated, confined flow system. The widespread, deep permafrost is essentially impermeable. Groundwater flow and connections between surface and deep bedrock groundwater systems occur exclusively in areas where lakes are associated with open taliks or in sub-permafrost zones. The primary controls on the groundwater system are the hydraulic conductivities of the overburden and bedrock, and the 3D geometries of permafrost and open taliks. K measurements for lake sediments and fractured rock fall within the bounds of published K values. The lakebeds are draped with fine sediments characterized with an average low K of $1x10^{-8}$ m/s. The fractured rock is characterized by K ranging between $<1x10^{-9}$ m/s and $4x10^{-6}$ m/s, with a higher K geomean at Doris than at Madrid, $5x10^{-8}$ m/s and $2x10^{-9}$ m/s respectively. Clear distinction between bedrock lithologies or geological structures are not observed, at least not consistently. At the project scale, fractured rock is treated as a single unit, with relatively higher K at shallow depths, gradually decreasing with depth due to increasing confining pressure. Groundwater is brackish to saline and can have

elevated concentrations of major ions and metals. The dissolved constituents of concern, when looking at potential discharges of groundwater to the environment, are ammonia, boron, cadmium, chloride, fluoride, iron, manganese, nickel, selenium, sulfate and zinc. The concentrations of chloride show a general trend of increasing concentration with depth; other constituents do not correlate with depth.

The dewatering activities during underground operations will alter groundwater flow gradients. Depressurization around parts of mines located within taliks or sub-permafrost will extend radially, drawing potential upward and lateral saline flow from the talik, and downward freshwater flow from the lakes above. The low permeability of the fine sediments present at the bottom of lakes will limit downward infiltrations. Initially, the salinity of the mine inflows will reflect the saline conditions of the surrounding groundwater system. Over time, as the dewatering expands, more freshwater from shallower zones will be mobilized and inflows will become progressively less saline. While the mine may intercept geological structures or fractures, historical observations of inflow during the development of the Doris mine suggest they will have limited storage capacity and be more likely connected to deep saline groundwater rather than directly to the lakes above.

At Closure, dewatering activities will stop. Re-flooding will result in a slow re-equilibration to baseline conditions, driven by the lakes' gradients and density gradients. At Post-closure, the groundwater system will have returned to the same conditions as baseline with local influences on flow and groundwater quality immediately around the mines.

The groundwater numerical model constructed by SRK was calibrated to the mine inflow rates, and chloride concentrations observed during the 7-years of underground operations at Doris. The calibrated model resulted in reasonable model fit to the observations. The calibrated model predicted the following:

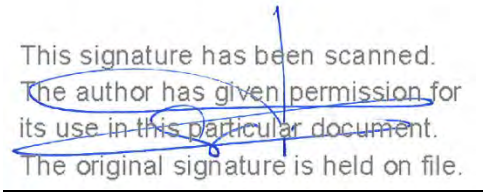
- A maximum annual average inflow of 2,260 m^3/d in 2031 at Doris, and 750 m^3/d in 2039 at Madrid.
- The model captures the overall trend of mine inflows, but not temporary inflow events from discrete structures. Additional inflows between 100 m^3/d to 600 m^3/d could occur for periods of 2 to 8 months based on the historical mine inflow records of Doris.
- Dilution of inflow chloride concentration over time due to freshwater infiltration from the lakes. At End-Of-Mine, chloride concentrations are about 1,500 mg/L at Doris, and 9,500 mg/L at Madrid (i.e., equivalent TDS concentrations of 2,650 and 16,780 mg/L respectively).
- An increase in freshwater infiltration from lakes over time with greater changes for the lakes located directly above the mines: Doris Lake, Patch Lake, and Wolverine Lake.
- At Closure, underground reflood periods of 4 years at Doris and about 50 years at Madrid.
- At Post-Closure, the groundwater flow system will return to a state similar to pre-mining conditions. The model forecasts groundwater will flow very slowly towards the lakes in

close proximity and towards Roberts Bay to the north. No particles are predicted to have reached surface water bodies after 1,000 years.

The analysis of the model's sensitivity to parametrization showed model calibration and predictions were sensitive to changes in hydraulic conductivity of lakebed sediment or bedrock. These are considered sufficiently constrained by the field data and calibration to current conditions for Doris, but can affect predictions:

- Permafrost variations can influence the predicted leakages for Imniagut Lake and Wolverine Lake.
- Changes in K contrast between shallow and deep bedrock, or a low K cutoff of $1x10^{-9}$ m/s (testing instrument limits) have limited effects on the predicted mine inflows but significant influence on chloride concentration at both Doris and Madrid, as well as leakage from lakes.
- Madrid has less K data than at Doris, but also a lower average than at Doris. Using the Doris K profile (which was calibrated to operational data) at Madrid resulted in significantly higher predicted inflow, but lower chloride concentration due to increased infiltration from Patch Lake.
- The "worst case" scenario combined the most conservative assumptions for the permafrost and hydraulic conductivity field in bedrock at Madrid. This model also resulted in increased flow at Madrid, a subsequent decrease in chloride concentration and a large increases in leakage from Imniagut and Wolverine lakes.
- Models did not explicitly assess the potential for mine inflow from unplugged surface drillholes, either as direct connection to lakes, or as small-scale, local connectors between fractures. Observations from Doris operations indicate an un-grouted surface exploration hole could produce an average flow of about 3,650 m^3/d. Predicting likelihood of any given drillhole to flow is difficult, but Operators were able to divert, manage and stop inflow from the hole within a relatively short time.

This report, 2024 Hydrogeological Modeling Update, was prepared by



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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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Appendix A – Lake Bathymetries

Appendix V5-3A

Lake Bathymetry Surveys in the LSA and RSA

Figure V5-3C-1
Doris Lake

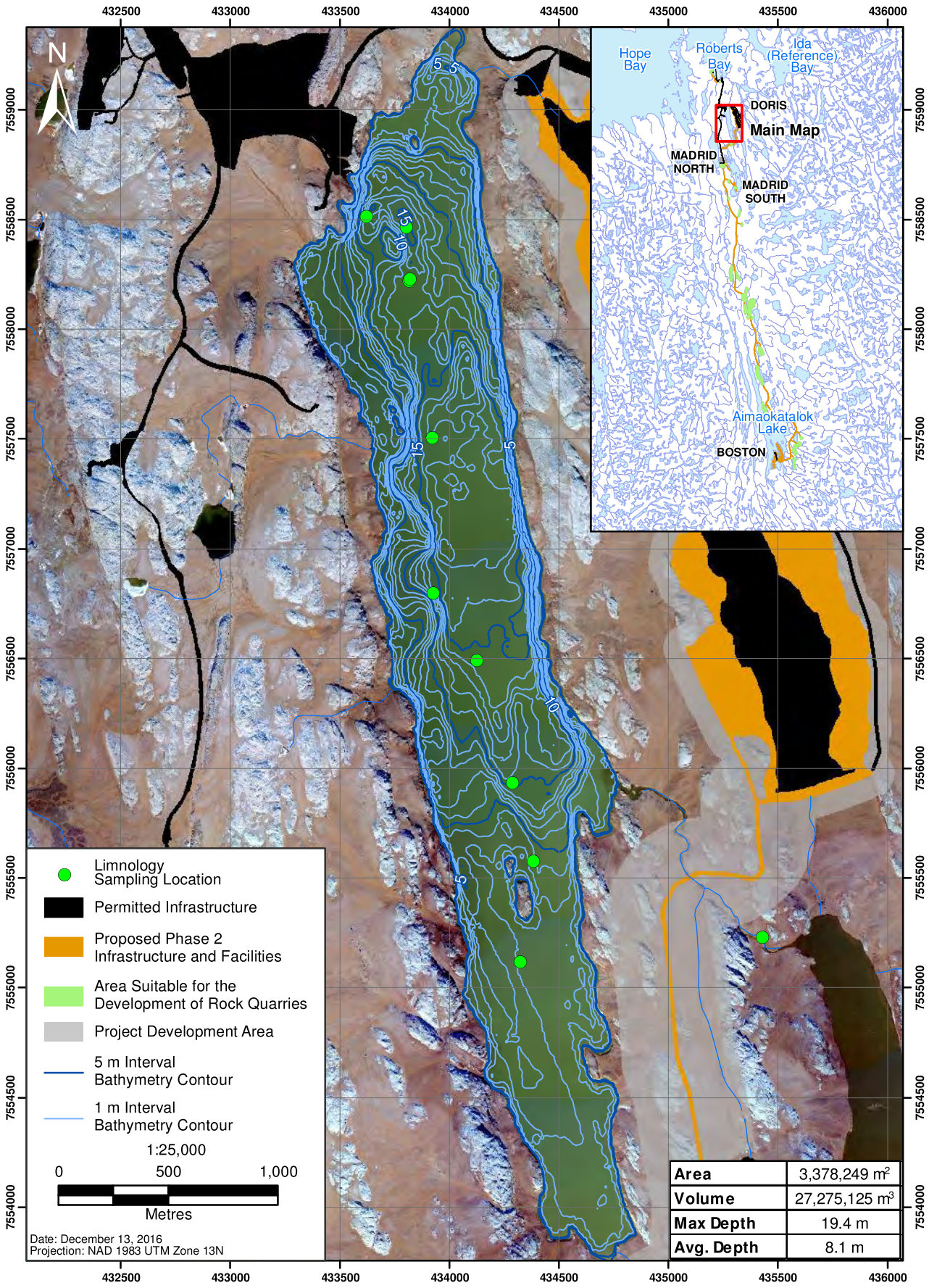


Figure V5-3C-2
Ogama Lake

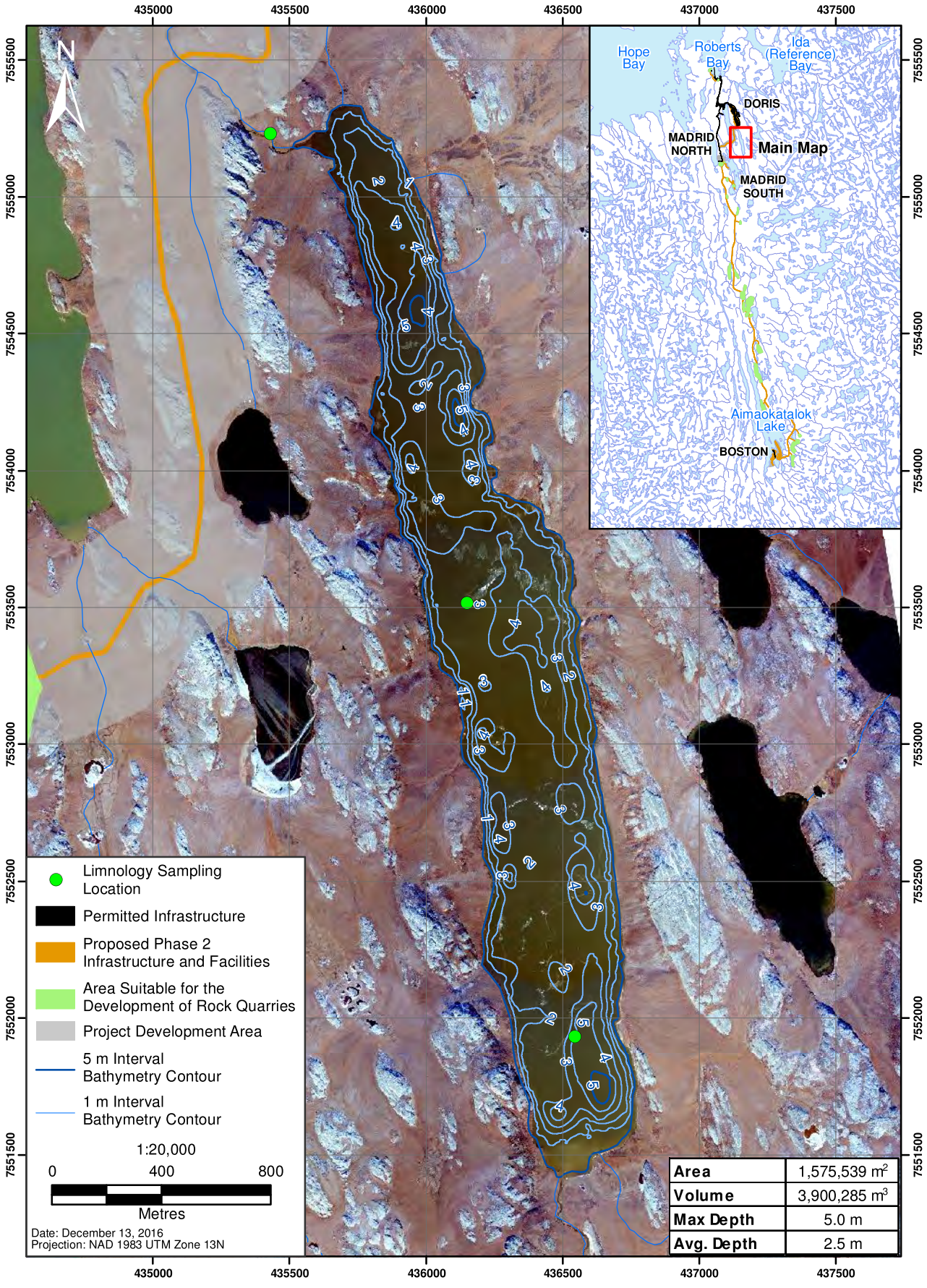


Figure V5-3C-3
Patch Lake

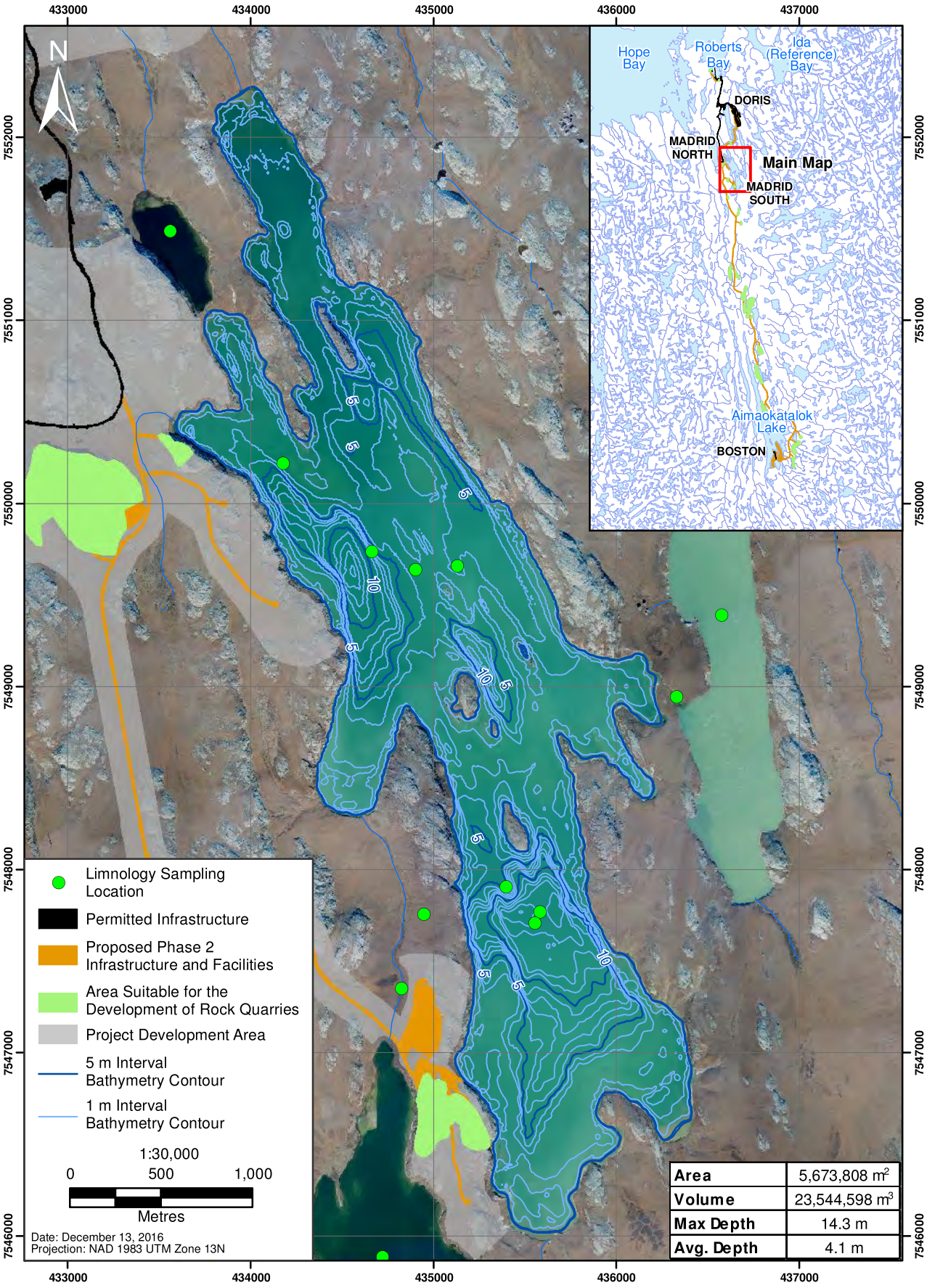


Figure V5-3C-4
Wolverine Lake

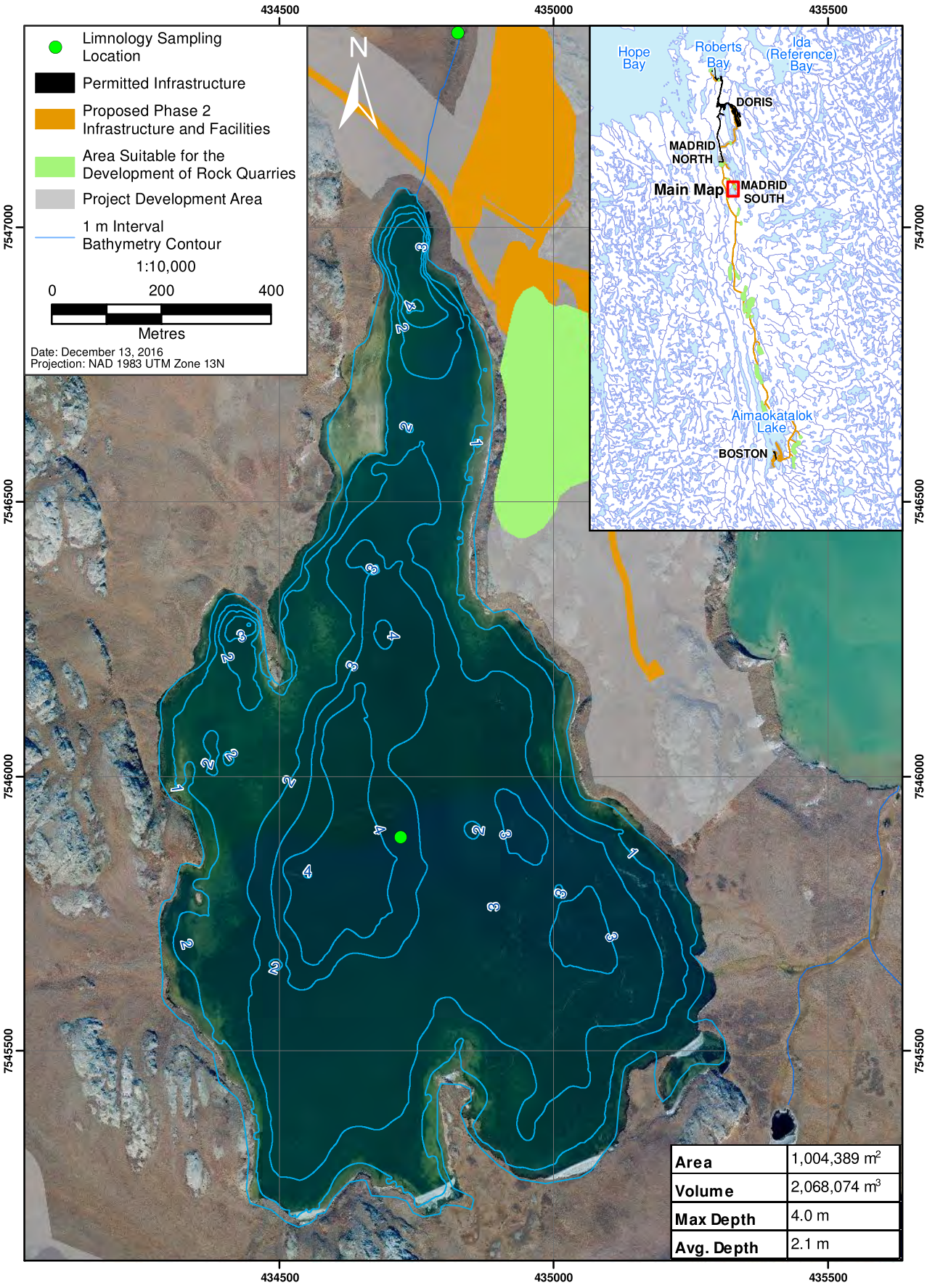


Figure V5-3C-5
Little Roberts Lake

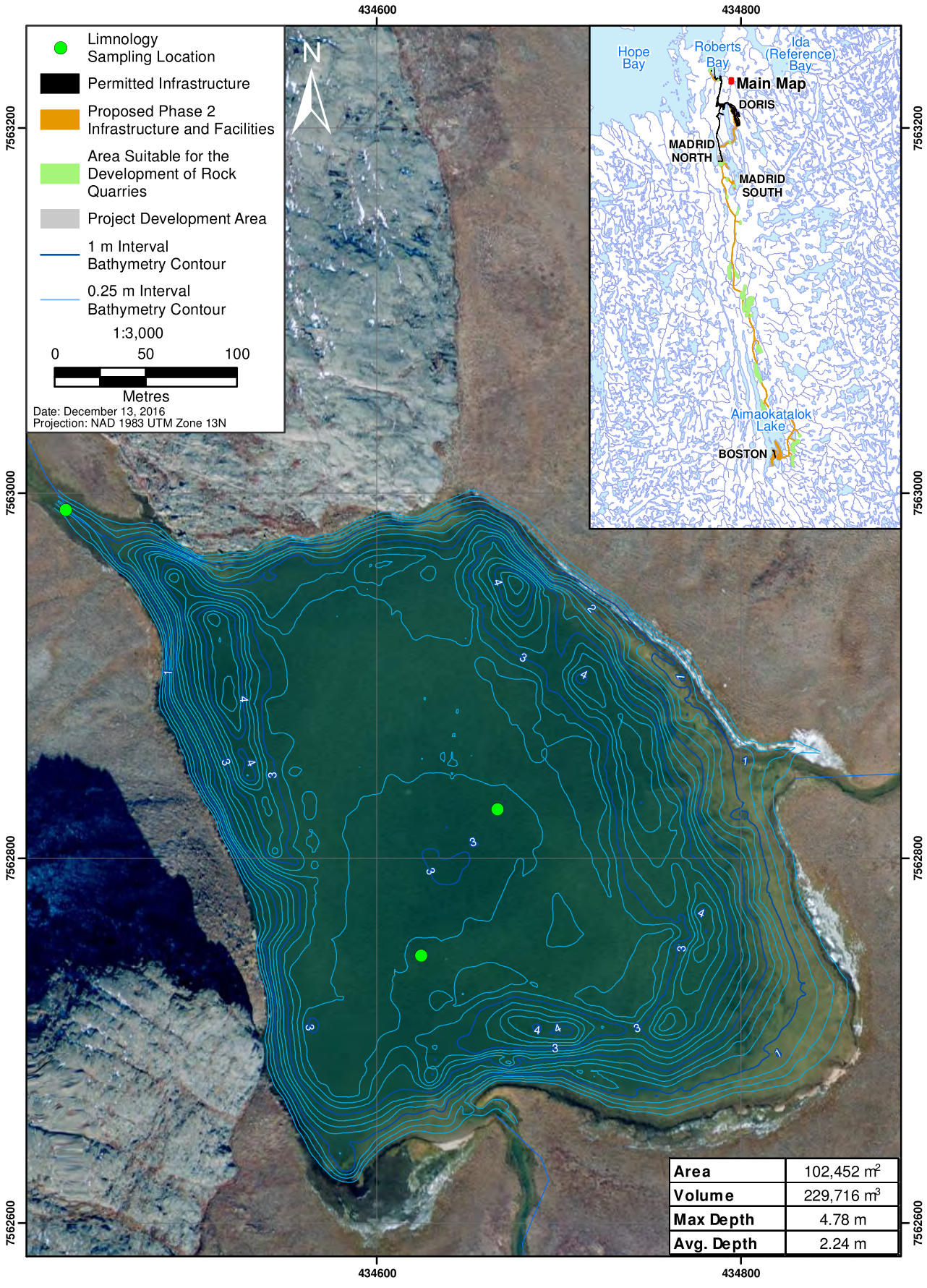


Figure V5-3C-6
Imniagut Lake

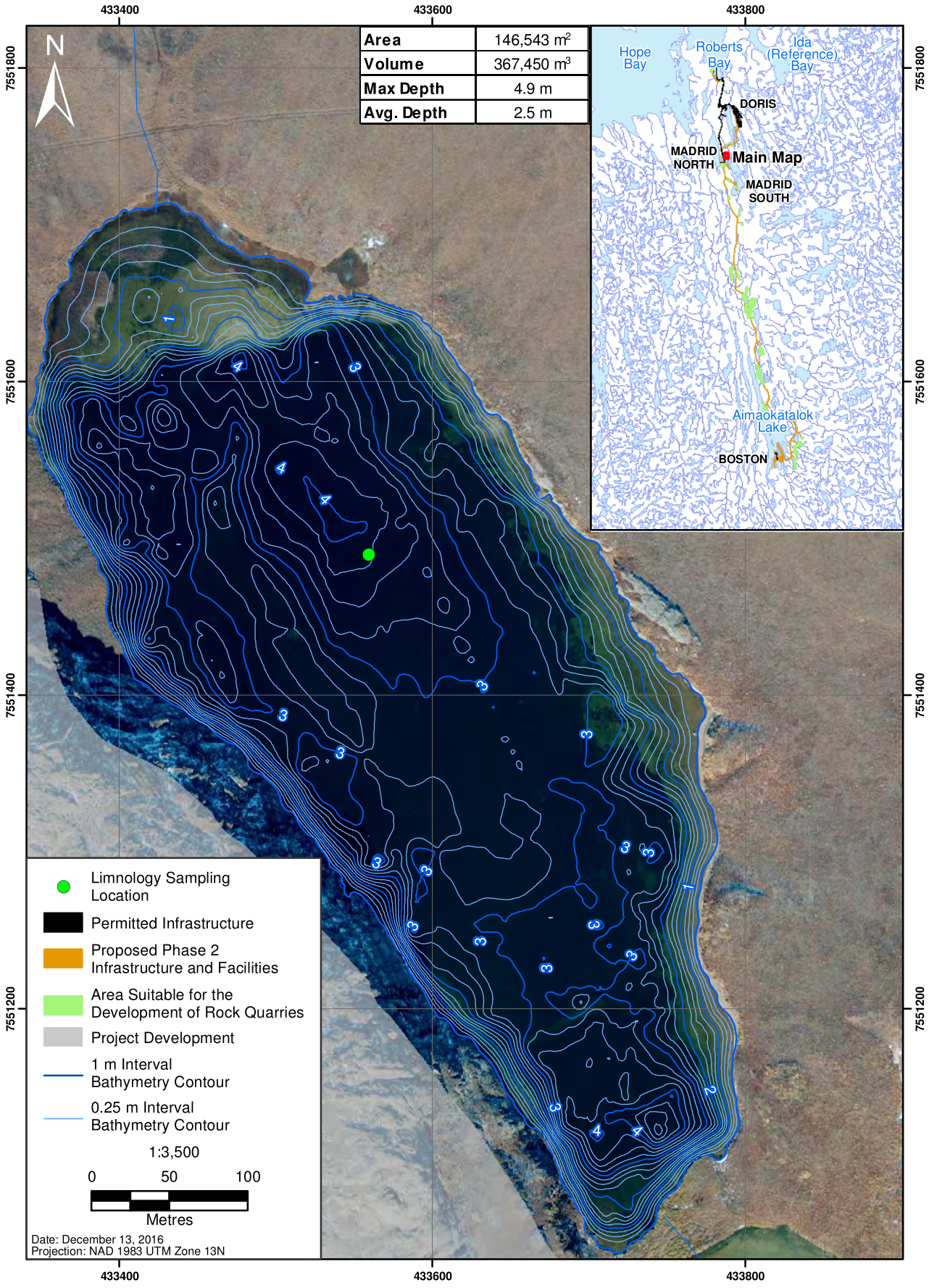


Figure V5-3C-7
P.O. Lake

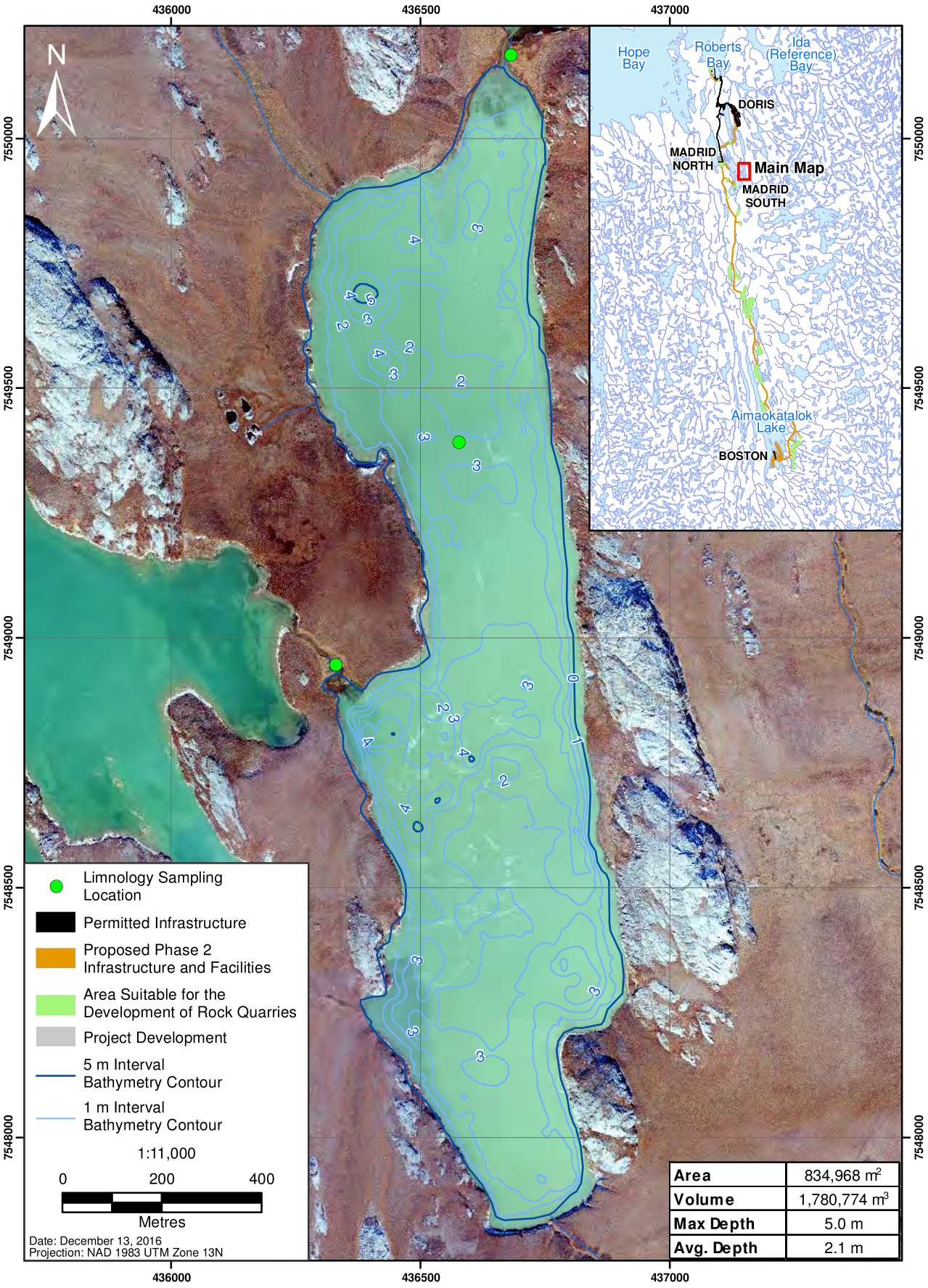


Figure V5-3C-8
Windy Lake

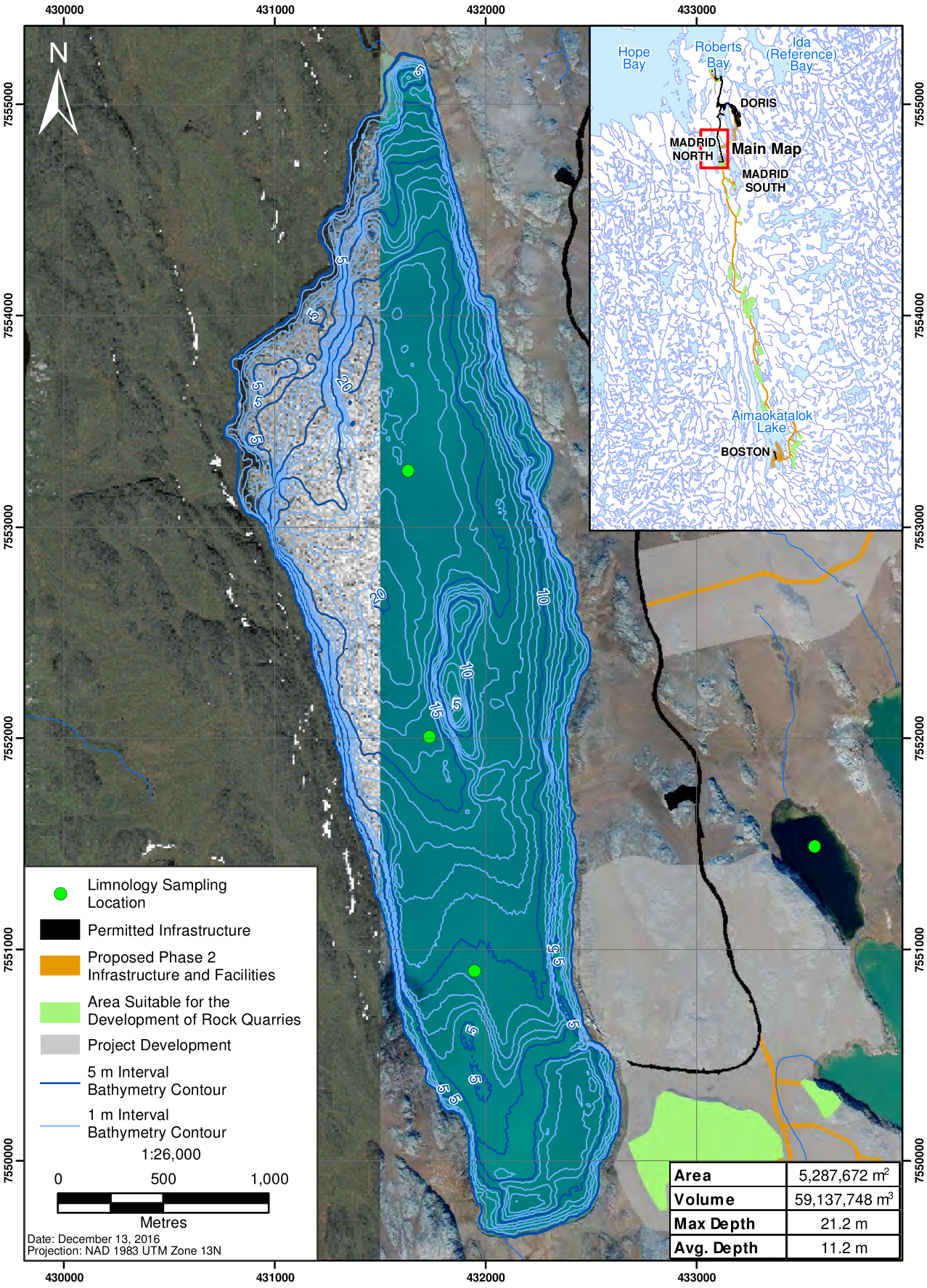


Figure V5-3C-9
Aimaokatalok Lake

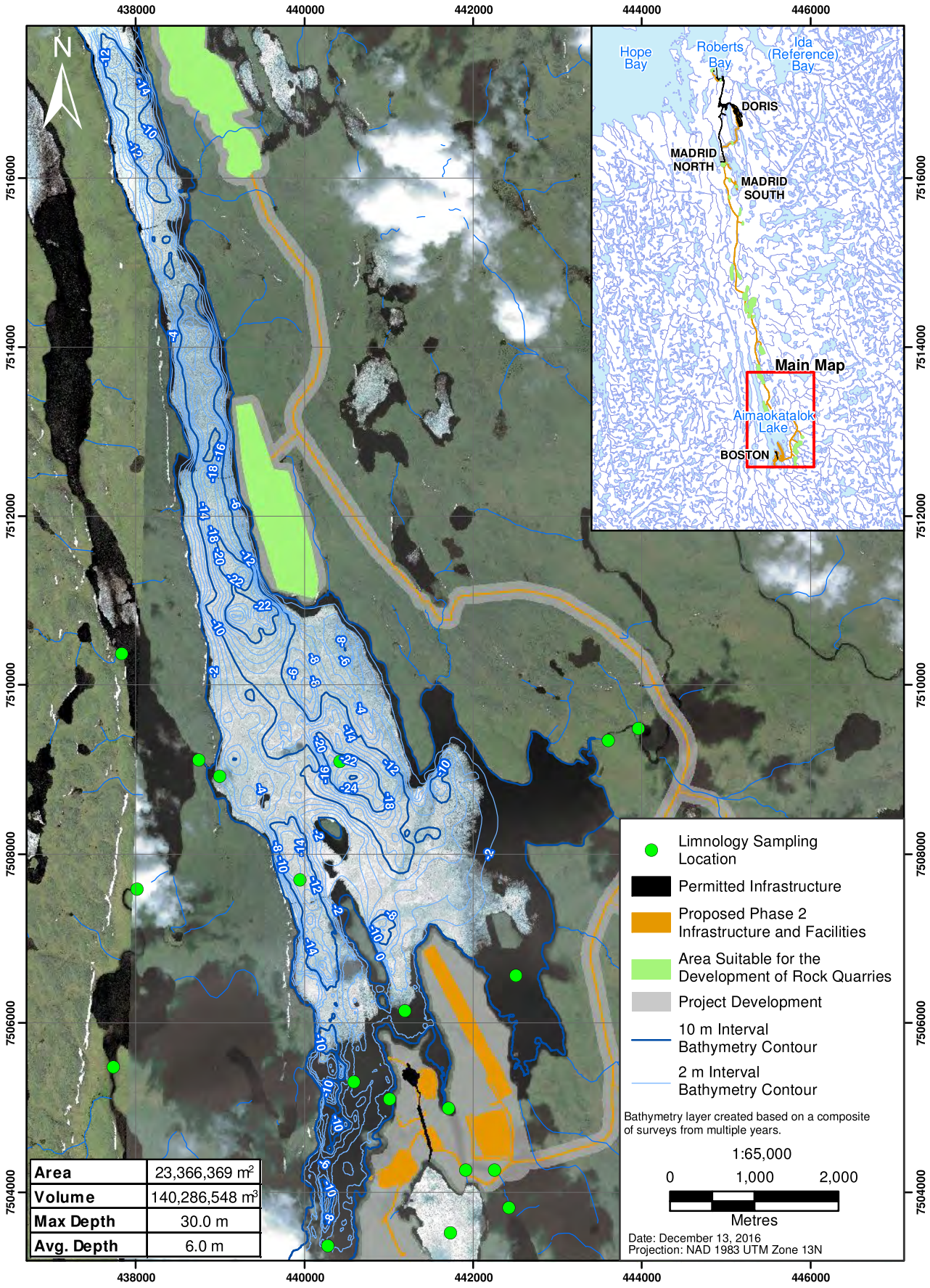


Figure V5-3C-10
Stickleback Lake

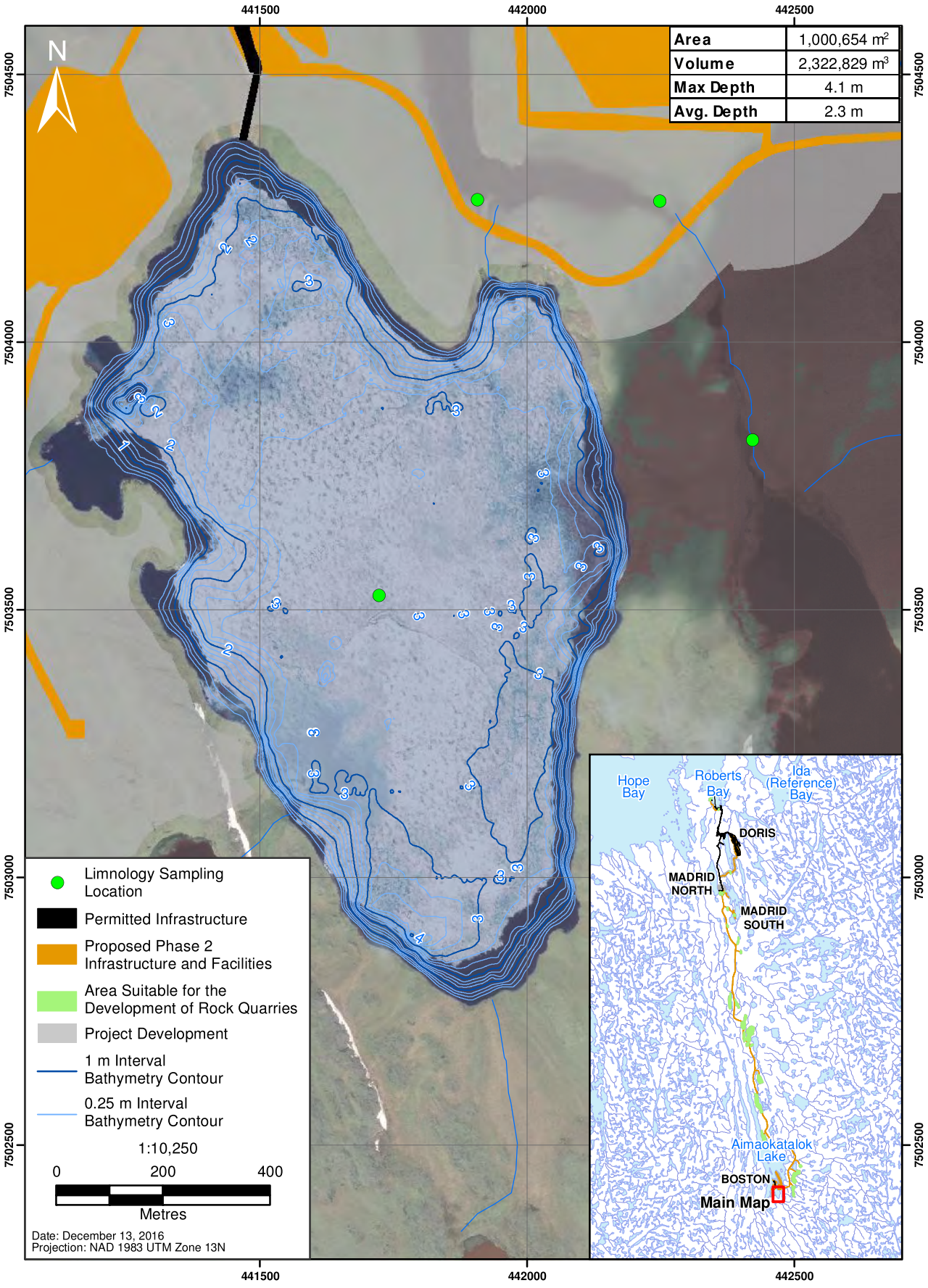


Figure V5-3C-11
Trout Lake

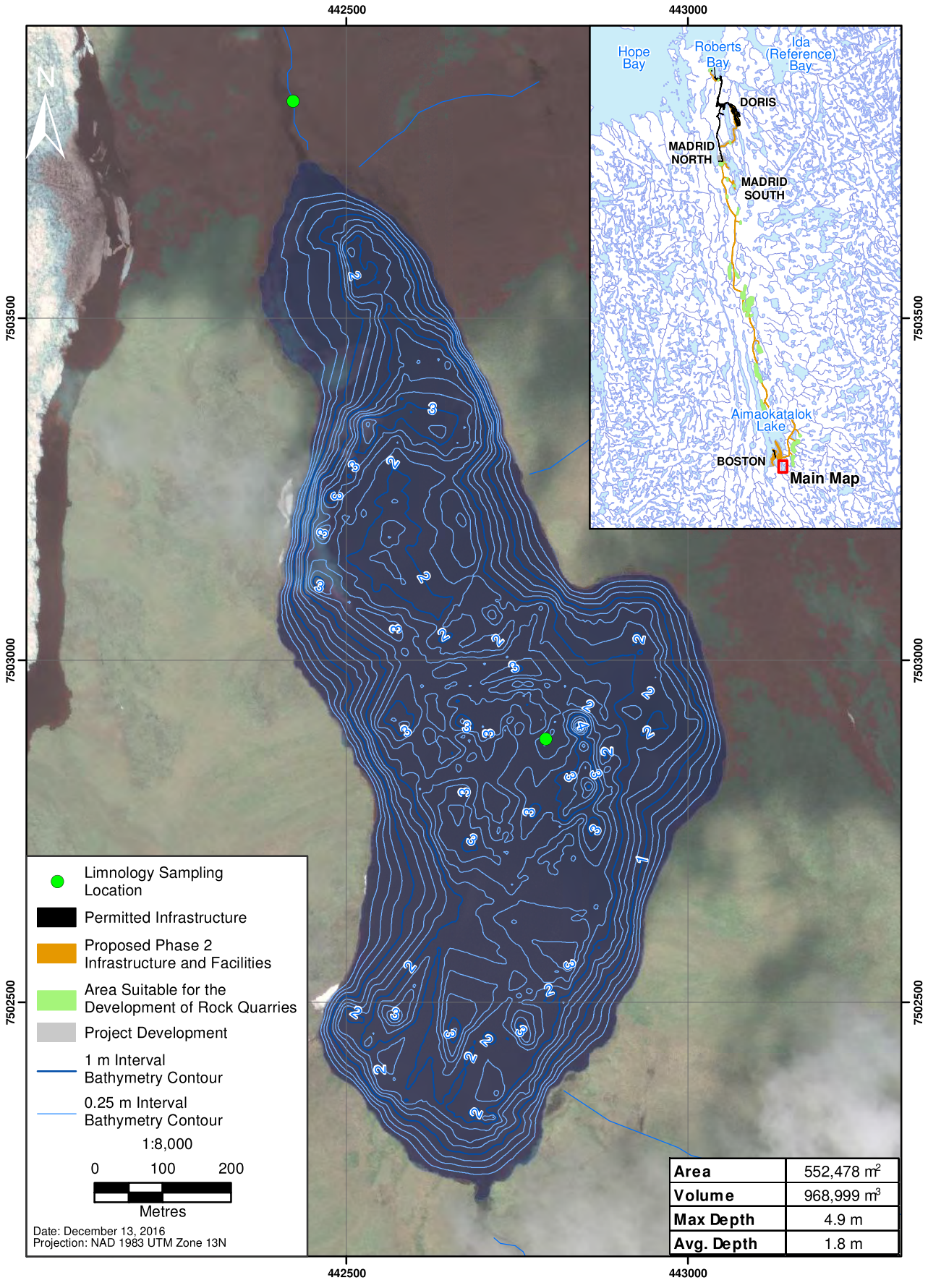
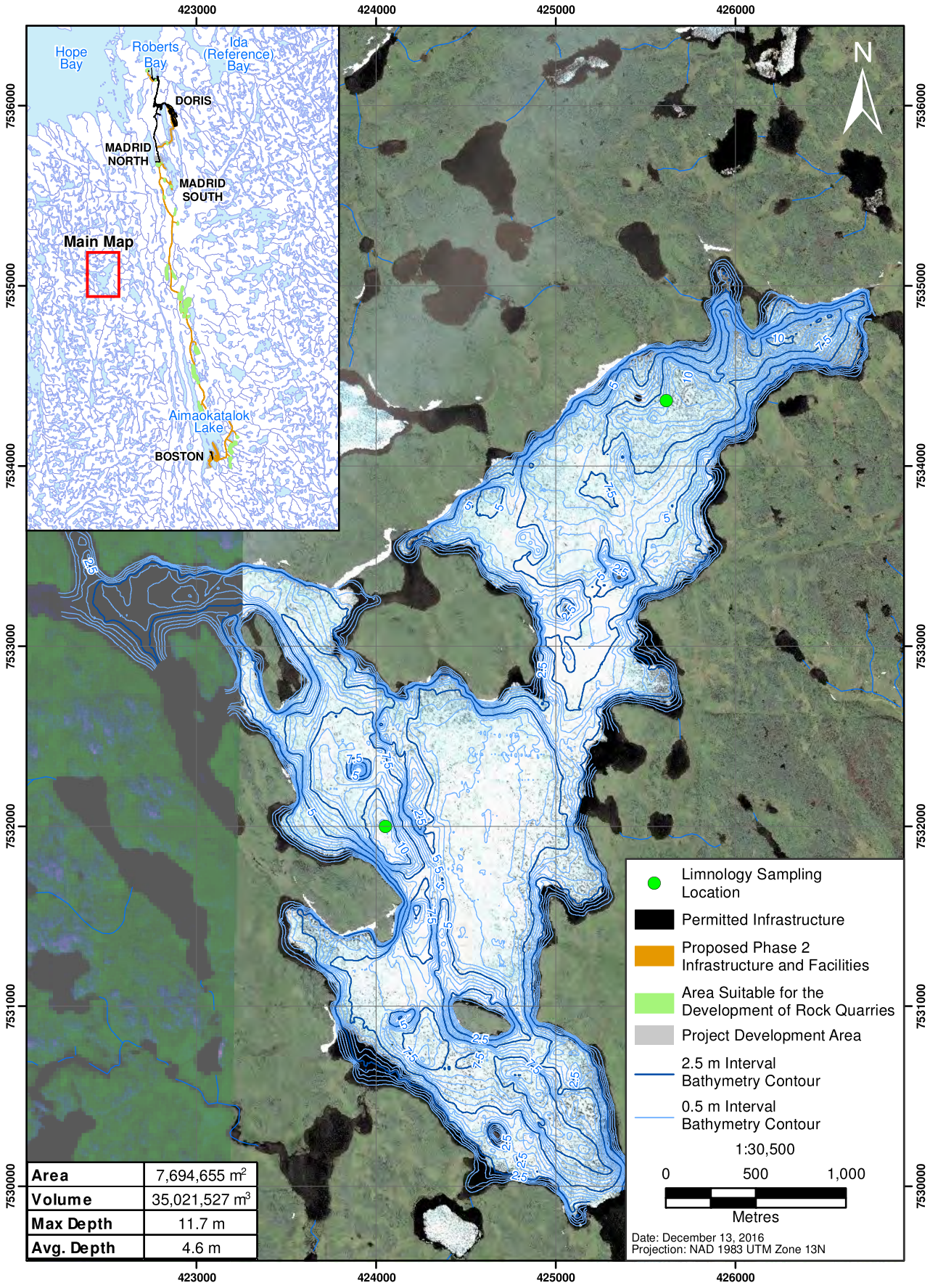


Figure V5-3C-12
Reference Lake B



Appendix B – Overburden Data

Table 1: Drillhole Summary for Onshore Overburden Drill Holes

Hole ID	Interval (m)	Description
SRK-07-34	0.0 – 0.03	Frozen Muskeg
	0.03 – 0.5	Brown sandy silt with rootlets
	0.5 – 1.4	Brown silty clay; Vs with occasional thick ice layers
	1.4 – 14.5	Consolidated grey clay; Vx, Vs and occasional thick ice layers
	14.5 – 14.8	Well graded till
	14.8 – 19.7	Competent bedrock to EOH
SRK-07-35	0 – 0.1	Frozen Muskeg
	0.1 – 1.7	Dark brown sandy silt; Vs
	1.7 – 14.0	Dark grey silty fine sand; Vx, Vs, and Vr (ice content 10 - 50%) with massive ice lenses 0.9 – 1.2 m thick
	14.0 – 15.6	Fine sand, Nbn
	15.6 – 16.2	Till
	16.2 – 19.2	Bedrock to EOH
SRK-07-36	0 – 0.03	Frozen Muskeg
	0.03 – 0.4	Brown Sandy Silt
	0.4 – 3.3	Silty Sand; Vs with massive ice
	3.3 – 7.9	Dark grey silty fine sand; Vx, Vs, and Vr (ice content 10 - 15%) with massive ice lenses 0.9 – 1.2 m thick
	7.9 – 8.5	Till
	8.5 – 9.7	Intensely fractured bedrock
	9.7 – 12.5	Competent bedrock to EOH
SRK-07-37	0 – 0.2	Frozen Muskeg
	0.2 – 0.6	Dry light tan silt with rootlets
	0.6 – 1.9	Silty clay; Vx and Vs = 35%
	1.9 – 3.4	Grey consolidated glacial clay Vs = 10 – 15%
	3.4 – 5.3	Consolidated grey/brown silty clay; Vs with occasional massive ice lenses
	5.3 – 7.2	Consolidated glacial clay grading to sand with depth; Vx with occasional massive ice layers
	7.2 – 11.6	Bedrock to EOH

Vx – Individual ice inclusion
Vs – Stratified or distinctly oriented ice formations
Vr – Random or irregularly oriented ice formations
EOH – End of Hole

Table 2: Drillhole Summary for Holes Below Patch Lake at a Proposed Dewatering Dike Alignment Location

Hole ID	Interval (m)	Description
SRK-07-27	0.0 – 3.0	Ice (2 m) & water
	3.0 – 6.0	Lacustrine sediments / Unconsolidated glacial clay
	6.0 – 24.3	Consolidated glacial clay; granular ice crystals at ~11 m
	24.3 – 27.5	Well graded till with boulders
	27.5 – 36.7	Highly fractured bedrock
	36.7 – 40.0	Competent bedrock to EOH
SRK-07-28	0.0 – 3.0	Ice (2 m) & water
	3.0 – 9.0	Lacustrine sediments
	9.0 – 20.0	Glacial clay; ice lenses present
	20.0 – 20.3	Till (upper zone mainly sand; bottom contains boulders)
	20.3 – 25.0	Competent bedrock to EOH
SRK-07-29	0 – 1.9	Ice
	1.0 – 11.9	Unconsolidated soupy glacial clay
	11.9 – 19.3	Consolidated glacial clay; no ice present
	19.3 – 27.4	Sandy till; occasional pebbles, cobbles and boulders
	27.4 – 33.0	Fractured bedrock; fracture density decreases with depth
	33.0 – 37.4	Competent bedrock to EOH
SRK-07-30	0.0 – 3.0	Ice (2.1 m) & water
	3.0 – 8.0	Lacustrine deposits / Unconsolidated glacial clay; visible Ice lenses
	8.0 – 16.0	Consolidated glacial clay; Vs present in upper zone
	16.0 –17.0	Sand
	17.0 – 32.0	Consolidated glacial clay
	32.0 – 37.3	Bedrock to EOH

Vx – Individual ice inclusion
Vs – Stratified or distinctly oriented ice formations
Vr – Random or irregularly oriented ice formations
EOH – End of Hole

Table 3: Drillhole Summary for Holes Below Patch Lake in the Vicinity of the Proposed Suluk and Rand Open Pits

Hole ID	Interval (m)	Description
SRK-07-38	0.0 – 2.3	Ice (0.2 m) & water
	2.3 – 6.1	Very loose lacustrine and glacial clay
	6.1 – 21.3	Grey unconsolidated glacial clay, black mottled texture
	21.3 – 22.9	Sandy silty clay. Sand fraction is coarse
	22.9 – 25.9	Grey unconsolidated glacial clay with black mottling
	25.9 – 29.0	Sand
	29.0 – 31.4	Well graded Till
	31.4 – 35.1	Unconsolidated glacial clay
	35.1 – 38.1	Well graded Till
	38.1 – 45.7	Bedrock to EOH
SRK-07-39	0.0 – 2.3	Ice (1.8 m) & water
	2.3 – 3.8	Light grey unconsolidated glacial clay; Vx
	3.8 – 6.7	Dark grey consolidated glacial clay (one ice lens at 4 m)
	6.7 – 7.1	Sand
	7.1 – 11.9	Competent bedrock to EOH
SRK-07-40	0.0 – 12.8	Ice (1.8 m) & water
	12.8 – 30.6	Consolidated Glacial Clay; 0.04 m ice lens at top
	30.6 – 36.6	Highly fractured bedrock
	36.6 – 39.6	Competent bedrock to EOH
SRK-07-40A	0.0 – 7.0	Ice (1.8 m) & water
	7.0 – 7.6	Unconsolidated Glacial Clay; Vx, 0.05 m massive ice at top
	7.6 – 11.6	No recovery (drill rods met no resistance)
	11.6 – 15.6	Well graded sand, clay to coarse sand; 0.08 m ice lens at 11.6 m
	15.6 – 19.8	Competent bedrock to EOH
SRK-07-41	0 – 1.8	Ice
	1.8 – 12.2	Water / Unconsolidated Sediments
	12.2 – 13.7	Unconsolidated Glacial Clay; 0.05 m ice lenses throughout
	13.7 – 15.2	Unconsolidated Glacial Clay
	15.2 – 18.9	Consolidated Glacial Clay
	18.9 – 30.5	Well graded Till
	30.5 – 36.6	Competent bedrock to EOH

Vx – Individual ice inclusion
Vs – Stratified or distinctly oriented ice formations
Vr – Random or irregularly oriented ice formations
EOH – End of Hole

Table 4: Pore Pressure Dissipation Test Results under Doris Lake

Hole	Duration (s)	Test Depth Below Ground Level (m)	Equilibrium Pore Pressure (m)	Inferred Soil Type (CPT Log)
SRK CPT08-06	2,000	10.00	10.1	Clayey Silt
	700	11.95	11.8	Silty Sand/Sand
SRK CPT08-07	2,000	5.00	Not Achieved	Sensitive Fines
	600	7.78	Not Achieved	Silty Sand/Sand
SRK CPT08-08	1,600	15.00	Not Achieved	Sensitive Fines
	3,600	20.60	Not Achieved	Silty Sand/Sand

Table 5: Pore Pressure Dissipation Test Results under Patch Lake

Hole	Duration (s)	Test Depth Below Ground Level (m)	Equilibrium Pore Pressure (m)	Inferred Soil Type
SRK CPT08-14	650	10.00	Not Achieved	Sensitive Fines
	2,200	10.50	Not Achieved	Sensitive Fines
	2,000	16.80	16.9	Silty Sand/Sand
SRK CPT08-15	1,200	10.00	Not Achieved	Sensitive Fines
SRK CPT08-16	1,800	10.00	Not Achieved	Sensitive Fines
	200	15.73	15.7	Silty Sand/Sand
SRK CPT08-17	2,000	8.53	Not Achieved	Sensitive Fines
	900	25.33	Not Achieved	Sandy Silt
SRK CPT08-19	2,000	10.00	Not Achieved	Clayey Silt
	600	14.43	14.3	Sandy Silt
SRK CPT08-20	6,000	15.33	Not Achieved	Sensitive Fines
	2,905	25.08	Not Achieved	Clayey Silt
	1,200	33.90	35.2	Sandy Silt
SRK CPT08-21	3,600	10.00	Not Achieved	Sensitive Fines
	2,500	20.00	Not Achieved	Sensitive Fines
	1,200	30.00	Not Achieved	Silt
SRK CPT08-23[1]	200	3.75	3.6	Data point does not exist
SRK CPT08-23	2,400	10.00	Not Achieved	Sensitive Fines
	2,700	20.00	Not Achieved	Sensitive Fines
	3,000	28.48	28.4	Silty Sand/Sand

1. At a depth of 3.75 m in SRK CPT08-23 there is lake water. This data point is therefore erroneous.

Table 6: Pore Pressure Dissipation Test Results under Spyder Lake

Hole	Duration (s)	Test Depth Below Ground Level (m)	Equilibrium Pore Pressure (m)	Inferred Soil Type
SRK CPT08-29	13,755	5.00	Not Achieved	Sensitive Fines
SRK CPT08-31	5,000	5.00	Not Achieved	Sensitive Fines
	200	9.03	9.2	Sand

Table 7: Summary of Typical Overburden Characteristics

Area	Element	Value/Comment
Thermal Properties	Permafrost Zone	Continuous
	Permafrost Temperature	-8°C to -11°C
	Thermal Gradient	11.4°C/km at Doris and 18°C/km at Boston
	Permafrost Depth	About 550 m at Doris and 560 m at Boston
	Active Layer Thickness	0.5 to 1.0 m
	Depth of Zero Annual Amplitude	10 m
	Pore Water Salinity	Variable, but typically between 34 and 45 ppm
	Recommended Design Freezing Point	-2°C
	Talik Conditions	Assume open talik under Doris, Patch and Spyder Lakes with vertical transition at the shoreline. Assume closed talik under Tail Lake.

Area	Element	Value/Comment
Indicator Properties	Natural Moisture Content	Variable, but typically greater than 40%
	Plastic Limit	38 to 58
	Liquid Limit	22 to 35
	Plasticity Index	16 to 19
	Clay Fraction	31 to 52%
	Clay Mineralogy	Illite, chlorite, albite, kaolin, quartz, plagioclase
	Primary Soil Type	Clay (CL)
	Specific Gravity	2.7
	Bulk Density	1.55 to 1.93 kg/m^3
	Shrinkage Limit	17 to 23
	Shrinkage Ratio	1.5 to 1.8
Engineering Properties	Volumetric Fraction of Unfrozen Water at -5ºC	0.3 to 0.6
	Peak Undrained Shear Strength	11 to 25 kPa
	Remoulded Shear Strength	0 to 4 kPa
	Clay Sensitivity	4 to 22
	Total Strength, cohesion	3 to 10 kPa
	Total Strength, friction angle	12 to 15º
	Effective Strength, cohesion	5 to 8 kPa
	Effective Strength, friction angle	26 to 31º
	Coefficient of Consolidation	0.59 to 1.03 m^2/yr
	Saturated Hydraulic Conductivity	3.55 to 4.61 x 10^{-10} m/sec

Appendix C – Hydraulic Conductivity Data

Test Information										Test Interval along hole (mah)		
ID1	Area	Sub-Area	Test Number	Date	Time test started	Time not drilled (hours)	QA/QC	Last checked by	Date checked	Top	Bottom	Interval length
08TDD628	Doris	Central	1	27-May-08	11:02	2:47	SRK	JA	Jul-2011	52.2	141.0	88.8
08TDD630	Doris	Central	1	29-May-08	9:20	1:58	SRK	JA	Jul-2011	32.2	62.0	29.8
08TDD630	Doris	Central	2	30-May-08	9:00	4:00	SRK	JA	Jul-2011	99.2	134.0	34.8
08TDD630	Doris	Central	3	31-May-08	15:30	1:00	SRK	JA	Jul-2011	138.2	164.0	25.8
08TDD630	Doris	Central	4	1-Jun-08	12:30	1:10	SRK	JA	Jul-2011	166.2	195.0	28.8
08TDD630	Doris	Central	5	3-Jun-08	14:30	2:20	SRK	JA	Jul-2011	201.2	263.0	61.8
08TDD631	Doris	Central	1	1-Jun-08	9:00	3:00	SRK	JA	Jul-2011	39.2	65.0	25.8
08TDD631	Doris	Central	2	3-Jun-08	17:30	5:30	SRK	JA	Jul-2011	96.2	122.0	25.8
08TDD632	Doris	North	1	8-Jun-08	10:30	2:00	SRK	JA	Jul-2011	48.2	122.0	73.8
08TDD632	Doris	North	2	11-Jun-08	8:20	3:20	SRK	JA	Jul-2011	174.2	245.0	70.8
08TDD632	Doris	North	3	13-Jun-08	13:30	3:00	SRK	JA	Jul-2011	264.2	338.0	73.8
08TDD632	Doris	North	4	14-Jun-08	23:55	2:35	SRK	JA	Jul-2011	339.2	401.0	61.8
08TDD633	Doris	Central	1	8-Jun-08	12:00	4:15	SRK	JA	Jul-2011	15.2	50.0	34.8
08TDD633	Doris	Central	2	11-Jun-08	11:30	2:00	SRK	JA	Jul-2011	156.2	218.0	61.8
08TDD633	Doris	Central	3	13-Jun-08	8:30	3:00	SRK	JA	Jul-2011	279.2	341.0	61.8
08TDD633	Doris	Central	4	15-Jun-08	4:00	2:30	SRK	JA	Jul-2011	357.2	401.0	43.8
08TDD634	Doris	North	1	#N/A	#N/A	#N/A	SRK	JA	Jul-2011	43.3	140.3	97.1
10WBW001	Doris	Central	1	17-Apr-10	14:45	2:45	SRK	JA	Jul-2011	25.0	63.0	38.0
10WBW001	Doris	Central	2	18-Apr-10	15:15	1:30	SRK	JA	Jul-2011	64.0	102.0	38.0
10WBW001	Doris	Central	3	19-Apr-10	14:00	1:00	SRK	JA	Jul-2011	121.5	144.5	23.0
10WBW001	Doris	Central	4	19-Apr-10	15:00	1:15	SRK	JA	Jul-2011	103.0	144.5	41.5
10WBW001	Doris	Central	5	20-Apr-10	13:15	1:55	SRK	JA	Jul-2011	154.0	204.8	50.8
10WBW001	Doris	Central	6	20-Apr-10	15:10	1:35	SRK	JA	Jul-2011	103.0	154.0	51.0

Test Information										Test Interval along hole (mah)		
ID1	Area	Sub-Area	Test Number	Date	Time test started	Time not drilled (hours)	QA/QC	Last checked by	Date checked	Top	Bottom	Interval length
10WBW001	Doris	Central	7	21-Apr-10	15:00	2:10	SRK	JA	Jul-2011	203.0	252.0	49.0
10WBW001	Doris	Central	8	22-Apr-10	12:45	1:20	SRK	JA	Jul-2011	252.0	279.0	27.0
10WBW001	Doris	Central	9	22-Apr-10	12:45	1:20	SRK	JA	Jul-2011	279.0	297.0	18.0
10WBW001	Doris	Central	10	23-Apr-10	14:15	1:50	SRK	JA	Jul-2011	297.0	345.0	48.0
10WBW001	Doris	Central	11	24-Apr-10	12:50	1:50	SRK	JA	Jul-2011	345.0	387.0	42.0
10WBW001	Doris	Central	12	25-Apr-10	15:05	2:25	SRK	JA	Jul-2011	387.0	422.5	35.5
10WBW001	Doris	Central	13	26-Apr-10	15:50	1:25	SRK	JA	Jul-2011	423.0	471.0	48.0
10WBW001	Doris	Central	14	28-Apr-10	16:05	1:25	SRK	JA	Jul-2011	471.0	564.0	93.0
10WBW001	Doris	Central	14a	28-Apr-10	16:05	1:25	SRK	JA	Jul-2011	548.0	564.0	16.1
10WBW001	Doris	Central	6a	20-Apr-10	15:10	1:35	SRK	JA	Jul-2011	103.0	204.8	101.8
10WBW001	Doris	Central	8a	22-Apr-10	12:45	1:20	SRK	JA	Jul-2011	252.0	297.0	45.0
10WBW002	Doris	North	1	21-Jun-10	11:00	2:30	SRK	JA	Jul-2011	402.3	482	79.7

Test Information										Test Interval along hole (mah)		
ID1	Area	Sub-Area	Test Number	Date	Time test started	Time not drilled (hours)	QA/QC	Last checked by	Date checked	Top	Bottom	Interval length
10WBW002	Doris	North	2	21-Jun-10	14:00	1:30	SRK	JA	Jul-2011	447.3	482	34.7
10WBW002	Doris	North	3	22-Jun-10	14:30	2:00	SRK	JA	Jul-2011	483.3	518	34.7
10WBW002	Doris	North	4	23-Jun-10	16:45	1:30	SRK	JA	Jul-2011	519.3	569	49.7
10WBW002	Doris	North	5	24-Jun-10	13:00	15:30	SRK	JA	Jul-2011	570.3	602	31.7
11TDD763	Doris	Central	1	11-Mar-11	12:30	2:10	SRK	JA	Jul-2011	52.3	207.0	154.7
11TDD764	Doris	Und Con	1	14-Mar-11	12:00	1:35	SRK	JA	Jul-2011	41.4	131.1	89.7
11TDD764	Doris	Und Con	2	19-Mar-11	14:30	3:30	SRK	JA	Jul-2011	264.3	341.1	76.8
11TDD765	Doris	Near Mine	1	23-Mar-11	16:30	2:00	SRK	JA	Jul-2011	310.3	322.0	11.7
11TDD765	Doris	Near Mine	2	26-Mar-11	15:30	1:30	SRK	JA	Jul-2011	398.1	437.2	39.1
11TDD766	Doris	Central	1	22-Mar-11	14:00	2:00	SRK	JA	Jul-2011	28.75	51.2	22.4
11TDD766	Doris	Central	2	23-Mar-11	14:45	1:15	SRK	JA	Jul-2011	101.75	130.5	28.7
11TDD766	Doris	Central	3	25-Mar-11	11:00	2:00	SRK	JA	Jul-2011	198.85	240.3	41.4
11TDD768	Doris	Central	1	30-Mar-11	13:15	1:15	SRK	JA	Jul-2011	69.4	104.2	34.8
11TDD768	Doris	Central	2	31-Mar-11	9:15	1:30	SRK	JA	Jul-2011	111.4	152.2	40.8
11TDD768	Doris	Central	3	2-Apr-11	18:30	2:15	SRK	JA	Jul-2011	225.4	242.2	16.8
11TDD768	Doris	Central	4	3-Apr-11	11:30	1:15	SRK	JA	Jul-2011	225.4	269.2	43.8
11TDD768	Doris	Central	5	3-Apr-11	13:10	1:20	SRK	JA	Jul-2011	234.4	269.2	34.8
11TDD768	Doris	Central	6	4-Apr-11	20:00	3:00	SRK	JA	Jul-2011	267.43	299.2	31.8
11TDD769	Doris	Central	1	7-Apr-11	17:00	5:30	SRK	JA	Jul-2011	30.4	38.2	7.8
11TDD769	Doris	Central	2	9-Apr-11	15:50	2:40	SRK	JA	Jul-2011	129.4	143.2	13.8
11TDD769	Doris	Central	3	10-Apr-11	14:00	2:00	SRK	JA	Jul-2011	189.4	200.2	10.8
11TDD769	Doris	Central	4	13-Apr-11	23:30	2:00	SRK	JA	Jul-2011	299.3	309	9.7

Test Information										Test Interval along hole (mah)		
ID1	Area	Sub-Area	Test Number	Date	Time test started	Time not drilled (hours)	QA/QC	Last checked by	Date checked	Top	Bottom	Interval length
11TDD769	Doris	Central	1ss	12-Apr-11	12:30	1:45	SRK	JA	Jul-2011	129.1	290	160.9
11TDD769	Doris	Central	2ss	12-Apr-11	14:00	9:30	SRK	JA	Jul-2011	153.1	290	136.9
11TDD771	Doris	Central	1	21-Apr-11	17:00	1:45	SRK	JA	Jul-2011	48.6	74.25	25.7
11TDD771	Doris	Central	2	24-Apr-11	15:15	2:15	SRK	JA	Jul-2011	112.3	135	22.7
11TDD771	Doris	Central	3	26-Apr-11	9:45	1:30	SRK	JA	Jul-2011	118.3	162	43.7
11TDD771	Doris	Central	4	27-Apr-11	8:30	1:30	SRK	JA	Jul-2011	151.3	198	46.7
11TDD771	Doris	Central	5	27-Apr-11	10:00	1:15	SRK	JA	Jul-2011	181.3	198	16.7
11TDD771	Doris	Central	6	1-May-11	10:00	1:30	SRK	JA	Jul-2011	232.1	294	61.9
11TDD772	Doris	Central	1	4-May-11	13:40	1:30	SRK	JA	Jul-2011	55.3	87.2	31.9
11TDD772	Doris	Central	2	6-May-11	11:00	1:05	SRK	JA	Jul-2011	88.3	147.2	58.9
11TDD772	Doris	Central	3	8-May-11	8:20	1:00	SRK	JA	Jul-2011	145.3	228.2	82.9
11TDD772	Doris	Central	4	11-May-11	1:20	0:45	SRK	JA	Jul-2011	283.3	321.2	37.9
11TDD772	Doris	Central	5	11-May-11	2:10	1:00	SRK	JA	Jul-2011	289.3	321.2	31.9
DCN-20-52118	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	123.5	123.5
DCN-20-52119	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	102.02	102.0
DCN-20-52123	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	114	114.0

Test Information										Test Interval along hole (mah)		
ID1	Area	Sub-Area	Test Number	Date	Time test started	Time not drilled (hours)	QA/QC	Last checked by	Date checked	Top	Bottom	Interval length
DCN-20-52125	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	174	174.0
DCN-20-52126	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	170	170.0
DCN-20-52127	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	177	177.0
DCN-20-52127	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	177	177.0
DCN-20-52128	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	174.02	174.0
DCN-20-52128	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	174.02	174.0
DCN-20-52221	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	128.67	128.7
DCN-20-52222	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	130.22	130.2
DCN-20-52223	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	145.1	145.1
DCN-20-52225	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	377.02	377.0
DCN-20-52228	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	140.22	140.2
DCN-20-52229	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	110.42	110.4
DCN-20-52230	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	170.7	170.7
DCN-20-52230	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	170.7	170.7

Test Information										Test Interval along hole (mah)		
ID1	Area	Sub-Area	Test Number	Date	Time test started	Time not drilled (hours)	QA/QC	Last checked by	Date checked	Top	Bottom	Interval length
DCN-20-52231	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	130	130.0
DCN-20-52232	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	125.3	125.3
DCN-20-52232	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	125.3	125.3
DCN-20-52234	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	143	143.0
DCN-20-52235	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	100	100.0
DCN-20-52236	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	338.7	338.7
DCN-20-52237	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	127.02	127.0
DCN-20-52238	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	129.5	129.5
DCN-20-52241	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	209.62	209.6
DCN-21-50206	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	89.72	89.7
DCN-21-50207	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	104.97	105.0
DCN-21-50211	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	111.7	111.7
DCN-21-50219	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	110.62	110.6
DCN-21-50221	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	102.52	102.5
DCN-21-50222	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	128.42	128.4

Test Information										Test Interval along hole (mah)		
ID1	Area	Sub-Area	Test Number	Date	Time test started	Time not drilled (hours)	QA/QC	Last checked by	Date checked	Top	Bottom	Interval length
DCN-21-50228	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	122	122.0
DCN-21-50240	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	133.32	133.3
DCN-21-50242	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	137.32	137.3
DCN-21-50246	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	167.42	167.4
DCN-21-50247	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	99	99.0
DCN-21-50248	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	217	217.0
DCN-21-50249	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	187.02	187.0
DCN-21-50250	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	107.8	107.8
DCN-21-50252	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	89	89.0
DCN-21-50264	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	104.02	104.0
DCN-21-50267	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	139.02	139.0
DCN-21-52246	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	115.32	115.3
DCN-21-52247	Doris	-	-	-	-	-	HR	GF	Apr-2022	0	119.62	119.6
HB-BCO-22-150	Doris	-	12	20-Nov-22	-	-	Lorax	GF	Oct-2024	22.3	378	355.7
HB-BCO-22-150	Doris	-	23	30-Nov-22	-	-	Lorax	GF	Oct-2024	376.3	699	322.7
HB-BCO-22-150	Doris	-	24	1-Dec-22	-	-	Lorax	GF	Oct-2024	22.3	699	676.7

Test Information				Test Interval - Vertical depth (mbgs)					Hydraulic Conductivity K (m/s)				Test Description			
ID1	Area	Sub-Area	Test Number	Hole Dip (degrees)	Top	Bottom	Interval length	Mid point	Max	Geomean	Min	Valid K (excl. poor or in prmfst)	Geol. Type	Test Zone Lithology	Test Quality	Subprmf, talik/ Frozen
08TDD628	Doris	Central	1	62.3	46.2	124.8	78.6	85.5	2.8E-08	2.0E-08	1.2E-08	**2.0E-08**	BDR	Deformation zone with basalts and foliation	G	-
08TDD630	Doris	Central	1	65.0	29.2	56.2	27.0	42.7	1.5E-07	1.2E-07	9.7E-08	**1.2E-07**	BDR	Basalt	G	-
08TDD630	Doris	Central	2	65.0	89.9	121.4	31.5	105.7	3.1E-07	2.4E-07	2.1E-07	**2.4E-07**	BDR	Foliated Basalt	G	-
08TDD630	Doris	Central	3	65.0	125.3	148.6	23.4	136.9	1.4E-08	1.3E-08	1.2E-08	**1.3E-08**	BDR	Foliated Basalt	G	-
08TDD630	Doris	Central	4	65.0	150.6	176.7	26.1	163.7	2.4E-08	2.2E-08	2.1E-08	**2.2E-08**	BDR	Basalt and diabase contact	G	-
08TDD630	Doris	Central	5	65.0	182.3	238.4	56.0	210.4	7.5E-08	6.6E-08	6.1E-08	**6.6E-08**	BDR	Basalt-diabase-gabbro; quartz veining	G	-
08TDD631	Doris	Central	1	80.0	38.6	64.0	25.4	51.3	4.6E-08	3.5E-08	2.1E-08	**3.5E-08**	BDR	Foliated Basalt w calcite and dolomite veining	G	-
08TDD631	Doris	Central	2	80.0	94.7	120.1	25.4	107.4	1.0E-08	3.5E-09	1.4E-09	**3.5E-09**	BDR	Basalt	G	-
08TDD632	Doris	North	1	61.0	42.2	106.7	64.5	74.4	5.0E-10	3.0E-10	1.7E-10	**#N/A**	BDR	Foliated Basalt	G	Frozen
08TDD632	Doris	North	2	61.0	152.4	214.3	61.9	183.3	2.4E-10	1.4E-10	5.5E-11	**#N/A**	BDR	Foliated to Massive Basalt; diabase contact; structure 178.7-180.2m - fault and gouge	G	Frozen
08TDD632	Doris	North	3	61.0	231.1	295.6	64.5	263.3	1.7E-10	1.2E-10	9.4E-11	**#N/A**	BDR	Foliated Basalt and Diabase	OK	Frozen
08TDD632	Doris	North	4	61.0	296.7	350.7	54.1	323.7	2.2E-10	9.6E-11	4.7E-11	**#N/A**	BDR	pillow basalt below flow basalts	OK	Frozen
08TDD633	Doris	Central	1	55.0	12.5	41.0	28.5	26.7	1.1E-09	3.6E-10	3.9E-10	**#N/A**	BDR	Foliated Basalt	G	Frozen
08TDD633	Doris	Central	2	55.0	128.0	178.6	50.6	153.3	2.6E-10	6.3E-11	#N/A	**#N/A**	BDR	Foliated Basalt	G	Frozen
08TDD633	Doris	Central	3	55.0	228.7	279.3	50.6	254.0	4.3E-09	3.4E-09	2.5E-09	**#N/A**	BDR	Foliated Basalt	G	Partially frozen
08TDD633	Doris	Central	4	55.0	292.6	328.5	35.9	310.5	2.1E-10	4.8E-11	2.2E-10	**4.8E-11**	BDR	Diabase/foliated basalt contact - mostly in diabase; RZ at 357m along upper contact	G	-
08TDD634	Doris	North	1	60.0	37.5	121.5	84.0	79.5	#N/A	3.0E-10	#N/A	**#N/A**	BDR	Basalt, basalt-dibase contact at 116 m	na	Frozen
10WBW001	Doris	Central	1	62.3	22.1	55.8	33.6	39.0	2.4E-06	1.4E-06	1.0E-06	**1.4E-06**	BDR	Fractured basalt. Loss of circulation during drilling in this zone.	G	-
10WBW001	Doris	Central	2	62.3	56.7	90.3	33.6	73.5	5.6E-07	4.7E-07	3.7E-07	**4.7E-07**	BDR	Fractured basalt with foliation. Jointed diabase in test zone, contact also jointed.	G	-
10WBW001	Doris	Central	3	62.3	107.6	127.9	20.4	117.8	6.5E-07	3.8E-07	2.2E-07	**#N/A**	BDR	[packer bybass ignore results]	P	-
10WBW001	Doris	Central	4	62.3	91.2	127.9	36.7	109.6	3.8E-07	2.8E-07	1.8E-07	**#N/A**	BDR	[packer bybass ignore results]	P	-
10WBW001	Doris	Central	5	62.3	136.4	181.3	45.0	158.8	3.3E-09	2.6E-09	2.1E-09	**2.6E-09**	BDR	Altered and foliated basalt, some heavy foliation but low joint frequency.	G	-
10WBW001	Doris	Central	6	62.3	91.2	136.4	45.2	113.8	6.7E-08	5.2E-08	4.1E-08	**5.2E-08**	BDR	Same as test 6a and 5.	G	-

Test Information				Test Interval - Vertical depth (mbgs)					Hydraulic Conductivity K (m/s)				Test Description			
ID1	Area	Sub-Area	Test Number	Hole Dip (degrees)	Top	Bottom	Interval length	Mid point	Max	Geomean	Min	Valid K (excl. poor or in prmfst)	Geol. Type	Test Zone Lithology	Test Quality	Subprmf, talik/ Frozen
10WBW001	Doris	Central	7	62.3	179.7	223.1	43.4	201.4	1.2E-07	9.4E-08	7.0E-08	9.4E-08	BDR	Basalt with quartz veins and two small dykes. Higher FF/m around dykes. Slow artesian flow from rods before test, shut in pressure low, artesian head ~ 3m above Doris Lk level estimate. Formation could be pressurized from other drills.	G	-
10WBW001	Doris	Central	8	62.3	223.1	247.0	23.9	235.1	2.0E-06	1.5E-06	1.3E-06	1.5E-06	BDR	Basalt, quartz and dolomite veins (2m) with fractures (no recovery). Main ore body. Loss of pressue during drilling, artesian flow source, and also reach limit of injection rate.	G	-
10WBW001	Doris	Central	9	62.3	247.0	263.0	15.9	255.0	1.2E-08	9.6E-09	7.7E-09	9.6E-09	BDR	Basalt, a few rubble zones or small faults between the altered baslat zones.	G	-
10WBW001	Doris	Central	10	62.3	263.0	305.5	42.5	284.2	8.5E-09	7.2E-09	5.8E-09	7.2E-09	BDR	Altered foliated basalt, intermediate dyke with broken contact, unaltered basalt.	G	-
10WBW001	Doris	Central	11	62.3	305.5	342.6	37.2	324.1	3.3E-08	2.7E-08	2.3E-08	2.7E-08	BDR	Basalt. Major diabase upper contact with only minor jointing.	G	-
10WBW001	Doris	Central	12	62.3	342.6	374.1	31.4	358.4	2.9E-11	1.4E-11	#N/A	1.4E-11	BDR	Diabase, very low FF/m.	G	-
10WBW001	Doris	Central	13	62.3	374.5	417.0	42.5	395.8	2.2E-11	1.4E-11	#N/A	1.4E-11	BDR	Diabase, very low FF/m.	G	-
10WBW001	Doris	Central	14	62.3	417.0	499.4	82.3	458.2	6.4E-09	5.1E-09	4.1E-09	5.1E-09	BDR	Major diabase lower contact, then fractured foliated vuggy basalt below. 83% of test zone is low FF/m diabase.	G	-
10WBW001	Doris	Central	14a	62.3	485.2	499.4	14.2	492.3	3.7E-08	2.9E-08	2.4E-08	2.9E-08	BDR	The result from test 14 if flow only came from the vuggy basalt below the diabase.	G	-
10WBW001	Doris	Central	6a	62.3	91.2	181.3	90.1	136.3	3.4E-08	2.7E-08	2.1E-08	2.7E-08	BDR	Competent basalt, small shears possible including alpha fault?, foliation. Test result determined by subtracting result from test 6a from test 5.	G	-
10WBW001	Doris	Central	8a	62.3	223.1	263.0	39.8	243.0	1.2E-06	9.2E-07	7.6E-07	9.2E-07	BDR	Same as test 8 and 9.	G	-
10WBW002	Doris	North	1	75.4	389.3	466.4	77.1	427.9	5.8E-10	2.6E-10	9.9E-11	2.6E-10	BDR	Basalt, foliated and unfoliated. Small diabase dyke. Very low fracture frequency. Possibly in permafrost	G	-

Test Information				Test Interval - Vertical depth (mbgs)					Hydraulic Conductivity K (m/s)				Test Description			
ID1	Area	Sub-Area	Test Number	Hole Dip (degrees)	Top	Bottom	Interval length	Mid point	Max	Geomean	Min	Valid K (excl. poor or in prmfst)	Geol. Type	Test Zone Lithology	Test Quality	Subprmf, talik/ Frozen
10WBW002	Doris	North	2	75.4	432.9	466.4	33.6	449.6	3.2E-09	9.6E-10	3.7E-10	**9.6E-10**	BDR	Unfoliated basalt. Small diabase dyke. Very low fracture frequency. Possibly in permafrost.	G	-
10WBW002	Doris	North	3	75.4	467.7	501.3	33.6	484.5	2.5E-10	7.3E-11	#N/A	**7.3E-11**	BDR	Basalt with small diabase dykes. Possibly in permafrost	G	-
10WBW002	Doris	North	4	75.4	502.5	550.6	48.1	526.6	3.9E-09	7.5E-10	1.2E-10	**7.5E-10**	BDR	Basalt, unfoliated. Low fracture frequency.	G	-
10WBW002	Doris	North	5	75.4	551.9	582.6	30.7	567.2	4.5E-09	1.6E-10	1.3E-10	**1.6E-10**	BDR	Basalt, unfoliated. Low fracture frequency.	G	-
11TDD763	Doris	Central	1	57.0	43.9	173.6	129.7	108.7	8.0E-08	7.3E-08	6.7E-08	**7.3E-08**	BDR	Mafic volcanic flow w 5m ore zone and 5m dyke	G	-
11TDD764	Doris	Und Con	1	59.0	35.5	112.4	76.9	73.9	2.3E-07	2.0E-07	1.8E-07	**2.0E-07**	BDR	Mafic volcanic pillow w Gabbro intrusion (95-114m), occasional mafic dyke	G	-
11TDD764	Doris	Und Con	2	53.0	211.1	272.4	61.3	241.7	5.2E-09	4.2E-09	2.8E-09	**4.2E-09**	BDR	Mafic volcanic pillow w ore zones (275-276m, 293-296m).	G	-
11TDD765	Doris	Near Mine	1	45.0	219.4	227.7	8.3	223.6	7.2E-09	4.4E-09	2.5E-09	**#N/A**	BDR	Diabase/basalt contact @ 318.5m	G	Frozen
11TDD765	Doris	Near Mine	2	44.0	276.5	303.7	27.2	290.1	5.7E-10	3.9E-10	1.0E-10	**#N/A**	BDR	Deep basalt	G	Frozen
11TDD766	Doris	Central	1	60.0	24.9	44.3	19.4	34.6	2.6E-06	1.8E-06	1.4E-06	**#N/A**	BDR	Mafic volcanic flow w felsic dyke (28-34m)	P	-
11TDD766	Doris	Central	2	60.0	88.1	113.0	24.9	100.5	1.7E-09	8.9E-10	8.5E-10	**8.9E-10**	BDR	Mafic volcanic pillow	G	-
11TDD766	Doris	Central	3	60.0	172.2	208.1	35.9	190.1	5.5E-08	4.2E-08	3.3E-08	**#N/A**	BDR	Mafic volcanic flow	P	-
11TDD768	Doris	Central	1	61.0	60.7	91.1	30.4	75.9	3.4E-07	1.3E-07	6.6E-08	**1.3E-07**	BDR	Mafic volcanic pillow foliated basalt w volcanic flow feldspar (82-86m)	OK	-
11TDD768	Doris	Central	2	61.0	97.4	133.1	35.7	115.3	6.9E-09	3.4E-09	1.2E-09	**3.4E-09**	BDR	Mafic volcanic pillow (foliated basalt) w ore zone (122-131m)	G	-
11TDD768	Doris	Central	3	61.0	197.1	211.8	14.7	204.5	#N/A	#N/A	#N/A	**#N/A**	BDR	mafic volcanic pillow	P	-
11TDD768	Doris	Central	4	58.0	191.2	228.3	37.1	209.7	2.3E-08	1.8E-08	1.5E-08	**1.8E-08**	BDR	Mafic volcanic pillow (foliated basalt) w ore zone (231-247m)	G	-
11TDD768	Doris	Central	5	57.0	196.6	225.8	29.2	211.2	1.9E-08	1.7E-08	1.5E-08	**1.7E-08**	BDR	Mafic volcanic pillow (foliated basalt) w ore zone (231-247m)	G	-
11TDD768	Doris	Central	6	57.0	224.3	250.9	26.6	237.6	6.2E-07	5.9E-07	5.7E-07	**5.9E-07**	BDR	Mafic volcanic pillow (foliated basalt)	G	-
11TDD769	Doris	Central	1	67.0	28.0	35.2	7.2	31.6	7.3E-07	5.9E-07	4.3E-07	**5.9E-07**	BDR	Mafic volcanic pillow (foliated basalt); major structure (20cm) shear zone	G	-
11TDD769	Doris	Central	2	65.0	117.3	129.8	12.5	123.5	3.3E-06	2.9E-06	2.5E-06	**2.9E-06**	BDR	Mafic volcanic pillow (foliated basalt); major joints with gouge present	G	-
11TDD769	Doris	Central	3	64.0	170.2	179.9	9.7	175.1	8.8E-07	7.5E-07	6.8E-07	**7.5E-07**	BDR	Mafic volcanic pillow (foliated basalt); natural rubble zone present	G	-
11TDD769	Doris	Central	4	65.0	271.3	280.0	8.8	275.7	#N/A	#N/A	#N/A	**#N/A**	BDR	Diabase/basalt contact	P	-

Test Information				Test Interval - Vertical depth (mbgs)					Hydraulic Conductivity K (m/s)				Test Description			
ID1	Area	Sub-Area	Test Number	Hole Dip (degrees)	Top	Bottom	Interval length	Mid point	Max	Geomean	Min	Valid K (excl. poor or in prmfst)	Geol. Type	Test Zone Lithology	Test Quality	Subprmf, talik/ Frozen
11TDD769	Doris	Central	1ss	66.0	117.9	264.9	147.0	191.4	2.8E-07	3.2E-08	#N/A	3.2E-08	BDR	Primarily Mafic volcanic pillow, w 3m gabbro and 5m diabase intrusion, + ore zone.	OK	-
11TDD769	Doris	Central	2ss	66.0	139.9	264.9	125.1	202.4	1.7E-07	1.0E-07	7.5E-08	1.0E-07	BDR	Primarily Mafic volcanic pillow, w 3m gabbro and 5m diabase intrusion, + ore zone.	G	-
11TDD771	Doris	Central	1	80.0	47.9	73.1	25.3	60.5	4.7E-08	3.4E-08	2.5E-08	3.4E-08	BDR	Mafic volcanic pillow (foliated basalt)	G	-
11TDD771	Doris	Central	2	79.0	110.2	132.5	22.3	121.4	2.6E-08	1.7E-08	1.2E-08	1.7E-08	BDR	Primarily quartz (ore zone) w mafic volcanic pillow (112-118m)	G	-
11TDD771	Doris	Central	3	78.0	115.7	158.5	42.7	137.1	1.7E-09	5.3E-10	5.2E-10	5.3E-10	BDR	Primarily quartz (discontinuous) w mafic volcanic pillow (153-162m); small structure	G	-
11TDD771	Doris	Central	4	78	148.0	193.7	45.7	170.8	3.0E-06	7.1E-08	2.8E-08	7.1E-08	BDR	Primarily volcanic pillow w quartz (ore zone, 166-171m); structure at ore zone contact	G	-
11TDD771	Doris	Central	5	78	177.3	193.7	16.3	185.5	4.5E-06	1.9E-07	7.3E-08	1.9E-07	BDR	Primarily quartz (discontinuous) w mafic volcanic pillow (181-186m); structure at contact with ore	G	-
11TDD771	Doris	Central	6	77	226.2	286.5	60.3	256.3	1.4E-07	9.5E-08	6.9E-08	9.5E-08	BDR	Mafic volcanic pillow (foliated basalt) to 286, above diabase; contact	G	-
11TDD772	Doris	Central	1	65	50.1	79.0	28.9	64.6	3.6E-08	3.3E-08	3.0E-08	3.3E-08	BDR	Mafic volcanic pillow w quartz (ore zone, 57-59m); fault C3PO, NW6	G	-
11TDD772	Doris	Central	2	65	80.0	133.4	53.4	106.7	1.9E-08	1.6E-08	1.2E-08	1.6E-08	BDR	Mafic volcanic pillow (foliated basalt)	G	-
11TDD772	Doris	Central	3	65	131.7	206.8	75.1	169.3	1.9E-08	1.7E-08	1.5E-08	1.7E-08	BDR	Mafic volcanic pillow (foliated basalt) w felsic dyke (200-202m)	G	-
11TDD772	Doris	Central	4	65	256.8	291.1	34.3	273.9	7.4E-08	6.0E-08	4.6E-08	6.0E-08	BDR	Mafic volcanic pillow (foliated basalt) w quartz (ore zone); fault Force 1	G	-
11TDD772	Doris	Central	5	65	262.2	291.1	28.9	276.7	5.8E-08	4.9E-08	4.1E-08	4.9E-08	BDR	Mafic volcanic pillow (foliated basalt) w quartz (ore zone)	G	-
DCN-20-52118	Doris	-	-	see survey and HR compil	#N/A	#N/A	0.8	73.0	-	1.0E-06	-	1.0E-06	BDR	Bedrock	na	-
DCN-20-52119	Doris	-	-	see survey and HR compil	#N/A	#N/A	19.8	97.4	-	1.0E-06	-	1.0E-06	BDR	Bedrock	na	-
DCN-20-52123	Doris	-	-	see survey and HR compil	#N/A	#N/A	42.0	118.9	-	4.0E-08	-	4.0E-08	BDR	Bedrock	na	-

Test Information				Test Interval - Vertical depth (mbgs)					Hydraulic Conductivity K (m/s)				Test Description			
ID1	Area	Sub-Area	Test Number	Hole Dip (degrees)	Top	Bottom	Interval length	Mid point	Max	Geomean	Min	Valid K (excl. poor or in prmfst)	Geol. Type	Test Zone Lithology	Test Quality	Subprmf, talik/ Frozen
DCN-20-52125	Doris	-	-	see survey and HR compil	#N/A	#N/A	32.7	102.7	-	2.0E-07	-	**2.0E-07**	BDR	Bedrock	na	-
DCN-20-52126	Doris	-	-	see survey and HR compil	#N/A	#N/A	63.1	136.0	-	4.0E-06	-	**4.0E-06**	BDR	Bedrock	na	-
DCN-20-52127	Doris	-	-	see survey and HR compil	#N/A	#N/A	2.8	73.1	-	8.0E-07	-	**8.0E-07**	BDR	Bedrock	na	-
DCN-20-52127	Doris	-	-	see survey and HR compil	#N/A	#N/A	2.8	73.1	-	4.0E-07	-	**4.0E-07**	BDR	Bedrock	na	-
DCN-20-52128	Doris	-	-	see survey and HR compil	#N/A	#N/A	32.7	107.4	-	5.0E-07	-	**5.0E-07**	BDR	Bedrock	na	-
DCN-20-52128	Doris	-	-	see survey and HR compil	#N/A	#N/A	32.7	107.4	-	2.0E-07	-	**2.0E-07**	BDR	Bedrock	na	-
DCN-20-52221	Doris	-	-	see survey and HR compil	#N/A	#N/A	0.5	72.2	-	3.0E-07	-	**3.0E-07**	BDR	Bedrock	na	-
DCN-20-52222	Doris	-	-	see survey and HR compil	#N/A	#N/A	40.4	116.6	-	4.0E-08	-	**4.0E-08**	BDR	Bedrock	na	-
DCN-20-52223	Doris	-	-	see survey and HR compil	#N/A	#N/A	69.8	146.5	-	6.0E-07	-	**6.0E-07**	BDR	Bedrock	na	-
DCN-20-52225	Doris	-	-	see survey and HR compil	#N/A	#N/A	66.4	141.1	-	1.0E-07	-	**1.0E-07**	BDR	Bedrock	na	-
DCN-20-52228	Doris	-	-	see survey and HR compil	#N/A	#N/A	0.5	70.2	-	3.0E-07	-	**3.0E-07**	BDR	Bedrock	na	-
DCN-20-52229	Doris	-	-	see survey and HR compil	#N/A	#N/A	22.7	90.9	-	2.0E-09	-	**2.0E-09**	BDR	Bedrock	na	-
DCN-20-52230	Doris	-	-	see survey and HR compil	#N/A	#N/A	22.7	90.9	-	3.0E-08	-	**3.0E-08**	BDR	Bedrock	na	-
DCN-20-52230	Doris	-	-	see survey and HR compil	#N/A	#N/A	36.2	110.9	-	1.0E-07	-	**1.0E-07**	BDR	Bedrock	na	-

Test Information				Test Interval - Vertical depth (mbgs)					Hydraulic Conductivity K (m/s)				Test Description			
ID1	Area	Sub-Area	Test Number	Hole Dip (degrees)	Top	Bottom	Interval length	Mid point	Max	Geomean	Min	Valid K (excl. poor or in prmfst)	Geol. Type	Test Zone Lithology	Test Quality	Subprmf, talik/ Frozen
DCN-20-52231	Doris	-	-	see survey and HR compil	#N/A	#N/A	49.2	125.9	-	1.0E-07	-	1.0E-07	BDR	Bedrock	na	-
DCN-20-52232	Doris	-	-	see survey and HR compil	#N/A	#N/A	49.2	125.9	-	5.0E-08	-	5.0E-08	BDR	Bedrock	na	-
DCN-20-52232	Doris	-	-	see survey and HR compil	#N/A	#N/A	2.8	69.5	-	4.0E-08	-	4.0E-08	BDR	Bedrock	na	-
DCN-20-52234	Doris	-	-	see survey and HR compil	#N/A	#N/A	17.6	93.6	-	1.0E-08	-	1.0E-08	BDR	Bedrock	na	-
DCN-20-52235	Doris	-	-	see survey and HR compil	#N/A	#N/A	104.3	177.6	-	3.0E-08	-	3.0E-08	BDR	Bedrock	na	-
DCN-20-52236	Doris	-	-	see survey and HR compil	#N/A	#N/A	52.8	132.2	-	9.0E-07	-	9.0E-07	BDR	Bedrock	na	-
DCN-20-52237	Doris	-	-	see survey and HR compil	#N/A	#N/A	59.6	142.8	-	1.0E-08	-	1.0E-08	BDR	Bedrock	na	-
DCN-20-52238	Doris	-	-	see survey and HR compil	#N/A	#N/A	68.2	144.3	-	1.0E-06	-	1.0E-06	BDR	Bedrock	na	-
DCN-20-52241	Doris	-	-	see survey and HR compil	#N/A	#N/A	8.6	84.9	-	3.0E-07	-	3.0E-07	BDR	Bedrock	na	-
DCN-21-50206	Doris	-	-	see survey and HR compil	#N/A	#N/A	29.6	108.2	-	2.0E-07	-	2.0E-07	BDR	Bedrock	na	-
DCN-21-50207	Doris	-	-	see survey and HR compil	#N/A	#N/A	11.0	85.1	-	4.0E-07	-	4.0E-07	BDR	Bedrock	na	-
DCN-21-50211	Doris	-	-	see survey and HR compil	#N/A	#N/A	22.7	93.6	-	5.0E-07	-	5.0E-07	BDR	Bedrock	na	-
DCN-21-50219	Doris	-	-	see survey and HR compil	#N/A	#N/A	12.2	82.4	-	1.0E-07	-	1.0E-07	BDR	Bedrock	na	-
DCN-21-50221	Doris	-	-	see survey and HR compil	#N/A	#N/A	36.5	108.7	-	2.0E-07	-	2.0E-07	BDR	Bedrock	na	-
DCN-21-50222	Doris	-	-	see survey and HR compil	#N/A	#N/A	30.4	258.5	-	1.0E-07	-	1.0E-07	BDR	Bedrock	na	-

Test Information				Test Interval - Vertical depth (mbgs)					Hydraulic Conductivity K (m/s)				Test Description			
ID1	Area	Sub-Area	Test Number	Hole Dip (degrees)	Top	Bottom	Interval length	Mid point	Max	Geomean	Min	Valid K (excl. poor or in prmfst)	Geol. Type	Test Zone Lithology	Test Quality	Subprmf, talik/ Frozen
DCN-21-50228	Doris	-	-	see survey and HR compil	#N/A	#N/A	53.5	133.9	-	5.0E-07	-	**5.0E-07**	BDR	Bedrock	na	-
DCN-21-50240	Doris	-	-	see survey and HR compil	#N/A	#N/A	54.7	135.9	-	1.0E-07	-	**1.0E-07**	BDR	Bedrock	na	-
DCN-21-50242	Doris	-	-	see survey and HR compil	#N/A	#N/A	73.0	165.0	-	7.0E-08	-	**7.0E-08**	BDR	Bedrock	na	-
DCN-21-50246	Doris	-	-	see survey and HR compil	#N/A	#N/A	24.5	115.4	-	2.0E-07	-	**2.0E-07**	BDR	Bedrock	na	-
DCN-21-50247	Doris	-	-	see survey and HR compil	#N/A	#N/A	71.8	164.6	-	3.0E-07	-	**3.0E-07**	BDR	Bedrock	na	-
DCN-21-50248	Doris	-	-	see survey and HR compil	#N/A	#N/A	70.4	163.0	-	3.0E-07	-	**3.0E-07**	BDR	Bedrock	na	-
DCN-21-50249	Doris	-	-	see survey and HR compil	#N/A	#N/A	25.6	117.1	-	6.0E-07	-	**6.0E-07**	BDR	Bedrock	na	-
DCN-21-50250	Doris	-	-	see survey and HR compil	#N/A	#N/A	38.7	202.1	-	1.0E-06	-	**1.0E-06**	BDR	Bedrock	na	-
DCN-21-50252	Doris	-	-	see survey and HR compil	#N/A	#N/A	25.8	253.8	-	9.0E-07	-	**9.0E-07**	BDR	Bedrock	na	-
DCN-21-50264	Doris	-	-	see survey and HR compil	#N/A	#N/A	8.9	216.4	-	4.0E-07	-	**4.0E-07**	BDR	Bedrock	na	-
DCN-21-50267	Doris	-	-	see survey and HR compil	#N/A	#N/A	34.0	108.2	-	9.0E-10	-	**9.0E-10**	BDR	Bedrock	na	-
DCN-21-52246	Doris	-	-	see survey and HR compil	#N/A	#N/A	46.1	120.9	-	2.0E-07	-	**2.0E-07**	BDR	Bedrock	na	-
DCN-21-52247	Doris	-	-	see survey and HR compil	#N/A	#N/A	79.4	151.6	-	1.0E-07	-	**1.0E-07**	BDR	Bedrock	na	-
HB-BCO-22-150	Doris	-	12	see survey and Lorax 2024	21.4	346.5	325.1	162.6	-	1.0E-10	-	**#N/A**	BDR	Bedrock	G	Frozen
HB-BCO-22-150	Doris	-	23	see survey and Lorax 2024	345.0	608.3	263.3	131.7	-	3.0E-10	-	**#N/A**	BDR	Bedrock	G	Frozen
HB-BCO-22-150	Doris	-	24	see survey and Lorax 2024	21.4	608.3	586.9	293.5	-	7.0E-10	-	**#N/A**	BDR	Bedrock	G	Frozen

Test Information										Test Interval along hole (mah)		
ID1	Area	Sub-Area	Test Number	Date	Time test started	Time not drilled (hh:mm)	QA/QC'ed by	Last checked by	Date checked	Top	Bottom	Interval length
10WBW003	Madrid South	Patch 14	1	1-Jul-10	17:15	2:45	SRK	JA	Jul-2011	96.4	173.2	76.8
10WBW003	Madrid South	Patch 14	2	2-Jul-10	17:30	2:12	SRK	JA	Jul-2011	171.4	248.2	76.8
10WBW003	Madrid South	Patch 14	3	3-Jul-10	12:39	2:46	SRK	JA	Jul-2011	246.4	293.2	46.8
10WBW003	Madrid South	Patch 14	4	5-Jul-10	10:00	2:26	SRK	JA	Jul-2011	291.4	392.2	100.8
10WBW003	Madrid South	Patch 14	5	6-Jul-10	16:00	2:00	SRK	JA	Jul-2011	393.4	458.2	64.8
10WBW003	Madrid South	Patch 14	6	7-Jul-10	16:00	2:10	SRK	JA	Jul-2011	456.4	500.2	43.8
10WBW003	Madrid South	Patch 14	7	9-Jul-10	10:00	1:45	SRK	JA	Jul-2011	498.4	548.2	49.8
11PSD259	Madrid South	Patch 14	1	9-Mar-11	13:30	2:00	SRK	JA	Jul-2011	53.3	161.0	107.7
11PSD260	Madrid South	Patch 14	1	10-Mar-11	14:00	1:03	SRK	JA	Jul-2011	51.3	183.0	131.7
11PSD260	Madrid South	Patch 14	2	18-Mar-11	12:40	1:18	SRK	JA	Jul-2011	553.3	618.0	64.7
11PSD260	Madrid South	Patch 14	3	18-Mar-11	14:30	1:25	SRK	JA	Jul-2011	493.3	618.0	124.7
11PSD261	Madrid South	Patch 14	1	15-Mar-11	14:40	1:35	SRK	JA	Jul-2011	126.3	212.0	85.7
11PSD261	Madrid South	Patch 14	2	19-Mar-11	11:20	1:15	SRK	JA	Jul-2011	357.2	431.0	73.8
11PSD263	Madrid South	Patch 14	1	21-Mar-11	13:30	1:30	SRK	JA	Jul-2011	96.3	125.0	28.7
11PSD267	Madrid South	Patch 14	1	25-Mar-11	15:00	1:40	SRK	JA	Jul-2011	101.0	152.0	51.0
11PSD267	Madrid South	Patch 14	2	28-Mar-11	12:30	1:30	SRK	JA	Jul-2011	270.3	350.0	79.7

Test Information										Test Interval along hole (mah)		
ID1	Area	Sub-Area	Test Number	Date	Time test started	Time not drilled (hh:mm)	QA/QC'ed by	Last checked by	Date checked	Top	Bottom	Interval length
11PSD267	Madrid South	Patch 14	3	28-Mar-11	14:00	1:00	SRK	JA	Jul-2011	309.3	350.0	40.7
11PSD269	Madrid South	Patch 14	1	31-Mar-11	14:45	0:45	SRK	JA	Jul-2011	117.3	191.0	73.7
11PSD269	Madrid South	Patch 14	2	31-Mar-11	15:30	1:45	SRK	JA	Jul-2011	168.3	191.0	22.7
11PSD270	Madrid South	Patch 14	1	8-Apr-11	17:10	2:00	SRK	JA	Jul-2011	450.2	524.0	73.8
11PSD271	Madrid South	Wolverine	1	1-Apr-11	16:50	2:00	SRK	JA	Jul-2011	127.2	201.0	73.8
11PSD275	Madrid South	Patch 14	1	14-Apr-11	12:20	1:10	SRK	JA	Jul-2011	82.3	129.0	46.7
11PSD275A	Madrid South	Patch 14	1	17-Apr-11	15:50	1:25	SRK	JA	Jul-2011	90.3	130.0	39.7
11PSD275A	Madrid South	Patch 14	2	18-Apr-11	16:00	2:00	SRK	JA	Jul-2011	167.3	217.0	49.7
11PSD275A	Madrid South	Patch 14	3	20-Apr-11	15:00	1:30	SRK	JA	Jul-2011	311.3	358.0	46.7
11PSD276	Madrid South	Patch 14	1	14-Apr-11	14:15	1:45	SRK	JA	Jul-2011	73.8	103.0	29.2
11PSD276A	Madrid South	Patch 14	1	16-Apr-11	13:00	2:30	SRK	JA	Jul-2011	101.3	124.4	23.1
11PSD276A	Madrid South	Patch 14	2	18-Apr-11	13:30	1:00	SRK	JA	Jul-2011	180.5	209.7	29.2
11PSD276A	Madrid South	Patch 14	3	18-Apr-11	14:30	1:30	SRK	JA	Jul-2011	134.8	209.7	74.9
11PSD276A	Madrid South	Patch 14	5	22-Apr-11	13:00	3:00	SRK	JA	Jul-2011	363.4	395.6	32.2
11PSD276A	Madrid South	Patch 14	4si	19-Apr-11	10:00	2:45	SRK	JA	Jul-2011	40.1	306.2	266.1
11PSD279	Madrid South	Patch 14	1	25-Apr-11	14:00	1:30	SRK	JA	Jul-2011	70.8	112.2	41.4
11PSD279	Madrid South	Patch 14	2	25-Apr-11	15:30	1:30	SRK	JA	Jul-2011	97.2	112.2	15.0
11PSD279	Madrid South	Patch 14	3	27-Apr-11	14:00	2:00	SRK	JA	Jul-2011	204.9	231.0	26.1
11PSD279	Madrid South	Patch 14	4	30-Apr-11	10:20	2:00	SRK	JA	Jul-2011	284.0	359.0	75.0
11PSD279	Madrid South	Patch 14	5	2-May-11	10:30	6:30	SRK	JA	Jul-2011	357.1	444.4	87.3
11PSD284	Madrid South	Patch 14	1	4-May-11	9:00	2:00	SRK	JA	Jul-2011	52.3	103.0	50.7
11PSD284	Madrid South	Patch 14	2	4-May-11	11:15	1:00	SRK	JA	Jul-2011	77.7	103.0	25.3
HBM-23-085	Madrid South	-	1	24-Mar-23	-	-	Lorax	GF	Apr-2022	51.2	86.0	34.8
HBM-23-085	Madrid South	-	2	26-Mar-23	-	-	Lorax	GF	Apr-2022	84.2	128.0	43.8

Test Information										Test Interval along hole (mah)		
ID1	Area	Sub-Area	Test Number	Date	Time test started	Time not drilled (hh:mm)	QA/QC'ed by	Last checked by	Date checked	Top	Bottom	Interval length
HBM-23-085	Madrid South	-	3	27-Mar-23	-	-	Lorax	GF	Apr-2022	126.2	170.0	43.8
HBM-23-085	Madrid South	-	4	28-Mar-23	-	-	Lorax	GF	Apr-2022	168.2	251.0	82.8
HBM-23-085	Madrid South	-	5	29-Mar-23	-	-	Lorax	GF	Apr-2022	249.2	257.0	7.8
HBM-23-085	Madrid South	-	5	29-Mar-23	-	-	Lorax	GF	Apr-2022	258.2	323.0	64.8
HBM-23-085	Madrid South	-	6	30-Mar-23	-	-	Lorax	GF	Apr-2022	384.2	477.2	93.0
HBM-23-085	Madrid South	-	8	31-Mar-23	-	-	Lorax	GF	Apr-2022	384.2	497.0	112.8
HBM-23-085	Madrid South	-	9	2-Apr-23	-	-	Lorax	GF	Apr-2022	477.2	497.0	19.8
HBM-23-085	Madrid South	-	10	2-Apr-23	-	-	Lorax	GF	Apr-2022	495.2	587.0	91.8
08PMD668	Madrid North	Naartok	1	4-Apr-23	#N/A	#N/A	Test sheet not found	JA	Jul-2011	165.3	176.0	10.8
08PMD669	Madrid North	Naartok	1	28-Jun-08	14:10	2:50	SRK	JA	Jul-2011	318.3	368.0	49.8
08PMD669	Madrid North	Naartok	2	30-Jun-08	10:45	4:15	SRK	JA	Jul-2011	369.3	428.0	58.8
08PMD669	Madrid North	Naartok	3	4-Jul-08	2:17	1:32	SRK	JA	Jul-2011	468.3	530.0	61.8
08PMD671	Madrid North	Naartok	1	#N/A	#N/A	#N/A	Test sheet not found	JA	Jul-2011	160.3	275.0	114.7
08PMD650	Madrid North	Suluk	1	1-May-08	9:45	1:45	SRK	JA	Jul-2011	32.0	36.0	4.0
08PMD650	Madrid North	Suluk	2	4-May-08	8:45	1:45	SRK	JA	Jul-2011	99.0	111.0	12.0
08PMD650	Madrid North	Suluk	3	5-May-08	12:00	4:00	SRK	JA	Jul-2011	133.0	156.0	23.0
08PMD650	Madrid North	Suluk	4	6-May-08	14:00	2:00	SRK	JA	Jul-2011	161.7	196.5	34.8

Test Information										Test Interval along hole (mah)		
ID1	Area	Sub-Area	Test Number	Date	Time test started	Time not drilled (hh:mm)	QA/QC'ed by	Last checked by	Date checked	Top	Bottom	Interval length
08PMD657a	Madrid North	Suluk	1	19-May-08	8:30	1:45	SRK	JA	Jul-2011	92.2	131.0	38.8
08PMD657a	Madrid North	Suluk	2	19-May-08	19:30	3:15	SRK	JA	Jul-2011	123.2	179.0	55.8
08PMD657a	Madrid North	Suluk	3	20-May-08	16:00	1:00	SRK	JA	Jul-2011	179.2	241.0	61.8
08PMD657a	Madrid North	Suluk	4	#N/A	#N/A	#N/A	SRK	JA	Jul-2011	294.0	300.0	6.0
08PSD142	Madrid North	Suluk	1	6-May-08	9:00	1:30	SRK	JA	Jul-2011	60.2	86.0	25.8
08PSD142	Madrid North	Suluk	2	7-May-08	20:30	1:50	SRK	JA	Jul-2011	156.0	182.0	26.0
08PSD142	Madrid North	Suluk	3	8-May-08	19:00	2:30	SRK	JA	Jul-2011	191.3	227.0	35.7
08PSD142	Madrid North	Suluk	4	8-May-08	16:40	1:20	SRK	JA	Jul-2011	248.2	284.0	35.8
08PSD142	Madrid North	Suluk	5	11-May-08	11:00	0:45	SRK	JA	Jul-2011	318.2	356.0	37.8
08PSD143B	Madrid North	Suluk	1	25-May-08	8:00	7:00	SRK	JA	Jul-2011	240.2	293.0	52.8
08PSD143B	Madrid North	Suluk	2	#N/A	#N/A	#N/A	SRK	JA	Jul-2011	#N/A	#N/A	#N/A
08PSD144	Madrid North	Suluk	1	#N/A	#N/A	#N/A	SRK	JA	Jul-2011	246.8	350.0	103.2
HBM-22-059	Madrid North	Naartok	1	2-Nov-22	-	-	Lorax	GF	Apr-2022	333.4	362.2	28.8
HBM-22-059	Madrid North	Naartok	2	3-Nov-22	-	-	Lorax	GF	Apr-2022	362.2	395.2	33.0
HBM-22-059	Madrid North	Naartok	3	4-Nov-22	-	-	Lorax	GF	Apr-2022	393.4	428.2	34.8
HBM-22-059	Madrid North	Naartok	4	5-Nov-22	-	-	Lorax	GF	Apr-2022	426.2	464.2	38.0
HBM-22-059	Madrid North	Naartok	5	7-Nov-22	-	-	Lorax	GF	Apr-2022	465.0	508.8	43.8
HBM-22-059	Madrid North	Naartok	6	8-Nov-22	-	-	Lorax	GF	Apr-2022	507.0	559.8	52.8
HBM-22-059	Madrid North	Naartok	7	10-Nov-22	-	-	Lorax	GF	Apr-2022	558.0	625.8	67.8
HBM-22-059	Madrid North	Naartok	8	12-Nov-22	-	-	Lorax	GF	Apr-2022	624.0	700.8	76.8
HBM-22-059	Madrid North	Naartok	9	12-Nov-22	-	-	Lorax	GF	Apr-2022	501.0	700.8	199.8

Test Information				Test Interval - Vertical depth (mbgs)					Hydraulic Conductivity K (m/s)				Test description	
ID1	Area	Sub-Area	Test Number	Hole Dip (degrees)	Top	Bottom	Interval length	Mid point	Max	Geomean	Min	Valid K (excl. poor or in prmfst)	Geol. type	Test Zone Lithology
10WBW003	Madrid South	Patch 14	1	67.3	88.9	159.8	70.9	124.4	5.5E-09	4.4E-09	3.2E-09	#N/A	BDR	Unstrained volcanics. Permafrost at top of interval.
10WBW003	Madrid South	Patch 14	2	67.3	158.1	229.0	70.9	193.5	6.3E-09	5.4E-09	4.6E-09	5.4E-09	BDR	Weakly strained, complex metavolcanics. Overall competent rock.
10WBW003	Madrid South	Patch 14	3	67.3	227.3	270.5	43.2	248.9	4.5E-11	2.3E-11	1.1E-11	2.3E-11	BDR	Widely intercalated felsic and mafic metavolcanics. Increasing strain. Very low / no flow despite broken zones and faults. Pre-plug blowout flows exceeded injection test flows.
10WBW003	Madrid South	Patch 14	4	67.3	268.8	361.8	93.0	315.3	7.3E-11	5.8E-11	4.5E-11	5.8E-11	BDR	Widely intercalated highly strained felsic and mafic metavolcanics. Some qtz/carbonate veining, some veins brecciated. Increasing strain. Otherwise competent rock Pre-plug blowout flows exceeded injection test flows.
10WBW003	Madrid South	Patch 14	5	67.3	362.9	422.7	59.8	392.8	3.6E-09	2.5E-09	1.8E-09	2.5E-09	BDR	Widely intercalated highly strained felsic and mafic metavolcanics. Permeability consistent with observations.
10WBW003	Madrid South	Patch 14	6	67.3	421.0	461.5	40.4	441.2	8.3E-10	7.4E-10	6.3E-10	7.4E-10	BDR	Continuation of metavolcanics. Permeability could be significantly less than shown. Pre-test leakage exceeded injection test flows.
10WBW003	Madrid South	Patch 14	7	67.3	459.8	505.7	45.9	482.8	1.5E-09	1.1E-09	8.7E-10	1.1E-09	BDR	Mafic metavolcancis and carbonate/qtz veinings. Low fracture count. Pre-plug blowout flows exceeded injection test fows.
11PSD259	Madrid South	Patch 14	1	54.5	43.4	131.1	87.7	87.2	3.6E-09	3.0E-09	2.5E-09	3.0E-09	BDR	Primarily mafic volcanic undifferentiated, w occasional felsic, dolomite and quartz zones
11PSD260	Madrid South	Patch 14	1	67.5	47.4	169.1	121.7	108.2	1.1E-10	8.3E-11	2.1E-11	8.3E-11	BDR	Mafic volcanic pillow and felsic volcanic flow w 3 ore zones
11PSD260	Madrid South	Patch 14	2	64.0	497.3	555.5	58.2	526.4	1.0E-09	7.1E-10	5.0E-10	7.1E-10	BDR	Felsic volcanic flow w ore zone (discontinuous, 554-580m)
11PSD260	Madrid South	Patch 14	3	63.0	439.5	550.6	111.1	495.1	4.7E-10	3.7E-10	3.1E-10	3.7E-10	BDR	Felsic volcanic flow w ore zone (discontinuous, 554-580m)
11PSD261	Madrid South	Patch 14	1	50.0	96.8	162.4	65.7	129.6	1.2E-08	9.8E-09	7.5E-09	9.8E-09	BDR	Mafic volcanic pillow (foliated basalt) w minor felsic volcanic and argillite, and quartz (175-177m)
11PSD261	Madrid South	Patch 14	2	45.0	252.6	304.8	52.2	278.7	1.8E-10	1.1E-10	6.8E-11	1.1E-10	BDR	Mafic volcanic pillow and felsic volcanic flow w quartz (discontinuous, 362-368m)
11PSD263	Madrid South	Patch 14	1	53.0	76.9	99.8	22.9	88.4	1.2E-07	9.5E-08	7.4E-08	9.5E-08	BDR	Mafic volcanic flow (to 112m) above felsic volcanic flow
11PSD267	Madrid South	Patch 14	1	48.0	75.1	113.0	37.9	94.0	4.6E-09	2.2E-09	7.2E-10	2.2E-09	BDR	Mafic volcanic and felsic flows w quartz (discontinuous ore zone 112-118m)
11PSD267	Madrid South	Patch 14	2	48.0	200.9	260.1	59.2	230.5	5.0E-09	2.6E-09	1.5E-09	2.6E-09	BDR	Mafic volcanic flow w quartz (discontinuous ore zone, 271-288m)

Test Information				Test Interval - Vertical depth (mbgs)					Hydraulic Conductivity K (m/s)				Test description	
ID1	Area	Sub-Area	Test Number	Hole Dip (degrees)	Top	Bottom	Interval length	Mid point	Max	Geomean	Min	Valid K (excl. poor or in prmfst)	Geol. type	Test Zone Lithology
11PSD267	Madrid South	Patch 14	3	48.0	229.9	260.1	30.2	245.0	9.8E-09	4.7E-09	2.1E-09	**4.7E-09**	BDR	Mafic volcanic flow
11PSD269	Madrid South	Patch 14	1	64.0	105.4	171.7	66.2	138.5	1.5E-06	5.9E-07	3.4E-07	**5.9E-07**	BDR	Mafic volcanic flow w quartz (3 discontinuous ore zone)
11PSD269	Madrid South	Patch 14	2	64.0	151.3	171.7	20.4	161.5	1.7E-08	1.2E-08	7.9E-09	**1.2E-08**	BDR	Mafic volcanic flow w quartz (discontinuous ore zone, 171-175m)
11PSD270	Madrid South	Patch 14	1	58.0	381.8	444.4	62.6	413.1	2.0E-10	7.4E-11	##N/A	**#N/A**	BDR	Mafic voclanic flow w quartz (2 ore zones, 451-452m, 482-483m)
11PSD271	Madrid South	Wolverine	1	69.0	118.8	187.6	68.9	153.2	2.0E-09	9.7E-10	5.7E-10	**9.7E-10**	BDR	Primarily felsic volcanic pillow
11PSD275	Madrid South	Patch 14	1	66.0	75.2	117.8	42.7	96.5	1.3E-07	1.1E-08	4.6E-09	**1.1E-08**	BDR	Felsic volcanic pillow w intervleaved quartz (ore zone)
11PSD275A	Madrid South	Patch 14	1	65.0	81.8	117.8	36.0	99.8	7.9E-09	5.3E-09	3.2E-09	**5.3E-09**	BDR	Felsic volcanic flow w quartz (ore zone 111-118m)
11PSD275A	Madrid South	Patch 14	2	62.0	147.7	191.6	43.9	169.7	5.1E-10	3.6E-10	1.6E-10	**3.6E-10**	BDR	Felsic volcanic flow above mafic volcanic flow (213-217m)
11PSD275A	Madrid South	Patch 14	3	59.0	266.8	306.9	40.0	286.9	4.3E-10	1.4E-10	#N/A	**1.4E-10**	BDR	Mafic volcanic flow w quartz (discontinuous ore zone, 311-323m, 257-158m)
11PSD276	Madrid South	Patch 14	1	57.0	61.9	86.4	24.5	74.1	2.4E-06	9.0E-07	5.2E-07	**9.0E-07**	BDR	Mafic volcanic (undifferentiated) w quartz (ore zone, 101-103m) based on 11PSD276A
11PSD276A	Madrid South	Patch 14	1	59.0	86.8	106.6	19.8	96.7	3.3E-08	2.1E-08	1.4E-08	**2.1E-08**	BDR	Mafic volcanic (undifferentiated) w quartz (101-103m, 120-124m)
11PSD276A	Madrid South	Patch 14	2	57.5	152.2	176.9	24.6	164.5	5.2E-09	4.4E-09	3.3E-09	**4.4E-09**	BDR	Felsic volcanic
11PSD276A	Madrid South	Patch 14	3	57.5	113.7	176.9	63.2	145.3	4.2E-08	3.4E-08	2.8E-08	**3.4E-08**	BDR	Felsic volcanic and quartz (ore zone, discontinuous, 139-175m)
11PSD276A	Madrid South	Patch 14	5	56.0	301.3	328.0	26.7	314.6	#N/A	#N/A	#N/A	**#N/A**	BDR	Primarliy mafic volcanic w quartz (ore zone, discontinuous, 333-348m)
11PSD276A	Madrid South	Patch 14	4si	57.0	33.6	256.8	223.2	145.2	#N/A	#N/A	#N/A	**#N/A**	BDR	Primarily mafic volcanic w quartz and felsic volcanic
11PSD279	Madrid South	Patch 14	1	60.0	61.3	97.2	35.9	79.2	1.7E-08	1.2E-08	7.7E-09	**1.2E-08**	BDR	Mafic volcanic pillow w quartz (ore zone, 102-108m)
11PSD279	Madrid South	Patch 14	2	60.0	84.2	97.2	13.0	90.7	#N/A	#N/A	#N/A	**#N/A**	BDR	Mafic volcanic pillow w quartz (ore zone, 102-108m)
11PSD279	Madrid South	Patch 14	3	56.0	169.9	191.5	21.6	180.7	2.3E-08	1.2E-08	6.5E-09	**1.2E-08**	BDR	Felisc volcanic flow (to 206m) over Mafic volcanic pillow
11PSD279	Madrid South	Patch 14	4	56.0	235.4	297.6	62.2	266.5	2.4E-09	2.1E-09	1.8E-09	**2.1E-09**	BDR	Felsic and mafic volcanic flows w quartz (discontinuous ore zone 348-258m)
11PSD279	Madrid South	Patch 14	5	53.0	285.2	354.9	69.7	320.1	#N/A	#N/A	#N/A	**#N/A**	BDR	Mafic volcanic pillow w quartz (discontinuous ore zones 373-382m, 243-432m)
11PSD284	Madrid South	Patch 14	1	67.0	48.1	94.8	46.7	71.5	1.7E-07	1.5E-07	1.2E-07	**1.5E-07**	BDR	Mafic volcanic undifferentiated (to 98m) overlying felsic volcanic flow w quartz (52-56m, 97-98m)
11PSD284	Madrid South	Patch 14	2	67.0	71.5	94.8	23.3	83.2	3.4E-07	3.2E-07	2.8E-07	**3.2E-07**	BDR	Mafic volcanic undifferentiated (to 98m) overlying felsic volcanic flow w quartz (97-98m)
HBM-23-085	Madrid South	-	1	See survey and Lorax 2023a	48.3	80.9	32.6	16.3	#N/A	3.0E-08	#N/A	**3.0E-08**	BDR	Mafic Volcanic
HBM-23-085	Madrid South	-	2	See survey and Lorax 2023a	79.2	119.9	40.7	20.4	#N/A	1.0E-08	#N/A	**1.0E-08**	BDR	Mafic Volcanic

Test Information				Test Interval - Vertical depth (mbgs)					Hydraulic Conductivity K (m/s)				Test description	
ID1	Area	Sub-Area	Test Number	Hole Dip (degrees)	Top	Bottom	Interval length	Mid point	Max	Geomean	Min	Valid K (excl. poor or in prmfst)	Geol. type	Test Zone Lithology
HBM-23-085	Madrid South	-	3	See survey and Lorax 2023a	118.2	158.3	40.1	20.1	#N/A	2.0E-10	#N/A	**2.0E-10**	BDR	Mafic Volcanic
HBM-23-085	Madrid South	-	4	See survey and Lorax 2023a	156.6	231.3	74.7	37.4	#N/A	6.0E-11	#N/A	**6.0E-11**	BDR	Mafic Volcanic / Argillite
HBM-23-085	Madrid South	-	5	See survey and Lorax 2023a	229.7	236.6	6.9	3.5	#N/A	1.0E-06	#N/A	**1.0E-06**	BDR	Argillite / Mafic Volcanic
HBM-23-085	Madrid South	-	5	See survey and Lorax 2023a	237.7	294.8	57.1	28.6	#N/A	5.0E-10	#N/A	**5.0E-10**	BDR	Mafic Volcanic
HBM-23-085	Madrid South	-	6	See survey and Lorax 2023a	347.9	426.7	78.8	39.4	#N/A	5.0E-10	#N/A	**5.0E-10**	BDR	Mafic Volcanic / Ultramafic Volcanic
HBM-23-085	Madrid South	-	8	See survey and Lorax 2023a	347.9	443.3	95.4	47.7	#N/A	6.0E-10	#N/A	**6.0E-10**	BDR	Mafic Volcanic / Ultramafic Volcanic / Argillite
HBM-23-085	Madrid South	-	9	See survey and Lorax 2023a	426.7	443.3	16.6	8.3	#N/A	1.0E-09	#N/A	**1.0E-09**	BDR	Ultramafic Volcanic / Argillite / Mafic Volcanic
HBM-23-085	Madrid South	-	10	See survey and Lorax 2023a	441.8	516.4	74.6	37.3	#N/A	2.0E-10	#N/A	**2.0E-10**	BDR	Mafic Volcanic / Ultramafic Volcanic
08PMD668	Madrid North	Naartok	1	55.0	135.4	144.2	8.8	139.8	#N/A	1.0E-09	#N/A	**#N/A**	BDR	Fault/Deformation zone; Lithologoical change with breccia at top
08PMD669	Madrid North	Naartok	1	65.0	288.4	333.5	45.1	311.0	5.2E-10	3.7E-10	2.3E-10	**#N/A**	BDR	PGP Basalt
08PMD669	Madrid North	Naartok	2	63.0	329.0	381.4	52.3	355.2	1.8E-09	1.5E-09	1.2E-09	**#N/A**	BDR	Flow basalt
08PMD669	Madrid North	Naartok	3	62.5	415.3	470.1	54.8	442.7	1.3E-09	1.1E-09	1.0E-09	**#N/A**	BDR	Flow basalt, ore
08PMD671	Madrid North	Naartok	1	60.0	138.8	238.2	99.3	188.5	#N/A	1.0E-10	#N/A	**#N/A**	BDR	altered basalts with joints and rubble zones between ~175-195m, and ~212-227m
08PMD650	Madrid North	Suluk	1	60.0	27.7	31.2	3.5	29.4	2.3E-09	5.6E-10	2.5E-10	**5.6E-10**	BDR	PGP Basalt; shattered structure (possibly mechanical); graphite and sediments present
08PMD650	Madrid North	Suluk	2	60.0	85.7	96.1	10.4	90.9	7.7E-09	5.6E-09	4.5E-09	**5.6E-09**	BDR	PGP Basalt; 4cm fault zone (no gouge)
08PMD650	Madrid North	Suluk	3	60.0	115.2	135.1	19.9	125.1	5.0E-09	4.0E-09	3.1E-09	**4.0E-09**	BDR	PGP Basalt
08PMD650	Madrid North	Suluk	4	60.0	140.0	170.2	30.1	155.1	#N/A	#N/A	#N/A	**#N/A**	BDR	PGP basalt

Test Information				Test Interval - Vertical depth (mbgs)					Hydraulic Conductivity K (m/s)				Test description	
ID1	Area	Sub-Area	Test Number	Hole Dip (degrees)	Top	Bottom	Interval length	Mid point	Max	Geomean	Min	Valid K (excl. poor or in prmfst)	Geol. type	Test Zone Lithology
08PMD657a	Madrid North	Suluk	1	55.0	75.5	107.3	31.8	91.4	9.2E-10	6.9E-10	4.7E-10	**6.9E-10**	BDR	Deformation Zone (Foliated basalt with med-strong sericitic ateration)
08PMD657a	Madrid North	Suluk	2	55.0	100.9	146.6	45.7	123.8	6.7E-10	5.1E-10	3.2E-10	**5.1E-10**	BDR	Deformation Zone (Foliated basalt with med-strong sericitic ateration)
08PMD657a	Madrid North	Suluk	3	55.0	146.8	197.4	50.6	172.1	4.9E-10	3.9E-10	3.3E-10	**3.9E-10**	BDR	Deformation Zone (Foliated basalt with med-strong sericitic ateration)
08PMD657a	Madrid North	Suluk	4	55.0	240.8	245.7	4.9	243.3	#N/A	#N/A	#N/A	**#N/A**	BDR	#N/A
08PSD142	Madrid North	Suluk	1	55.0	49.3	70.4	21.1	59.9	7.0E-09	5.5E-09	4.1E-09	**5.5E-09**	BDR	PGP Basalt
08PSD142	Madrid North	Suluk	2	55.0	127.8	149.1	21.3	138.4	1.0E-07	7.7E-08	6.5E-08	**7.7E-08**	BDR	Basalt, transition to PGP; set of joints with calcite crystals formed inside
08PSD142	Madrid North	Suluk	3	55.0	156.7	185.9	29.2	171.3	1.2E-08	9.0E-09	5.0E-09	**9.0E-09**	BDR	PGP Basalt with calcite veining
08PSD142	Madrid North	Suluk	4	55.0	203.3	232.6	29.3	218.0	1.0E-09	6.3E-10	4.5E-10	**6.3E-10**	BDR	PGP Basalt
08PSD142	Madrid North	Suluk	5	55.0	260.7	291.6	31.0	276.1	7.6E-10	6.0E-10	4.0E-10	**6.0E-10**	BDR	PGP Basalt & Deformation Zone
08PSD143B	Madrid North	Suluk	1	55.0	196.8	240.0	43.3	218.4	9.5E-10	8.0E-10	6.8E-10	**8.0E-10**	BDR	Deformation zone with basalts
08PSD143B	Madrid North	Suluk	2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	**#N/A**	BDR	#N/A
08PSD144	Madrid North	Suluk	1	53.0	197.1	279.5	82.4	238.3	#N/A	#N/A	#N/A	**#N/A**	BDR	#N/A
HBM-22-059	Madrid North	Naartok	1	66.0	313.1	339.6	26.4	13.2	#N/A	< 1E-10	#N/A	**#N/A**	BDR	Deformation zone
HBM-22-059	Madrid North	Naartok	2	66.0	339.6	369.8	30.1	15.1	#N/A	< 1E-10	#N/A	**#N/A**	BDR	Deformation zone
HBM-22-059	Madrid North	Naartok	3	66.0	368.2	399.6	31.4	15.7	#N/A	< 1E-10	#N/A	**#N/A**	BDR	Deformation zone
HBM-22-059	Madrid North	Naartok	4	66.0	397.8	431.4	33.7	16.8	#N/A	< 1E-10	#N/A	**#N/A**	BDR	Deformation zone
HBM-22-059	Madrid North	Naartok	5	66.0	432.2	470.4	38.2	19.1	#N/A	< 1E-10	#N/A	**#N/A**	BDR	Fresh rock
HBM-22-059	Madrid North	Naartok	6	66.0	468.9	514.5	45.6	22.8	#N/A	< 1E-10	#N/A	**#N/A**	BDR	Fresh rock
HBM-22-059	Madrid North	Naartok	7	66.0	513.0	571.0	58.0	29.0	#N/A	< 1E-10	#N/A	**#N/A**	BDR	Fresh rock
HBM-22-059	Madrid North	Naartok	8	66.0	569.5	634.5	65.1	32.5	#N/A	< 1E-10	#N/A	**#N/A**	BDR	Fresh rock -
HBM-22-059	Madrid North	Naartok	9	66.0	463.7	634.5	170.9	85.4	#N/A	< 1E-10	#N/A	**#N/A**	BDR	Fresh rock

Appendix D – CPT Data

Table 1: Pore Pressure Dissipation Test Results under Doris Lake

Hole	Duration (s)	Test Depth Below Ground Level (m)	Equilibrium Pore Pressure (m)	Inferred Soil Type (CPT Log)
SRK CPT08-06	2,000	10.00	10.1	Clayey Silt
	700	11.95	11.8	Silty Sand/Sand
SRK CPT08-07	2,000	5.00	Not Achieved	Sensitive Fines
	600	7.78	Not Achieved	Silty Sand/Sand
SRK CPT08-08	1,600	15.00	Not Achieved	Sensitive Fines
	3,600	20.60	Not Achieved	Silty Sand/Sand

Table 2: Pore Pressure Dissipation Test Results under Patch Lake

Hole	Duration (s)	Test Depth Below Ground Level (m)	Equilibrium Pore Pressure (m)	Inferred Soil Type
SRK CPT08-14	650	10.00	Not Achieved	Sensitive Fines
	2,200	10.50	Not Achieved	Sensitive Fines
	2,000	16.80	16.9	Silty Sand/Sand
SRK CPT08-15	1,200	10.00	Not Achieved	Sensitive Fines
SRK CPT08-16	1,800	10.00	Not Achieved	Sensitive Fines
	200	15.73	15.7	Silty Sand/Sand
SRK CPT08-17	2,000	8.53	Not Achieved	Sensitive Fines
	900	25.33	Not Achieved	Sandy Silt
SRK CPT08-19	2,000	10.00	Not Achieved	Clayey Silt
	600	14.43	14.3	Sandy Silt
SRK CPT08-20	6,000	15.33	Not Achieved	Sensitive Fines
	2,905	25.08	Not Achieved	Clayey Silt
	1,200	33.90	35.2	Sandy Silt
SRK CPT08-21	3,600	10.00	Not Achieved	Sensitive Fines
	2,500	20.00	Not Achieved	Sensitive Fines
	1,200	30.00	Not Achieved	Silt
SRK CPT08-23[1]	200	3.75	3.6	Data point does not exist
SRK CPT08-23	2,400	10.00	Not Achieved	Sensitive Fines
	2,700	20.00	Not Achieved	Sensitive Fines
	3,000	28.48	28.4	Silty Sand/Sand

1. At a depth of 3.75 m in SRK CPT08-23 there is lake water. This data point is therefore erroneous.

Table 3: Pore Pressure Dissipation Test Results under Spyder Lake

Hole	Duration (s)	Test Depth Below Ground Level (m)	Equilibrium Pore Pressure (m)	Inferred Soil Type
SRK CPT08-29	13,755	5.00	Not Achieved	Sensitive Fines
SRK CPT08-31	5,000	5.00	Not Achieved	Sensitive Fines
	200	9.03	9.2	Sand

Appendix E – Groundwater Quality Data

Field Sample ID	Deposit	Sample Location	Sample Zone	Location of port in zone	Zone port drillhole depth	Zone port vertical depth	Field Data	Field pH	Field Electrical Conductivity	Field Turbidity	Field DO	Field Temperature	Field Salinity	Field TDS	Field ORP	ALS DATA	ALS File No.	ALS Date Sampled	ALS Time Sampled	ALS Lab Reference	Physical Tests	Conductivity (EC)	Density	Hardness (as CaCO3)	pH	Salinity (EC)	Total Dissolved Solids	
					m	m		pH Units	mS/cm	NTU	mg/L	°C	%	g/L	mV							uS/cm	kg/m3	mg/L	pH	g/L	mg/L	
10WBW004-123	Boston	10WBW004	6	Meas Port Upper	295.7	271.54		6.26	37.2	6.9	13.54	5.5	2.3	23	163		L957001	18-NOV-10	18:00	L957001-1		30200	1.02	13900	7.05	-	28500	
10WBW004-124	Boston	10WBW004	6	Meas Port Upper	295.7	271.54		5.43	39	0.05	19.97	6.37	2.4	23.5	263		L960194	25-NOV-10	18:00	L960194-1		30900	1.00	12900	6.66	-	32000	
10WBW004-125	Boston	10WBW004	6	Meas Port Upper	295.7	271.54		5.43	39	0.05	19.97	6.37	2.4	23.5	263		L960194	25-NOV-10	18:00	L960194-2		30700	1.02	12700	6.68	-	30800	
10WBW004-126	Boston	10WBW004	6	Meas Port Lower	304.8	379.6		6.83	40.4	40.0	19.08	10.52	2.5	25.0	161		L960194	26-NOV-10	19:00	L960194-3		33800	1.02	12100	6.81	-	33500	
10WBW004-128	Boston	10WBW004	6	Meas Port Upper	295.7	271.54		6.38	44.0	0.0	>20	3.68	2.7	27	199		L960194	27-NOV-10	16:00	L960194-4		31400	1.02	12100	6.96	-	31700	
10WBW004-129	Boston	10WBW004	6	Meas Port Lower	304.8	379.6		6.64	40.3	0.0	15.85	15.13	2.6	25	251		L960194	28-NOV-10	10:30	L960194-5		33000	1.02	12600	7.02	-	33900	
10WBW004-130	Boston	10WBW004	6	Meas Port Lower	304.8	379.6		6.80	40.0	0.0	19.37	9.23	2.5	24	164		L960194	29-NOV-10	11:00	L960194-6		33000	1.02	13300	7.09	21.0	33300	
10WBW004-131	Boston	10WBW004	6	Meas Port Upper	295.7	271.54		6.30	39.1	0.2	14.71	6.88	2.4	24	195		L960194	30-NOV-10	09:00	L960194-7		31800	1.01	11800	7.03	20.2	32300	
10WBW004-Z6-312	Boston	10WBW004	6	Meas Port Upper	295.7	271.54		6.61	35.2	25.2	9.4	18.9	2.3	21.7	-28.7		L998529	21-APR-11	16:00	L998529-3		30800	1.02	14300	6.63	-	24200	
10WBW004-Z6-313	Boston	10WBW004	6	Meas Port Upper	295.7	271.54		6.61	35.2	25.2	9.4	18.9	2.3	21.7	-28.7		L998529	21-APR-11	16:00	L998529-4		30700	1.02	12900	6.59	-	25000	
10WBW004-Z6-314	Boston	10WBW004	6	Meas Port Lower	304.8	379.6		6.51	41.3	38.35	7.75	16.65	2.65	25	-17.5		L998529	22-APR-11	08:00	L998529-5		41000	1.02	14800	6.41	-	33500	
10WBW004-Z6-315	Boston	10WBW004	6	Meas Port Upper	295.7	271.54		7.04	36	7.6	8.8	15.21	2.3	22	-67		L998529	22-APR-11	15:40	L998529-6		31200	-	13800	6.94	-	25100	
10WBW004-Z6-316	Boston	10WBW004	6	Meas Port Lower	304.8	379.6		-	-	-	-	-	-	-	-		L998529	23-APR-11	09:00	L998529-7		34200	-	14400	6.91	-	27500	
10WBW004-Z6-317	Boston	10WBW004	6	Meas Port Upper	295.7	271.54		7.13	36	36.7	7.86	17.2	2.3	22	-80		L998529	23-APR-11	15:00	L998529-8		31400	1.02	12900	7.00	-	25300	
10WBW004-Z6-318	Boston	10WBW004	6	Meas Port Lower	304.8	379.6		-	-	-	-	-	-	-	-		L998529	23-APR-11	16:30	L998529-9		34400	1.02	13700	6.98	-	27700	
10WBW004-Z6-404	Boston	10WBW004	6	Bottom	305	279.60		6.63	33.1	244	13.58	7.87	2	20	36		-	23-JUN-11	12:00	L1023975-1		36500	1.02	11900	6.67	-	38800	
10WBW004-Z6-405	Boston	10WBW004	6	Bottom	305	279.60		6.63	33.1	244	13.58	7.87	2	20	36		-	23-JUN-11	12:00	L1023975-2		36600	1.02	11900	6.72	-	39000	
10WBW004-Z6-406	Boston	10WBW004	6	Top	296	271.54		7.12	30.5	86.6	13.02	11.45	1.9	19	-17		-	23-JUN-11	16:00	L1023975-3		32100	1.02	11400	7	-	35300	
10WBW004-Z6-508	Boston	10WBW004	6	Bottom	305	279.60		7.12	36.07	5.1	11.04	6.28	22.47	23.44	-63		-	15-SEP-11	09:00	L1060807-1		37400	1	14300	6.66	-	28200	
10WBW004-Z6-509	Boston	10WBW004	6	Top	296	271.54		7.04	31.27	0.5	9.57	8.86	19.34	20.31	-35.7		-	15-SEP-11	12:00	L1060807-2		31500	1.02	13000	6.74	-	21900	
10WBW001-02b	Doris Central	10WBW001	6	Meas Port Upper	246.0	221.1		6.975	>20	-	-	-	-	-	-		L909782	09-JUL-10	14:00	L909782-2		52800	1.02	9980	6.90	-	36900	
10WBW001-03b	Doris Central	10WBW001	10	Meas Port Upper	63.5	57.4		7.765	>20	-	-	-	-	-	-		L909782	09-JUL-10	14:00	L909782-3		27600	1.00	4960	7.37	-	18700	
10WBW001-04b	Doris Central	10WBW001	10	Meas Port Upper	63.5	57.4		7.8	>20	-	-	-	-	-	-		L909782	09-JUL-10	14:00	L909782-4		27500	1.01	5060	7.42	-	18500	
10WBW001-12	Doris Central	10WBW001	10	Pump Port Lower	107.50	97		7.5	>20	-	-	4.5	-	-	-		L911681	20-JUL-01	09:49	L911681-3		41400	1.01	7150	7.38	-	27700	
10WBW001-14	Doris Central	10WBW001	10	Pump Port Lower	107.50	97		7.56	>20	-	-	4.6	-	-	-		L911681	20-JUL-01	16:30	L911681-5		45700	1.02	7750	7.34	-	31000	
10WBW001-15	Doris Central	10WBW001	10	Pump Port Lower	107.50	97		7.39	>20	-	-	8	-	-	-		L915201	21-JUL-10	16:28	L915201-1		46500	-	8360	7.35	-	32200	
10WBW001-16	Doris Central	10WBW001	10	Pump Port Lower	107.50	97		7.39	>20	-	-	8	-	-	-		L915201	21-JUL-10	17:28	L915201-2		46600	-	9250	7.39	-	32700	
10WBW001-28	Doris Central	10WBW001	6	Pump Port Lower	274.00	246		8.04	>20	-	-	2.8	-	-	-		L915201	26-JUL-10	16:23	L915201-16		41600	-	7280	7.58	-	29000	
10WBW001-31	Doris Central	10WBW001	6	Pump Port Lower	274.00	246		7.78	>20	-	-	2.6	-	-	-		L915201	27-JUL-10	10:35	L915201-19		42900	-	8550	7.51	-	30000	
10WBW001-33	Doris Central	10WBW001	6	Pump Port Lower	274.00	246		7.52	>20	-	-	3.1	-	-	-		L915201	27-JUL-10	15:21	L915201-21		44400	-	8870	7.43	-	30400	
10WBW001-36	Doris Central	10WBW001	6	Meas Port Upper	246.0	221.1		8.27	>20	-	-	9.6	-	-	-		L917645	05-AUG-10	09:00	L917645-2		24600	-	4760	7.83	-	19600	
10WBW001-37	Doris Central	10WBW001	10	Meas Port Upper	63.5	57.4		7.86	>20	-	-	8.3	-	-	-		L917645	05-AUG-10	11:40	L917645-3		30300	-	6030	7.47	-	23100	
10WBW001-101	Doris Central	10WBW001	6	Meas Port Upper	246.0	221.1		7.91	40.3	118	12.23	7.44	2.5	25	10		L946743	19-OCT-10	15:00	L946743-2		34900	1.01	6720	7.79	22.10	28900	
10WBW001-102	Doris Central	10WBW001	10	Meas Port Upper	63.5	57.4		7.55	40.60	39.35	6.44	5.09	2.45	24.50	-151.50		L946743	20-OCT-10	11:00	L946743-3		33800	1.01	6360	7.46	-	28300	
10WBW001-103	Doris Central	10WBW001	6	Pump Port Lower	274.00	246		5.59	60.13	7.30	11.52	2.66	3.77	36.00	-115.00		L948685	25-OCT-10	00:00	L948685-2		48500		10000	7.04	32.4	35400	
10WBW001-105	Doris Central	10WBW001	10	Meas Port Upper	63.5	57.4		7.50	50.20	36.85	10.44	6.19	3.20	30.00	-117.00		L949713	29-OCT-10	15:00	L949713-1		43300	1.01	8900	7.44	28.5	34500	
10WBW001-107	Doris Central	10WBW001	6	Pump Port Lower	274.00	246		6.35	62.75	6.20	12.33	1.73	3.90	37.50	-110.00		L949713	30-OCT-10	14:00	L949713-4		48800	1.03	9760	7.46	32.6	39000	
10WBW001-108	Doris Central	10WBW001	6	Meas Port Upper	246.0	221.1		7.29	44.10	38.90	8.26	6.47	2.75	27.00	-55.00		L951724	01-NOV-10	15:00	L951724-2		37000	1.03	7340	7.59	23.5	25500	
10WBW001-Z1-300	Doris Central	10WBW001	1	Meas Port Upper	548.0	484.8		7.79	>40	-	-	11.7	-	-	-		L994212	06-APR-11	09:00	L994212-1		46700	1.03	12200	7.09	-	41200	
10WBW001-Z6-301	Doris Central	10WBW001	6	Meas Port Upper	246.0	221.1		7.71	>20	-	-	8.5	-	-	-		L994212	06-APR-11	14:00	L994212-2		45500	1.03	8720	7.67	-	36100	
10WBW001-Z10-302	Doris Central	10WBW001	10	Meas Port Upper	63.5	57.4		7.32	>20	-	-	9.3	-	-	-		L994212	06-APR-11	09:00	L994212-3		47000	1.03	8810	7.59	-	37800	
10WBW001-Z10-303	Doris Central	10WBW001	10	Meas Port Lower	105.0	94.8		7.22	>20	-	-	8.2	-	-	-		L994212	07-APR-11	11:00	L994212-4		51800	1.03	11000	7.56	-	40800	
10WBW001-Z6-304	Doris Central	10WBW001	6	Meas Port Lower	271.0	243.2		7.07	>20	-	-	11.7	-	-	-		L994212	08-APR-11	16:00	L994212-5		57300	1.03	11800	7.37	-	48300	
10WBW001-Z10-500	Doris Central	10WBW001	10	Top	63.00	57.43		6.43	36.26	99.1	9.75	11.46	31.86	31.8	227.5		-	11-SEP-11	15:00	L1060818-1		47600	1.02	9000	7.68	-	32400	
10WBW001-Z1-501	Doris Central	10WBW001	1	Bottom	548.00	484.82		6.93	48.32	-1.1	9.24	6.04	30.8	31.29	199.7		-	12-SEP-11	07:00	L1060818-2		48500	1.02	12300	7.21	-	36500	
10WBW001-Z6-502	Doris Central	10WBW001	6	Top	246.00	221.06		6.91	50.02	12.3	9.35	5.65	32.12	32.43	-66.7		-	12-SEP-11	10:30	L1060818-3		49300	1.02	9220	7.63	-	34600	
10WBW001-Z6-503	Doris Central	10WBW001	6	Top	246.00	221.06		6.91	50.02	12.3	9.35	5.65	32.12	32.43	-66.7		-	12-SEP-11	10:30	L1060818-4		47000	1.02	9270	7.35	-	33500	
10WBW001-Z6-504	Doris Central	10WBW001	6	Bottom	271.00	243.15		7.07	62.28	1.8	11.37	3.3	40.54	40.45	-70.4		-	12-SEP-11	02:00	L1060818-5		56800	1	12200	7.09	-	40200	
10WBW001-Z10-505	Doris Central	10WBW001	10	Bottom	105.0	94.8		7.11	56.38	0.9	9.55	3.3	36.29	36.63	20.5		-	12-SEP-11	07:00	L1060818-6		51300	1.03	10300	7.23	-	41400	
10WBW001-Z10	Doris Central	10WBW001	10	Top	63.5	57.43		6.73	41.8	0	5.39	11.9	2.63	25.5	-55		L1193743	6-Aug-12	14:00	L1193743-1		44200	1.02	8150	7.61	-	32200	
10WBW001-Z01	Doris Central	10WBW001	1	Top	548	484.82		6.54	44.2	40.8	8.71	13.75	2.81	26.9	36		L1193743	6-Aug-12	0:00	L1193743-2		45700	1.02	11300	7.36	-	44400	
10WBW001-Z6	Doris Central	10WBW001	6	Top	246	221.06		6.68	48.9	6.5	6.68	13.04	3.14	29.8	-58		L1193743	7-Aug-12	8:45	L1193743-4		51800	1.02	9650	7.49	-	40800	
10WBW001-01-2022	Doris Central	10WBW001	1	Top	548	484.8		6.91	over range	-	-	3.8	over range	over range	95		YL2201796	4-Oct-22	16:00	YL2201796-003		47200	-	11200	6.7	-	38100	
10WBW001-01-2023	Doris Central	10WBW001	1	Top	548	484.8		7.24	45.479	-	10.27	11.6	2.929	over range	80.4		EO2306938	31-Jul-23	14:00	EO2306938-004		23700	-	12100	6.78	-	29600	
10WBW001-01-2024	Doris Central	10WBW001	1	Top	548	484.8		7.2	43.383	-	N/A	4.1	2.753	over range	48		EO2405676	4-Jul-24	13:00	EO2405676-001		N/A	-	12200	N/A	-	31400	
10WBW001-06-2022	Doris Central	10WBW001	6	Top	246	221.1		7.43	17.38	-	-	3.5	over range	-	135		YL2201796	4-Oct-22	14:25	YL2201796-002		17300	-	2140	8.22	-	13400	
10WBW001-06-2023	Doris Central	10WBW001	6	Top	246	221.1		7.6	17.89	-	-	12.5	1.01	-	8.1		EO2306938	31-Jul-23	11:00	EO2306938-003		11900	-	2450	7.75	-	10300	
10WBW001-06-2024	Doris Central	10WBW001	6	Top	246	221.1		7.5	16.32	-	-	7.97	0.945	-	-77		EO2405676	4-Jul-24	9:50	EO2405676-003		N/A	-	2060	-	-	10200	
10WBW001-10-2022	Doris Central	10WBW001	10	Top	63.5	57.43		8.18	0.00315	-	-	3	-	3.1	136		YL2201796	4-Oct-22	12:20	YL2201796-001		-	-	206	-	-	-	
10WBW001-10-2023	Doris Central	10WBW001	10	Top	63.5	57.43		8.15	0.00333	-	8.46	10.6	0.176	0.00265	90.9		EO2306938	31-Jul-23	8:30	EO2306938-001		3430	-	215	8.23	-	1910	
10WBW001-10-2024	Doris Central	10WBW001	10	Top	63.5	57.43		8.21	3.512	-	8.79	3.7	0.182	-	79		EO2405676	4-Jul-24	15:30	EO2405676-005		N/A	-	222	N/A	-	1920	
10WBW001-01b	Doris Lower	10WBW001	1	Meas Port Upper	548.0	484.8		8.03	>20	-	-	-	-	-	-		L909782	08-JUL-10	15:00	L909782-1		47600	1.02	11700	7.67	-	33100	
10WBW001-17	Doris Lower	10WBW001	1	Meas Port Upper	548.0	484.8		8	>20	-	-	14.4	-	-	-		L915201	25-JUL-10	11:25	L915201-3		47400	-	11500	7.91	-	32400	
10WBW001-20	Doris Lower	10WBW001	1	Pump Port Middle	554.0	490.8		8.19	>20	-	-	3.9	-	-	-		L915201	25-JUL-10	17:11	L915201-6		47500	-	10900	7.83	-	33200	
10WBW001-25	Doris Lower	10WBW001	1	Pump Port Middle	554.0	490.8		8.24	>20	-	-	-	-	-	-		L915201	25-JUL-10	12:37	L915201-13		47600	-	11500	7.65	-	33300	
10WBW001-26	Doris Lower	10WBW001	1	Pump Port Middle	554.0	490.8		8.24	>20	-	-	-	-	-	-		L915201	25-JUL-10	12:37	L915201-14		47600	-	11100	7.72	-	32400	
10WBW001-35	Doris Lower	10WBW001	1	Meas Port Upper	548.0	484.8		8.44	>20	-	-	-	-	-	-		L917645	04-AUG-10	13:42	L917645-1		46600	-	12700	7.43	-	47800	
10WBW001-100	Doris Lower	10WBW001	1	Meas Port Upper	548.0	484.8		7.73	52	72.85	11.2	11.79	3.5	32.5	39.5		L946743	19-OCT-10	12:00	L946743-1		46700	1.01	12600	7.38	30.50	42300	
10WBW001-106	Doris Lower	10WBW001	1	Meas Port Upper	548.0	484.8		6.00	52.65	211.00	11.43	4.51	3.50	32.00	15.00		L949713	30-OCT-10	13:00	L949713-3		46900	1.03	12100	7.69	31.2	47500	
10WBW002-01	Doris North	10WBW002	1	Meas Port Upper	594.4	575.06		-	-	-	-	-	-	-	-		L909782	03-JUL-10	14:00	L909782-5		160000	1.13	180000	-	-	250000	
10WBW002-02	Doris North	10WBW002	1	Meas Port Upper	594.4	575.06		-	-	-	-	-	-	-	-		L909782	04-JUL-10	14:00	L909782-6		182000	1.14	200000	-	-	225000	
10WBW002-109a	Doris North	10WBW002	1	Meas Port Upper	594.4	575.06		6.02	> 99.9	409	12.35	0.69	> 4.0	> 99	146		L956881	07-NOV-10	17:00	L956881-1		-	-	187000	-	-	-	
10WBW002-109b	Doris North	10WBW002	1	Meas Port Upper	594.4	575.06		6.02	> 99.9	409	12.35	0.69	> 4.0	> 99	146		L956881	08-NOV-10	11:00	L956881-2			-	189000	-	-	-	
10WBW002-121	Doris North	10WBW002	1	Meas Port Upper	594.4	575.06		6.13	99.9	-5.0	14.15	4.33	4.0	99.0	106		L956881	13-NOV-10	11:00	L956881-4		182000	1.17	183000	8.51	-	223000	
10WBW002-Z1-305	Doris North	10WBW002	1	Meas Port Upper	594.40	575.06		-	-	-	-	-	-	-	-		L996991	16-APR-11	15:18	L996991-1		182000	1.16	-	7.22	-	207000	
10WBW002-Z1-306	Doris North	10WBW002	1	Meas Port Upper	594.40	575.06		8.85	>99.9	515	15.73	4.85	>4	>99	272		L996991	16-APR-11	17:18	L996991-2		-	-	172000	-	-	-	
10WBW002-Z1-307	Doris North	10WBW002	1	Meas Port Upper	594.40	575.06		8.21 to 8.66	>99.9	443 to 395	10.08 to 8.64	4.6 to 1.51	>4	>99	288 to 201		L996991	17-APR-11	14:00	L996991-3		183000	1.16	178000	8.10	-	202000	
10WBW002-Z3-308	Doris North	10WBW002	3	Meas Port Upper	498.40	481.78		8.43	>99.9	31	13.12	1.25	>4	>99	138		L996991	17-APR-11	18:10	L996991-4		176000	1.15	164000	7.95	-	205000	
10WBW002-Z2-309	Doris North	10WBW002	2	Meas Port Upper	506.00	489.16		7.46	43	94.4	12.44	0.92	2.5	26	73		L996991	18-APR-11	13:30	L996991-5		39400	1.07	57600	7.50	-	97600	
10WBW002-Z1-400	Doris North	10WBW002	1	Top	594.4	575.06		8.41	>99.9	262	19.38	-2.25	>4.0%	>99	230		-	20-JUN-11	11:00	L1021760-1		181000	1.16	208000	7.57	-	-	
10WBW002-Z1-401	Doris North	10WBW002	1	Top	594.4	575.06		9.17	>99.9	112	19.69	-1.49	>4.0%	>99	181		-	20-JUN-11	15:00	L1021760-2		182000	1.16	187000	8.12	-	193000	
10WBW002-Z3-403	Doris North	10WBW002	3	Top	498.4	481.78		6.87	>99.9	164	17.15	-2.13	>4.0%	>99	301		-	21-JUN-11	11:00	L1021760-4		159000	-	158000	7.03	-	169000	
10WBW002-Z1-510	Doris North	10WBW002	1	Top	594.4	575.06		7.21	176.8	-0.3	4.88	4.83	140.9	114.8	349.7		-	15-SEP-11	08:00	L1060807-3		189000	1.1	179000	7.16	-	205000	
10WBW002-Z1-511	Doris North	10WBW002	1	Top	594.4	575.06		8.03	175.1	20.4	6.26	7.53	141.3	113.7	231.8		-	15-SEP-11	10:30	L1060807-4		189000	1.11	200000	7.72	-	204000	
10WBW002-Z3-512	Doris North	10WBW002	3	Top	498.4	481.78		-	-	-	-	-	-	-	-		-	15-SEP-11	13:30	L1060807-5		155000	1.1	161000	7.41	-	171000	

Field Sample ID	Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3)	Alkalinity, Carbonate (as CaCO3)	Alkalinity, Hydroxide (as CaCO3)	Alkalinity, Total (as CaCO3)	Ammonia as N	Bromide (Br)	Chloride (Cl)	Fluoride (F)	Nitrate (as N)	Nitrite (as N)	Ortho Phosphate as P	Total Phosphate as P	Silicate (as SIO2)	Sulfate (SO4)	Additional Anions and Nutrients
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
10WBW004-123		35.8	<1	<1	35.8	2.33	6.3	12100	0.78	<0.5	<0.1	<0.005	0.123	<10	244	
10WBW004-124		35.5	<1.0	<1.0	35.5	-	6.4	12400	0.669	<0.50	<0.10	-	-	-	264	
10WBW004-125		35.3	<1.0	<1.0	35.3	-	6.5	12400	0.677	<0.50	<0.10	-	-	-	260	
10WBW004-126		40.0	<1.0	<1.0	40.0	-	9.2	13700	0.983	<0.50	<0.10	-	-	-	336	
10WBW004-128		48.7	<1.0	<1.0	48.7	-	8.2	12600	0.645	0.53	<0.10	-	-	-	322	
10WBW004-129		50.5	<1.0	<1.0	50.5	-	9.9	13400	0.716	<0.50	<0.10	-	-	-	349	
10WBW004-130		53.0	<1.0	<1.0	53.0	1.96	9.3	13400	0.689	<0.50	<0.10	<0.0010	0.148	8.2	347	
10WBW004-131		53.5	<1.0	<1.0	53.5	1.95	9.0	12800	0.642	<0.50	<0.10	<0.0010	0.155	6.5	330	
10WBW004-Z6-312		24.5	<2.0	<2.0	24.5	2.38	5.1	12100	0.76	<0.50	<0.10	<0.0010	0.190	<10	271	
10WBW004-Z6-313		25.3	<2.0	<2.0	25.3	2.37	7.3	12700	0.78	<0.50	<0.10	<0.0010	0.189	<10	285	
10WBW004-Z6-314		11.6	<2.0	<2.0	11.6	-	7.3	17400	1.48	<0.50	<0.10	-	-	-	300	
10WBW004-Z6-315		34.9	<2.0	<2.0	34.9	-	6.8	12300	0.83	<0.50	<0.10	-	-	-	278	
10WBW004-Z6-316		33.0	<2.0	<2.0	33.0	-	8.0	13500	0.94	<0.50	<0.10	-	-	-	330	
10WBW004-Z6-317		35.4	<2.0	<2.0	35.4	2.38	7.3	13000	0.83	<0.50	<0.10	<0.0010	0.196	<10	295	
10WBW004-Z6-318		34.0	<2.0	<2.0	34.0	-	9.4	14600	0.95	<0.50	<0.10	-	-	-	360	
10WBW004-Z6-404		32.5	<1.0	<1.0	32.5	2.38	12.1	14700	0.749	<0.50	<0.10	-	0.0787	<10	385	
10WBW004-Z6-405		34.7	<1.0	<1.0	34.7	2.44	14.2	14900	0.727	<0.50	<0.10	-	0.0897	<10	405	
10WBW004-Z6-406		45.6	<1.0	<1.0	45.6	2.45	11	12400	0.587	<0.50	<0.10	-	0.11	<10	325	
10WBW004-Z6-508		17.4	<2.0	<2.0	17.4	2.28	18.2	13800	0.618	0.88	<0.10	<0.0010	0.145	<10	405	
10WBW004-Z6-509		23.3	<2.0	<2.0	23.3	2.48	16.6	13000	0.528	0.84	<0.10	<0.0010	0.0918	<10	361	
10WBW001-02b		-	-	-	87.3	-	-	20100	<5	<5	<5	-	-	-	2090	
10WBW001-03b		-	-	-	66.3	-	-	9650	<5	<5	<5	-	-	-	995	
10WBW001-04b		-	-	-	64.8	-	-	9610	<5	<5	<5	-	-	-	991	
10WBW001-12		-	-	-	90.6	-	-	15200	<2.5	<2.5	<2.5	-	-	-	1490	
10WBW001-14		-	-	-	83.3	-	-	17100	<2.5	<2.5	<2.5	-	-	-	1700	
10WBW001-15		-	-	-	82.3	-	-	17700	<1	<1	<1	-	-	-	1750	
10WBW001-16		-	-	-	81.7	-	-	18200	<1	<1	<1	-	-	-	1790	
10WBW001-28		-	-	-	63.4	-	-	15900	<1	<1	<1	-	-	-	1690	
10WBW001-31		-	-	-	67.7	-	-	16500	<1	<1	<1	-	-	-	1760	
10WBW001-33		-	-	-	70.8	-	-	17100	<1	<1	<1	-	-	-	1820	
10WBW001-36		-	-	-	44.2	-	21.2	09130	<0.75	<0.5	<0.1	-	-	-	0940	
10WBW001-37		-	-	-	49.7	-	27.6	11500	<0.75	<0.5	<0.1	-	-	-	1160	
10WBW001-101		44.2	<2	<2	44.2	-	38.1	13400	<0.75	<0.5	<0.1	0.0017	-	5.0	1390	
10WBW001-102		77.3	<1	<1	77.3	-	36.4	13100	<0.75	<0.5	<0.1	<0.001	-	3.8	1230	
10WBW001-103			-	-	72.4	3.14	49.1	19000	0.091	<0.5	<0.1		0.0262	6.1	2020	
10WBW001-105		106	<2	<2	106	3.46	41	16500	<0.75	<1	<0.2	<0.001	0.0389	7.5	1580	
10WBW001-107		76.5	<1	<1	76.5	3.37	52	19100	<0.75	<1	<0.2	<0.001	0.0124	9.7	2000	
10WBW001-108		43.7	<2	<2	43.7	2.32	41.3	14200	<0.75	<0.5	<0.1	<0.001	0.0162	5.8	1500	
10WBW001-Z1-300		2.7	<2.0	<2.0	2.7	0.0619	100	19000	<0.75	<0.50	<0.10	<0.0010	0.0094	<10	944	
10WBW001-Z6-301		49.8	<2.0	<2.0	49.8	2.90	67	18300	<0.75	<1.0	<0.20	0.0012	0.0314	9.0	1780	
10WBW001-Z10-302		119	<2.0	<2.0	119	3.54	63	18800	<0.75	<1.0	<0.20	<0.0010	0.0644	5.7	1730	
10WBW001-Z10-303		115	<2.0	<2.0	115	4.05	77	21100	<0.75	<1.0	<0.20	<0.0010	0.0150	8.8	2040	
10WBW001-Z6-304		102	<2.0	<2.0	102	3.65	84	24000	<0.75	<1.0	<0.20	<0.0010	0.0145	9.1	2450	
10WBW001-Z10-500		115	<2.0	<2.0	115	3.29	63.5	18100	0.094	0.72	<0.10	<0.0010	0.0433	11.3	1720	
10WBW001-Z1-501		<2.0	<2.0	<2.0	<2.0	0.0538	122	18600	0.057	<0.50	<0.10	0.0031	0.0194	5.3	972	
10WBW001-Z6-502		44.1	<2.0	<2.0	44.1	3.22	67.3	18800	0.087	0.53	<0.10	<0.0010	0.0316	9.9	2000	
10WBW001-Z6-503		44.7	<2.0	<2.0	44.7	3.16	68	19000	0.083	0.6	<0.10	<0.0010	0.0306	8.2	2030	
10WBW001-Z6-504		47.4	<2.0	<2.0	47.4	3.87	83.6	23600	0.075	0.61	<0.10	<0.0010	0.0137	12.2	2510	
10WBW001-Z10-505		97.7	<2.0	<2.0	97.7	4.2	75.3	21000	0.097	0.64	<0.10	<0.0010	0.018	18.1	2150	
10WBW001-Z10		116	<2.0	<2.0	116	2.94	74.8	18700	<0.75	<0.50	<0.10	<0.0010	0.0649	1.94	1900	
10WBW001-Z01		<2.0	<2.0	<2.0	<2.0	0.0492	131	18100	<0.75	<0.50	<0.10	<0.0010	0.0073	6.7	940	
10WBW001-Z6		47	<2.0	<2.0	47	2.98	78.8	20600	<0.75	<0.50	<0.10	<0.0010	0.022	6	2110	
10WBW001-01-2022		14.4	<1	<1	14.4	0.0138	129	19700	<2	<0.5	<0.10	0.01	-	6.38	964	
10WBW001-01-2023		15	<1	<1	15	<0.005	21.6	19800	<2	0.879	<0.10	<0.10	-	9.52	476	
10WBW001-01-2024		16.5	<1	<1	16.5	N/A	114	18300	<2	<0.5	<0.10	0.001	-	8.67	922	
10WBW001-06-2022		260	<1	<1	260	1.99	21.8	6060	<2	<0.5	<0.10	0.11	-	11	403	
10WBW001-06-2023		289	<1	<1	289	3.23	20.6	6020	<0.2	0.093	0.0159	0.16	-	11.2	440	
10WBW001-06-2024		316	<1	<1	316	N/A	18.4	5440	0.4	0.1	0.2	0.206	-	11.9	405	
10WBW001-10-2022		-	-	-	-	0.61	-	-	-	-	-	-	-	11.6	-	
10WBW001-10-2023		229	<1	<1	229	0.731	3.4	992	<0.7	<0.025	<0.10	<0.55	-	11.7	85.9	
10WBW001-10-2024		256	1.8	<1	258	N/A	3.28	1000	0.846	<0.025	0.005	0.652	-	11.9	92.9	
10WBW001-01b		8.4	-	-	-	-	-	18200	<5	<5	<5	-	-	-	1020	
10WBW001-17		9.7	-	-	-	-	-	19100	<1	<1	<1	-	-	-	1010	
10WBW001-20		9.3	-	-	-	-	-	19000	<1	<1	<1	-	-	-	0997	
10WBW001-25		8.2	-	-	-	-	-	18700	<1	<1	<1	-	-	-	0960	
10WBW001-26		7.9	-	-	-	-	-	18800	<1	<1	<1	-	-	-	0964	
10WBW001-35		<2	-	-	-	-	100	19000	<0.75	<0.5	<0.1	-	-	-	0981	
10WBW001-100		<2	<2	<2	<2	-	101	19000	<0.75	0.96	<0.1	0.0264	-	7.8	980	
10WBW001-106		<2	<2	<2	<2	0.0631	101	18400	<0.75	<0.5	<0.1	0.0086	0.0163	<10	935	
10WBW002-01		-	-	-	56.0	-	-	114000	16	<10	<10	-	-	-	<100	
10WBW002-02		-	-	-	59.5	-	-	123000	20	<10	<10	-	-	-	<100	
10WBW002-109a		-	-	-	-	4.55	-	-	-	-	-	-	-	-	-	
10WBW002-109b		-	-	-	-	-	-	-	-	-	-	-	-	-	-	
10WBW002-121		57.4	1.6	<1	59.0	4.58	<250	133000	<100	<25	<5	<0.1	1.01	<100	<2500	
10WBW002-Z1-305		220	<1.0	<1.0	220	-	10.6	138000	<30	<0.50	<0.10	0.53	0.62	-	<50	
10WBW002-Z1-306		-	-	-	-	-	-	-	-	-	-	-	-	-	-	
10WBW002-Z1-307		160	<1.0	<1.0	160	6.4	58.9	138000	<30	<0.50	<0.10	0.41	0.81	<100	70	
10WBW002-Z3-308		145	<1.0	<1.0	145	6.3	<5.0	129000	<30	<0.50	<0.10	0.57	0.57	<100	78	
10WBW002-Z2-309		97.7	<2.0	<2.0	97.7	-	<5.0	43600	<30	<0.50	<0.10	-	-	-	<50	
10WBW002-Z1-400		-	-	-	-	-	-	-	-	-	-	-	-	-	-	
10WBW002-Z1-401		49.8	<1.0	<1.0	49.8	8.3	-	128000	-	-	-	-	0.58	-	51	
10WBW002-Z3-403		-	-	-	-	-	-	104000	-	-	-	-	-	-	146	
10WBW002-Z1-510		40.2	<1.0	<1.0	40.2	-	30.9	126000	2.31	1.75	<0.10	-	-	-	55	
10WBW002-Z1-511		44.9	<1.0	<1.0	44.9	7.22	30.5	125000	2.31	0.91	<0.10	0.021	0.336	386	55	
10WBW002-Z3-512		47.3	<1.0	<1.0	47.3	-	28.8	99200	2.65	1.62	<0.10	-	-	-	170	

Field Sample ID	Bicarbonate (HCO3)	Carbonate (CO3)	Hydroxide (OH)	Nitrate and Nitrite as N	TDS (Calculated)	Total Metals	Aluminum (Al)-Total	Antimony (Sb)-Total	Arsenic (As)-Total	Barium (Ba)-Total	Beryllium (Be)-Total	Bismuth (Bi)-Total	Boron (B)-Total	Cadmium (Cd)-Total	Calcium (Ca)-Total
	mg/L	mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10WBW004-123	-	-	-	-	-		0.0469	0.0184	<0.002	0.530	<0.0005	<0.0005	0.79	<0.0001	4700
10WBW004-124	-	-	-	-	-		0.0114	0.0180	<0.0020	0.567	<0.00050	<0.00050	0.87	<0.00010	4460
10WBW004-125	-	-	-	-	-		0.0133	0.0180	<0.0020	0.557	<0.00050	<0.00050	0.87	<0.00010	4510
10WBW004-126	-	-	-	-	-		0.0152	0.0176	<0.0030	0.554	<0.00050	<0.00050	1.00	<0.00010	4730
10WBW004-128	-	-	-	-	-		0.0189	0.0199	<0.0020	0.570	<0.00050	<0.00050	0.92	<0.00010	4180
10WBW004-129	-	-	-	-	-		0.0110	0.0199	<0.0030	0.562	<0.00050	<0.00050	0.96	<0.00010	4330
10WBW004-130	-	-	-	-	-		0.0167	0.0214	<0.0030	0.596	<0.00050	<0.00050	0.99	<0.00010	4380
10WBW004-131	-	-	-	-	-		0.0087	0.0203	<0.0030	0.564	<0.00050	<0.00050	0.96	<0.00010	4110
10WBW004-Z6-312	-	-	-	-	-		0.0123	0.0179	<0.0020	0.553	<0.00050	<0.00050	0.90	<0.00010	4730
10WBW004-Z6-313	-	-	-	-	-		0.0069	0.0163	<0.0020	0.500	<0.00050	<0.00050	0.84	<0.00010	4560
10WBW004-Z6-314	-	-	-	-	-		0.0118	0.0139	<0.0020	0.532	<0.00050	<0.00050	0.92	<0.00010	5360
10WBW004-Z6-315	-	-	-	-	-		-	-	-	-	-	-	-	-	4830
10WBW004-Z6-316	-	-	-	-	-		-	-	-	-	-	-	-	-	4960
10WBW004-Z6-317	-	-	-	-	-		<0.0050	0.0204	<0.0020	0.577	<0.00050	<0.00050	0.89	<0.00010	4590
10WBW004-Z6-318	-	-	-	-	-		0.0071	0.0178	0.0021	0.479	<0.00050	<0.00050	0.88	<0.00010	4710
10WBW004-Z6-404	-	-	-	-	-		0.0105	0.0134	<0.0020	0.467	<0.00050	<0.00050	0.87	<0.000050	4510
10WBW004-Z6-405	-	-	-	-	-		0.039	0.0139	<0.0020	0.494	<0.00050	<0.00050	0.88	<0.000050	4530
10WBW004-Z6-406	-	-	-	-	-		0.0068	0.0161	<0.0020	0.528	<0.00050	<0.00050	0.77	<0.000050	4630
10WBW004-Z6-508	-	-	-	-	-		0.02	0.0167	<0.0050	0.466	<0.00050	<0.00050	0.83	<0.000050	5490
10WBW004-Z6-509	-	-	-	-	-		0.0078	0.0136	<0.0080	0.537	<0.00050	<0.00050	0.89	<0.000050	4580
10WBW001-02b	106.0	<5	<5	<7.1	34600		<0.2	<0.008	<0.08	0.072	<0.02	-	2.88	<0.001	1750
10WBW001-03b	80.9	<5	<5	<7.1	16800		<0.2	<0.008	<0.08	0.187	<0.02	-	1.34	<0.001	851
10WBW001-04b	79.0	<5	<5	<7.1	16900		<0.2	<0.008	<0.08	0.185	<0.02	-	1.37	<0.001	867
10WBW001-12	111	<5	<5	<3.5	26300		<2	<0.08	<0.08	0.125	<0.2	-	1.91	<0.01	1120
10WBW001-14	102	<5	<5	<3.5	29300		<2	<0.08	0.098	0.136	<0.2	-	2.22	<0.01	1290
10WBW001-15	100	<5	<5	<1.4	30300		<2	<0.08	0.083	0.102	<0.2	-	2.32	<0.01	1590
10WBW001-16	99.6	<5	<5	<1.4	32600		<2	<0.08	0.090	0.113	<0.2	-	2.31	<0.01	1580
10WBW001-28	77.3	<5	<5	<1.4	26500		<2	<0.08	0.085	0.139	<0.2	-	1.54	<0.01	1190
10WBW001-31	083	<5	<5	<1.4	29000		<2	<0.08	0.095	0.125	<0.2	-	1.64	<0.01	1370
10WBW001-33	086	<5	<5	<1.4	30000		<2	<0.08	0.121	0.107	<0.2	-	1.91	<0.01	1280
10WBW001-36	-	-	-	-	-		0.0281	0.00745	0.003	0.130	<0.0005	<0.0005	1.04	<0.00012	0805
10WBW001-37	-	-	-	-	-		0.0146	0.00349	<0.002	0.179	<0.0005	<0.0005	1.51	<0.00012	1020
10WBW001-101	-	-	-	-	-		0.0052	0.005	<0.002	0.175	<0.0005	<0.0005	1.38	<0.00005	1140
10WBW001-102	-	-	-	-	-		<0.005	0.00099	<0.002	0.177	<0.0005	<0.0005	1.53	<0.00005	1080
10WBW001-103	-	-	-	-	-		0.0318	0.00127	0.007	0.117	<0.0005	<0.0005	2.65	<0.00005	1600
10WBW001-105	-	-	-	-	-		<0.005	0.00054	<0.002	0.129	<0.0005	<0.0005	2.8	<0.00005	1540
10WBW001-107	-	-	-	-	-		0.0053	0.00115	0.0068	0.112	<0.0005	<0.0005	2.66	<0.00005	1570
10WBW001-108	-	-	-	-	-		0.0059	0.00461	<0.002	0.169	<0.0005	<0.0005	1.50	<0.00005	1170
10WBW001-Z1-300	-	-	-	-	-		0.0109	0.00081	<0.0020	0.0539	<0.00050	<0.00050	3.05	<0.000050	4930
10WBW001-Z6-301	-	-	-	-	-		0.0058	<0.00050	<0.0020	0.181	<0.00050	<0.00050	1.79	<0.000050	1420
10WBW001-Z10-302	-	-	-	-	-		0.0242	0.00131	<0.0020	0.105	<0.00050	<0.00050	2.72	0.000411	1630
10WBW001-Z10-303	-	-	-	-	-		0.0740	<0.00050	<0.0020	0.0680	<0.00050	<0.00050	2.81	0.000095	2130
10WBW001-Z6-304	-	-	-	-	-		0.168	<0.00050	<0.0020	0.0615	<0.00050	<0.00050	3.33	0.000130	2140
10WBW001-Z10-500	-	-	-	-	-		<0.0050	<0.00050	<0.0050	0.111	<0.00050	<0.00050	1.92	<0.000050	1580
10WBW001-Z1-501	-	-	-	-	-		0.0089	0.00063	<0.0050	0.0477	<0.00050	<0.00050	2.48	0.00012	5010
10WBW001-Z6-502	-	-	-	-	-		0.0102	0.00067	<0.020	0.131	<0.00050	<0.00050	1.74	0.000076	1490
10WBW001-Z6-503	-	-	-	-	-		<0.0050	0.00058	<0.0030	0.135	<0.00050	<0.00050	1.9	0.000112	1490
10WBW001-Z6-504	-	-	-	-	-		0.015	0.00069	<0.010	0.0589	<0.00050	<0.00050	2.72	0.000087	1990
10WBW001-Z10-505	-	-	-	-	-		0.0537	<0.00050	<0.0040	0.0647	<0.00050	<0.00050	2.56	0.000163	1880
10WBW001-Z10	-	-	-	-	-		0.0224	<0.00050	<0.0040	0.102	<0.00050	<0.00050	2.66	0.000088	1460
10WBW001-Z01	-	-	-	-	-		0.0327	0.00069	<0.040	0.0681	<0.00050	<0.00050	6.75	0.000145	4800
10WBW001-Z6	-	-	-	-	-		0.0102	<0.00050	<0.0020	0.123	<0.00050	<0.00050	2.78	0.000096	1570
10WBW001-01-2022	-	-	-	-	-		<0.06	<0.0020	<0.0020	0.0585	<0.0004	<0.001	2.55	<0.0001	4730
10WBW001-01-2023	-	-	-	-	-		<0.15	<0.005	<0.005	0.0617	<0.001	<0.0025	2.86	<0.00025	4800
10WBW001-01-2024	-	-	-	-	-		<0.15	0.005	<0.005	0.0577	<0.001	<0.0025	3.27	0.00025	4660
10WBW001-06-2022	-	-	-	-	-		<0.06	<0.0020	<0.0020	0.0508	<0.0004	<0.001	1.72	<0.0001	323
10WBW001-06-2023	-	-	-	-	-		<0.03	<0.001	<0.001	0.0616	<0.0002	<0.0005	2.14	<0.00005	348
10WBW001-06-2024	-	-	-	-	-		<0.03	0.001	0.00148	0.0538	0.0002	<0.0005	2.31	0.00005	304
10WBW001-10-2022	-	-	-	-	-		0.018	0.0005	0.00066	0.046	<0.0001	<0.00025	1.24	-	31
10WBW001-10-2023	-	-	-	-	-		0.0212	<0.0020	0.00109	0.0481	<0.00004	<0.0001	1.19	0.0000138	28.3
10WBW001-10-2024	-	-	-	-	-		0.0132	<0.0020	0.00088	0.0551	<0.00004	<0.0001	1.46	0.00001	29.7
10WBW001-01b	10.2	<5	<5	<7.1	30700		0.42	<0.008	<0.08	0.059	<0.02	-	3.11	<0.001	4650
10WBW001-17	11.9	<5	<5	<1.4	31500		<2	<0.08	0.113	0.046	<0.2	-	2.38	<0.01	4100
10WBW001-20	011	<5	<5	<1.4	30800		<2	<0.08	0.114	0.054	<0.2	-	2.59	<0.01	4430
10WBW001-25	010	<5	<5	<1.4	31000		<2	<0.08	0.296	0.054	<0.2	-	2.56	<0.01	4430
10WBW001-26	010	<5	<5	<1.4	30500		<2	<0.08	0.101	0.059	<0.2	-	2.50	<0.01	4380
10WBW001-35	-	-	-	-	-		0.0992	<0.0005	<0.002	0.051	<0.0005	<0.0005	2.93	<0.00012	5070
10WBW001-100	-	-	-	-	-		0.0136	<0.0005	<0.002	0.053	<0.0005	<0.0005	2.89	0.000066	4960
10WBW001-106	-	-	-	-	-		0.0086	<0.0005	<0.002	0.0521	<0.0005	<0.0005	3.25	0.000085	4700
10WBW002-01	68.3	<5	<5	<14	187000		30.5	<0.08	0.218	0.719	<0.2	-	0.95	<0.01	78500
10WBW002-02	11.9	29.9	<5	<14	203000		9.7	<0.08	0.507	0.736	<0.2	-	0.99	<0.01	96200
10WBW002-109a	-	-	-	-	-		0.161	0.0104	<0.02	0.860	<0.005	<0.005	<1	<0.0005	77400
10WBW002-109b	-	-	-	-	-		9.40	0.0107	<0.02	0.827	<0.005	<0.005	<1	<0.0005	75500
10WBW002-121	-	-	-	-	-		9.94	0.0117	<0.02	0.832	<0.005	<0.005	<1	<0.0005	78800
10WBW002-Z1-305	-	-	-	-	-		-	-	-	-	-	-	-	-	-
10WBW002-Z1-306	-	-	-	-	-		6.24	0.0110	<0.020	0.808	<0.0050	<0.0050	1.0	<0.00050	68800
10WBW002-Z1-307	-	-	-	-	-		7.04	0.0109	<0.020	0.845	<0.0050	<0.0050	<1.0	<0.00060	70800
10WBW002-Z3-308	-	-	-	-	-		0.254	0.0085	<0.020	0.964	<0.0050	<0.0050	<1.0	<0.00050	65900
10WBW002-Z2-309	-	-	-	-	-		0.256	0.0065	0.038	0.276	<0.0025	<0.0025	<0.50	0.00115	22600
10WBW002-Z1-400	-	-	-	-	-		-	-	-	-	-	-	-	-	-
10WBW002-Z1-401	-	-	-	-	-		-	-	-	-	-	-	-	-	-
10WBW002-Z3-403	-	-	-	-	-		0.172	0.0068	<0.020	0.715	<0.0025	<0.0025	0.91	<0.00050	57600
10WBW002-Z1-510	-	-	-	-	-		-	-	-	-	-	-	-	-	-
10WBW002-Z1-511	-	-	-	-	-		0.308	0.0091	<0.050	0.741	<0.0050	<0.0050	<1.0	<0.00050	76500
10WBW002-Z3-512	-	-	-	-	-		-	-	-	-	-	-	-	-	-

Field Sample ID	Cesium (Cs)-Total	Chromium (Cr)-Total	Cobalt (Co)-Total	Copper (Cu)-Total	Gallium (Ga)-Total	Iron (Fe)-Total	Lead (Pb)-Total	Lithium (Li)-Total	Magnesium (Mg)-Total	Manganese (Mn)-Total	Mercury (Hg)-Total	Molybdenum (Mo)-Total	Nickel (Ni)-Total	Phosphorus (P)-Total	Potassium (K)-Total
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10WBW004-123	0.00485	0.00776	0.00717	0.00083	<0.0005	8.23	0.00602	0.049	287	0.965	<0.00001	0.0837	0.0343	<1	44
10WBW004-124	0.00531	<0.0020	0.00712	<0.00050	<0.00050	7.74	<0.00050	0.052	305	0.936	-	0.0879	0.0309	<1.0	46
10WBW004-125	0.00519	<0.0030	0.00699	<0.00050	<0.00050	7.62	<0.00050	0.051	306	0.926	-	0.0853	0.0305	<1.0	47
10WBW004-126	0.00665	<0.0040	0.00562	<0.00050	<0.00050	8.25	<0.00050	0.059	413	0.909	-	0.118	0.0220	<1.0	50
10WBW004-128	0.00600	<0.0020	0.00585	<0.00050	<0.00050	5.83	<0.00050	0.054	370	0.903	-	0.0937	0.0239	<1.0	48
10WBW004-129	0.00659	<0.0030	0.00537	<0.00050	<0.00050	5.68	<0.00050	0.055	414	0.888	-	0.101	0.0216	<1.0	50
10WBW004-130	0.00671	<0.0030	0.00612	<0.00050	<0.00050	5.21	<0.00050	0.057	411	0.953	<0.000050	0.108	0.0228	<1.0	50
10WBW004-131	0.00644	<0.0030	0.00556	<0.00050	<0.00050	4.89	<0.00050	0.053	394	0.887	<0.000050	0.0942	0.0223	<1.0	49
10WBW004-Z6-312	0.00619	0.00106	0.00352	0.00592	<0.00050	12.1	0.00067	0.046	415	0.890	<0.000010	0.0975	0.0130	<1.0	52
10WBW004-Z6-313	0.00565	<0.00070	0.00313	0.00286	<0.00050	10.8	<0.00030	0.047	408	0.814	<0.000010	0.0914	0.0123	<1.0	51
10WBW004-Z6-314	0.00809	<0.00050	0.00482	<0.00050	<0.00050	15.7	<0.00030	0.053	447	0.989	-	0.110	0.0121	<1.0	51
10WBW004-Z6-315	-	-	-	-	-	-	-	-	422	-	-	-	-	-	54
10WBW004-Z6-316	-	-	-	-	-	-	-	-	481	-	-	-	-	-	53
10WBW004-Z6-317	0.00622	0.00155	0.00509	<0.00050	<0.00050	4.74	<0.00030	0.048	411	0.847	<0.000010	0.0968	0.0180	<1.0	52
10WBW004-Z6-318	0.00674	0.00213	0.00339	<0.00050	<0.00050	5.05	0.00802	0.047	494	0.826	-	0.0966	0.0143	<1.0	53
10WBW004-Z6-404	0.00806	0.00251	0.00295	<0.00050	<0.00050	13.3	0.00045	0.043	476	0.847	<0.000050	0.0968	0.0109	<1.0	48
10WBW004-Z6-405	0.00821	0.00834	0.00306	<0.00050	<0.00050	13.4	0.00046	0.044	475	0.864	<0.000050	0.1	0.0147	<1.0	48
10WBW004-Z6-406	0.00589	0.00591	0.00477	<0.00050	<0.00050	6.7	<0.00030	0.04	417	0.841	<0.000050	0.0908	0.0187	<1.0	51
10WBW004-Z6-508	0.00815	0.00903	0.00298	<0.00050	<0.00050	10.5	0.00071	0.045	519	0.841	<0.000050	0.101	0.0165	<1.0	52
10WBW004-Z6-509	0.00682	0.00521	0.00341	<0.00050	<0.00050	10.4	0.0004	0.043	452	0.855	<0.000050	0.101	0.015	<1.0	52
10WBW001-02b	-	0.033	<0.004	<0.02	-	12.00	0.002	0.37	1540	2.62	<0.0001	0.0059	0.0335	-	268
10WBW001-03b	-	<0.016	<0.004	<0.02	-	3.53	<0.002	0.13	726	1.04	<0.0001	0.0244	0.0138	-	114
10WBW001-04b	-	0.024	<0.004	<0.02	-	3.65	<0.002	0.14	736	1.06	<0.0001	0.0237	0.0144	-	116
10WBW001-12	-	<0.16	<0.04	<0.2	-	7.51	<0.02	<1.2	914	1.23	<0.0001	<0.02	<0.04	-	211
10WBW001-14	-	0.55	<0.04	<0.2	-	5.08	<0.02	<1.2	1020	1.40	<0.0001	<0.02	<0.04	-	223
10WBW001-15	-	0.61	<0.04	<0.2	-	7.15	<0.02	<1.2	1290	1.73	<0.0001	<0.02	<0.04	-	294
10WBW001-16	-	0.66	<0.04	<0.2	-	7.14	<0.02	<1.2	1290	1.76	<0.0001	<0.02	<0.04	-	292
10WBW001-28	-	0.660	<0.04	<0.2	-	4.74	<0.02	<1.2	1120	1.27	<0.0001	0.0250	<0.04	-	185
10WBW001-31	-	0.72	<0.04	<0.2	-	3.33	<0.02	<1.2	1290	1.73	<0.0001	0.02	<0.04	-	227
10WBW001-33	-	0.86	<0.04	<0.2	-	3.54	<0.02	<1.2	1210	1.81	<0.0001	<0.02	<0.04	-	203
10WBW001-36	0000	0.00	<0.0005	<0.001	<0.0005	1.60	<0.001	0.093	0739	0.56	-	0.0403	0.00159	<1	125
10WBW001-37	0.00097	0.0030	<0.0005	<0.001	<0.0005	3.95	<0.001	0.128	867	1.09	-	0.0225	0.00237	<1	166
10WBW001-101	0000	0.00	0.000092	<0.0005	<0.0005	2.94	0.00035	0.117	1010	0.95	<0.00001	0.037	0.00059	<1	171
10WBW001-102	0.001	0.00011	0.000084	<0.0005	<0.0005	4.31	<0.0003	0.128	797	1.15	<0.00001	0.0244	<0.0005	<1	166
10WBW001-103	0.00155	<0.0005	0.000381	<0.0005	<0.0005	4.53	<0.0003	0.228	1510	2.08	<0.00005	0.0140	0.00095	<1	240
10WBW001-105	0.00151	0.00016	0.000132	<0.0005	<0.0005	11	<0.0003	0.2	1230	1.73	<0.00001	0.0072	<0.0005	<1	262
10WBW001-107	0.00155	<0.0001	0.000356	<0.0005	<0.0005	4.56	<0.0003	0.217	1480	2.13	<0.00001	0.012	0.00098	<1	233
10WBW001-108	0.00095	<0.0005	0.000103	0.00061	<0.0005	2.28	<0.0003	0.131	1080	0.892	-	0.0361	0.00120	<1	172
10WBW001-Z1-300	0.00101	0.0139	0.000241	0.00354	<0.00050	0.256	0.00061	0.375	74.9	0.750	<0.000010	0.0145	0.00733	<1.0	41
10WBW001-Z6-301	0.00114	0.00163	0.000078	0.00065	<0.00050	4.41	0.00044	0.167	1280	1.25	<0.000010	0.0292	0.00169	<1.0	210
10WBW001-Z10-302	0.00120	0.00132	0.000159	0.00122	<0.00050	9.52	0.00051	0.194	1250	1.29	<0.000010	0.0056	0.00230	<1.0	261
10WBW001-Z10-303	0.00085	0.00294	0.000171	<0.00050	<0.00050	1.45	0.00083	0.192	1480	2.04	<0.000010	<0.0020	0.00185	<1.0	282
10WBW001-Z6-304	0.00203	0.00321	0.000535	0.00181	<0.00050	10.3	0.00111	0.470	1760	2.45	<0.000010	0.0051	0.00192	<1.0	286
10WBW001-Z10-500	0.00105	0.00364	0.000235	0.00346	<0.00050	6.7	<0.00030	0.143	1230	1.3	<0.000050	0.0062	0.00363	<1.0	243
10WBW001-Z1-501	0.00095	0.00481	0.000322	0.00064	<0.00050	0.274	<0.00030	0.301	71.4	0.69	<0.000050	0.0107	0.00346	<1.0	39
10WBW001-Z6-502	0.00127	0.00471	0.00019	0.00061	<0.00050	7.08	0.00051	0.158	1340	1.63	<0.000050	0.0211	0.00343	<1.0	213
10WBW001-Z6-503	0.00134	0.00697	0.000224	0.00057	<0.00050	7.29	<0.00030	0.171	1360	1.65	<0.000050	0.0225	0.00486	<1.0	218
10WBW001-Z6-504	0.00194	0.004	0.00018	0.00061	<0.00050	9.46	0.00054	0.368	1670	2.4	<0.000050	0.0052	0.0029	<1.0	277
10WBW001-Z10-505	0.00102	0.00307	0.000209	0.0007	<0.00050	4.03	0.00103	0.169	1360	2.07	<0.000050	<0.0020	0.00201	<1.0	262
10WBW001-Z10	0.00123	0.0185	0.000709	0.00171	<0.00050	8.72	0.00038	0.208	1150	1.14	<0.000010	0.0102	0.0163	<1.0	249
10WBW001-Z01	0.00122	0.0098	0.000447	0.00184	<0.00050	0.554	0.00037	0.561	69.9	0.706	<0.000010	0.0217	0.0117	<1.0	39
10WBW001-Z6	0.00154	0.0151	0.000269	0.00145	<0.00050	11.5	<0.00030	0.278	1420	1.83	<0.000010	0.0158	0.00675	<1.0	244
10WBW001-01-2022	0.00104	-	<0.002	<0.01	-	2.58	<0.001	0.362	68.3	0.887	<0.000005	0.0124	<0.01	<1	40.5
10WBW001-01-2023	0.00106	<0.025	<0.005	<0.025	-	2.92	<0.0025	0.321	64.4	0.902	<0.000005	0.012	<0.025	<2.5	41.1
10WBW001-01-2024	0.00108	<0.025	<0.005	<0.025	-	2.27	<0.0025	0.355	63.7	0.85	<0.000005	0.0104	<0.025	<2.5	40.2
10WBW001-06-2022	0.00062	-	<0.002	<0.01	-	<0.2	<0.001	0.0675	332	0.293	<0.000005	<0.001	<0.01	<1	94.9
10WBW001-06-2023	0.000694	0.00567	<0.001	<0.005	-	0.12	<0.0005	0.0639	390	0.333	0.0000062	0.000601	<0.005	<0.5	107
10WBW001-06-2024	0.000633	0.0112	<0.001	<0.005	-	0.196	<0.0005	0.0648	326	0.28	<0.000005	0.0015	0.00512	<0.5	92.7
10WBW001-10-2022	0.000175	-	<0.0005	<0.0025	-	0.283	<0.00025	0.0176	36	0.0395	<0.000005	0.0024	<0.0025	0.7	30.8
10WBW001-10-2023	0.000161	0.00216	0.0002	0.00112	-	0.298	0.000135	0.0157	34.5	0.0378	<0.000005	0.003	0.0014	0.79	29.8
10WBW001-10-2024	0.000161	0.002	0.0035	0.00123	-	0.267	0.000114	0.0168	38	0.0407	<0.000005	0.00472	0.00109	0.842	30.6
10WBW001-01b	-	0.036	0.0046	<0.02	-	2.27	0.0021	0.37	181	1.44	<0.0001	0.0411	0.0774	-	057
10WBW001-17	-	0.960	<0.04	<0.2	-	0.51	<0.02	<1.2	076	0.77	<0.0001	0.0200	0.0740	-	036
10WBW001-20	-	0.95	<0.04	<0.2	-	0.68	<0.02	<1.2	066	0.71	<0.0001	<0.02	0.071	-	035
10WBW001-25	-	0.62	<0.04	<0.2	-	0.15	<0.02	<1.2	0051	0.62	<0.0001	<0.02	0.068	-	044
10WBW001-26	-	0.74	<0.04	<0.2	-	0.16	<0.02	<1.2	0053	0.64	<0.0001	<0.02	0.074	-	045
10WBW001-35	0000	0.01	<0.0005	0.0018	<0.0005	0.46	0.0013	0.37	0071	0.72	-	0.0136	0.00437	<1	040
10WBW001-100	0.00102	0.0006	0.000073	0.00059	<0.0005	0.24	<0.0003	0.346	064	0.72	<0.00001	0.0089	0.00075	<1	040
10WBW001-106	0.0011	0.0002	0.000051	0.00102	<0.0005	0.197	<0.0003	0.381	67.8	0.712	<0.00001	0.0088	0.00265	<1	39
10WBW002-01	-	0.63	0.094	<0.2	-	133	0.113	<1.2	132	2.68	<0.0001	0.222	1.40	-	36
10WBW002-02	-	0.48	0.088	<0.2	-	34.4	0.030	<1.2	114	0.47	<0.0001	0.223	1.82	-	35
10WBW002-109a	0.0057	0.0062	<0.0005	0.0242	<0.005	0.51	0.0039	<0.2	113	0.0233	<0.00001	0.178	0.0076	<10	<200
10WBW002-109b	0.0061	0.107	0.00841	0.0467	<0.005	38.6	0.0438	0.44	129	1.05	<0.00001	0.178	0.0359	<10	<200
10WBW002-121	0.0063	0.120	0.00949	0.0585	<0.005	54.6	0.0663	<0.2	135	1.15	0.000014	0.193	0.0402	<10	<200
10WBW002-Z1-305	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-306	0.0064	0.0707	0.00610	0.0409	<0.0050	27.0	0.0403	1.01	101	0.642	-	0.166	0.0321	<10	<200
10WBW002-Z1-307	0.0066	0.0783	0.00725	0.0406	<0.0050	28.4	0.0336	0.51	110	0.759	<0.000010	0.165	0.0299	<10	<200
10WBW002-Z3-308	<0.0050	0.0178	<0.00050	0.0127	<0.0050	0.94	<0.0030	0.21	103	0.0460	<0.000010	0.221	0.0220	<10	<200
10WBW002-Z2-309	<0.0025	0.00534	0.00071	0.0174	<0.0025	1.30	0.0154	<0.10	41.8	0.150	-	0.049	0.0145	<5.0	<100
10WBW002-Z1-400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-401	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z3-403	0.0045	<0.0090	0.00063	0.0231	<0.0025	0.734	0.0041	0.33	102	0.181	<0.000050	0.19	0.0231	<5.0	<200
10WBW002-Z1-510	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-511	0.0055	0.0111	0.00055	0.0135	<0.0050	1.19	<0.0030	<0.20	111	0.0347	<0.000050	0.177	0.0133	<10	<200
10WBW002-Z3-512	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Field Sample ID	Rhenium (Re)-Total	Rubidium (Rb)-Total	Selenium (Se)-Total	Silicon (Si)-Total	Silver (Ag)-Total	Sodium (Na)-Total	Strontium (Sr)-Total	Tellurium (Te)-Total	Thallium (Tl)-Total	Thorium (Th)-Total	Tin (Sn)-Total	Titanium (Ti)-Total	Tungsten (W)-Total	Uranium (U)-Total	Vanadium (V)-Total
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10WBW004-123	<0.0005	0.0533	<0.002	1.61	<0.0001	1680	17.2	<0.0005	<0.00005	<0.0005	<0.001	<0.005	<0.001	0.00503	<0.0005
10WBW004-124	<0.00050	0.0568	<0.0020	1.62	<0.00010	1760	19.9	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00517	<0.00050
10WBW004-125	<0.00050	0.0555	<0.0020	1.68	<0.00010	1780	19.8	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00501	<0.00050
10WBW004-126	<0.00050	0.0556	<0.0020	1.67	<0.00010	2500	26.1	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0014	0.00636	<0.00050
10WBW004-128	<0.00050	0.0544	<0.0020	1.76	<0.00010	2190	23.0	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0015	0.00733	<0.00050
10WBW004-129	<0.00050	0.0536	<0.0020	1.77	<0.00010	2480	26.0	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0029	0.00840	<0.00050
10WBW004-130	<0.00050	0.0554	<0.0020	1.80	<0.00010	2460	26.5	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0053	0.0101	<0.00050
10WBW004-131	<0.00050	0.0544	<0.0020	1.81	<0.00010	2360	24.8	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0015	0.00864	<0.00050
10WBW004-Z6-312	<0.00050	0.0540	<0.0020	1.81	<0.00010	2450	24.7	<0.00050	0.000055	<0.00050	<0.0010	<0.0050	<0.0010	0.00395	<0.00050
10WBW004-Z6-313	<0.00050	0.0502	<0.0020	1.76	<0.00010	2430	26.6	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00389	<0.00050
10WBW004-Z6-314	<0.00050	0.0523	<0.0020	1.47	<0.00010	2600	28.4	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00299	<0.00050
10WBW004-Z6-315	-	-	-	-	-	2500	-	-	-	-	-	-	-	-	-
10WBW004-Z6-316	-	-	-	-	-	2830	-	-	-	-	-	-	-	-	-
10WBW004-Z6-317	<0.00050	0.0529	<0.0020	1.88	<0.00010	2440	26.4	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00822	<0.00050
10WBW004-Z6-318	<0.00050	0.0496	<0.0020	1.92	<0.00010	2900	30.2	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0066	0.00783	<0.00050
10WBW004-Z6-404	<0.00050	0.0473	<0.0020	1.54	<0.00010	2840	25.3	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00398	<0.00050
10WBW004-Z6-405	<0.00050	0.0484	<0.0020	1.62	<0.00010	2850	26.3	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0012	0.00435	<0.00050
10WBW004-Z6-406	<0.00050	0.0476	<0.0020	1.92	<0.00010	2370	21.6	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00799	<0.00050
10WBW004-Z6-508	<0.00050	0.0481	<0.0080	1.88	<0.00010	3110	27.1	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.001	0.0047	<0.00050
10WBW004-Z6-509	<0.00050	0.0526	<0.020	1.88	<0.00010	2770	25.4	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00604	<0.00050
10WBW001-02b	-	-	<0.4	-	<0.002	9750	-	-	<0.002	-	<0.05	<0.012	-	<0.002	0.17
10WBW001-03b	-	-	<0.4	-	<0.002	4860	-	-	<0.002	-	<0.05	<0.012	-	<0.002	<0.1
10WBW001-04b	-	-	<0.4	-	<0.002	4930	-	-	<0.002	-	<0.05	<0.012	-	<0.002	<0.1
10WBW001-12	-	-	0.106	-	<0.02	6640	-	-	<0.02	-	<0.08	<0.12	-	<0.02	<0.1
10WBW001-14	-	-	0.147	-	<0.02	7150	-	-	<0.02	-	<0.08	<0.12	-	<0.02	0.18
10WBW001-15	-	-	<0.4	-	<0.02	9260	-	-	<0.02	-	<0.08	<0.12	-	<0.02	0.20
10WBW001-16	-	-	<0.4	-	<0.02	9580	-	-	<0.02	-	<0.08	<0.12	-	<0.02	0.22
10WBW001-28	-	-	<0.4	-	<0.02	6830	-	-	<0.02	-	<0.08	<0.12	-	<0.02	0.22
10WBW001-31	-	-	<0.4	-	<0.02	8290	-	-	<0.02	-	<0.08	<0.12	-	<0.02	0.25
10WBW001-33	-	-	<0.4	-	<0.02	7450	-	-	<0.02	-	<0.08	<0.12	-	<0.02	0.27
10WBW001-36	<0.0005	000	<0.002	2.88	<0.0002	4460	0010	<0.0005	<0.0005	<0.0005	<0.001	<0.005	0.0334	<0.0005	<0.0005
10WBW001-37	<0.0005	0.0816	<0.002	2.12	<0.0002	5590	11.7	<0.0005	<0.0005	<0.0005	<0.001	<0.005	0.0067	<0.0005	<0.0005
10WBW001-101	<0.0005	000	<0.002	3.5	<0.0001	6410	0014	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0247	<0.00005	<0.0005
10WBW001-102	<0.0005	0.0842	<0.002	2.42	<0.0001	5530	11.1	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0051	0.000057	<0.0005
10WBW001-103	<0.0005	0.1420	<0.002	3.68	<0.0001	9350	21.2	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0056	0.00023	0.00054
10WBW001-105	<0.0005	0.104	<0.002	3.51	<0.0001	8990	16.4	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0059	<0.00005	<0.0005
10WBW001-107	<0.0005	0.141	<0.002	3.48	<0.0001	9170	19.9	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0049	0.000228	<0.0005
10WBW001-108	<0.0005	0.102	<0.002	3.82	0.00018	6790	14.6	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0227	0.000059	<0.0005
10WBW001-Z1-300	<0.00050	0.0546	<0.0020	2.51	<0.00010	7290	57.7	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0018	<0.000050	<0.00050
10WBW001-Z6-301	<0.00050	0.133	<0.0020	3.36	<0.00010	8390	18.4	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0163	<0.000050	<0.00050
10WBW001-Z10-302	<0.00050	0.114	<0.0020	3.22	<0.00010	9090	17.7	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0088	<0.000050	<0.00050
10WBW001-Z10-303	<0.00050	0.115	<0.0020	3.6	<0.00010	10200	22.7	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0021	<0.000050	0.00087
10WBW001-Z6-304	<0.00050	0.193	<0.0020	4.1	<0.00010	11300	29.4	<0.00050	<0.000050	<0.00050	<0.0010	0.0303	0.0026	<0.000050	0.00157
10WBW001-Z10-500	<0.00050	0.0949	<0.030	3.38	<0.00010	8680	15.6	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0085	<0.000050	<0.00050
10WBW001-Z1-501	<0.00050	0.0481	<0.030	2.55	<0.00010	7130	52.9	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0018	<0.000050	0.00138
10WBW001-Z6-502	<0.00050	0.128	<0.050	3.08	<0.00010	8560	18	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0096	<0.000050	<0.00050
10WBW001-Z6-503	<0.00050	0.141	<0.030	3.11	<0.00010	8720	18.7	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0096	<0.000050	<0.00050
10WBW001-Z6-504	<0.00050	0.178	<0.050	3.6	<0.00010	10700	27.2	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0025	<0.000050	<0.00050
10WBW001-Z10-505	<0.00050	0.115	<0.030	3.03	<0.00010	9440	20.8	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0027	0.000201	<0.00050
10WBW001-Z10	<0.00050	0.111	<0.0020	3.04	0.00101	8710	16.4	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0084	0.00008	<0.00050
10WBW001-Z01	<0.00050	0.135	<0.0020	2.39	0.00015	7310	58.1	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0019	0.00165	0.00076
10WBW001-Z6	<0.00050	0.155	<0.0020	2.9	<0.00010	9470	21.5	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0098	<0.000050	<0.00050
10WBW001-01-2022	-	0.0493	0.00213	3.1	<0.0002	6720	60.3	0.00443	<0.0002	<0.002	<0.002	<0.006	<0.002	<0.0002	<0.01
10WBW001-01-2023	-	0.0495	<0.0025	<5	<0.0005	6720	55.4	<0.01	<0.0005	<0.005	<0.005	<0.015	<0.005	<0.0005	<0.025
10WBW001-01-2024	-	0.047	<0.0025	<5	<0.0005	6890	55.7	<0.01	<0.0005	<0.005	<0.005	<0.015	<0.005	<0.0005	<0.025
10WBW001-06-2022	-	0.0514	<0.001	5.14	<0.0002	2980	4.34	<0.004	<0.0002	<0.002	<0.002	<0.006	0.0026	<0.0002	<0.01
10WBW001-06-2023	-	0.056	<0.0005	6.39	<0.0001	3380	4.27	<0.002	<0.0001	<0.001	<0.001	<0.003	0.0022	0.00022	<0.01
10WBW001-06-2024	-	0.0491	<0.0005	6.09	0.0001	2980	3.8	<0.004	<0.0002	<0.002	<0.002	0.00116	0.00142	0.000237	0.00207
10WBW001-10-2022	-	0.0117	0.00101	5.54	<0.00005	715	0.382	<0.001	<0.00005	<0.0005	<0.0005	<0.0015	0.0014	0.000261	<0.0025
10WBW001-10-2023	-	0.0115	0.000168	5.84	<0.00002	656	0.311	<0.0004	<0.00002	<0.0002	<0.0002	0.00104	0.0013	0.000219	0.00229
10WBW001-10-2024	-	0.0118	0.000137	6.35	0.00002	696	0.334	<0.0004	<0.00002	<0.0002	<0.0002	0.00116	0.00142	0.000237	0.00207
10WBW001-01b	-	-	<0.4	-	<0.002	7390	-	-	<0.002	-	<0.05	0.052	-	<0.002	<0.1
10WBW001-17	-	-	<0.4	-	<0.02	6290	-	-	<0.02	-	<0.08	<0.12	-	<0.02	0.31
10WBW001-20	-	-	<0.4	-	<0.02	6580	-	-	<0.02	-	<0.08	<0.12	-	<0.02	0.33
10WBW001-25	-	-	<0.4	-	<0.02	7420	-	-	<0.02	-	<0.08	<0.12	-	<0.02	0.21
10WBW001-26	-	-	<0.4	-	<0.02	7870	-	-	<0.02	-	<0.08	<0.12	-	<0.02	0.23
10WBW001-35	<0.0005	000	<0.002	2.61	<0.0002	7470	0060	<0.0005	<0.0005	<0.0005	<0.001	0.0082	<0.001	<0.0005	0.00
10WBW001-100	<0.0005	0.0526	<0.002	2.79	<0.0001	7200	57.2	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0014	<0.00005	<0.0005
10WBW001-106	<0.0005	0.0531	<0.002	2.47	<0.0001	6850	54.6	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0016	<0.00005	<0.0005
10WBW002-01	-	-	<0.4	-	<0.02	580	-	-	<0.02	-	<0.08	2.97	-	<0.02	0.98
10WBW002-02	-	-	<0.4	-	<0.02	240	-	-	<0.02	-	<0.08	0.81	-	<0.02	1.34
10WBW002-109a	<0.005	0.051	<0.02	<5	<0.001	280	33.1	<0.005	0.00054	<0.005	<0.01	<0.05	0.028	<0.0005	<0.005
10WBW002-109b	<0.005	0.053	<0.02	25.4	0.0018	1770	59.0	<0.005	0.00052	<0.005	<0.01	0.366	0.028	<0.0005	0.0279
10WBW002-121	<0.005	<0.05	<0.02	27.8	0.0022	450	37.3	<0.005	<0.0005	<0.005	<0.01	0.378	0.030	<0.0005	0.0282
10WBW002-Z1-305	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-306	<0.0050	0.070	<0.020	9.8	0.0016	4070	94.3	<0.0050	0.00056	<0.0050	<0.010	0.315	0.030	<0.00050	0.0223
10WBW002-Z1-307	<0.0050	0.060	<0.020	11.2	0.0016	1930	60.3	<0.0050	0.00057	<0.0050	<0.010	0.386	0.028	<0.00050	0.0243
10WBW002-Z3-308	<0.0050	0.054	<0.020	<5.0	<0.0010	880	33.7	<0.0050	<0.00050	<0.0050	<0.010	<0.050	0.018	<0.00050	<0.0050
10WBW002-Z2-309	<0.0025	<0.025	<0.10	<2.5	<0.00050	<100	9.76	<0.0025	<0.00025	<0.0025	<0.0050	<0.025	<0.0050	<0.00025	<0.0025
10WBW002-Z1-400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-401	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z3-403	<0.0025	0.05	<0.030	<5.0	0.0018	1530	31.9	<0.0025	<0.00025	<0.0025	0.0052	<0.025	0.0121	<0.00025	<0.0025
10WBW002-Z1-510	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-511	<0.0050	0.05	<0.020	<5.0	<0.0010	810	35.5	<0.0050	<0.00050	<0.0050	<0.010	<0.050	0.023	<0.00050	<0.0050
10WBW002-Z3-512	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

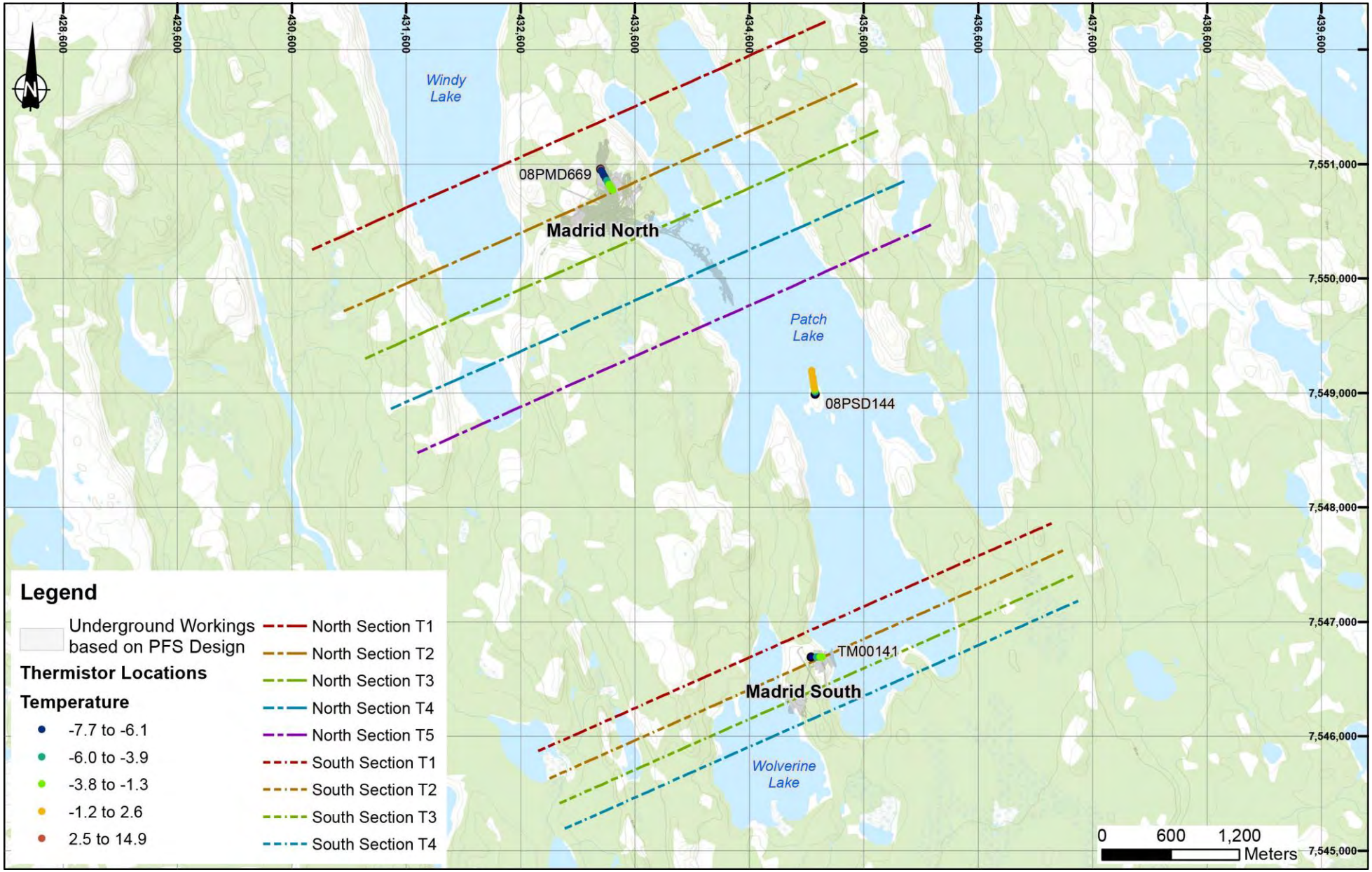
Field Sample ID	Yttrium (Y)-Total	Zinc (Zn)-Total	Zirconium (Zr)-Total	Dissolved Metals	Aluminum (Al)-Dissolved	Antimony (Sb)-Dissolved	Arsenic (As)-Dissolved	Barium (Ba)-Dissolved	Beryllium (Be)-Dissolved	Bismuth (Bi)-Dissolved	Boron (B)-Dissolved	Cadmium (Cd)-Dissolved	Calcium (Ca)-Dissolved	Cesium (Cs)-Dissolved	Chromium (Cr)-Dissolved
	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10WBW004-123	<0.0005	0.392	<0.0005		<0.005	0.0182	<0.002	0.594	<0.0005	<0.0005	0.84	<0.0001	5050	0.00540	<0.0001
10WBW004-124	<0.00050	0.188	<0.00050		<0.0050	0.0178	<0.0020	0.586	<0.00050	<0.00050	0.93	<0.00010	4630	0.00553	<0.00050
10WBW004-125	<0.00050	0.206	<0.00050		<0.0050	0.0182	<0.0020	0.570	<0.00050	<0.00050	0.90	<0.00010	4580	0.00537	<0.00050
10WBW004-126	<0.00050	0.204	<0.00050		<0.0050	0.0178	<0.0020	0.533	<0.00050	<0.00050	0.97	<0.00010	4180	0.00648	<0.00050
10WBW004-128	<0.00050	0.148	<0.00050		<0.0050	0.0194	<0.0020	0.563	<0.00050	<0.00050	0.92	<0.00010	4230	0.00595	<0.00050
10WBW004-129	<0.00050	0.196	<0.00050		<0.0050	0.0211	<0.0020	0.582	<0.00050	<0.00050	1.01	<0.00010	4350	0.00683	<0.00050
10WBW004-130	<0.00050	0.217	<0.00050		<0.0050	0.0207	<0.0020	0.575	<0.00050	<0.00050	0.96	<0.00010	4620	0.00651	<0.00050
10WBW004-131	<0.00050	0.193	<0.00050		<0.0050	0.0192	<0.0020	0.555	<0.00050	<0.00050	0.95	<0.00010	4080	0.00621	<0.00050
10WBW004-Z6-312	<0.00050	0.156	<0.00050		<0.0050	0.0156	<0.0020	0.544	<0.00050	<0.00050	0.86	<0.00010	5040	0.00605	<0.00010
10WBW004-Z6-313	<0.00050	0.145	<0.00050		<0.0050	0.0160	<0.0020	0.554	<0.00050	<0.00050	0.91	<0.00010	4490	0.00612	<0.00010
10WBW004-Z6-314	<0.00050	0.139	<0.00050		<0.0050	0.0118	<0.0020	0.491	<0.00050	<0.00050	0.83	<0.00010	5200	0.00737	<0.00010
10WBW004-Z6-315	-	-	-		-	-	-	-	-	-	-	-	-	-	-
10WBW004-Z6-316	-	-	-		-	-	-	-	-	-	-	-	-	-	-
10WBW004-Z6-317	<0.00050	0.180	<0.00050		<0.0050	0.0180	<0.0020	0.564	<0.00050	<0.00050	0.88	<0.00010	4500	0.00618	<0.00010
10WBW004-Z6-318	<0.00050	0.265	<0.00050		<0.0050	0.0176	<0.0020	0.499	<0.00050	<0.00050	0.88	<0.00010	4690	0.00693	<0.00010
10WBW004-Z6-404	<0.00050	0.125	<0.02		<0.0050	0.0152	<0.0020	0.496	<0.00050	<0.00050	0.9	<0.000050	4700	0.00786	<0.00050
10WBW004-Z6-405	<0.00050	0.867	<0.00050		<0.0050	0.0153	<0.0020	0.528	<0.00050	<0.00050	0.9	<0.000050	4530	0.00852	<0.00050
10WBW004-Z6-406	<0.00050	0.133	<0.00050		<0.0050	0.0157	<0.0030	0.541	<0.00050	<0.00050	0.81	<0.000050	4530	0.00618	<0.00050
10WBW004-Z6-508	<0.00050	0.881	<0.00050		<0.0050	0.0151	<0.0050	0.496	<0.00050	<0.00050	0.94	<0.00010	4860	0.00874	<0.00050
10WBW004-Z6-509	<0.00050	0.377	<0.00050		<0.0050	0.0122	<0.0030	0.533	<0.00050	<0.00050	0.85	<0.000050	4490	0.00658	<0.00050
10WBW001-02b	-	0.088	-		<0.1	<0.008	<0.08	0.062	<0.01	-	2.44	<0.001	1640	-	0.0385
10WBW001-03b	-	<0.08	-		0.13	<0.008	<0.08	0.186	<0.01	-	1.31	<0.001	822	-	0.0178
10WBW001-04b	-	<0.08	-		<0.1	<0.008	<0.08	0.188	<0.01	-	1.38	<0.001	837	-	0.0264
10WBW001-12	-	<0.8	-		<1	<0.08	0.100	0.135	<0.1	-	2.06	<0.01	1230	-	<0.8
10WBW001-14	-	<0.8	-		<1	<0.08	0.116	0.105	<0.1	-	2.43	<0.01	1340	-	0.739
10WBW001-15	-	<0.8	-		<1	<0.08	0.091	0.100	<0.1	-	2.23	<0.01	1420	-	0.747
10WBW001-16	-	<0.8	-		<1	<0.08	0.097	0.097	<0.1	-	2.32	<0.01	1560	-	0.874
10WBW001-28	-	<0.8	-		<1	<0.08	<0.08	0.143	<0.1	-	1.64	<0.01	1150	-	0.3130
10WBW001-31	-	<0.8	-		<1	<0.08	<0.08	0.115	<0.1	-	2.03	<0.01	1330	-	0.451
10WBW001-33	-	<0.8	-		<1	<0.08	0.102	0.120	<0.1	-	1.97	<0.01	1390	-	0.682
10WBW001-36	<0.0005	0.195	<0.0005		<0.005	0.00703	<0.002	0.120	<0.0005	<0.0005	0.94	<0.00012	0749	0000	<0.001
10WBW001-37	<0.0005	0.261	<0.0005		<0.005	0.00306	<0.002	0.169	<0.0005	<0.0005	1.42	<0.00012	1010	0.00092	<0.001
10WBW001-101	<0.0005	0.236	<0.0005		<0.005	0.0048	<0.002	0.178	<0.0005	<0.0005	1.38	<0.00005	1100	0000	<0.0001
10WBW001-102	<0.0005	0.173	<0.0005		<0.005	0.00097	<0.002	0.178	<0.0005	<0.0005	1.54	<0.00005	1110	0.00104	<0.0001
10WBW001-103	<0.0005	0.046	<0.0005		<0.005	0.00121	0.0066	0.113	<0.0005	<0.0005	2.64	<0.00005	1550	0.00154	<0.0005
10WBW001-105	<0.0005	0.107	<0.0005		<0.005	0.00053	<0.002	0.122	<0.0005	<0.0005	2.86	<0.00005	1560	0.00148	<0.0001
10WBW001-107	<0.0005	0.0241	<0.0005		<0.005	0.00116	0.0069	0.115	<0.0005	<0.0005	2.61	<0.00005	1520	0.00159	<0.0001
10WBW001-108	<0.0005	0.115	<0.0005		<0.005	0.00393	<0.002	0.169	<0.0005	<0.0005	1.48	<0.00005	1160	0.00097	<0.0005
10WBW001-Z1-300	<0.00050	0.150	<0.00050		<0.0050	<0.00050	<0.0020	0.0522	<0.00050	<0.00050	3.05	<0.000050	4770	0.00103	<0.00050
10WBW001-Z6-301	<0.00050	0.335	<0.00050		<0.0050	<0.00050	<0.0020	0.182	<0.00050	<0.00050	1.86	<0.000050	1400	0.00119	<0.00050
10WBW001-Z10-302	<0.00050	0.278	<0.00050		<0.0050	<0.00050	<0.0020	0.0973	<0.00050	<0.00050	2.67	0.000138	1560	0.00116	<0.00050
10WBW001-Z10-303	<0.00050	0.212	<0.00050		<0.0050	<0.00050	<0.0020	0.0651	<0.00050	<0.00050	2.75	0.000082	2050	0.00081	<0.00050
10WBW001-Z6-304	<0.00050	0.217	<0.00050		<0.0050	<0.00050	<0.0020	0.0576	<0.00050	<0.00050	3.05	0.000100	2010	0.00180	<0.00050
10WBW001-Z10-500	<0.00050	0.259	<0.00050		<0.0050	<0.00050	<0.0040	0.0986	<0.00050	<0.00050	2.13	<0.000050	1590	0.00114	<0.00050
10WBW001-Z1-501	<0.00050	0.279	<0.00050		<0.0050	<0.00050	<0.0020	0.051	<0.00050	<0.00050	2.54	0.000195	4820	0.00103	<0.00050
10WBW001-Z6-502	<0.00050	1.82	<0.00050		<0.0050	<0.00050	<0.0020	0.129	<0.00050	<0.00050	1.86	<0.000050	1480	0.00132	<0.00050
10WBW001-Z6-503	<0.00050	0.376	<0.00050		<0.0050	<0.00050	<0.0020	0.125	<0.00050	<0.00050	1.98	<0.000050	1490	0.00132	<0.00050
10WBW001-Z6-504	<0.00050	1.71	<0.00050		<0.0050	<0.00050	<0.0050	0.0568	<0.00050	<0.00050	2.83	0.000083	2030	0.00193	<0.00050
10WBW001-Z10-505	<0.00050	0.761	<0.00050		<0.0050	<0.00050	<0.0080	0.0621	<0.00050	<0.00050	2.52	0.000108	1870	0.00102	<0.00050
10WBW001-Z10	<0.00050	1.35	<0.00050		0.0056	0.0008	<0.11	0.102	<0.00050	<0.00050	2.66	0.000414	1430	0.00119	<0.00050
10WBW001-Z01	<0.00050	1.27	<0.00050		<0.0050	<0.00050	<0.020	0.0509	<0.00050	<0.00050	3.9	0.00013	4430	0.00102	<0.00050
10WBW001-Z6	<0.00050	0.488	<0.00050		<0.0050	<0.00050	<0.020	0.119	<0.00050	<0.00050	2.89	0.000158	1560	0.00152	<0.00050
10WBW001-01-2022	-	0.683	<0.004		<0.05	<0.005	<0.005	0.0642	<0.001	<0.0025	2.38	<0.00025	4400	0.00111	-
10WBW001-01-2023	-	0.685	<0.01		0.0861	<0.005	<0.005	0.0639	<0.001	<0.0025	3.14	<0.00025	4750	0.00103	<0.025
10WBW001-01-2024	-	1.52	<0.01		0.05	<0.005	<0.005	0.0627	<0.001	<0.0025	3.39	<0.00025	4730	0.00115	<0.025
10WBW001-06-2022	-	0.197	<0.004		0.0204	<0.002	<0.002	0.0506	<0.0004	<0.001	1.73	<0.0001	298	0.000572	-
10WBW001-06-2023	-	0.0913	<0.002		0.0188	<0.001	<0.001	0.0629	<0.0002	<0.0005	2.32	<0.00005	335	0.000704	<0.005
10WBW001-06-2024	-	0.198	<0.004		0.01	<0.001	<0.001	0.0525	<0.0002	<0.0005	2.5	<0.00005	295	0.00065	<0.005
10WBW001-10-2022	-	0.241	<0.001		0.015	<0.0005	0.00074	0.0438	<0.0001	<0.00025	1.1	-	26.9	0.000153	-
10WBW001-10-2023	-	0.248	<0.0004		0.0064	<0.0002	0.00055	0.0504	<0.00004	<0.0001	1.35	<0.00001	26.7	0.00017	<0.001
10WBW001-10-2024	-	0.198	<0.0004		0.0041	<0.0002	0.00058	0.053	<0.00004	<0.0001	1.53	<0.00001	31.2	0.00016	<0.001
10WBW001-01b	-	<0.08	-		0.12	<0.008	<0.08	0.057	<0.01	-	3.19	<0.001	4390	-	0.0444
10WBW001-17	-	<0.8	-		<1	<0.08	0.103	0.052	<0.1	-	2.64	<0.01	4480	-	0.8840
10WBW001-20	-	<0.8	-		<1	<0.08	0.103	0.048	<0.1	-	2.62	<0.01	4260	-	0.899
10WBW001-25	-	<0.8	-		<1	<0.08	<0.08	0.051	<0.1	-	2.87	<0.01	4520	-	0.351
10WBW001-26	-	<0.8	-		<1	<0.08	0.090	0.052	<0.1	-	2.74	<0.01	4360	-	0.532
10WBW001-35	<0.0005	0.503	<0.0005		<0.005	<0.0005	<0.002	0.052	<0.0005	<0.0005	2.99	<0.00012	4960	0000	<0.001
10WBW001-100	0.00052	0.279	<0.0005		<0.005	<0.0005	<0.002	0.053	<0.0005	<0.0005	2.92	0.000083	4920	0.00102	<0.0001
10WBW001-106	0.00057	0.285	<0.0005		0.005	<0.0005	<0.002	0.0526	<0.0005	<0.0005	3.3	0.000097	4730	0.0011	<0.0001
10WBW002-01	-	<0.8	-		<1	<0.08	0.266	0.683	<0.1	-	0.86	<0.01	72100	-	0.371
10WBW002-02	-	<0.8	-		<1	<0.08	0.421	0.770	<0.1	-	0.99	<0.01	79800	-	0.328
10WBW002-109a	<0.005	0.595	<0.005		<0.05	0.0093	<0.02	0.833	<0.005	<0.005	<1	<0.0005	74700	0.0063	0.0079
10WBW002-109b	<0.005	0.373	<0.005		-	-	-	-	-	-	-	-	-	-	-
10WBW002-121	<0.005	0.557	<0.005		<0.05	0.0094	<0.02	0.817	<0.005	<0.005	<1	<0.0005	73100	0.0062	<0.001
10WBW002-Z1-305	-	-	-		-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-306	<0.0050	2.51	<0.0050		-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-307	<0.0050	1.91	<0.0050		<0.050	0.0087	<0.020	0.815	<0.0050	<0.0050	<1.0	<0.00050	71100	0.0065	<0.0020
10WBW002-Z3-308	<0.0050	0.703	<0.0050		0.052	0.0082	<0.020	0.986	<0.0050	<0.0050	<1.0	<0.00050	65300	0.0052	<0.0010
10WBW002-Z2-309	<0.0025	76.7	<0.0025		<0.025	0.0044	0.029	0.265	<0.0025	<0.0025	<0.50	0.00094	23000	<0.0025	<0.00050
10WBW002-Z1-400	-	-	-		0.04	0.0087	<0.020	0.829	<0.0025	<0.0025	1.48	<0.00050	83000	0.0057	<0.0020
10WBW002-Z1-401	-	-	-		0.042	0.0085	<0.010	0.818	<0.0025	<0.0025	1.03	<0.00050	74600	0.0061	<0.00050
10WBW002-Z3-403	<0.0025	1.71	<0.0025		<0.025	0.0075	<0.020	0.795	<0.0025	<0.0025	0.9	<0.00050	63100	0.005	<0.00050
10WBW002-Z1-510	-	-	-		<0.050	0.0095	<0.20	0.82	<0.0050	<0.0050	<1.0	<0.00050	71600	0.0061	<0.0050
10WBW002-Z1-511	<0.0050	0.658	<0.0050		<0.050	0.0092	<0.20	0.851	<0.0050	<0.0050	<1.0	<0.00050	80000	0.0063	<0.0050
10WBW002-Z3-512	-	-	-		<0.050	0.0088	<0.20	0.728	<0.0050	<0.0050	<1.0	0.00059	64300	0.0052	<0.0050

Field Sample ID	Cobalt (Co)-Dissolved	Copper (Cu)-Dissolved	Gallium (Ga)-Dissolved	Iron (Fe)-Dissolved	Lead (Pb)-Dissolved	Lithium (Li)-Dissolved	Magnesium (Mg)-Dissolved	Manganese (Mn)-Dissolved	Mercury (Hg)-Dissolved	Molybdenum (Mo)-Dissolved	Nickel (Ni)-Dissolved	Phosphorus (P)-Dissolved	Potassium (K)-Dissolved	Rhenium (Re)-Dissolved	Rubidium (Rb)-Dissolved
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10WBW004-123	0.00779	<0.0005	<0.0005	8.05	<0.0003	0.054	311	1.01	<0.00001	0.0902	0.0320	<1	47	<0.0005	0.0601
10WBW004-124	0.00736	<0.00050	<0.00050	7.38	<0.00050	0.055	312	0.989	-	0.0866	0.0313	<1.0	47	<0.00050	0.0587
10WBW004-125	0.00708	<0.00050	<0.00050	7.06	<0.00050	0.055	309	0.950	-	0.0860	0.0301	<1.0	47	<0.00050	0.0576
10WBW004-126	0.00526	<0.00050	<0.00050	6.43	<0.00050	0.055	404	0.888	-	0.0990	0.0199	<1.0	48	<0.00050	0.0530
10WBW004-128	0.00575	<0.00050	<0.00050	5.06	<0.00050	0.055	365	0.899	-	0.0931	0.0229	<1.0	48	<0.00050	0.0551
10WBW004-129	0.00529	<0.00050	<0.00050	4.34	<0.00050	0.057	425	0.911	-	0.100	0.0203	<1.0	50	<0.00050	0.0564
10WBW004-130	0.00566	<0.00050	<0.00050	4.45	<0.00050	0.055	432	0.904	<0.000050	0.101	0.0201	<1.0	53	<0.00050	0.0541
10WBW004-131	0.00529	<0.00050	<0.00050	4.45	<0.00050	0.054	387	0.870	<0.000050	0.0967	0.0208	<1.0	49	<0.00050	0.0539
10WBW004-Z6-312	0.00452	<0.00050	<0.00050	3.50	<0.00030	0.044	425	0.859	<0.000010	0.0852	0.0157	<1.0	55	<0.00050	0.0531
10WBW004-Z6-313	0.00465	<0.00050	<0.00050	3.54	<0.00030	0.049	403	0.853	<0.000010	0.0868	0.0163	<1.0	51	<0.00050	0.0533
10WBW004-Z6-314	0.00434	<0.00050	<0.00050	11.8	<0.00030	0.048	435	0.889	-	0.0956	0.0110	<1.0	51	<0.00050	0.0483
10WBW004-Z6-315	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW004-Z6-316	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW004-Z6-317	0.00504	<0.00050	<0.00050	0.233	<0.00030	0.048	404	0.840	<0.000010	0.0878	0.0167	<1.0	51	<0.00050	0.0533
10WBW004-Z6-318	0.00327	<0.00050	<0.00050	3.48	<0.00030	0.047	492	0.836	-	0.0970	0.0138	<1.0	52	<0.00050	0.0499
10WBW004-Z6-404	0.00323	<0.00050	<0.00050	8.51	<0.00030	0.045	496	0.891	<0.000050	0.1	0.0122	<1.0	50	<0.00050	0.0494
10WBW004-Z6-405	0.00346	<0.00050	<0.00050	10	<0.00030	0.047	473	0.97	<0.000050	0.104	0.0129	<1.0	49	<0.00050	0.0525
10WBW004-Z6-406	0.00314	<0.00050	<0.00050	10.3	<0.00030	0.042	425	0.881	<0.000050	0.095	0.0115	<1.0	51	<0.00050	0.0503
10WBW004-Z6-508	0.00275	<0.00050	<0.00050	10.9	<0.00030	0.048	525	0.88	<0.000050	0.11	0.00999	<1.0	53	<0.00050	0.052
10WBW004-Z6-509	0.00374	0.00187	<0.00050	8.68	<0.00030	0.043	441	0.849	<0.000050	0.0988	0.0131	<1.0	51	<0.00050	0.051
10WBW001-02b	<0.002	<0.012	-	9.26	<0.002	0.297	1430	2.48	<0.0001	<0.005	0.0289	-	251	-	-
10WBW001-03b	<0.002	<0.012	-	1.88	<0.002	0.128	707	1.01	<0.0001	0.0240	0.0146	-	129	-	-
10WBW001-04b	<0.002	<0.012	-	1.63	<0.002	0.136	721	1.01	<0.0001	0.0239	0.0159	-	131	-	-
10WBW001-12	<0.02	0.13	-	-	<0.02	<0.6	990	-	<0.0001	<0.02	0.032	-	225	-	-
10WBW001-14	<0.02	<0.12	-	-	<0.02	<0.6	1070	-	<0.0001	<0.02	0.043	-	245	-	-
10WBW001-15	<0.02	0.19	-	5.77	<0.02	<0.6	1170	1.56	<0.0001	<0.02	<0.02	-	206	-	-
10WBW001-16	<0.02	<0.12	-	6.25	<0.02	<0.6	1300	1.72	<0.0001	<0.02	<0.02	-	294	-	-
10WBW001-28	<0.02	<0.12	-	1.54	<0.02	<0.6	1070	1.17	<0.0001	0.0280	<0.02	-	170	-	-
10WBW001-31	<0.02	<0.12	-	2.87	<0.02	<0.6	1270	1.7	<0.0001	0.023	<0.02	-	186	-	-
10WBW001-33	<0.02	<0.12	-	3.32	<0.02	<0.6	1310	1.96	<0.0001	<0.02	<0.02	-	194	-	-
10WBW001-36	<0.0005	<0.001	<0.0005	0.06	<0.001	0.087	0702	0.53	-	0.0379	0.00076	<1	117	<0.0005	000
10WBW001-37	<0.0005	<0.001	<0.0005	2.68	<0.001	0.121	849	1.04	-	0.0211	<0.0005	<1	160	<0.0005	0.0766
10WBW001-101	0.000087	<0.0005	<0.0005	0.13	<0.0003	0.12	0964	0.94	<0.00001	0.037	<0.0005	<1	160	<0.0005	000
10WBW001-102	0.000102	<0.0005	<0.0005	3.15	<0.0003	0.13	869	1.17	<0.00001	0.0259	<0.0005	<1	173	<0.0005	0.085
10WBW001-103	0.000315	<0.0005	<0.0005	4.31	<0.003	0.223	1490	2.03	<0.00005	0.0138	0.00101	<1	233	<0.0005	0.1400
10WBW001-105	0.000187	0.00296	<0.0005	8.94	<0.0003	0.201	1250	1.69	<0.00001	0.0044	0.0006	<1	249	<0.0005	0.107
10WBW001-107	0.000312	<0.0005	<0.0005	4.55	<0.0003	0.223	1450	2.11	<0.00001	0.0122	0.00094	<1	229	<0.0005	0.139
10WBW001-108	0.000091	<0.0005	<0.0005	0.503	<0.0003	0.127	1080	0.888	-	0.0345	0.00158	<1	172	<0.0005	0.106
10WBW001-Z1-300	0.000059	0.00083	<0.00050	0.034	<0.00030	0.371	71.2	0.731	<0.000010	0.0112	0.00163	<1.0	39	<0.00050	0.0529
10WBW001-Z6-301	<0.000050	<0.00050	<0.00050	0.624	<0.00030	0.175	1270	1.22	<0.000010	0.0311	0.00100	<1.0	208	<0.00050	0.140
10WBW001-Z10-302	<0.000050	<0.00050	<0.00050	5.83	<0.00030	0.190	1200	1.20	<0.000010	0.0038	0.00073	<1.0	251	<0.00050	0.109
10WBW001-Z10-303	<0.000050	<0.00050	<0.00050	0.881	<0.00030	0.189	1420	2.01	<0.000010	<0.0020	<0.00050	<1.0	270	<0.00050	0.112
10WBW001-Z6-304	0.000153	<0.00050	<0.00050	7.28	<0.00030	0.428	1640	2.15	<0.000010	0.0054	0.00140	<1.0	268	<0.00050	0.172
10WBW001-Z10-500	0.00012	<0.00050	<0.00050	6.72	<0.00030	0.156	1220	1.36	<0.000050	0.0052	0.00102	<1.0	244	<0.00050	0.101
10WBW001-Z1-501	<0.000050	<0.00050	<0.00050	0.02	<0.00030	0.309	67.9	0.736	<0.000050	0.0102	0.0005	<1.0	38	<0.00050	0.0502
10WBW001-Z6-502	0.000067	<0.00050	<0.00050	3.81	<0.00030	0.165	1340	1.7	<0.000050	0.0181	0.00063	<1.0	217	<0.00050	0.136
10WBW001-Z6-503	0.000075	<0.00050	<0.00050	3.96	<0.00030	0.173	1350	1.75	<0.000050	0.0187	0.00066	<1.0	218	<0.00050	0.141
10WBW001-Z6-504	0.000093	0.00054	<0.00050	8.91	<0.00030	0.379	1720	2.48	<0.000050	0.0044	0.00057	<1.0	282	<0.00050	0.182
10WBW001-Z10-505	0.000067	<0.00050	<0.00050	3.87	<0.00030	0.166	1370	2.09	<0.000050	<0.0020	0.00053	<1.0	264	<0.00050	0.115
10WBW001-Z10	0.00127	0.00064	<0.00050	5.78	<0.00030	0.213	1110	1.2	<0.000010	0.0116	0.0263	<1.0	245	<0.00050	0.112
10WBW001-Z01	0.000188	<0.00050	<0.00050	0.08	<0.00030	0.476	65.8	0.701	<0.000010	0.0129	0.00466	<1.0	40	<0.00050	0.0547
10WBW001-Z6	0.000127	<0.00050	<0.00050	4.81	<0.00030	0.275	1400	1.71	<0.000010	0.0143	0.00179	<1.0	242	<0.00050	0.158
10WBW001-01-2022	<0.005	<0.01	-	3.18	<0.0025	0.308	64	0.89	<0.000005	0.0116	0.128	<2.5	38.2	-	0.0471
10WBW001-01-2023	<0.005	<0.01	-	2.66	<0.0025	0.337	66.5	0.905	<0.000005	0.0101	<0.025	<2.5	41.2	-	0.0506
10WBW001-01-2024	<0.005	<0.01	-	2.09	<0.0025	0.366	63.4	0.85	<0.000005	0.00896	<0.025	<2.5	39.7	-	0.0473
10WBW001-06-2022	<0.002	<0.004	-	<0.2	<0.001	0.06	340	0.302	<0.000005	<0.001	<0.01	<1	94.7	-	0.0534
10WBW001-06-2023	<0.001	<0.002	-	<0.1	<0.0005	0.0672	393	0.316	<0.000005	<0.0005	<0.005	<0.5	103	-	0.056
10WBW001-06-2024	<0.001	<0.002	-	<0.1	<0.0005	0.064	321	0.275	<0.000005	<0.0005	<0.005	<0.5	208	-	0.0478
10WBW001-10-2022	<0.0005	0.00129	-	0.226	0.000298	0.0155	33.7	0.0359	<0.000005	0.00196	<0.0025	0.7	29.9	-	0.0118
10WBW001-10-2023	<0.0002	<0.0004	-	0.163	<0.0001	0.0167	36	0.0353	<0.000005	0.00225	<0.001	0.78	29.7	-	0.0117
10WBW001-10-2024	<0.0002	0.00043	-	0.136	<0.0001	0.0182	37.5	0.0397	<0.000005	0.00305	<0.001	0.818	30.5	-	0.0116
10WBW001-01b	0.0043	0.014	-	0.22	<0.002	0.370	172	1.34	<0.0001	0.0411	0.0817	-	054	-	-
10WBW001-17	<0.02	<0.12	-	<0.15	<0.02	<0.6	080	0.81	<0.0001	0.0200	0.0640	-	043	-	-
10WBW001-20	<0.02	<0.12	-	<0.15	<0.02	<0.6	066	0.694	<0.0001	<0.02	0.055	-	039	-	-
10WBW001-25	<0.02	<0.12	-	<0.15	<0.02	<0.6	0046	0.544	<0.0001	<0.02	0.061	-	039	-	-
10WBW001-26	<0.02	<0.12	-	<0.15	<0.02	<0.6	0045	0.53	<0.0001	<0.02	0.066	-	037	-	-
10WBW001-35	<0.0005	<0.001	<0.0005	<0.05	<0.001	0.37	0070	0.69	-	0.0128	<0.0005	<1	039	<0.0005	000
10WBW001-100	<0.00005	<0.0005	<0.0005	0.06	<0.0003	0.350	064	0.71	<0.00001	0.0092	<0.0005	<1	039	<0.0005	0.0528
10WBW001-106	<0.00005	0.00067	<0.0005	0.075	<0.0003	0.39	68.1	0.725	<0.00001	0.009	0.00237	<1	40	<0.0005	0.0532
10WBW002-01	0.061	<0.12	-	<1.5	<0.02	<0.6	113	<0.25	<0.0001	0.222	1.43	-	39	-	-
10WBW002-02	0.074	<0.12	-	<1.5	<0.02	<0.6	124	<0.25	<0.0001	0.180	1.68	-	52	-	-
10WBW002-109a	<0.0005	0.0129	<0.005	0.12	0.0030	0.44	110	0.0196	<0.00001	0.163	<0.005	<10	<200	<0.005	0.053
10WBW002-109b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-121	<0.0005	0.0158	<0.005	<0.1	<0.003	<0.2	113	0.0141	<0.00001	0.175	0.0072	<10	<200	<0.005	<0.05
10WBW002-Z1-305	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-306	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-307	<0.00050	0.0123	<0.0050	<0.10	<0.0030	0.50	102	0.0182	-	0.157	0.0059	<10	<200	<0.0050	0.059
10WBW002-Z3-308	<0.00050	0.0115	<0.0050	<0.10	<0.0030	0.22	102	0.0372	-	0.220	0.0098	<10	<200	<0.0050	0.057
10WBW002-Z2-309	0.00038	0.0094	<0.0025	<0.050	0.0024	<0.10	42.4	0.120	-	0.047	0.0103	<5.0	<100	<0.0025	<0.025
10WBW002-Z1-400	<0.00025	0.0155	<0.0025	<0.050	<0.0015	0.1	125	0.0088	-	0.189	0.0113	<5.0	<200	<0.0025	0.056
10WBW002-Z1-401	<0.00025	0.0134	<0.0025	0.058	<0.0015	0.29	111	0.0151	<0.000050	0.195	0.008	<5.0	<200	<0.0025	0.056
10WBW002-Z3-403	0.00039	0.0186	<0.0025	<0.050	<0.0015	0.37	111	0.185	<0.000050	0.199	0.0177	<5.0	<200	<0.0025	0.054
10WBW002-Z1-510	<0.00050	0.0129	<0.0050	<0.10	<0.0030	<0.20	108	0.0116	<0.000050	0.196	0.0069	<10	<200	<0.0050	0.052
10WBW002-Z1-511	<0.00050	0.0133	<0.0050	<0.10	<0.0030	<0.20	116	0.012	<0.000050	0.209	0.0082	<10	<200	<0.0050	0.053
10WBW002-Z3-512	<0.00050	0.0123	<0.0050	<0.10	<0.0030	0.39	112	0.252	<0.000050	0.21	0.0101	<10	<200	<0.0050	0.052

Field Sample ID	Selenium (Se)-Dissolved	Silicon (Si)-Dissolved	Silver (Ag)-Dissolved	Sodium (Na)-Dissolved	Strontium (Sr)-Dissolved	Tellurium (Te)-Dissolved	Thallium (Tl)-Dissolved	Thorium (Th)-Dissolved	Tin (Sn)-Dissolved	Titanium (Ti)-Dissolved	Tungsten (W)-Dissolved	Uranium (U)-Dissolved	Vanadium (V)-Dissolved	Yttrium (Y)-Dissolved	Zinc (Zn)-Dissolved
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10WBW004-123	<0.002	1.57	<0.0001	1820	18.8	<0.0005	<0.00005	<0.0005	<0.001	<0.005	<0.001	0.00512	<0.0005	<0.0005	0.156
10WBW004-124	<0.0020	1.65	<0.00010	1820	21.3	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00523	<0.00050	<0.00050	0.0944
10WBW004-125	<0.0020	1.63	<0.00010	1790	20.1	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00521	<0.00050	<0.00050	0.0933
10WBW004-126	<0.0030	1.65	<0.00010	2410	25.3	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0020	0.00730	<0.00050	<0.00050	0.136
10WBW004-128	<0.0020	1.72	<0.00010	2200	23.1	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0013	0.00730	<0.00050	<0.00050	0.114
10WBW004-129	<0.0021	1.71	<0.00010	2510	27.0	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0029	0.00909	<0.00050	<0.00050	0.0941
10WBW004-130	<0.0045	1.89	<0.00010	2600	26.3	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0050	0.0100	<0.00050	<0.00050	0.137
10WBW004-131	<0.0020	1.78	<0.00010	2330	24.4	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0014	0.00863	<0.00050	<0.00050	0.131
10WBW004-Z6-312	<0.0020	1.93	<0.00010	2600	26.3	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00621	<0.00050	<0.00050	0.298
10WBW004-Z6-313	<0.0020	1.75	<0.00010	2390	26.2	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00655	<0.00050	<0.00050	0.296
10WBW004-Z6-314	<0.0020	1.31	<0.00010	2540	27.5	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00281	<0.00050	<0.00050	0.105
10WBW004-Z6-315	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW004-Z6-316	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW004-Z6-317	<0.0020	1.75	<0.00010	2400	26.0	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00848	<0.00050	<0.00050	0.104
10WBW004-Z6-318	<0.0020	1.86	<0.00010	2890	30.1	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0054	0.00823	<0.00050	<0.00050	0.194
10WBW004-Z6-404	<0.0020	1.67	<0.00010	2960	26.8	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00617	<0.00050	<0.00050	0.153
10WBW004-Z6-405	<0.0020	1.6	<0.00010	2850	28	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00599	<0.00050	<0.00050	0.125
10WBW004-Z6-406	<0.0030	1.79	<0.00010	2400	23.1	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00508	<0.00050	<0.00050	0.0548
10WBW004-Z6-508	<0.020	1.83	<0.00010	3170	27.6	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.00469	<0.00050	<0.00050	0.456
10WBW004-Z6-509	<0.010	1.87	<0.00010	2670	24.7	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	<0.0010	0.0067	<0.00050	<0.00050	0.161
10WBW001-02b	<0.4	-	<0.002	9080	-	-	<0.001	-	<0.05	<0.006	-	<0.002	0.152	-	0.041
10WBW001-03b	<0.4	-	<0.002	4470	-	-	<0.001	-	<0.05	0.0135	-	<0.002	0.077	-	0.026
10WBW001-04b	<0.4	-	<0.002	4540	-	-	<0.001	-	<0.05	0.0081	-	<0.002	0.099	-	0.022
10WBW001-12	0.107	-	<0.02	7130	-	-	<0.01	-	<0.05	<0.06	-	<0.02	0.221	-	<0.2
10WBW001-14	0.139	-	<0.02	7840	-	-	<0.01	-	<0.05	<0.06	-	<0.02	0.214	-	<0.2
10WBW001-15	<0.4	-	<0.02	7970	-	-	<0.01	-	<0.05	<0.06	-	<0.02	0.259	-	0.22
10WBW001-16	<0.4	-	<0.02	9450	-	-	0.010	-	<0.05	<0.06	-	<0.02	0.292	-	<0.2
10WBW001-28	<0.4	-	<0.02	6450	-	-	<0.01	-	<0.05	<0.06	-	<0.02	0.128	-	<0.2
10WBW001-31	<0.4	-	<0.02	7910	-	-	<0.01	-	<0.05	<0.06	-	<0.02	0.176	-	<0.2
10WBW001-33	<0.4	-	<0.02	8160	-	-	<0.01	-	<0.05	<0.06	-	<0.02	0.229	-	<0.2
10WBW001-36	<0.002	2.48	<0.0002	4130	0009	<0.0005	<0.0005	<0.0005	<0.001	<0.005	0.0316	<0.0005	<0.0005	<0.0005	0.02
10WBW001-37	<0.002	1.99	<0.0002	5400	11.3	<0.0005	<0.0005	<0.0005	<0.001	<0.005	0.0059	<0.0005	<0.0005	<0.0005	0.0504
10WBW001-101	<0.002	2.88	<0.0001	6010	0013	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0246	<0.00005	<0.0005	<0.0005	0.0705
10WBW001-102	<0.002	2.38	<0.0001	5780	11.7	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.005	0.000059	<0.0005	<0.0005	0.061
10WBW001-103	<0.002	3.49	<0.0001	9130	21.1	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0053	0.000231	<0.0005	<0.0005	0.0384
10WBW001-105	<0.002	3.3	<0.0001	8700	16.8	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.006	<0.00005	<0.0005	<0.0005	0.0851
10WBW001-107	<0.002	3.38	<0.0001	8980	19.4	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0048	0.000234	<0.0005	<0.0005	0.0243
10WBW001-108	<0.002	3.33	<0.0001	6810	14.6	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0231	0.000058	<0.0005	<0.0005	0.0295
10WBW001-Z1-300	<0.0020	2.42	<0.00010	7020	55.8	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0018	<0.000050	<0.00050	<0.00050	0.157
10WBW001-Z6-301	<0.0020	3.00	<0.00010	8270	18.1	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0159	<0.000050	<0.00050	<0.00050	0.154
10WBW001-Z10-302	<0.0020	2.88	<0.00010	8700	17.0	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0082	<0.000050	<0.00050	<0.00050	0.0708
10WBW001-Z10-303	<0.0020	3.2	<0.00010	9790	21.8	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0020	<0.000050	0.00058	<0.00050	0.0049
10WBW001-Z6-304	<0.0020	3.4	<0.00010	10600	27.6	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0021	0.000054	<0.00050	<0.00050	0.669
10WBW001-Z10-500	<0.040	2.91	<0.00010	8540	16.5	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0072	<0.000050	<0.00050	<0.00050	0.0511
10WBW001-Z1-501	<0.0040	2.35	<0.00010	7030	54.1	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0018	<0.000050	<0.00050	<0.00050	0.116
10WBW001-Z6-502	<0.010	3.24	<0.00010	8650	18.2	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0086	<0.000050	<0.00050	<0.00050	0.252
10WBW001-Z6-503	<0.020	3.25	<0.00010	8670	18.8	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0087	<0.000050	<0.00050	<0.00050	0.304
10WBW001-Z6-504	<0.030	3.6	<0.00010	10900	27.3	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0026	<0.000050	<0.00050	<0.00050	0.114
10WBW001-Z10-505	<0.050	3	<0.00010	9500	19.9	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0025	0.000194	<0.00050	<0.00050	0.0337
10WBW001-Z10	<0.0020	2.78	<0.00010	8460	16.4	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.007	0.000063	<0.00050	<0.00050	2.28
10WBW001-Z01	<0.0020	2.16	<0.00010	6450	53.7	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.002	<0.000050	<0.00050	<0.00050	0.333
10WBW001-Z6	<0.0020	2.39	<0.00010	9370	21.1	<0.00050	<0.000050	<0.00050	<0.0010	<0.0050	0.0078	<0.000050	<0.00050	<0.00050	0.751
10WBW001-01-2022	<0.0025	3.1	<0.0005	6600	58.3	<0.01	<0.0005	<0.005	<0.005	<0.015	<0.005	<0.0005	<0.025	-	0.766
10WBW001-01-2023	<0.0025	3.36	<0.0005	6830	58.6	<0.01	<0.0005	<0.005	<0.005	<0.015	<0.005	<0.0005	<0.025	-	0.542
10WBW001-01-2024	<0.0025	3.26	<0.0005	6700	57.3	<0.01	<0.0005	<0.005	<0.005	<0.015	<0.005	<0.0005	<0.025	-	1.51
10WBW001-06-2022	<0.001	5.53	<0.0002	2960	4.23	<0.004	<0.0002	<0.002	<0.002	<0.006	0.0025	<0.0002	<0.01	-	0.208
10WBW001-06-2023	<0.0005	6.26	<0.0001	3370	4.49	<0.002	<0.0001	<0.001	<0.001	<0.003	0.0023	0.00022	<0.005	-	<0.01
10WBW001-06-2024	<0.0005	6.17	<0.0001	2850	3.66	<0.002	<0.0001	<0.001	<0.001	<0.003	0.00202	0.000234	<0.005	-	<0.01
10WBW001-10-2022	0.000286	5.36	<0.00005	664	0.335	<0.001	<0.00005	<0.0005	<0.0005	<0.0015	0.00115	0.000221	<0.0025	-	0.232
10WBW001-10-2023	0.000166	5.92	<0.00002	693	0.313	<0.0004	<0.00002	<0.0002	<0.0002	0.00063	0.00123	0.000208	0.00145	-	0.005
10WBW001-10-2024	0.000132	6.22	<0.00002	683	0.348	<0.0004	<0.00002	<0.0002	<0.0002	0.00066	0.00134	0.000221	0.00154	-	0.0312
10WBW001-01b	<0.4	-	<0.002	6840	-	-	<0.001	-	<0.05	0.0124	-	<0.002	0.129	-	0.044
10WBW001-17	<0.4	-	<0.02	6810	-	-	0.01	-	<0.05	<0.06	-	<0.02	0.291	-	<0.2
10WBW001-20	<0.4	-	<0.02	6480	-	-	0.013	-	<0.05	<0.06	-	<0.02	0.302	-	0.31
10WBW001-25	<0.4	-	<0.02	6730	-	-	<0.01	-	<0.05	<0.06	-	<0.02	0.122	-	<0.2
10WBW001-26	<0.4	-	<0.02	6260	-	-	<0.01	-	<0.05	<0.06	-	<0.02	0.174	-	<0.2
10WBW001-35	<0.002	2.3	<0.0002	7290	0059	<0.0005	<0.0005	<0.0005	<0.001	<0.005	<0.001	<0.0005	<0.0005	<0.0005	0.0897
10WBW001-100	<0.002	2.42	<0.0001	7200	56.7	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0014	<0.00005	<0.0005	0.00051	0.1130
10WBW001-106	<0.002	2.43	<0.0001	6910	55.1	<0.0005	<0.00005	<0.0005	<0.001	<0.005	0.0015	<0.00005	<0.0005	0.00054	0.137
10WBW002-01	<0.4	-	<0.02	655	-	-	<0.01	-	<0.05	<0.06	-	<0.02	0.863	-	<0.2
10WBW002-02	<0.4	-	<0.02	300	-	-	<0.01	-	<0.05	<0.06	-	<0.02	1.08	-	<0.2
10WBW002-109a	<0.02	<5	<0.001	1680	57.6	<0.005	0.00053	<0.005	<0.01	<0.05	0.026	<0.0005	<0.005	<0.005	<0.03
10WBW002-109b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-121	<0.02	<5	<0.001	490	35.8	<0.005	<0.0005	<0.005	<0.01	<0.05	0.024	<0.0005	<0.005	<0.005	0.044
10WBW002-Z1-305	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-306	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-307	<0.020	<5.0	<0.0010	1830	58.6	<0.0050	0.00054	<0.0050	<0.010	<0.050	0.024	<0.00050	<0.0050	<0.0050	0.294
10WBW002-Z3-308	<0.020	<5.0	<0.0010	900	33.2	<0.0050	<0.00050	<0.0050	<0.010	<0.050	0.019	<0.00050	<0.0050	<0.0050	0.180
10WBW002-Z2-309	<0.10	<2.5	<0.00050	<100	9.98	<0.0025	<0.00025	<0.0025	<0.0050	<0.025	<0.0050	<0.00025	<0.0025	<0.0025	35.2
10WBW002-Z1-400	<0.010	<5.0	0.00086	470	37.5	<0.0025	<0.00025	<0.0025	<0.0050	<0.025	0.0233	<0.00025	<0.0025	<0.0025	0.052
10WBW002-Z1-401	<0.010	<5.0	0.00109	1160	46	<0.0025	<0.00025	<0.0025	0.0068	<0.025	0.0229	<0.00025	<0.0025	<0.0025	0.06
10WBW002-Z3-403	<0.050	<5.0	0.00179	1680	35.1	<0.0025	<0.00025	<0.0025	<0.0050	<0.025	0.0131	<0.00025	<0.0025	<0.0025	0.828
10WBW002-Z1-510	<0.030	<5.0	<0.0010	810	39.8	<0.0050	<0.00050	<0.0050	<0.010	<0.050	0.026	<0.00050	<0.0050	<0.0050	0.085
10WBW002-Z1-511	<0.040	<5.0	<0.0010	870	41.3	<0.0050	<0.00050	<0.0050	<0.010	<0.050	0.026	<0.00050	<0.0050	<0.0050	0.197
10WBW002-Z3-512	<0.050	<5.0	<0.0010	2170	34.2	<0.0050	<0.00050	<0.0050	<0.010	<0.050	0.013	<0.00050	<0.0050	<0.0050	0.084

Field Sample ID	Zirconium (Zr)-Dissolved
	mg/L
10WBW004-123	<0.0005
10WBW004-124	<0.00050
10WBW004-125	<0.00050
10WBW004-126	<0.00050
10WBW004-128	<0.00050
10WBW004-129	<0.00050
10WBW004-130	<0.00050
10WBW004-131	<0.00050
10WBW004-Z6-312	<0.00050
10WBW004-Z6-313	<0.00050
10WBW004-Z6-314	<0.00050
10WBW004-Z6-315	-
10WBW004-Z6-316	-
10WBW004-Z6-317	<0.00050
10WBW004-Z6-318	<0.00050
10WBW004-Z6-404	<0.0149
10WBW004-Z6-405	<0.01536
10WBW004-Z6-406	<0.00050
10WBW004-Z6-508	<0.00050
10WBW004-Z6-509	<0.00050
10WBW001-02b	-
10WBW001-03b	-
10WBW001-04b	-
10WBW001-12	-
10WBW001-14	-
10WBW001-15	-
10WBW001-16	-
10WBW001-28	-
10WBW001-31	-
10WBW001-33	-
10WBW001-36	<0.0005
10WBW001-37	<0.0005
10WBW001-101	<0.0005
10WBW001-102	<0.0005
10WBW001-103	<0.0005
10WBW001-105	<0.0005
10WBW001-107	<0.0005
10WBW001-108	<0.0005
10WBW001-Z1-300	<0.00050
10WBW001-Z6-301	<0.00050
10WBW001-Z10-302	<0.00050
10WBW001-Z10-303	<0.00050
10WBW001-Z6-304	<0.00050
10WBW001-Z10-500	<0.00050
10WBW001-Z1-501	<0.00050
10WBW001-Z6-502	<0.00050
10WBW001-Z6-503	<0.00050
10WBW001-Z6-504	<0.00050
10WBW001-Z10-505	<0.00050
10WBW001-Z10	<0.00050
10WBW001-Z01	<0.00050
10WBW001-Z6	<0.00050
10WBW001-01-2022	<0.01
10WBW001-01-2023	<0.015
10WBW001-01-2024	<0.015
10WBW001-06-2022	<0.004
10WBW001-06-2023	<0.003
10WBW001-06-2024	<0.003
10WBW001-10-2022	<0.001
10WBW001-10-2023	<0.0006
10WBW001-10-2024	<0.0006
10WBW001-01b	-
10WBW001-17	-
10WBW001-20	-
10WBW001-25	-
10WBW001-26	-
10WBW001-35	<0.0005
10WBW001-100	<0.0005
10WBW001-106	<0.0005
10WBW002-01	-
10WBW002-02	-
10WBW002-109a	<0.005
10WBW002-109b	-
10WBW002-121	<0.005
10WBW002-Z1-305	-
10WBW002-Z1-306	-
10WBW002-Z1-307	<0.0050
10WBW002-Z3-308	<0.0050
10WBW002-Z2-309	<0.0025
10WBW002-Z1-400	<0.0025
10WBW002-Z1-401	<0.0025
10WBW002-Z3-403	<0.0025
10WBW002-Z1-510	<0.0050
10WBW002-Z1-511	<0.0050
10WBW002-Z3-512	<0.0050

Appendix F – Ground Temperature Data



Notes:

1. Coordinate System: UTM NAD 83 Zone13
2. Basemap Credits: ERSI, DeLorme, TomTom, Intermap, NRCAN, GeoBase
3. Underground Workings based on PFS Design

srk consulting

Job No: 1CT022.004

Filename: BostonDeepGroundTemperatures.pptx

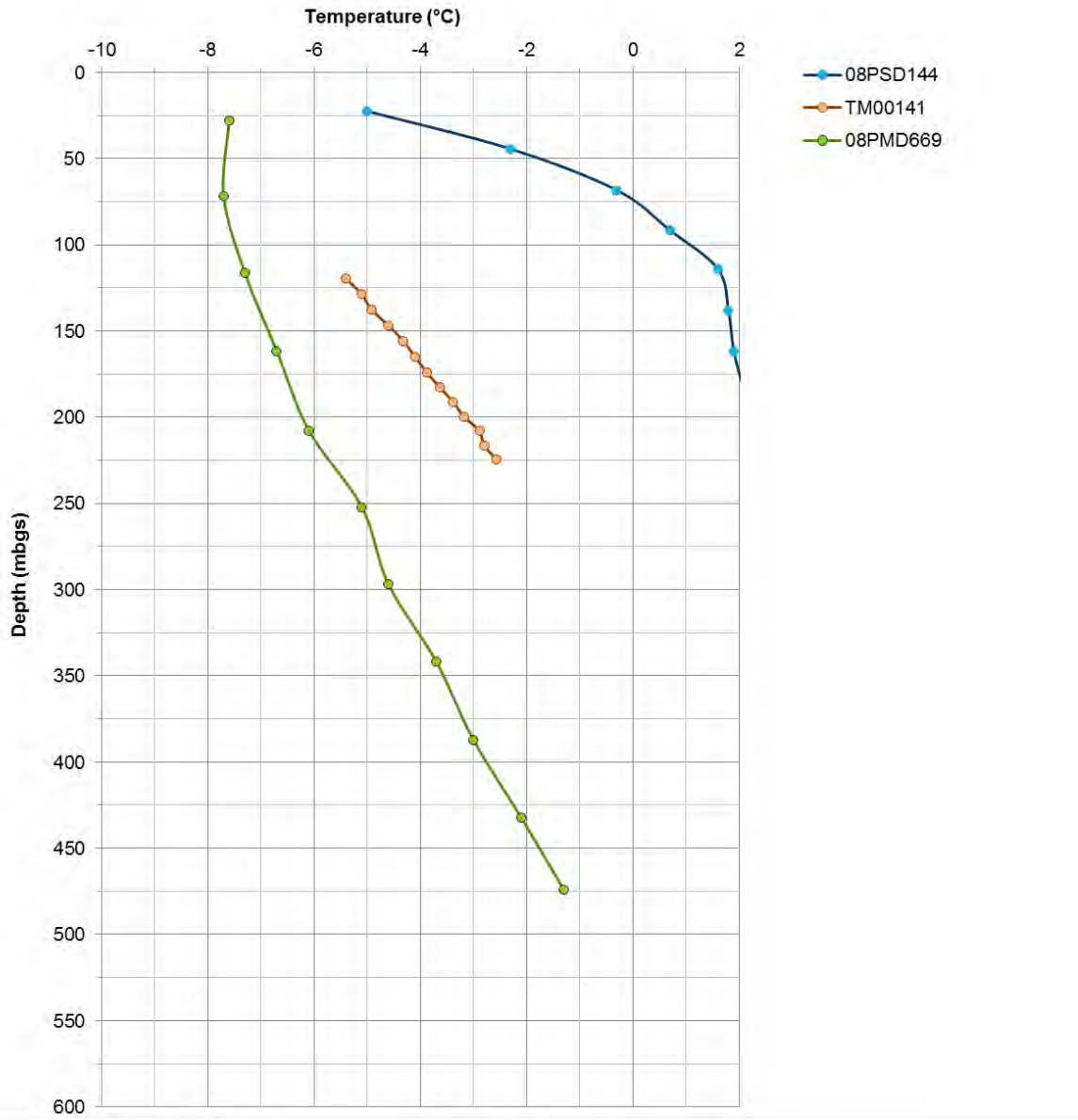
MAC RESOURCES

HOPE BAY PROJECT

Lake Talik Configuration

Madrid North and South Mining Areas

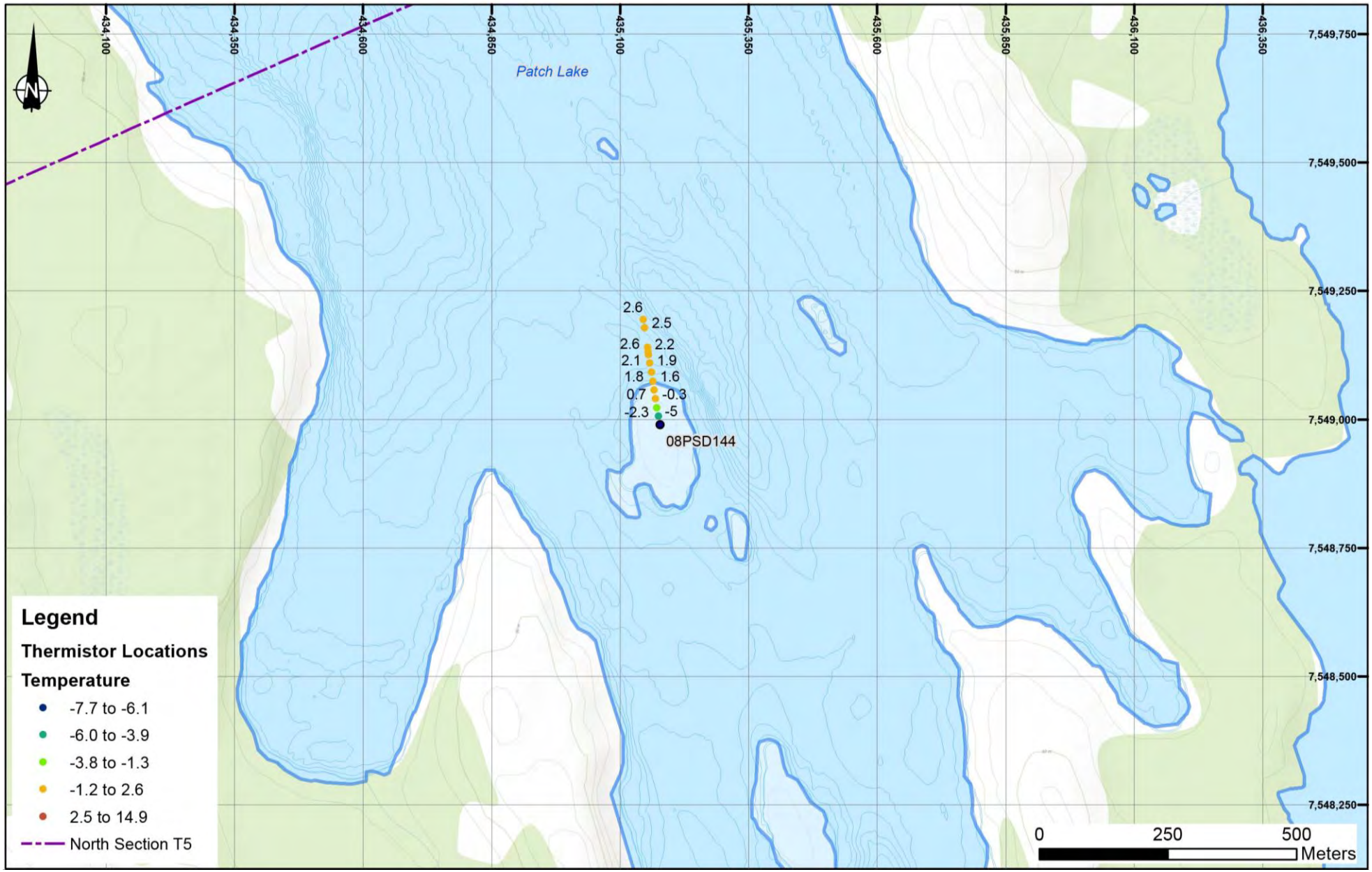
Date:	Approved:	Figure:
2/12/2016	cws	14



Notes:

1. Depth indicated as vertical metres below ground surface (mbgs)

srk consulting	TMAC RESOURCES	Lake Talik Configuration	
		Deep Ground Temperatures – Madrid Mining Area	
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	Date: 2/12/2016	Approved: cws	Figure: **15**



Notes:

1. Coordinate System: UTM NAD 83 Zone13
2. Basemap Credits: ERSI, DeLorme, TomTom, Intermap, NRCAN, GeoBase
3. Underground Workings based on PFS Design

srk consulting

Job No: 1CT022.004

Filename: BostonDeepGroundTemperatures.pptx

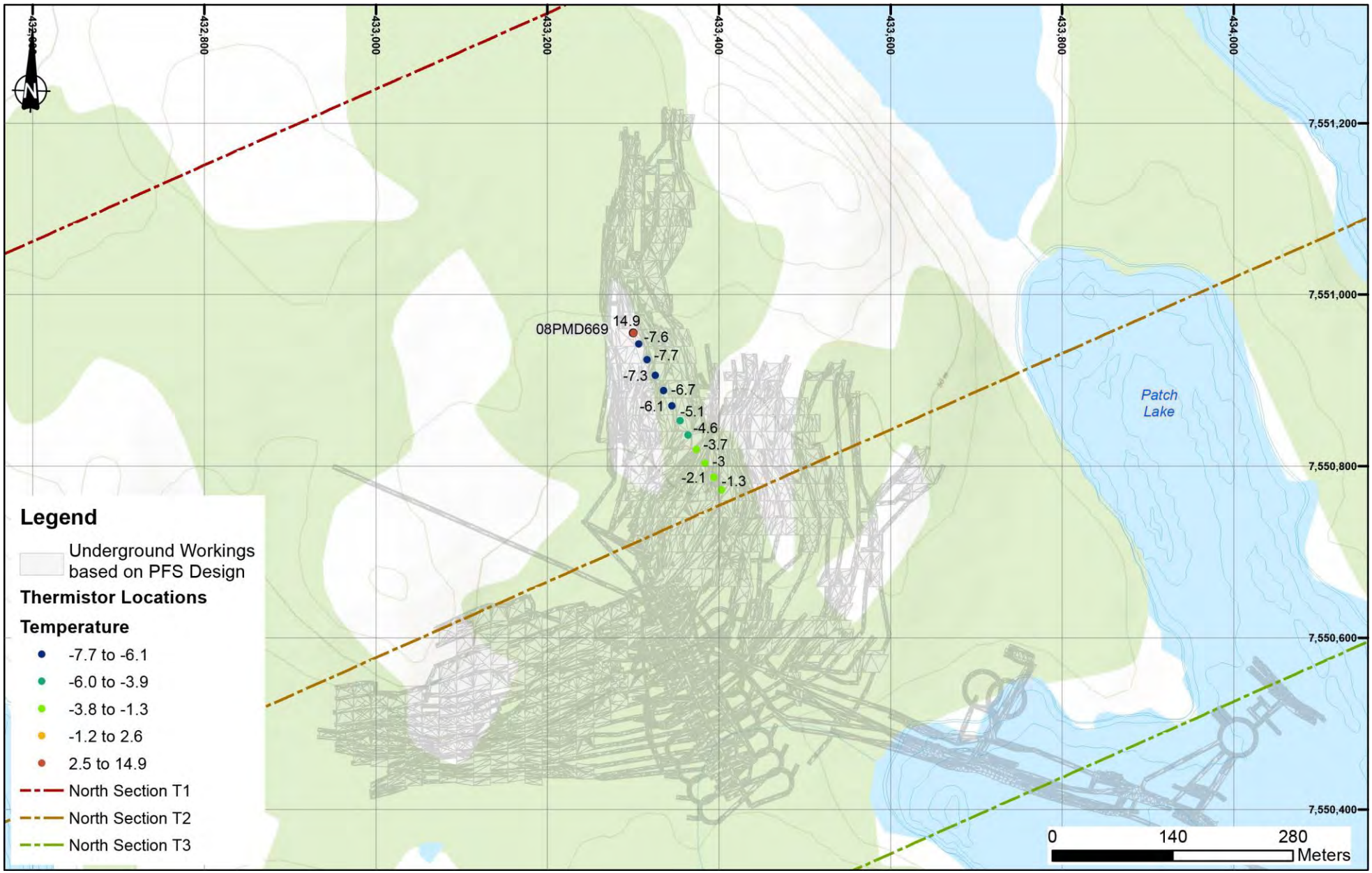
TMAC RESOURCES

HOPE BAY PROJECT

Lake Talik Configuration

Patch Island – Thermistor Site ID 08PSD144

Date:	Approved:	Figure:
2/12/2016	cws	16



Notes:

1. Coordinate System: UTM NAD 83 Zone13
2. Basemap Credits: ERSI, DeLorme, TomTom, Intermap, NRCAN, GeoBase
3. Underground Workings based on PFS Design

srk consulting

Job No: 1CT022.004

Filename: BostonDeepGroundTemperatures.pptx

TMAC RESOURCES

HOPE BAY PROJECT

Lake Talik Configuration

Madrid North Mining Area – Thermistor Site ID 08PMD669

Date:	Approved:	Figure:
2/12/2016	cws	17

Notes:

1. Coordinate System: UTM NAD 83 Zone13
2. Basemap Credits: ERSI, DeLorme, TomTom, Intermap, NRCAN, GeoBase
3. Underground Workings based on PFS Design

srk consulting

Job No: 1CT022.004

Filename: BostonDeepGroundTemperatures.pptx

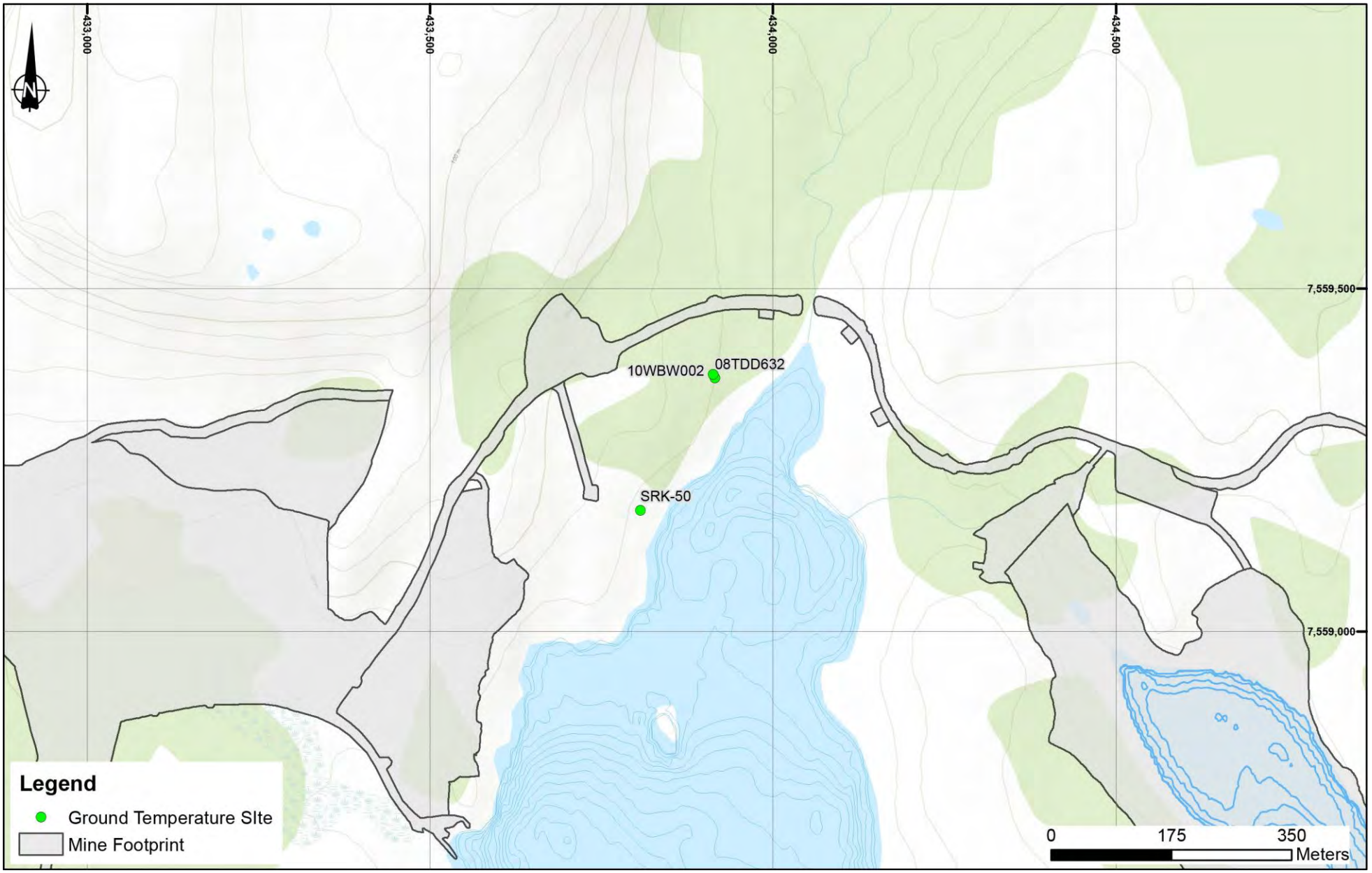
TMAC RESOURCES

HOPE BAY PROJECT

Lake Talik Configuration

Madrid South Mining Area – Thermistor Site ID TM00141

Date:	Approved:	Figure:
2/12/2016	cws	18



Notes:

1. Coordinate System: UTM NAD 83 Zone13
2. Basemap Credits: ERSI, DeLorme, TomTom, Intermap, NRCAN, GeoBase
3. Mine Footprint based on PFS Design

srk consulting

Job No: 1CT022.004

Filename: BostonDeepGroundTemperatures.pptx

TMAC RESOURCES

HOPE BAY PROJECT

Lake Talik Configuration

Madrid South Mining Area – Thermistor Site ID TM00141

Date:	Approved:	Figure:
2/12/2016	cws	19

4.3.2 VWP Data Summary

Multi-channel data logger collected readings from the VWP during grouting. The logger was removed once grout reached the surface so that the drillers could clean and push back the drill rig. All available readings collected were converted to pressure using the second order polynomial equation and are presented in Figure 4-2. Groundwater pressure at the elevation of the sensor was converted to a groundwater head by converting the recorded pressure from the VWP into a groundwater head reported in vertical meters below ground surface (m bgs). The water column above the pressure transducer was assumed to consist of fresh water with a density of 1000 kg/m^3, and VWP depth was estimated at 388.68 m bgs. However, it should be noted that these measurements are not representative of the piezometric conditions as the rock mass surrounding the borehole has not had time to stabilize following the grout injection.

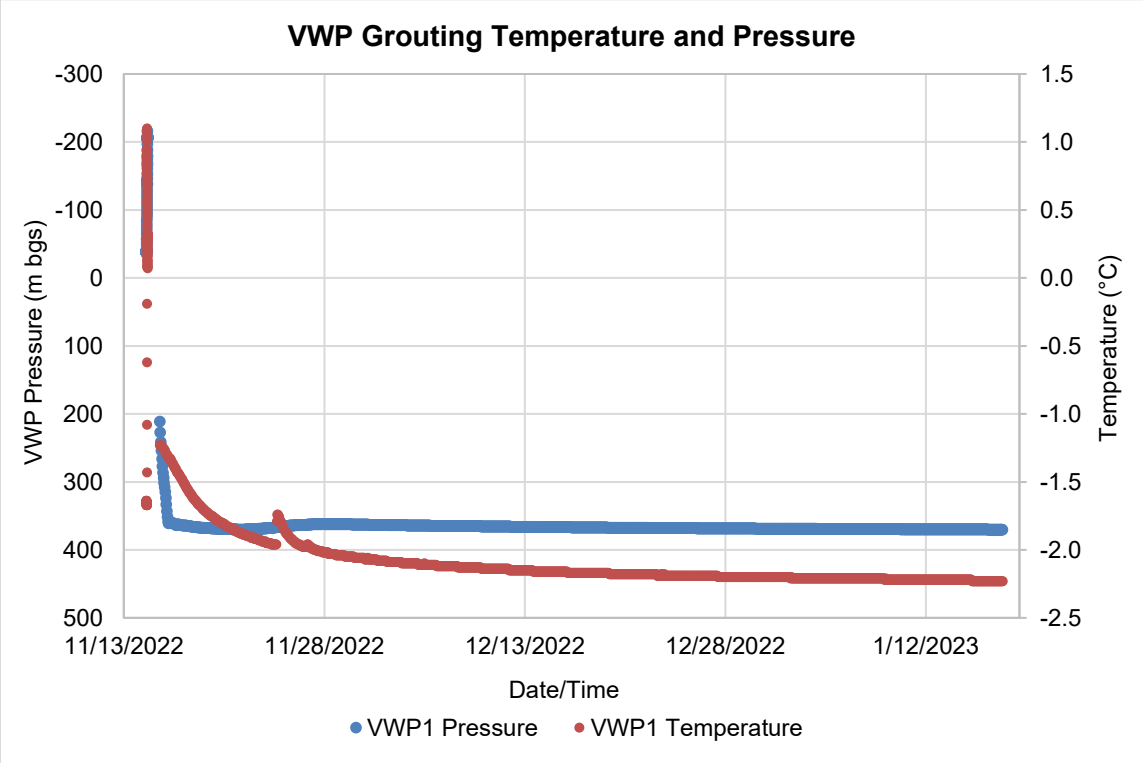


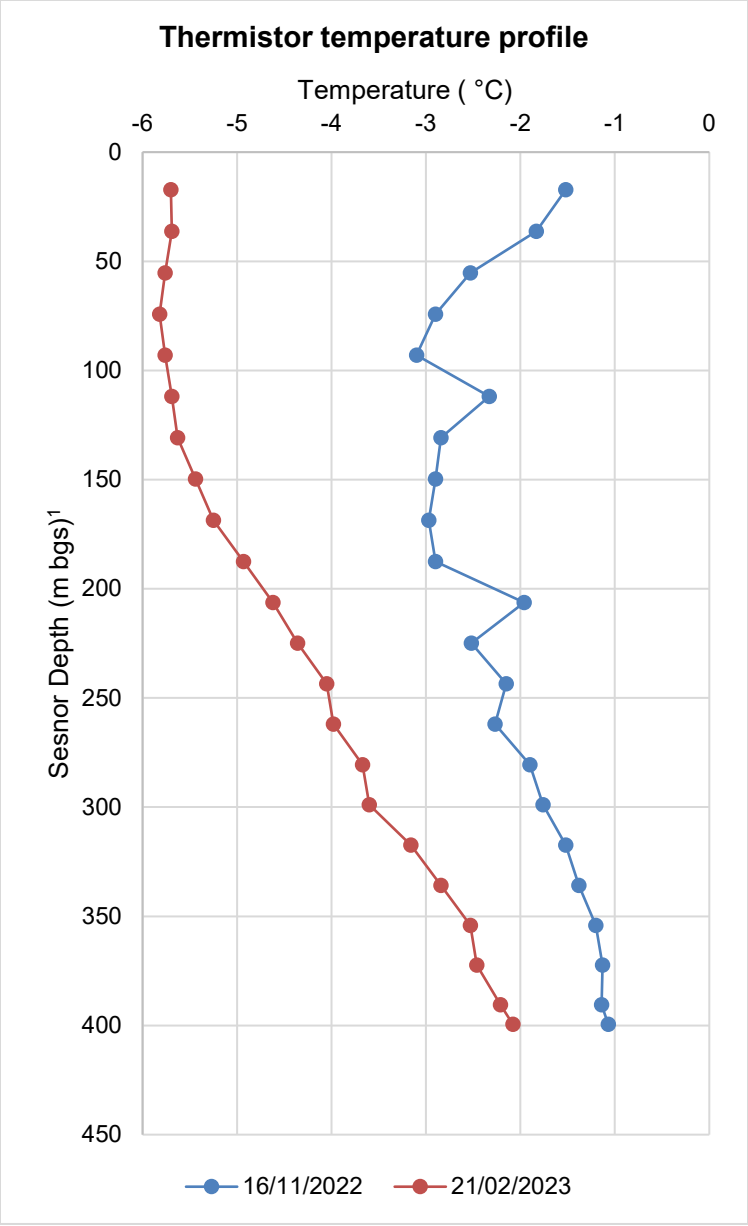
Figure 4-2 HBM-22-059 VWP Data

4.3.3 Thermistor

The thermistor installation was completed with a D605 data logger installed at surface for sensor data collection. The logger has an embedded two-way satellite transceiver and iridium antenna that allows for remote data collection and logger set-up. SRK plugged in the sensors and set the logger to be open for satellite transmission in the field and the manufacturer handled the remaining set-up remotely.

Thermistor temperature profiles from both 16th November 2022 and 21st February 2023 are presented below in Figure 4-3.The figure presents how the temperatures have altered since the installation was completed. The most recent profile might not be representative of the steady state temperature as based on similar installation (Mareschal et al. 2004) it could take up to one year for the temperature to return to the equilibrium following drilling and grouting.

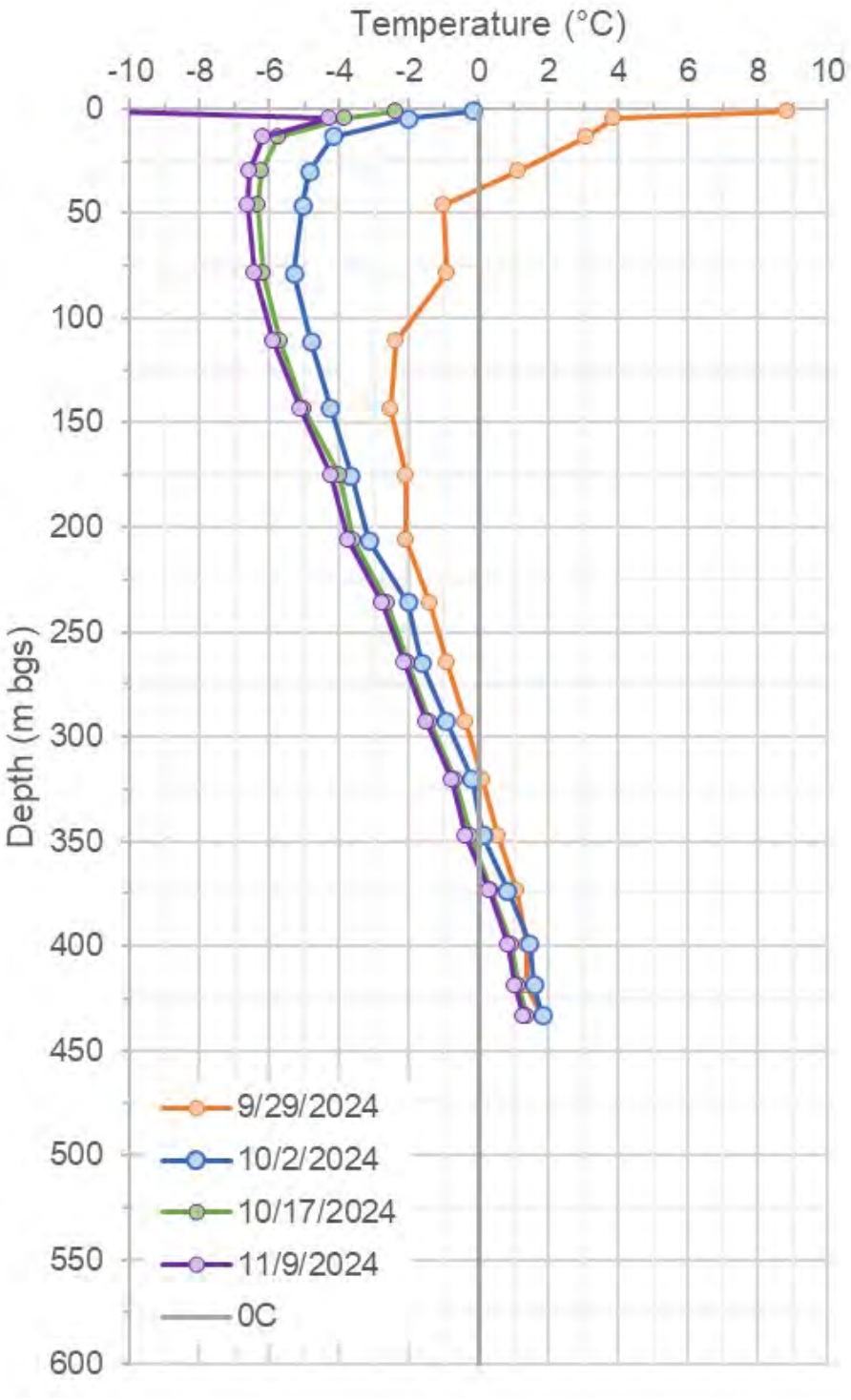
Based on geochemistry data reviewed by SRK as part of the Final Environmental Impact Assessment (SRK, 2017), the freeze point depression at the Hope Bay has been calculated at a temperature of -2°C. Therefore, the most recent ground temperature profile indicates that the base of permafrost is around 405 m bgs.



[1]. m bgs = vertical depth in meters below ground surface.

Figure 4-3 Thermistor temperature profiles

Figure 4-4: Ground temperature profiles from HBM-24-259



1. m bgs = vertical depth in meters below ground surface referenced to drillhole collar.

Appendix G – Thermal Models

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Memo

To:	John Roberts, PEng, Vice President Environment	**Client:**	TMAC Resources Inc.
From:	Christopher W. Stevens, PhD	**Project No:**	1CT022.013
Reviewed By:	Maritz Rykaart, PhD, PEng	**Date:**	November 30, 2017
Subject:	Hope Bay Project, Lake Talik Configuration		

Change Log

The following table provides an overview of material changes to this report from the previous version issued as Appendix V3-4B, Appendix A as part of the DEIS for Phase 2 of the Hope Bay Project dated December 2016.

Changes by Section

Information Request, Technical Comment, or Other Change	Section	Comments
NRCan-IR6	Section 5.2.1	Additional description of data added

1 Introduction

The Madrid-Boston Project (the Project) is a gold mining and milling undertaking of TMAC Resources Ltd (TMAC). The Project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory, and is situated east of Bathurst Inlet. The Project comprises three distinct areas of known mineralization plus extensive exploration potential and targets. The three areas that host mineral resources are Doris, Madrid, and Boston.

The Project consists of two phases; Phase 1 (Doris Project), which is currently being carried out under an existing Water Licence, and Phase 2 which is in the environmental assessment stage. Phase 1 includes mining and infrastructure at Doris only, while Phase 2 includes mining and infrastructure at Madrid and Boston located approximately 10 and 60 km due south from Doris respectively.

Although the Project is located in the continuous permafrost region of Canada, an evaluation is necessary to determine if the proposed underground mines will intercept talik zones. Where these talik zones are intercepted by the mine, groundwater inflow may be encountered, requiring appropriate management. Since the extent of these talik zones cannot be completely characterized through field verification, it is best practice to model the talik configuration. This memo provides a description of the modeling and presents the predicted talik configuration for use in subsequent mine inflow modeling.

2 Lake Taliks

2.1 Definition

A talik is defined as "*a layer or body of unfrozen ground occurring in a permafrost area due to local anomalies in thermal, hydrological, hydrogeological or hydrochemical conditions*" (van Everdingen 2005). In most cases, taliks are formed by lakes and other water bodies which cause a local departure in terrestrial ground temperature (Smith and Hwang 1973; Burn 2002).

In this memo, reference is made to both closed and open (or through) taliks. A closed talik is an unfrozen zone beneath a water body that is enclosed at the base and the surrounding sides by permafrost (Figure 1). An open talik is an unfrozen zone beneath a water body that penetrates the permafrost completely and may connect suprapermafrost (i.e. the layer of ground above permafrost) and subpermafrost (i.e. the unfrozen ground below the permafrost) groundwater.

2.2 Talik Configuration

Lake taliks are transient features in permafrost environments. Key factors influencing talik configuration include water bottom temperature, lake size (half width or radius), present and past ground thermal regime, and long-term changes to the landscape. Present-day water bathymetry can also effect talik configuration where shallow water allows for ice to seasonally freeze to the bottom (bottom-fast ice) and conduct heat from the ground (Burn 2002; 2005; Stevens *et al*. 2010a; 2010b).

The long-term thermal and physical evolution of the landscape is a factor in the present-day configuration of taliks that extend hundreds of metres below the surface. Lunardini (1995) showed temperature at depths up to 600 metres below ground surface (mbgs) can be influenced by surface temperatures as far back as 100,000 years.

Kerr (1994a) provides radiocarbon dating and stratigraphic interpretation of glacial and post-glacial deposits from Perry Peninsula and Queen Maud Gulf, and south of the Bathurst Inlet. His work suggests that deglaciation near the Madrid and Boston mining areas was between 9 ka and 8.7 ka (Kerr 1994a). Retreating ice may have been at or near the mining areas at around 9 ka, followed by a period of rapid ice retreat and ice-free conditions by 8.7 ka. Deglaciation was accompanied by synchronous marine incursion of the isostatically depressed terrain. Sea level curves constructed for the southern Bathurst Inlet suggest drainage of the marine water by at least 5 ka years BP (Kerr 1994b).

The sub-aerial exposure of land following drainage of marine water and cold air temperatures would have led to permafrost aggradation. Over time newly formed lakes and changes in water level of existing lakes due to changes in surface hydrology and climate would result in adjustment of lake taliks to a new equilibrium.

Open taliks are expected to be present beneath some lakes at the Property. Open taliks have been inferred from ground temperature measurements collected beneath Doris, Patch, and Aimaokatalok Lakes (SRK 2011a; Appendix A). Previous thermal modeling also supports the inference of open taliks beneath Doris and Tail Lakes, which are elongated lakes with a half-width of about 475 m and 390 m, respectively (SRK 2005a).

3 Ground Conditions

3.1 Permafrost

SRK (2017) provides detailed information on the baseline ground temperature and permafrost characteristics located in the Doris Mine, and the Madrid and Boston mining areas. The average present-day temperature of permafrost is -7.6°C at the Property, with a range from -5.6°C to -9.8°C (SRK 2017). The baseline ground temperature sites do not permit for separate assessment of permafrost temperatures at each of the three mining areas.

The base of permafrost has been estimated from ten sites to be 78 to 570 metres below ground surface(mbgs) based on the 0°C isotherm. Ground temperature sites removed from the thermal effects of nearby lakes indicate the base of permafrost extends to 570 mbgs (Site 08PMD669) at the Madrid mining area and 565 mbgs (Site 08SBD380) at the Boston mining area (Table 1). At Doris, the base of permafrost extent up to 511 mbgs at Site 10WB002. The geothermal gradient calculated from the deeper extent of permafrost averages 0.021°C m^{-1}, with a range of 0.014°C m^{-1} to 0.029°C m^{-1} (Table 1).

Table 1: Summary of Base of Permafrost and Geothermal Gradient

Thermistor Site ID	Northing	Easting	Location	Location Reference	Geothermal Gradient (°C/m)	Base of Permafrost (mbgs)
SRK-50	7,559,177	433,807	Doris Mining Area	Fig. 18	0.019	394
08TDD632	7,559,370	433,915	Doris Mining Area	Fig. 18	0.024	445
10WBW002	7,559,375	433,913	Doris Mining Area	Fig. 18	0.014	511
08PMD669	7,550,955	433,300	Madrid North Mining Area	Fig. 13+16	0.018	570
TM00141	7,546,691	435,141	Madrid South Mining Area	Fig. 13+17	0.023	346
08PSD144	7,548,990	435,178	Patch Lake Island	Fig. 13+15	-	78
08SBD380	7,504,780	441,080	Boston Mining Area	Fig. 5	0.017	565
08SBD381A	7,504,814	441,070	Boston Mining Area	Fig. 5	0.029	281
08SBD382	7,505,141	441,026	Boston Mining Area	Fig. 5	0.027	302
10WBW004	7,505,665	441,018	Boston Mining Area	Fig. 5	0.018	326
97NOD176	7,504,962	441,481	Boston Mining Area	Fig. 5	0.019	556
All Sites				**Average**	**0.021**	**398**
				Minimum	**0.014**	**78**
				Maximum	**0.029**	**570**
				Count	**10**	**11**

Water quality data collected from the Doris Central Westbay well (Site 10WBW001) indicates saline connate groundwater which is comparable to quality measurements observed at the Boston mining area. The lowest freezing point depression calculated from the concentration of dominate components of the groundwater was estimated to be -1.9°C (SRK 2011b). For the purpose of modeling talik extent, ground temperatures warmer than -2°C are expected to be unfrozen.

It should be recognized that the connection between surface water, mined structures, and subpermafrost groundwater is also a function of the hydraulic properties of the bedrock, the geological structures, and the hydraulic gradients that drive water movement; i.e. unfrozen ground does not necessarily constitute significant groundwater movement.

3.2 Lake Bottom Water Temperature

Table 2 shows average lake bottom water temperature (LbT) recorded during the month of April, July, August, and September for five lake locations over the period of 2010-2014 (ERM 2015; ERM 2014; Rescan 2012; Rescan 2011a). The lake bottom water temperatures are based on the deepest measurements collected at each site.

Table 2: Summary of Lake Bottom Water Temperatures

Location	Data Source (See notes)	Temperature (°C)					Ice Thickness (m)
		April	July	August	September	LbT	
Doris Lake North	1,3,4,5,6	1.5	7.8	11.0	6.2	4.7	1.8
Doris Lake South	1,3,4,5,6	1.0	9.0	10.7	5.7	4.2	1.9
Reference Lake A	1	1.6	-	4.3	-	2.5	1.8
Reference Lake B	1,3,4,5,6	2.6	9.1	11.1	3.9	5.5	1.7
Reference Lake C	2	2.0	-	8.3	-	4.1	1.9
Reference Lake D	1,3,4,5,6	0.8	11.4	12.1	2.5	4.6	1.9
Little Roberts Lake	1,3,4,5,6	0.7	10.6	10.9	3.4	4.1	1.9
Wolverine Lake	1	1.4	-	13.2	-	5.3	1.8
Patch Lake North	1	1.2	-	10.8	-	4.4	2.1
Patch Lake South	1	2.1	-	10.3	-	4.8	1.9
P.O. Lake	1	0.2	-	10.0	-	3.5	1.9
Ogama Lake	1	1.8	-	10.0	-	4.5	1.8
Doris Lake North	1	1.1	-	10.0	-	4.1	2.0
Doris Lake South	1	0.9	-	9.7	-	3.8	2.0
Naiqunnguut Lake	1	1.4	-	10.2	-	4.3	1.9
Nkhatok Lake	1	0.4	-	11.7	-	4.2	1.9
Glenn Lake	1	0.5	-	9.9	-	3.6	2.0
Imniagut Lake	1	-	-	12.2	-	-	2.0
Little Roberts Lake	1	1.3	-	10.0	-	4.2	2.1
Stickleback Lake	2	1.1	-	11.2	-	4.5	1.8
Trout Lake	2	0.8	-	12.6	-	4.7	1.8
Windy Lake	1,2	2.0	-	10.1	-	4.7	1.8
Aimaokatalok Lake: Station 2	2	-	-	11.6	-	-	-
Aimaokatalok Lake: Station 5	2	0.0	-	14.8	-	4.9	1.8
Aimaokatalok Lake: Station 6	2	2.3	-	12.1	-	5.6	1.6
Aimaokatalok Lake: Station 11	2	0.1	-	12.1	-	4.1	1.6
Aimaokatalok Lake: Station 13	2	-	-	13.9	-	-	-
All Sites					**Average**	**4.4**	**1.9**
					Minimum	**2.5**	**1.6**
					Maximum	**5.6**	**2.1**
					Count	**24**	**25**

Notes:

1. Average monthly temperature collected over the period of 2009- 2014 (see data source)
2. Annual lake bottom temperature (LbT) calculated using Equation 1
3. Ice thickness measured from ice auger hole drilled in April
4. Data source: 1 – Rescan (2010), 2 – Rescan (2011a), 3 – Rescan (2011b), 4 – Rescan (2012), 5 – ERM Rescan (2014), 6 – ERM (2015)

Mean annual lake bottom water temperature was calculated as a weighted mean of April and August temperatures:

$$LbT = 8LbTApr + 4LbTAug\ /P \quad \text{Eq. 1}$$

where:

LbT = mean annual lake bottom water temperature (°C)
$LbTApr$ = measured lake bottom water temperature in April (°C)
$LbTAug$ = measured lake bottom water temperature in August (°C)
P = is the period of time

Based on Equation 1, April water temperature is assumed to be representative of the period of ice cover (October to May). August water temperatures represent the warmest measurements and likely over-estimate water temperature throughout the ice-free period. Therefore, a conservative water temperature is computed using this approach, and allowed for in the thermal models.

The annual lake bottom water temperature is calculated to average of +4.4°C, with a range from +2.5°C to +5.6°C (Table 2). A value of +4.4°C is considered to be reasonable for base case conditions.

4 Regional Talik Model

4.1 Analytical Model

The critical lake dimension required for open (through) lake taliks was assessed using a one-dimensional (1D) steady state analytical model for lakes. The regional model was development to provide regional context for taliks in the area. The thermal models used for this assessment are presented by Mackay (1962), Smith (1976), and Burn (2002) for study sites in the Canadian Arctic, and have been used for talik characterization at other proposed mine projects located in the continuous permafrost region of mainland Nunavut, including the Back River Project (SRK 2015), Meliadine (Golder 2013), Kiggavik (Areva Resources Canada 2011), High Lake (Wolfden Resources Inc. 2006), Doris (SRK 2005b), and Meadowbank (Cumberland Resources Ltd. 2005) projects.

The temperature profile beneath the centre of a circular lake without terraces has been modeled by Mackay (1962) as:

$$T_z = T_g + \frac{z}{I} + (LbT - T_g)\left(1 - \frac{z}{\sqrt{z^2+R^2}}\right) \quad \text{Eq. 2.}$$

Where:
Tz = temperature at depth z (ºC)
LbT = Average annual lake bottom water temperature (°C)
Tg = average annual ground temperature (ºC)
I = inverse of the geothermal gradient (m ºC^{-1})
z = depth below bottom of lake (m)
R = radius of the lake (m)

The temperature profile beneath symmetrical elongated lakes without terraces has been modeled by Smith (1976) as:

$$T_z = T_g + \frac{z}{I} + \frac{LbT - T_g}{\pi}\left(2\tan^{-1}\frac{w}{z}\right) \quad \text{Eq. 3.}$$

Where:

Tz = Temperature at depth z (ºC)
LbT = Average annual lake bottom water temperature (°C)
Tg = Average annual ground temperature (ºC)
I= inverse of the geothermal gradient (m ºC^{-1})
z = depth below bottom of lake (m)
w = half-width of an elongated lake (m)

For conservatism, shallow-water terraces (lake terraces) which may be thermally influenced by bottom-fast ice were not considered in the analytical model. Table 3 shows the base case and sensitivity values using the in the 1D model. Base case values are representative of average measurements from the mining areas.

Table 3: Thermal Modeling Input Values for Analytical Talik Model

Parameter	Value (Base Case)	Value (Sensitivity Analysis)
Ground temperature (Tg)	-7.6°C	-5°C to -9°C
Mean annual lake-bottom temperature (LbT)	+4.4°C	+3°C to +6°C
Geothermal heat flux (G)	0.021°C m^{-1}	0.014 to 0.029°C m^{-1}

Notes:

1. Measured mean annual permafrost temperature is -7.6°C and mean annual lake bottom temperature is +4.4°C

2. Average geothermal gradient calculated from ground temperature measurements is 0.021°C m^{-1}

4.2 Model Assumptions

The modeling, as presented, is based on the following assumptions:

- Lake geometry is defined in the models as either circular or elongate, and does not account for actual lake geometries which can be quite complex.
- Modeling does not account for the thermal influence of adjacent lakes (lateral heat flow) and spatial variability in ground surface temperature. However, the sensitivity to lake-bottom temperature (LbT) and permafrost temperature are considered (Table 3).
- Water depth is assumed to be greater than the maximum thickness of seasonal ice, and the thermal influence of bottom-fast ice is not considered, making the results more conservative.
- Ground thermal properties and complex mechanisms for heat flow such as convection are not accounted for in the model.
- Geothermal heat flux is based on an average value calculated from ground temperature measurements with sensitivity around the range of values collected at the Property (Table 3).

- Steady-state models are used and therefore the transient effects, such as paleo-climate (i.e. long-term changes in ground surface and water temperature) are not considered.

Talik will naturally adjust to changes in climate and evolution of the landscape. Over the time scale of the Project, the most immediate effects would be an increase in extent of the talik beneath the shoreline, and possible subsidence and erosion of the shoreline at locations with ice-rich permafrost. A reduction in lake ice growth due to climate change would also be expected to widen and deepen existing taliks beneath shallow water bodies which rely on seasonal heat loss though the establishment of bottom-fast ice (Burn 2002; 2005; Stevens *et al*. 2010a; 2010b). The natural development of new ponds at the Property would also result in newly formed closed taliks. On the time scale of hundreds to thousands of years, open taliks may form as permafrost degrades beneath these recently formed water bodies. Natural lowering of lake water level or even complete drainage due to climate change may also result in permafrost aggradation beneath the former lake basin and long-term freezeback of taliks.

4.3 Model Results

The estimated critical dimensions for open (through) taliks beneath lakes at the Property are summarized in Table 4 and Table 5. The findings are based on a groundwater freezing point depression of -2°C and are graphically depicted in Figure 2 and Figure 3.

For the base case scenario, open taliks are estimated to occur beneath circular lakes with a diameter >224 m (i.e. lake radius of >112 m). For elongated lakes, the critical lake width is estimated to be >104 m wide (i.e. lake half-width >52 m).

Sensitivity of the critical lake dimension to change in the geothermal gradient is shown in Figure 4 and Figure 5.

Table 4: Circular Lake Critical Radius for Open (Through) Taliks Based on -2°C Isotherm

Permafrost Temperature	Annual Lake Bottom Temperature (LbT)				
	+3.0°C	+4.0°C	+4.4°C	+5.0°C	+6.0°C
-9.0°C	169 m	159 m	155 m	151 m	144 m
-8.0°C	138 m	129 m	126 m	122 m	117 m
-7.6°C	123 m	115 m	112 m	109 m	104 m
-7.0°C	108 m	101 m	98 m	95 m	91 m
-6.0°C	80 m	74 m	72 m	70 m	67 m
-5.0°C	54 m	50 m	49 m	47 m	44 m

Table 5: Elongated Lake Critical Half-width for Open (Through) Taliks Based on -2°C Isotherm

Permafrost Temperature	Annual Lake Bottom Temperature (LbT)				
	+3.0°C	+4.0°C	+4.4°C	+5.0°C	+6.0°C
-9.0°C	83 m	76 m	73 m	70 m	65 m
-8.0°C	66 m	60 m	58 m	55m	50 m
-7.6°C	60 m	54 m	52 m	49 m	45 m
-7.0°C	50 m	45 m	43 m	41 m	38 m
-6.0°C	36 m	32 m	30 m	28 m	26 m
-5.0°C	23 m	20 m	19 m	17 m	15 m

5 Site-specific Talik Model

5.1 Approach

Lake talik configuration adjacent to the Boston and Madrid mining areas was estimated using 2D thermal modeling. The model results were fitted to field observations of the -2°C isotherm, and therefore use calculated heat flow as a basis for estimating talik geometry. The modeling was carried out using a finite element code SVHeat developed by SoilVision Systems Ltd. with the FlexPDE solver.

5.1.1 Model Setup and Inputs

A long-term mean annual ground surface temperature was applied to the upper model boundary over areas of land. Long-term ground surface temperature was based on a projection of the thermal gradient from deep ground temperature measurements to the surface. The projected ground surface temperature reflects approximate paleo-surface temperature, which is typically colder than present day permafrost temperature calculated from the baseline ground temperature sites (SRK 2017). At the Madrid and Boston mining areas, the long-term ground surface temperature was estimated to be -9.6°C (Site 08PMD669) and -9.2°C (Site 08SBD380), respectively. A long-term ground surface temperature was used to more closely estimate talik configuration and the base of permafrost which result from paleo conditions. The geothermal gradient applied to the lower boundary of the model was based on Site 08PMD669 for Madrid Mining Area and Site 08SBD380 for the Boston mining area (Table 1).

A mean annual lake bottom water temperature of +4.4°C was applied to the upper boundary for lakes (Table 2). Lake width was based on current extent of water bodies at the underground mining areas. At Aimaokatalok Lake adjacent to the Boston mining area, an annual temperature of -2°C was also applied to lake areas with a water depth less than 1.3 m (i.e. water depth that is two-thirds of the mean annual ice thickness). A value of -2°C was applied to the shallow water lake terrace based on measured temperatures from similar environments (Burn 2002; 2005).The ice across these shallow water lake terraces freezes to the bottom with sufficient heat loss from the lake bottom to sustain permafrost beneath the shallow water terraces of Arctic lakes (Mackay 1992; Burn 2002). The thermal regime of shallow water was not considered at the Madrid underground mining areas due to the relatively rapid increase in water depth from shore.

Model simulations were based on a time step of one year. Table 5 summarises the thermal properties used in the transient lake talik model. The frozen and unfrozen thermal conductivity and heat capacity for bedrock (basalt) was based on previous thermal modeling at Hope Bay (SRK 2005; SRK 2011a).

Table 5: Bedrock Thermal Properties 2D Lake Talik Model

Material	Degree of Saturation (%)	Porosity	Thermal Conductivity (kJ m^{-1} day^{-1} $°C^{-1}$)		Volumetric Heat Capacity (kJ m^{-3} $°C^{-1}$)	
			Unfrozen	Frozen	Unfrozen	Frozen
Basalt Bedrock	100	0.05	260	260	2,380	2,133

5.1.2 Model Assumptions

The 2D thermal modeling, as presented, is based on the following assumptions:

- Lake geometry is defined by current lake extent and does not account for historic lake configuration which can be complex.
- Lake-bottom geometry is not directly considered in the model sections. The relatively shallow lake depths would have limited impact on talik configuration deep below the ground surface.
- Surface topography is not considered in the model sections due to low relatively relief across the Property and its limited influence on talik configuration.
- Long-term paleo ground surface temperatures are based on values projected from deep ground temperature measurements, and do not capture more recent variability in surface temperature.
- Ground thermal properties and complex mechanisms for heat flow such as convection are not accounted for in the model.

5.2 Boston Mine Area

The Boston underground mine will be located on the east side of Aimaokatalok Lake (Figure 6). A total of four sections were used to model the lake talik.

5.2.1 Ground Temperature Measurements

Deep ground temperature measurements have been collected from three deep inclined wells which extend beneath Aimaokatalok Lake; well 08SBD381A, 08SBD382, and 10WBW004 (Figure 7). Well 08SBD380 and 97NOD176 are two additional deep wells that have been drilled inland near the Boston mine workings.

Table 6 summarizes the position of the 0°C and -2°C isotherms for the Boston mining area. At 08SBD380 and 97NOD176, the ground temperature has been measured to a maximum depth of 241 mbgs and 247 mbgs, respectively. The base of permafrost is not directly incepted by these wells and the lowermost thermistors nodes indicate relatively cold permafrost temperatures (-5.1°C at 08SBD380 and -5.5°C at 97NOD176). The projected base of permafrost based on the

0°C isotherm is 565 mbgs at 08SBD380 and 556 mbgs at 97NOD176 (Table 6). The -2°C isotherm is projected to be 430 mbgs at 08SBD380 and 449 mbgs at 97NOD176. At site 08SBD380, the drill hole is orientated at an inclined angle toward Stickleback Lake. Based on the depth of the 0°C and -2°C isotherm and relatively cold temperatures measured from the lowermost thermistor node, it can be inferred that permafrost continues in the direction of Stickleback Lake and beyond the extent of the underground mine.

Ground temperatures measured at three sites beneath Aimaokatalok Lake provide information on the extent of the lake talik adjacent to the shoreline (Figure 6 and Figure 7). Figure 8 shows the depth of the -2°C isotherm and its distance from shore for these sites. The water bathymetry for the three areas with ground temperatures beneath the lake are shown in Figure 9. At site 08SBD382, the -2°C isotherm is up to 115 m from the lake shoreline and located at a depth of 224 mbgs. At site 08SBD381A and 10WBW004, the -2°C isotherm is 17 and 42 metres from shore and located between 202 and 209 mbgs (Table 6).

Table 6: Boston Mining Area Depth of 0°C and -2°C Isotherm from Ground Temperature Data

Site	Location	Maximum Instrumented Depth (mbgs)	-2°C Isotherm (mbgs)	0°C Isotherm (mbgs)
08SBD380	Near Underground Mine	241	430	565
97NOD176	Near Underground Mine	247	449	556
08SBD381A	Extends Beneath Lake	291	202	281
08SBD382	Extends Beneath Lake	313	224	302
10WBW004	Extends Beneath Lake	399	209	326

Notes:

1. Digital data not available for 97NOD176, depth and temperature determined from graphical form of data
2. Thermistor node depth corrected for vertical depth using downhole well survey and surface elevation
3. Depth shown as vertical metres below ground surface (mbgs)

For sites 08SBD381A and 08SBD382, the -2°C is located beneath water depths which are not expected to seasonally freeze to the bottom and therefore do not experience thermal conduction of heat through bottom-fast ice cover. The presence of floating ice at these locations implies that there is no significant means to vertically remove heat gained from the water and the lake bottom. At site 10WBW004, the -2°C isotherm is located beneath water depths that are about two-thirds the maximum ice thickness (i.e. an ice thickness of 1.3 m). It has been suggested that water depth less than two-thirds the maximum later winter ice thickness is required to sustain permafrost beneath shallow water margins of Arctic lakes impacted by bottom-fast ice (Mackay 1992; Burn 2002). This finding was also in agreement with shallow-water permafrost located within the nearshore zone of the Beaufort Sea (Stevens *et al*. 2010b).

Therefore, under present-day lake configuration the offshore position of the -2°C isotherm cannot be explained by heat loss from seasonal bottom-fast ice. Lateral heat flow from the adjacent land also does not explain the current talik extent beneath the lake. Significantly colder ground surface temperatures and lake bottom-temperatures would be required for the talik to extend beneath the Aimaokatalok Lake. Figure 8 shows the expected configuration of the Aimaokatalok Lake talik for

steady state compared to the position of the measured position of the -2°C isotherm. For steady state talik configuration to meet the field observations, the mean annual ground surface temperatures would need to be around -20°C.

We postulate that the lateral extent of permafrost beneath Aimaokatalok Lake is a direct physical consequence of the rise in lake level through time. Over time, permafrost formed through terrestrial exposure to cold air temperatures has been submerged with lake expansion. The talik is currently responding to the thermal forcing from the current lake and the talik will adjust to new conditions and evolve with the lake. The talik would be expected to adjust to equilibrium conditions on the time scale of hundreds to thousands of years.

5.2.2 Model Results

The 2D model sections were setup to simulate possible expansion of Aimaokatalok Lake and to allow for talik adjustment to meet ground temperature measured at the site. The model was run for 5,000 years which is estimated to be the approximate duration of time since drainage of the post-glacial marine incursion. The following major periods were included in the thermal model:

- From model year 0 to 4.5 ka, the lake was assumed to occupy a smaller area defined by current water depths greater than 5 m deep. This water depth represents the approximate transition from a relatively shallow to steep gradient in the water depth profile; i.e. the change in water depth verses distance (Figure 9). It was thus assumed that lake expansion would be most rapid across areas with a water depth less than 5 m deep where the gradient is shallow.
- From model year 4.5 to 5.0 ka, the lake was allowed to expand and flood the existing permafrost. This step was included in the model to allow for the interpreted adjustment of the talik over time. The position of the -2°C isotherm modeled was then selected to closely fit to the equivalent isotherm measured at sites 08SBD381A, 08SBD382, and 10WBW004.

Figures 10 to 13 show the model results for the Boston mining area. Table 7 shows a comparison between the model fit and the ground temperatures for the -2°C isotherm which represents the transition from frozen to unfrozen conditions at the three sites. In all cases, the model fit is conservative and underestimates the measured depth of the talik.

Table 7: Measured and Model Fit for Talik Surface

Model Section	Thermistor Site ID	Model (-2°C Isotherm)	Measured (-2°C Isotherm)
T1	10WBW004	192	209
T2	08SBD382	215	224
T3	08SBD381A	196	202

Notes:

1. Model position of the -2C isotherm based on manual fit to field data

5.3 Madrid Mining Area

The Madrid mining area consist of two distinct mines along the west side of Patch Lake. The northern mine (Madrid North) will be located between Windy Lake and Patch Lake, and the southern mine (Madrid South) will be located between Wolverine Lake and Patch Lake.

The 2D models included five sections for Madrid North and four sections for Madrid South (Figure 14). The model sections extend across the underground mining areas with an orientation that is approximately perpendicular to the long axis of the adjacent lakes. The modeled data was fit to the position of the -2°C isotherm measured at Madrid North. At Madrid South, the -2°C isotherm is located beyond the instrumented depth of the ground temperature cable. At this site, the modeled data was fit to the lowermost thermistor sensor (node).

5.3.1 Ground Temperature Measurements

Deep ground temperature measurements have been collected from three inclined wells; 08PMD669, 08PSD144, and TM00141 at the Madrid mining areas (Figure 14 and Figure 15).

Well 08PSD144 is located beneath an island centred within Patch Lake (Figure 16). Ground temperature measurements at the site indicate relatively shallow permafrost beneath the island (base of permafrost 78 mbgs) due to the surrounding heat from the lake.

Well 08PMD669 is located within the area of the Madrid North underground mine workings (Figure 17) and is instrumented to a maximum depth of 474 mbgs. The base of permafrost is 570 mbgs at this location.

Well TM00141 is located within the Madrid South underground mine between Wolverine Lake and Patch Lake (Figure 18). The well extends toward Patch Lake. Ground temperature measured from lowermost thermistors node is -2.6°C at 225 mbgs. The projected base of permafrost is 346 mbgs, intercepting the talik at the edge of the Patch Lake. The range in depth to the base of permafrost at Madrid North and Madrid South is similar to comparable measurements made at the Doris Mining Area (Table 1; Figure 19).

Table 8: Madrid Mining Area Depth of 0°C and -2°C Isotherm from Ground Temperature Data

Site ID	Location	Maximum Instrumented Depth (mbgs)	-2°C Isotherm (mbgs)	0°C Isotherm (mbgs)
08PMD669	Madrid North	474	438	570
08PSD144	Patch Lake Island	275	50	78
TM00141	Madrid South	225	303	346

Notes:

1. Thermistor node depth corrected for vertical depth using downhole well survey and surface elevation
2. Depth shown as vertical metres below ground surface (mbgs)

5.3.2 Model Results

Figures 20 to 24 show the model results for the Madrid North mining area. Lake expansion was not considered in the 2D thermal models since it is not supported by ground temperature data collected at the Madrid mining areas. Table 9 shows a comparison between site ground temperature measurements and the model fit. In all cases, the model fit is conservative and underestimates the depth of the talik

Table 9: Measured and Model Fit for Talik Surface

Model Section	Thermistor Site ID	Model (-2°C Isotherm)	Measured (-2°C Isotherm)
T2 (Madrid North)	08PMD669	412	438
T2* (Madrid South)	TM00141	258	303

Notes:

1. Asterisk indicates model fit with lowermost thermistor sensor.

At Madrid North, the model was fit to the -2°C isotherm at site 08PMD669. At this site, the lowermost sensor (node) measures -1.3°C at 474 mbgs. The equivalent isotherm estimated by the model is located at 453 mbgs or 21 m less than the measured depth.

Figures 25 to 28 show the model result for the Madrid South mining area. At Madrid South, the model was fit to the lowermost thermistor sensor (node) at site TM00141 which measures -2.6°C. The projected depth of the -2°C isotherm is 303 mbgs at the site. The equivalent isotherm estimated by the fitted model is located 258 mbgs. The model underestimates the position of the -2°C by 45 m.

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The opinions expressed in this document have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. While SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

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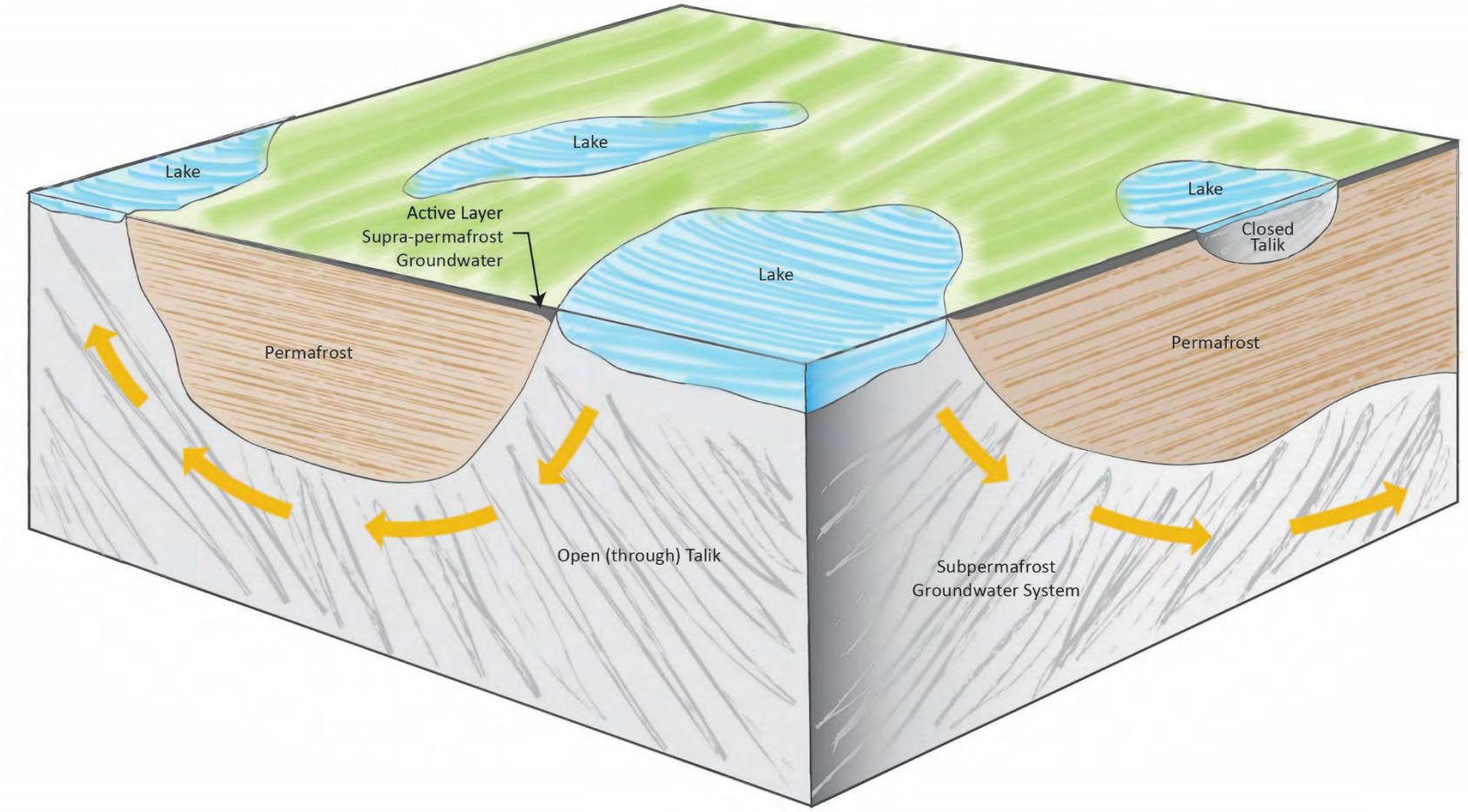
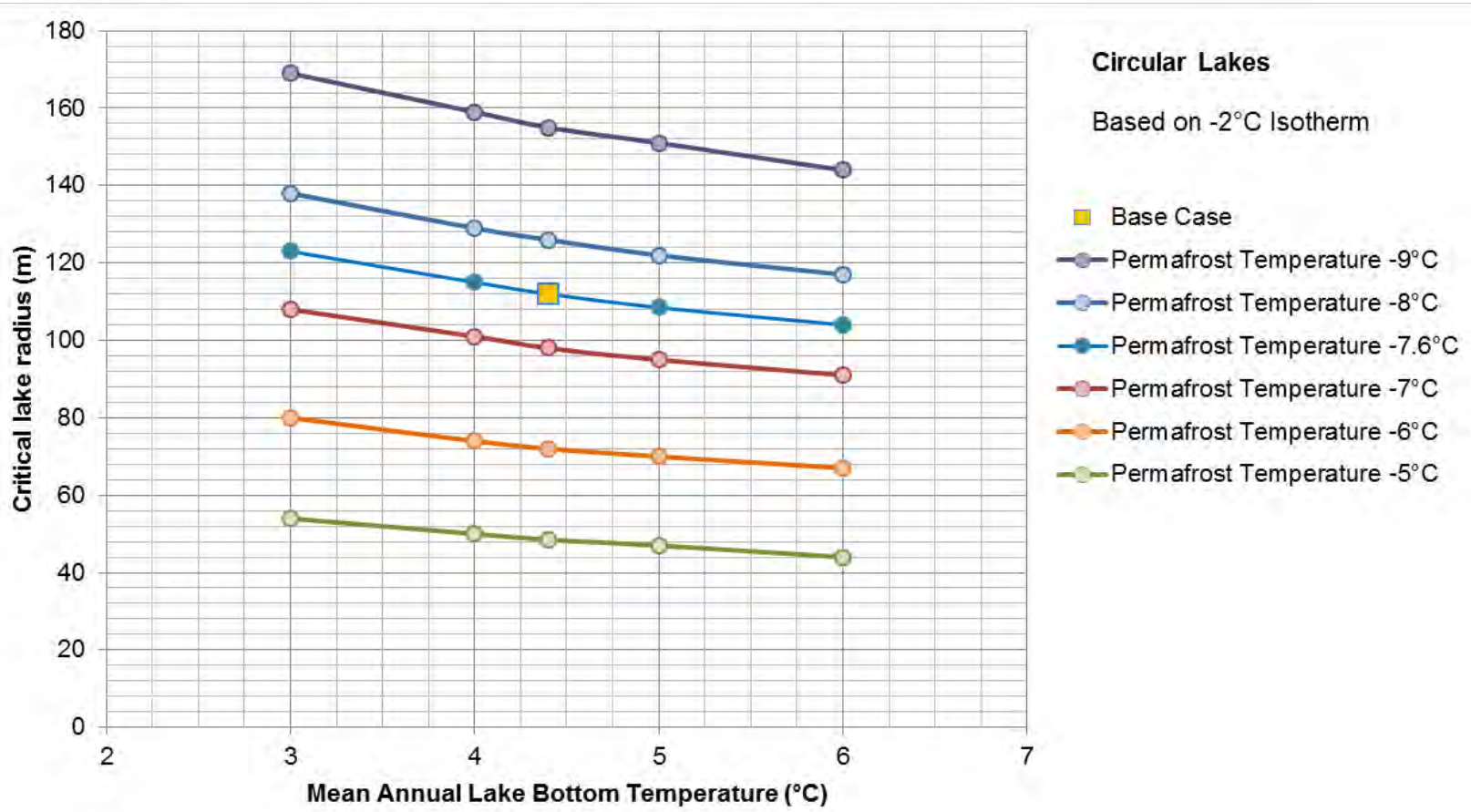
Figures



Notes:

1. Orange arrows show potential direction of groundwater flow for illustrative purposes only

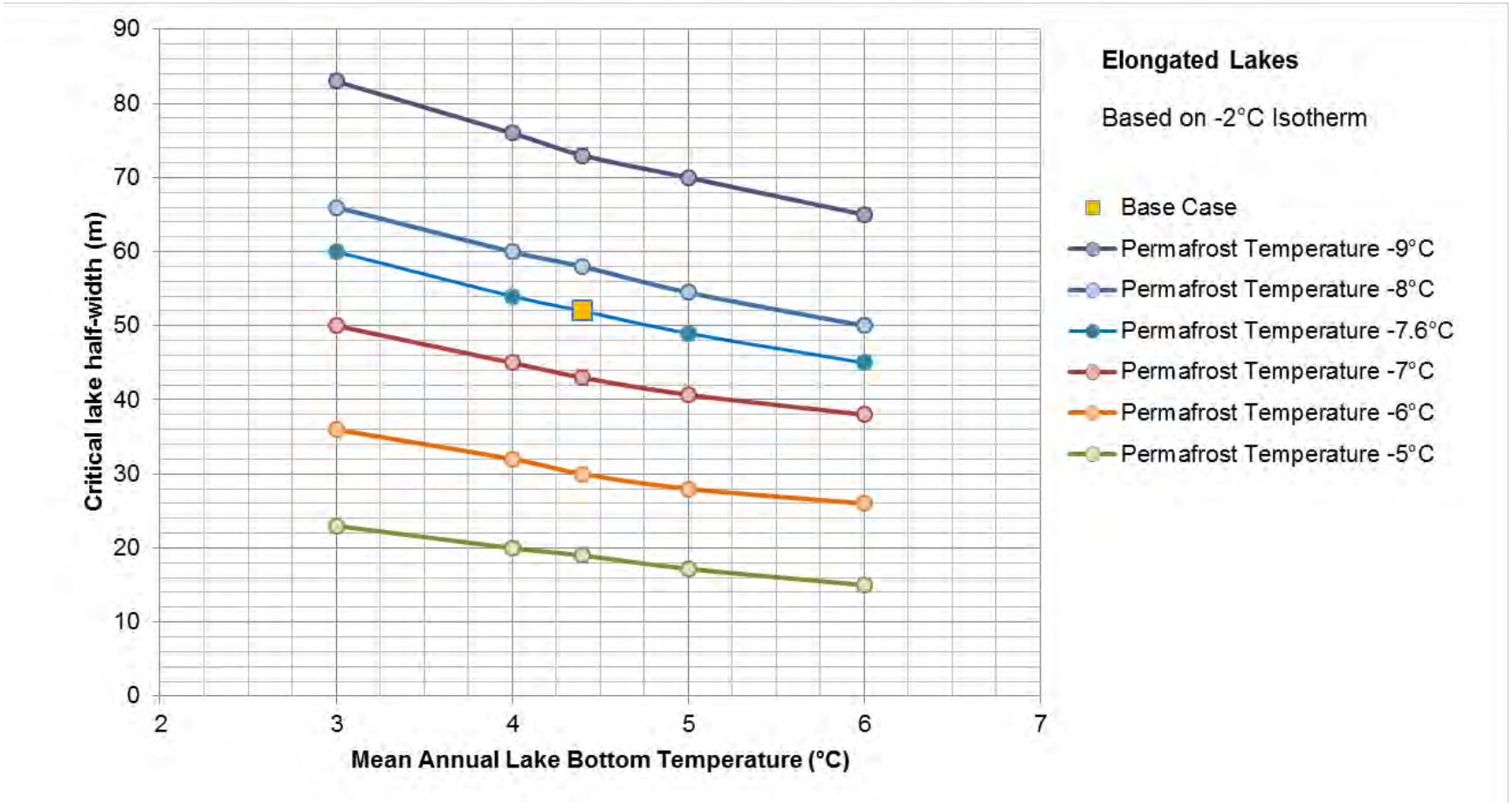
srk consulting	TMAC RESOURCES	Lake Talik Configuration
Job No: 1CT022.004 Filename: ElongatedLakesCriticalLakeHalf-Width.pptx	HOPE BAY PROJECT	**Conceptual Drawing – Open and Closed Lake Taliks**
		Date: 2/12/2016 | Approved: cws | Figure: **1**



Notes:

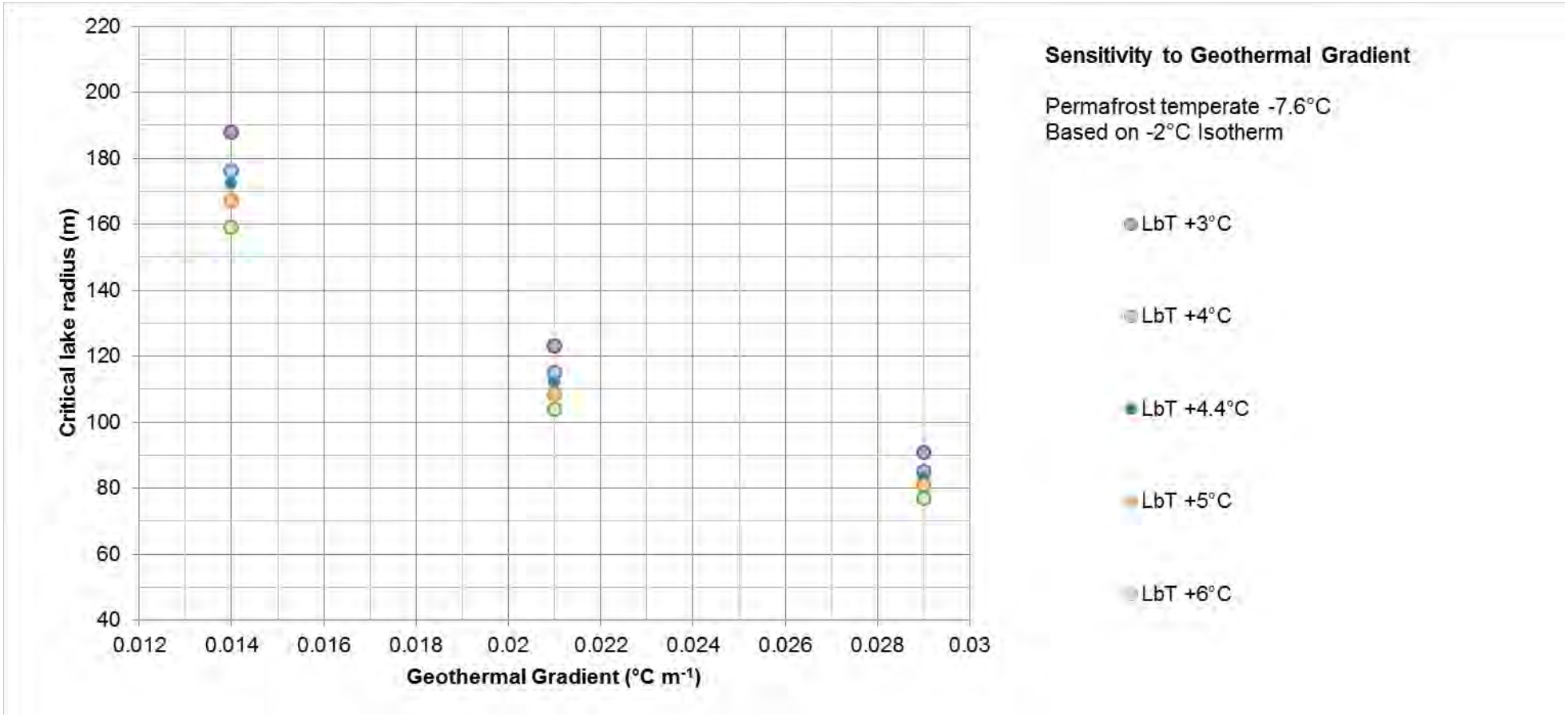
1. Open (through) taliks estimated for circular lakes with a dimensions greater than the critical radius
2. Permafrost temperature refers to mean annual ground temperature near the depth of zero annual amplitude
3. Results based on -2°C isotherm

srk consulting	TMAC RESOURCES	Lake Talik Configuration
		Circular Lakes - Critical Half-width for Open Taliks
Job No: 1CT022.004 Filename: ElongatedLakesCriticalLakeHalf-Width.pptx	HOPE BAY PROJECT	Date: 2/12/2016 | Approved: cws | Figure: **2**



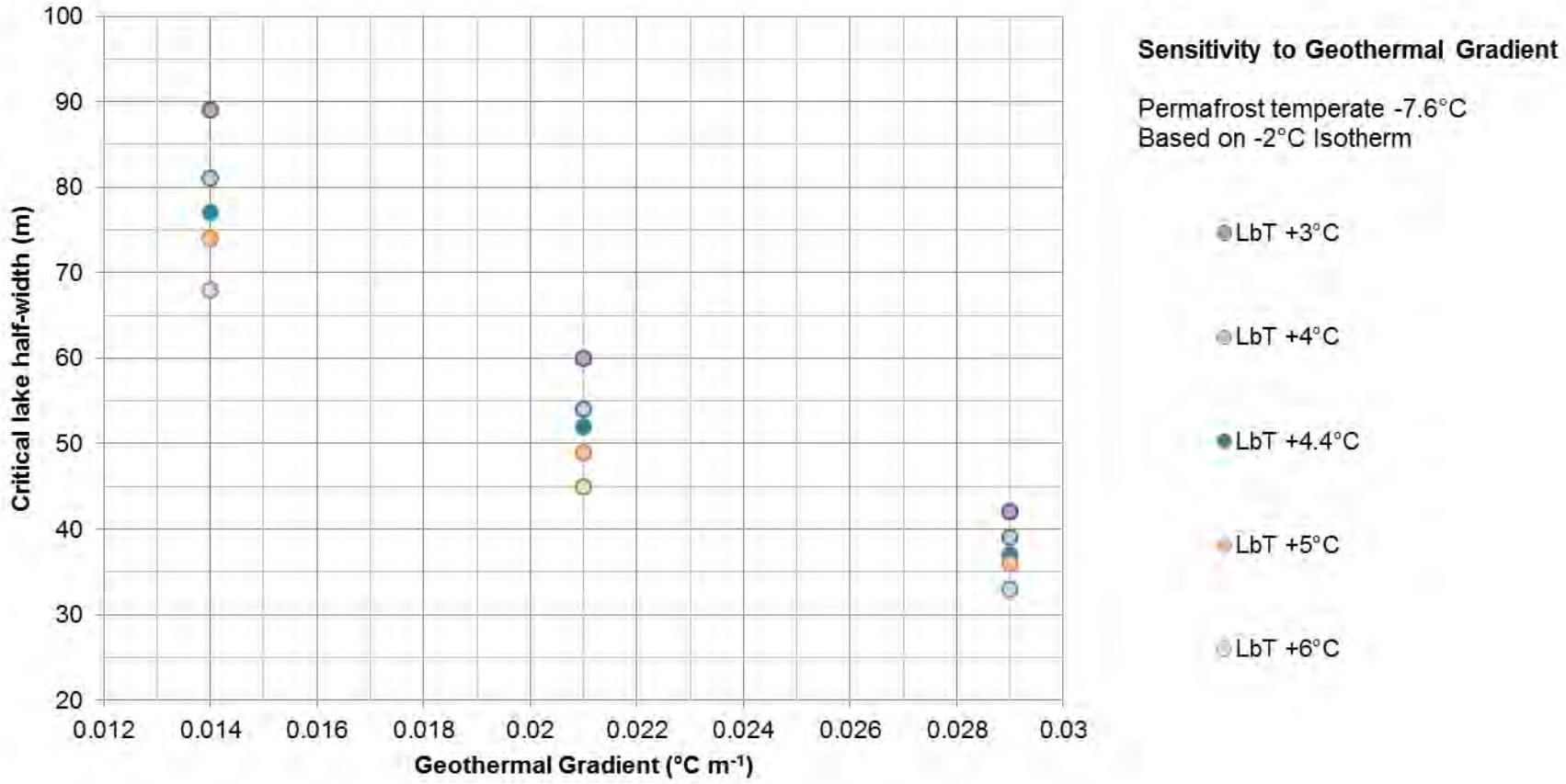
Notes:
1. Open (through) taliks estimated for circular lakes with a dimensions greater than the critical half-width
2. Permafrost temperature refers to mean annual ground temperature near the depth of zero annual amplitude
3. Results based on -2°C isotherm

srk consulting	MAC RESOURCES	Lake Talik Configuration
Job No: 1CT022.004 Filename: ElongatedLakesCriticalLakeHalf-Width.pptx	HOPE BAY PROJECT	**Elongated Lakes - Critical Half-width for Open Taliks**
		Date: 2/12/2016 | Approved: cws | Figure: **3**



Notes:
1. Open (through) taliks estimated for circular lakes with a dimensions greater than the critical radius
2. Sensitivity of critical lake radius based on average geothermal gradient measured at the Doris, Madrid, and Boston mining areas
3. Permafrost temperature based on base case value of -7.6°C
4. LbT – Lake bottom temperature
5. Results based on -2°C isotherm

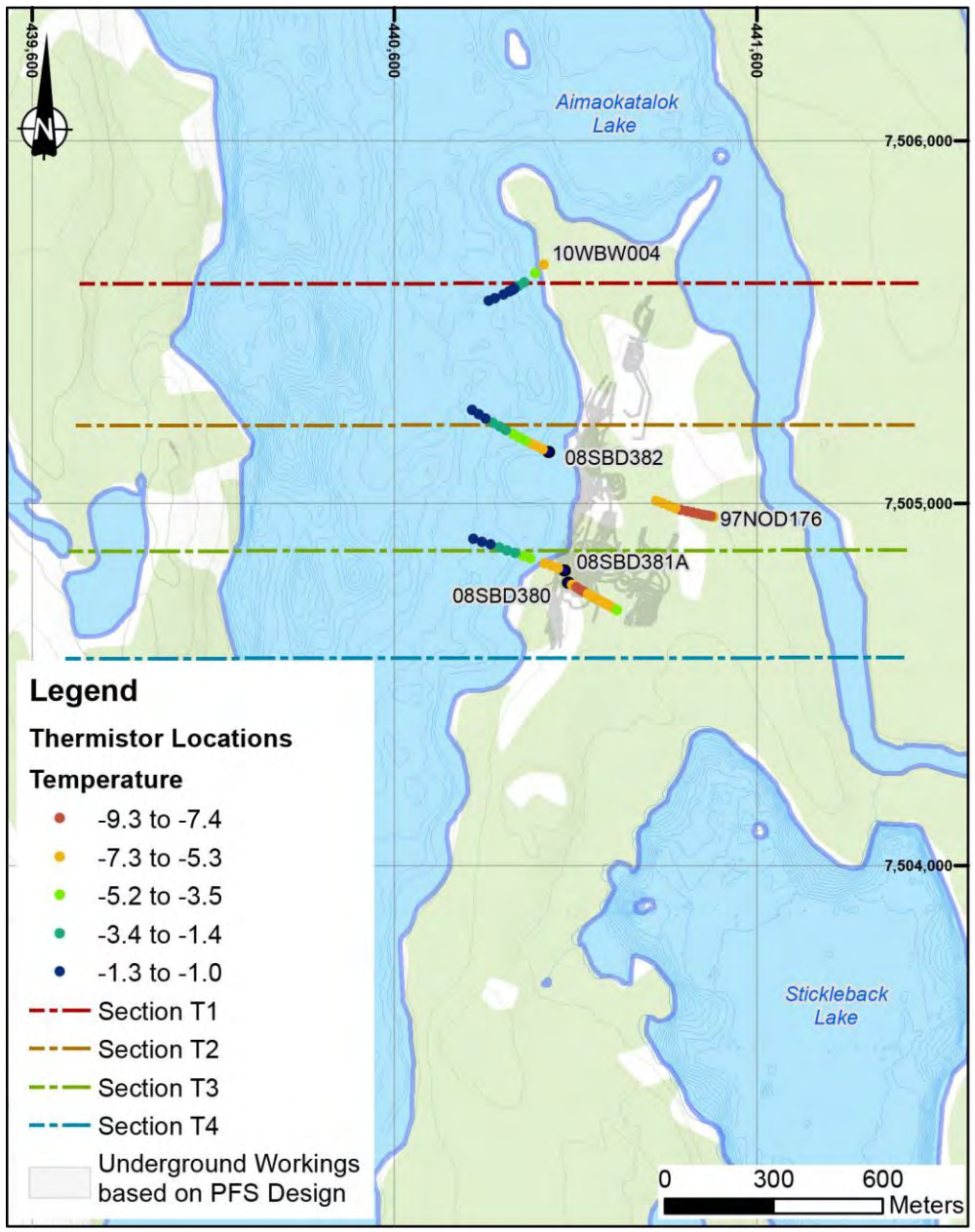
srk consulting	MAC RESOURCES	Lake Talik Configuration
Job No: 1CT022.004 Filename: CircularLakesSensitivitytoGeothermalGradient.pptx	HOPE BAY PROJECT	**Circular Lakes – Sensitivity to Geothermal Gradient**
		Date: 2/12/2016 | Approved: cws | Figure: **4**

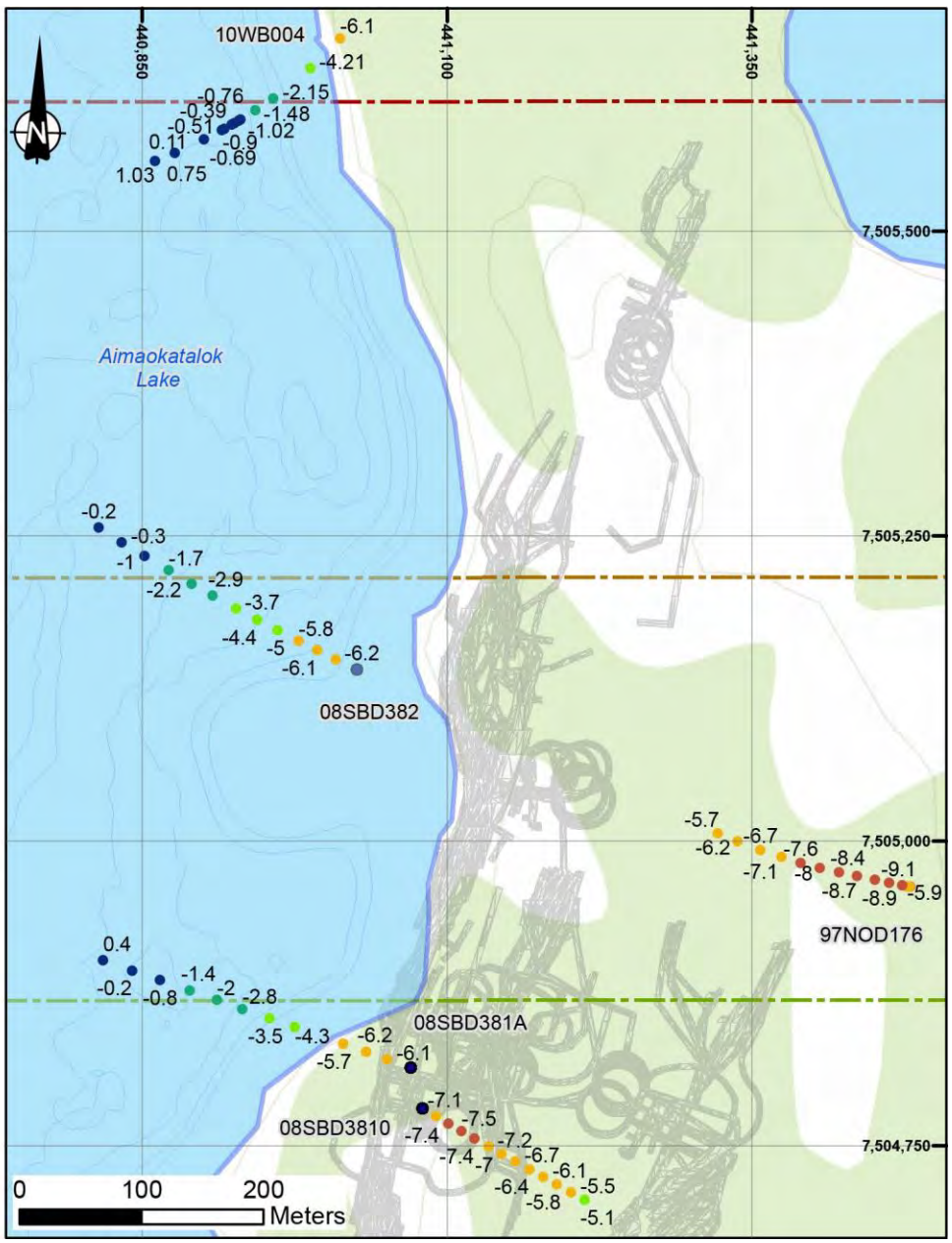


Notes:

1. Open (through) taliks estimated for circular lakes with a dimensions greater than the critical half-width
2. Sensitivity of critical lake half-width based on average geothermal gradient measured at the Doris, Madrid, and Boston mining areas
3. Permafrost temperature based on base case value of -7.6°C
4. LbT – Lake bottom temperature
5. Results based on -2°C isotherm

srk consulting	TMAC RESOURCES	Lake Talik Configuration
Job No: 1CT022.004 Filename: ElongatedLakesSensitivitytoGeothermalGradient.pptx	HOPE BAY PROJECT	**Elongated Lakes – Sensitivity to Geothermal Gradient** Date: 2/12/2016 | Approved: cws | Figure: **5**





Notes:

1. Coordinate System: UTM NAD 83 Zone13
2. Basemap Credits: ERSI, DeLorme, TomTom, Intermap, NRCAN, GeoBase
3. Underground Workings based on PFS Design

srk consulting

Job No: 1CT022.004

Filename: BostonDeepGroundTemperatures.pptx

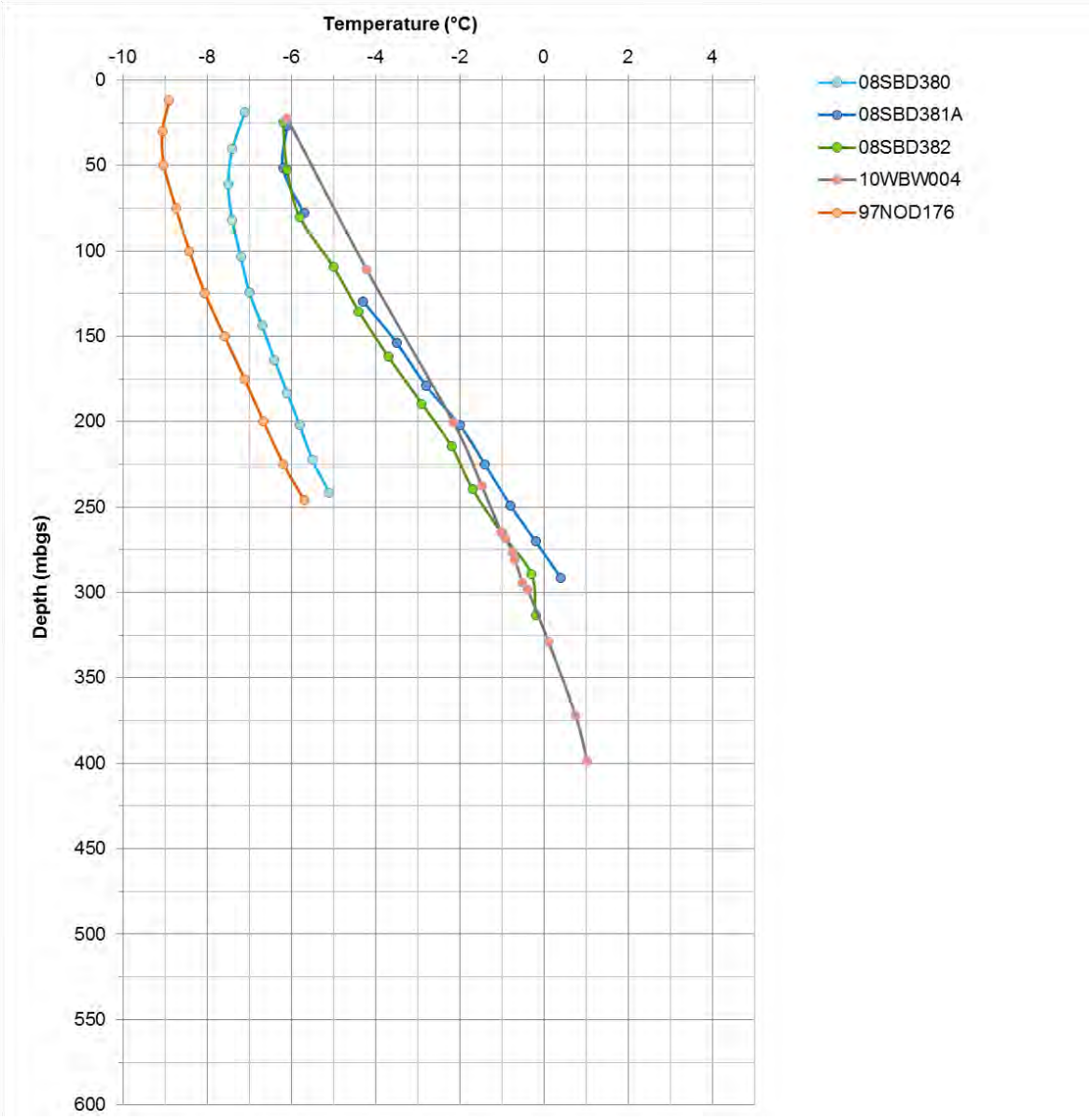
TMAC RESOURCES

HOPE BAY PROJECT

Lake Talik Configuration

Boston Mining Area

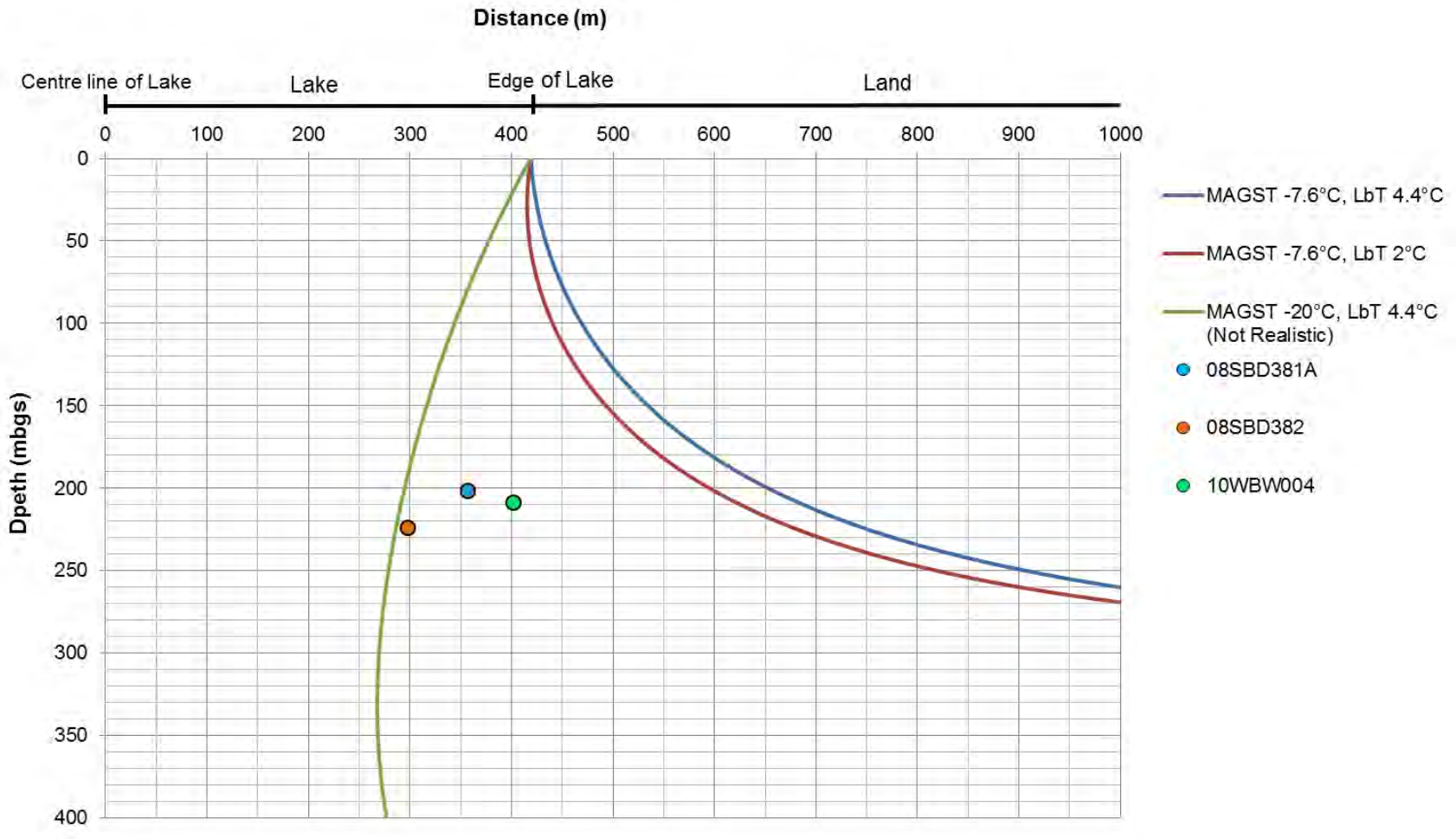
Date:	Approved:	Figure:
2/12/2016	cws	6



Notes:

1. Depth indicated as vertical metres below ground surface (mbgs)

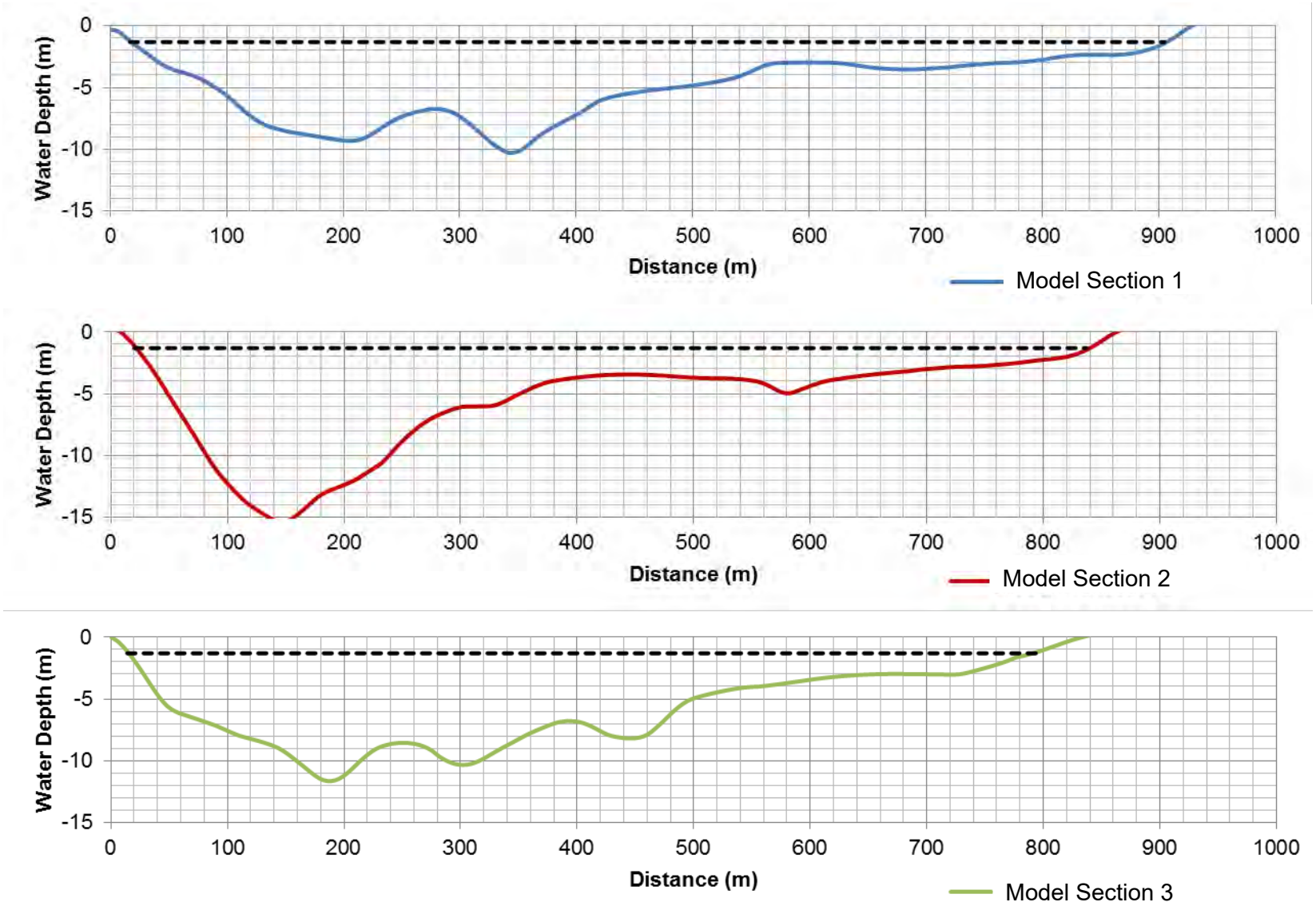
srk consulting	TMAC RESOURCES	Lake Talik Configuration	
		Deep Ground Temperatures – Boston Mining Area	
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	Date: 2/12/2016	Approved: cws	Figure: **7**



Notes:

1. 2D analytical model of steady state talik configuration based on -2°C isotherm (solid lines)
2. Position of -2°C isotherm based on thermistor measurements (solid circles)
3. Depth indicated as vertical metres below ground surface (mbgs)
4. Mean annual ground surface temperature (MAGST)
5. Lake bottom temperature (LbT)

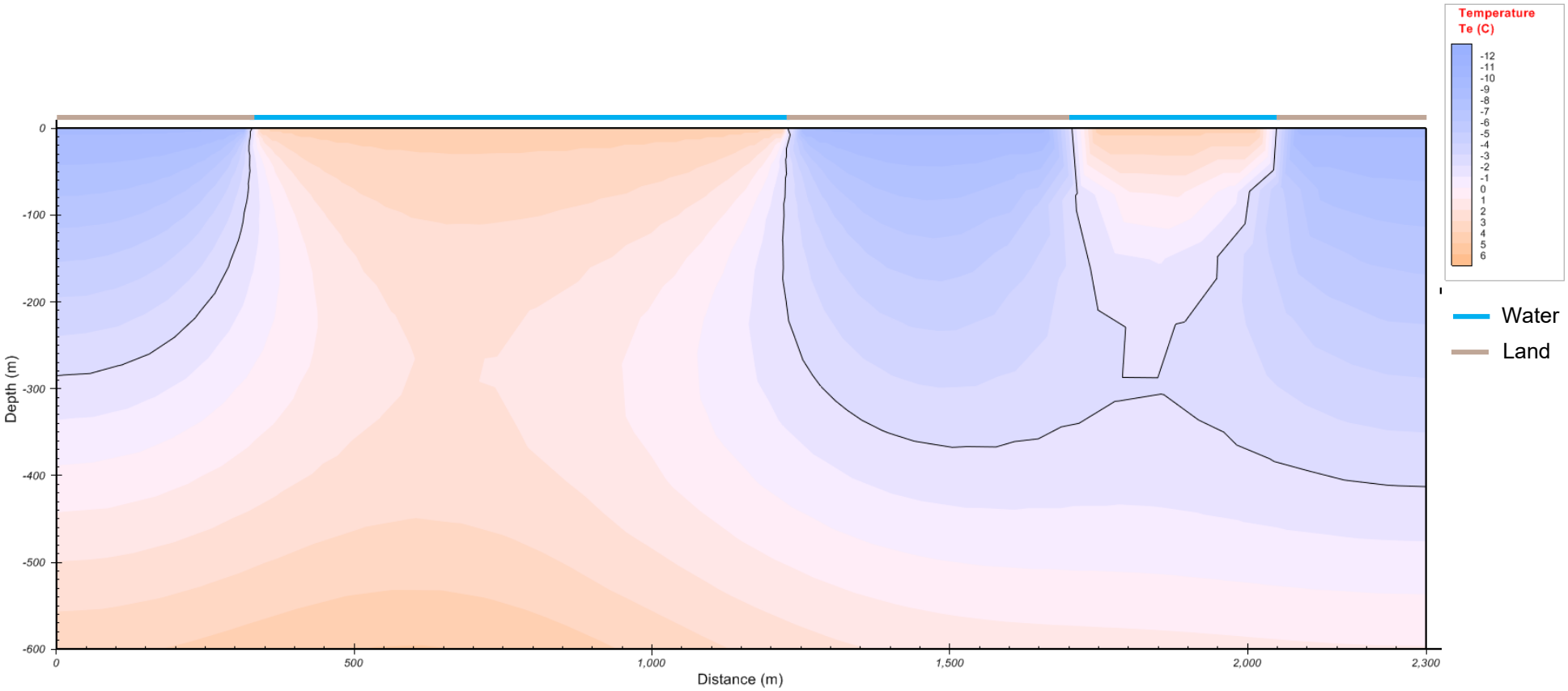
srk consulting	MAC RESOURCES	Lake Talik Configuration
		Steady State Model – Aimaokatalok Lake Talik
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	Date: 2/12/2016 | Approved: cws | Figure: **8**



Notes:

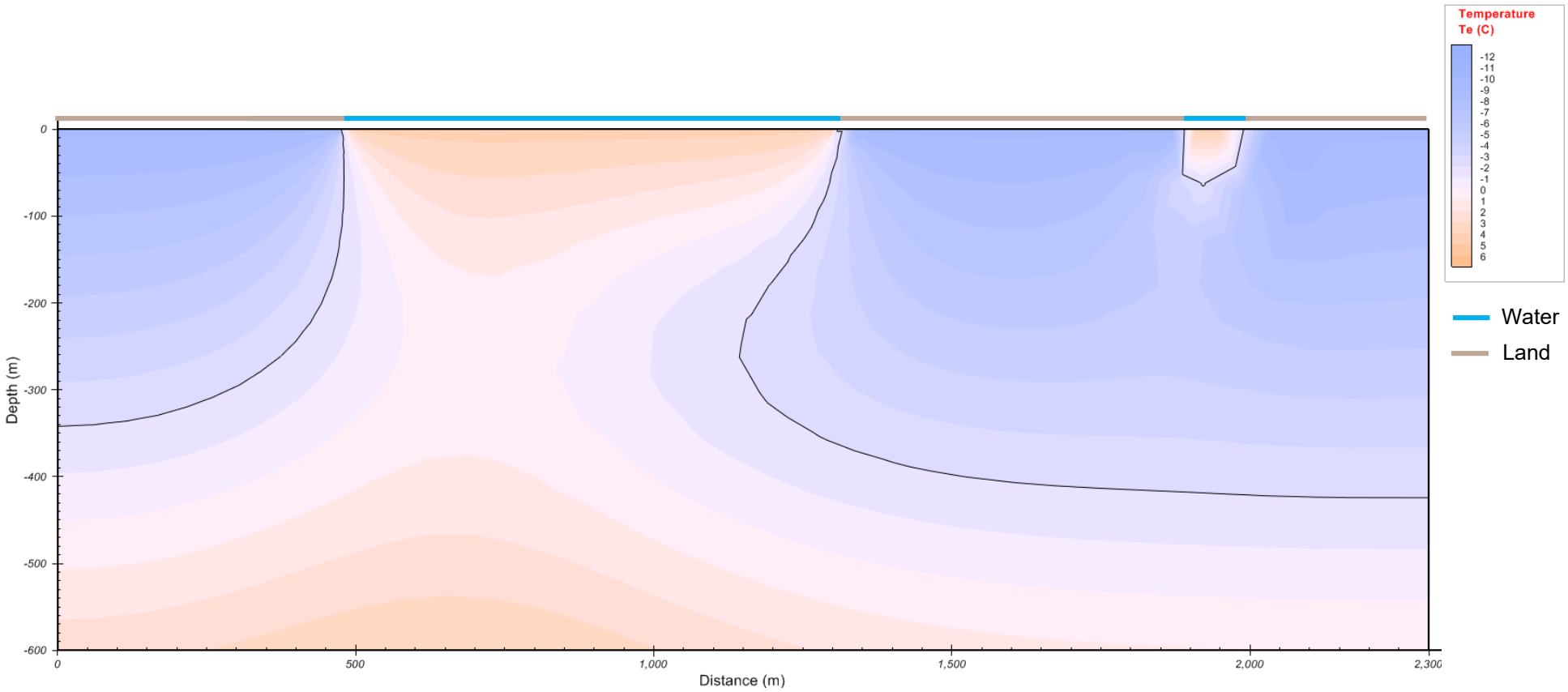
1. Solid line indicates water depth along model section
2. Section only shown for locations where ground temperature measurements extend beneath the lake
3. Dashed black line is two-thirds of the average late-winter ice thickness

srk consulting	MAC RESOURCES	Lake Talik Configuration
		Aimaokatalok Lake Water Bathymetry
Job No: 1CT022.004 Filename: WaterBathymetryModelTransects.pptx	HOPE BAY PROJECT	Date: 2/12/2016 | Approved: cws | Figure: **9**



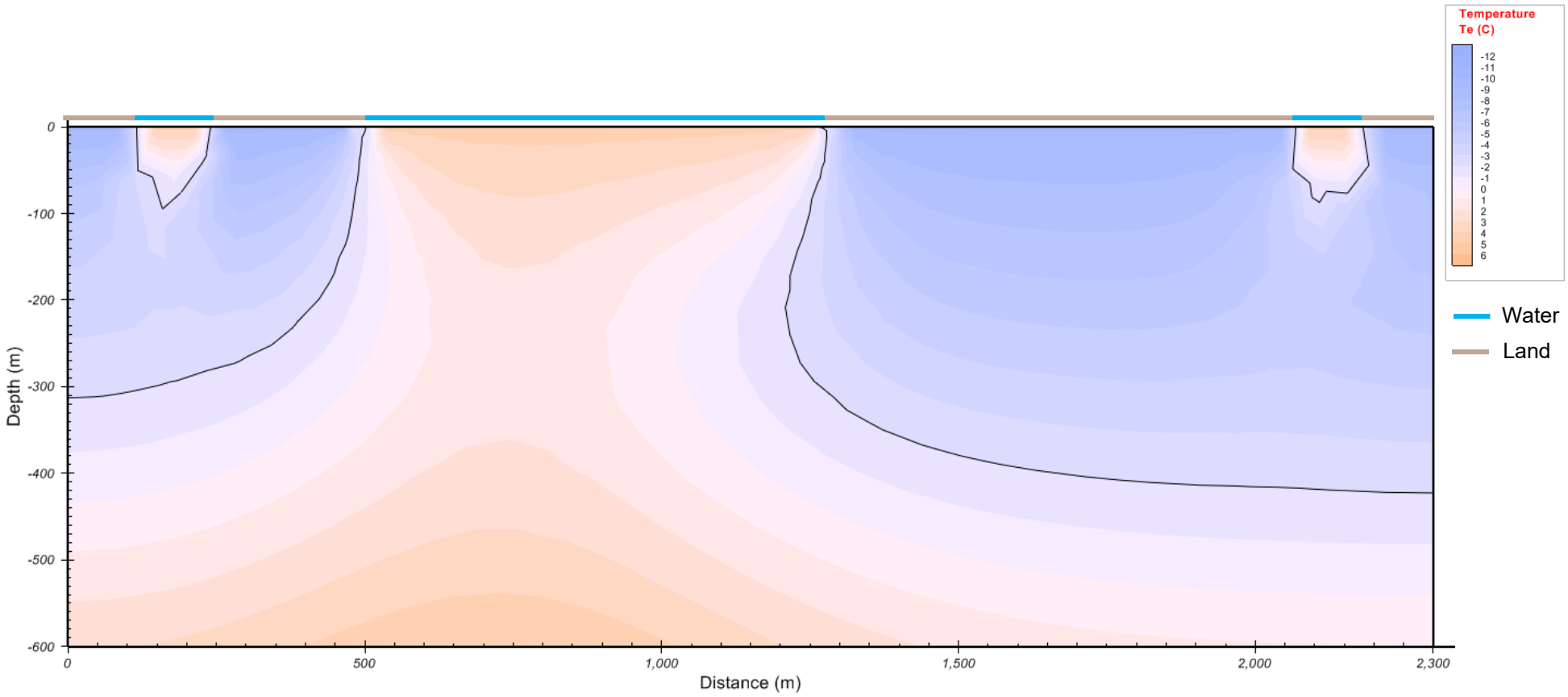
Notes:
1. -2°C isotherm indicated with solid black line
2. Model section extends from west to east

srk consulting	TMAC RESOURCES	Lake Talik Configuration		
		Boston Mining Area – 2D Model Section T1		
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	Date: 2/12/2016	Approved: cws	Figure: **10**



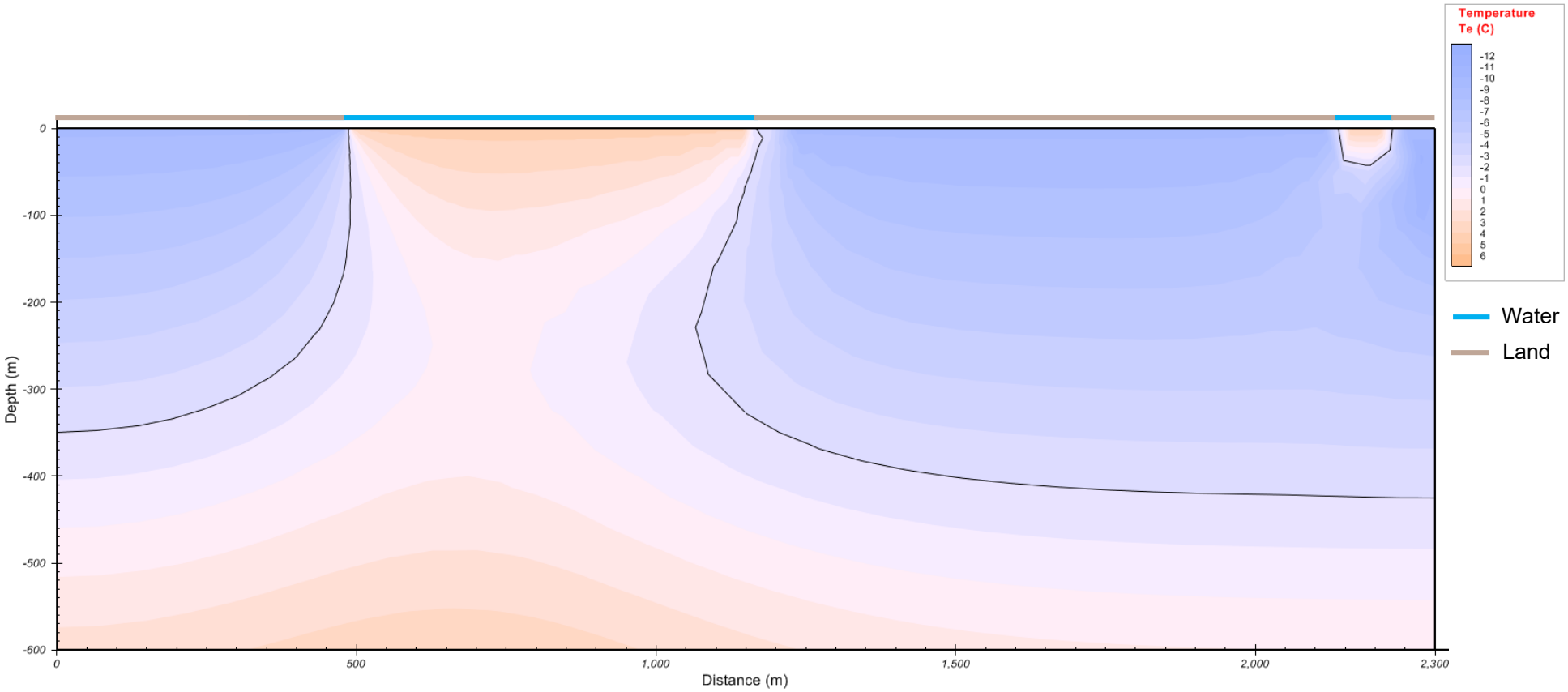
Notes:
1. -2°C isotherm indicated with solid black line
2. Model section extends from west to east

srk consulting	TMAC RESOURCES	Lake Talik Configuration
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	**Boston Mining Area – 2D Model Section T2**
		Date: 2/12/2016 | Approved: cws | Figure: **11**



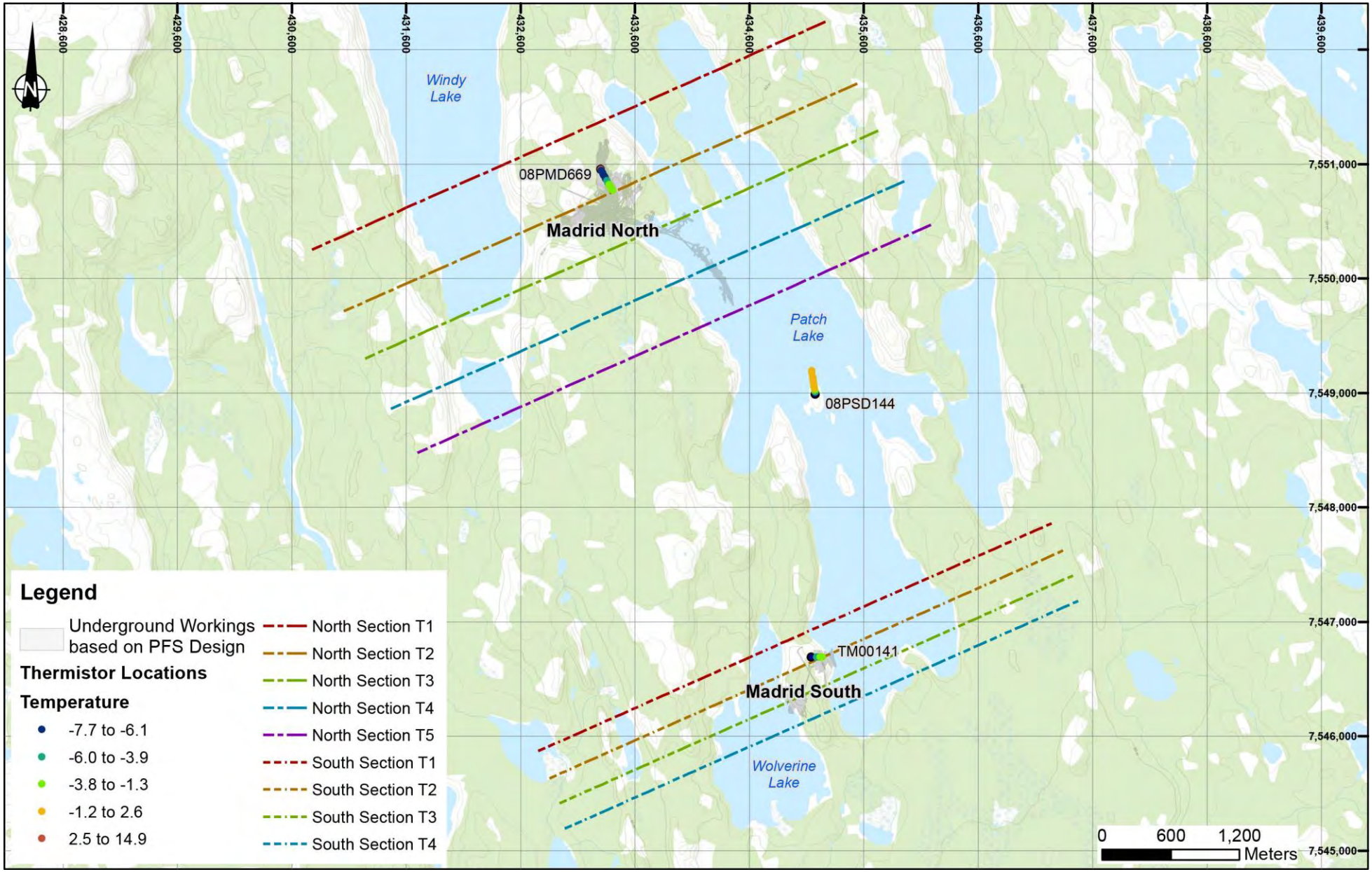
Notes:
1. -2°C isotherm indicated with solid black line
2. Model section extends from west to east

srk consulting	TMAC RESOURCES	Lake Talik Configuration
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	**Boston Mining Area – 2D Model Section T3**
		Date: 2/12/2016 | Approved: cws | Figure: **12**



Notes:
1. -2°C isotherm indicated with solid black line
2. Model section extends from west to east

srk consulting	TMAC RESOURCES	Lake Talik Configuration
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	**Boston Mining Area – 2D Model Section T4**
		Date: 2/12/2016 | Approved: cws | Figure: **13**



Notes:

1. Coordinate System: UTM NAD 83 Zone13
2. Basemap Credits: ERSI, DeLorme, TomTom, Intermap, NRCAN, GeoBase
3. Underground Workings based on PFS Design

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Job No: 1CT022.004

Filename: BostonDeepGroundTemperatures.pptx

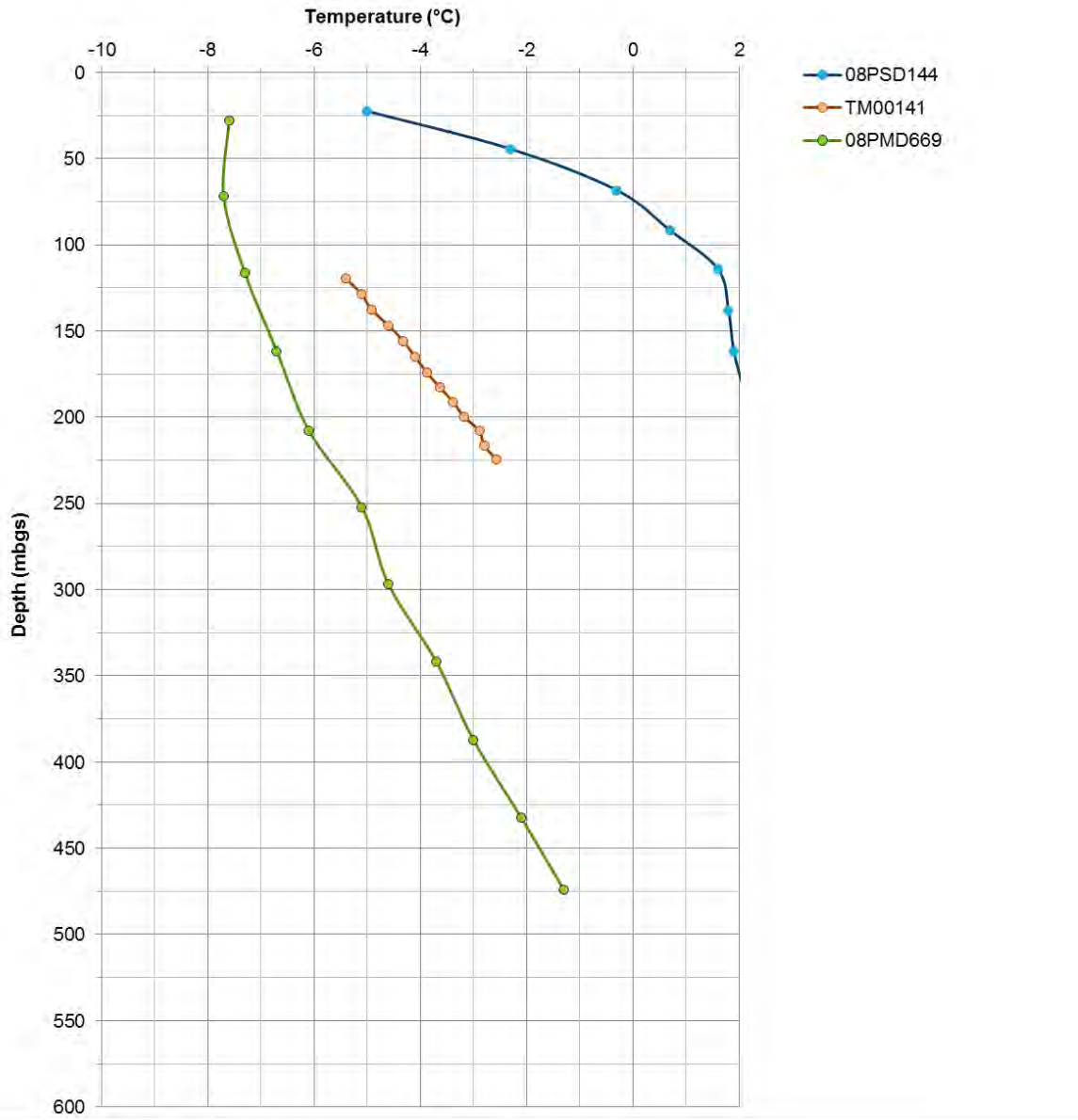
MAC RESOURCES

HOPE BAY PROJECT

Lake Talik Configuration

Madrid North and South Mining Areas

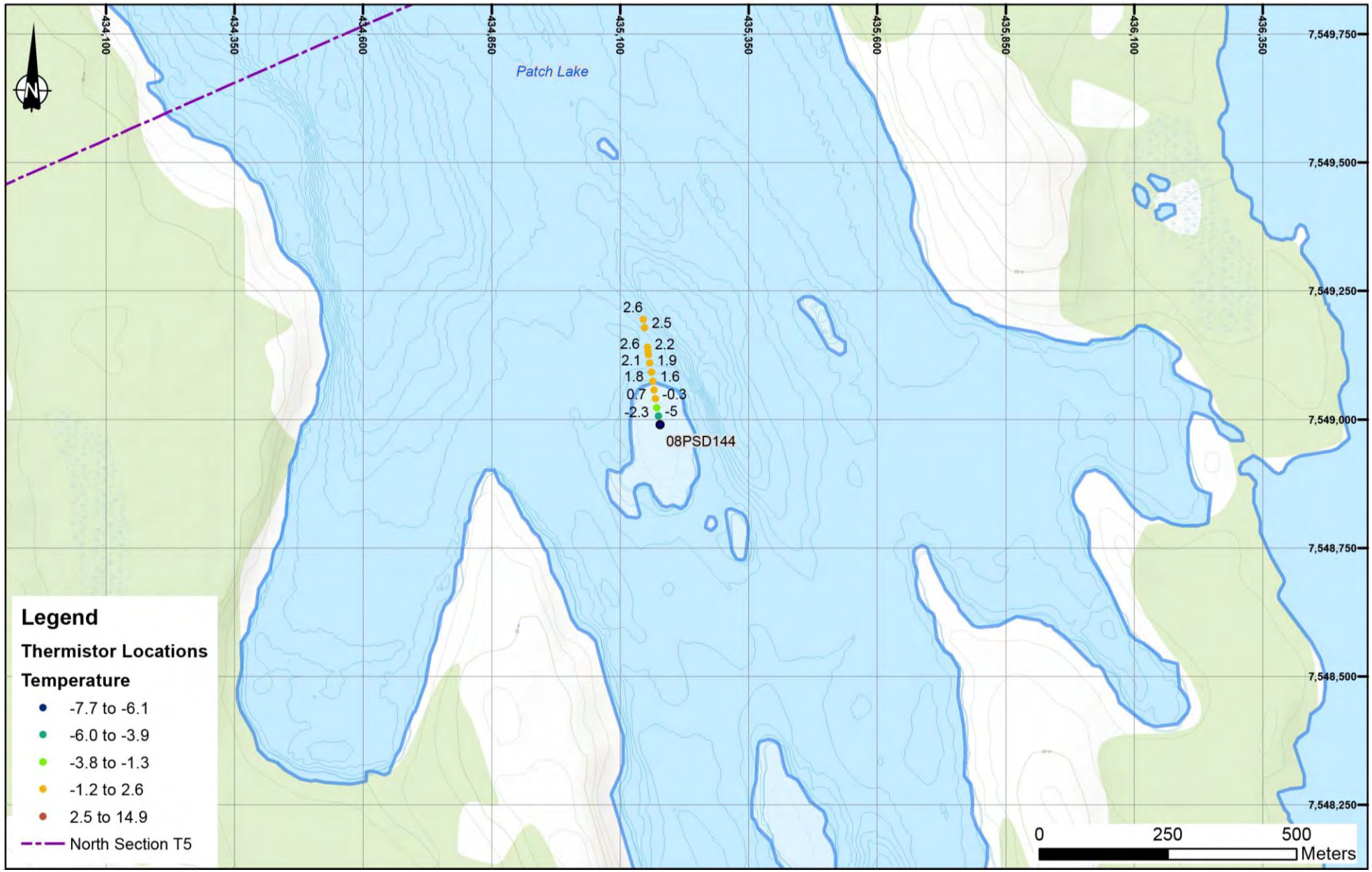
Date:	Approved:	Figure:
2/12/2016	cws	14



Notes:

1. Depth indicated as vertical metres below ground surface (mbgs)

srk consulting	TMAC RESOURCES	Lake Talik Configuration	
		Deep Ground Temperatures – Madrid Mining Area	
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	Date: 2/12/2016	Approved: cws	Figure: **15**



Notes:

1. Coordinate System: UTM NAD 83 Zone13
2. Basemap Credits: ERSI, DeLorme, TomTom, Intermap, NRCAN, GeoBase
3. Underground Workings based on PFS Design

srk consulting

Job No: 1CT022.004

Filename: BostonDeepGroundTemperatures.pptx

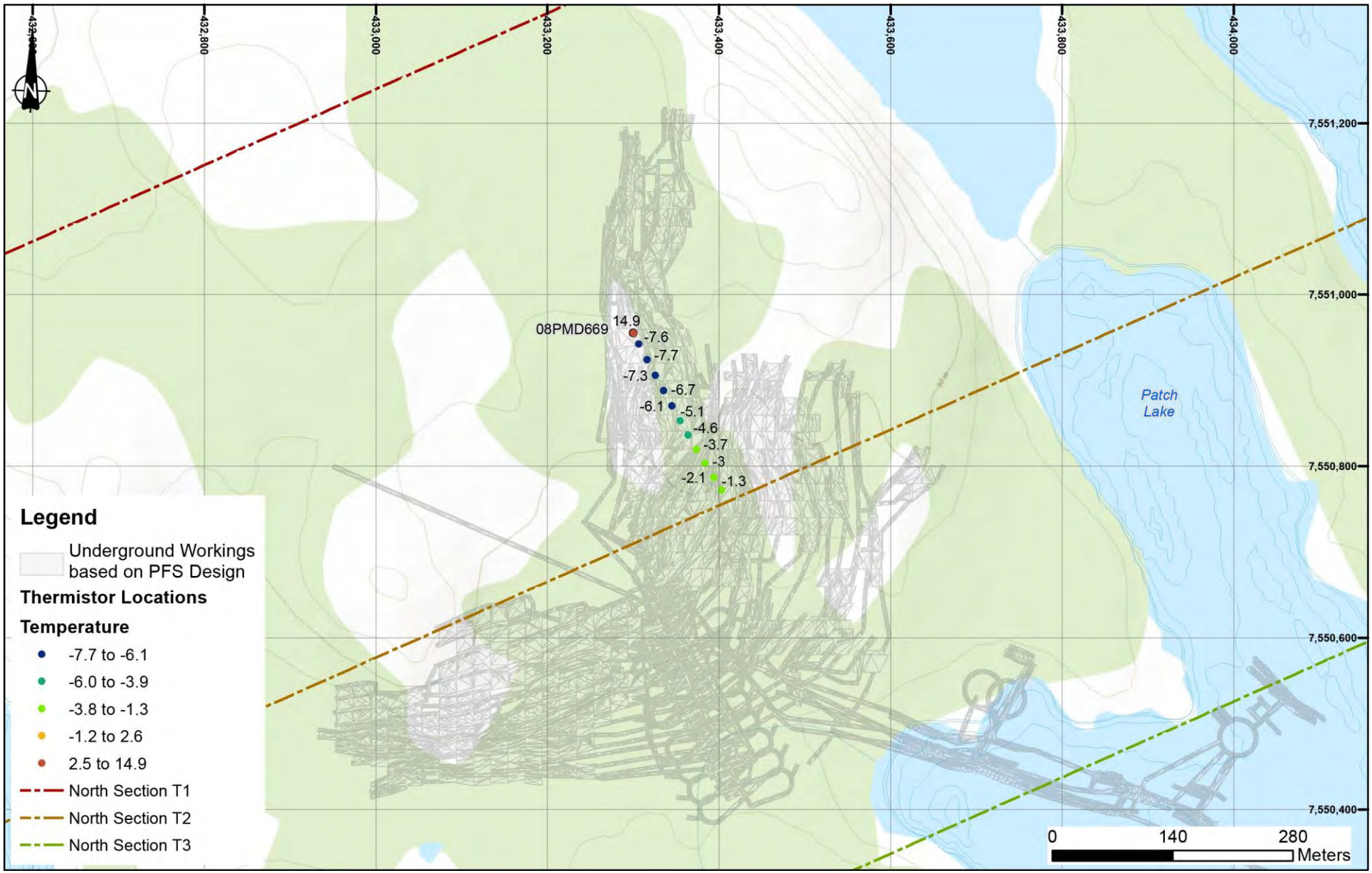
TMAC RESOURCES

HOPE BAY PROJECT

Lake Talik Configuration

Patch Island – Thermistor Site ID 08PSD144

Date:	Approved:	Figure:
2/12/2016	cws	16



Notes:

1. Coordinate System: UTM NAD 83 Zone13
2. Basemap Credits: ERSI, DeLorme, TomTom, Intermap, NRCAN, GeoBase
3. Underground Workings based on PFS Design

srk consulting

Job No: 1CT022.004

Filename: BostonDeepGroundTemperatures.pptx

TMAC RESOURCES

HOPE BAY PROJECT

Lake Talik Configuration

Madrid North Mining Area – Thermistor Site ID 08PMD669

Date:	Approved:	Figure:
2/12/2016	cws	17

Notes:

1. Coordinate System: UTM NAD 83 Zone13
2. Basemap Credits: ERSI, DeLorme, TomTom, Intermap, NRCAN, GeoBase
3. Underground Workings based on PFS Design

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Job No: 1CT022.004

Filename: BostonDeepGroundTemperatures.pptx

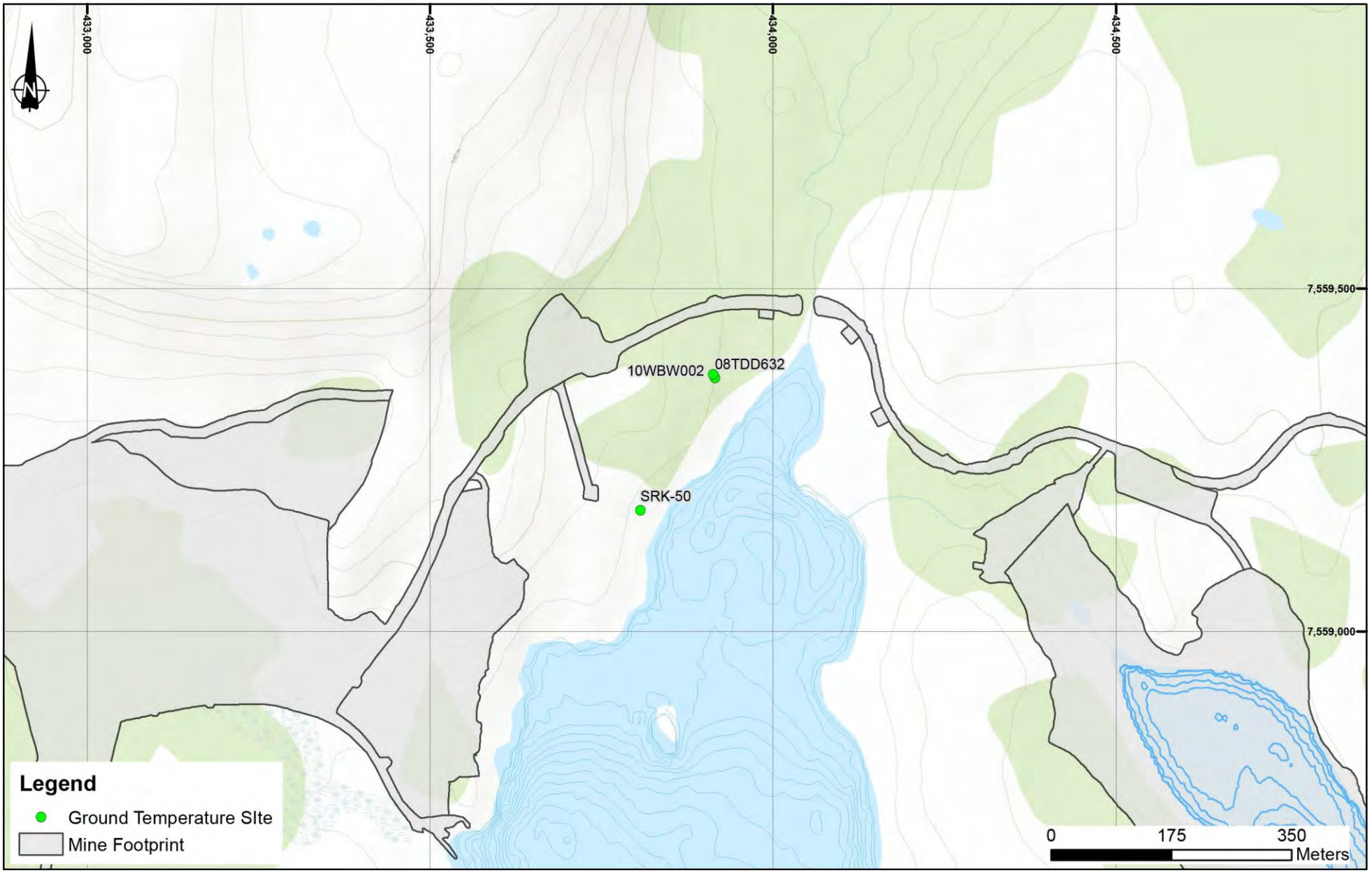
TMAC RESOURCES

HOPE BAY PROJECT

Lake Talik Configuration

Madrid South Mining Area – Thermistor Site ID TM00141

Date:	Approved:	Figure:
2/12/2016	cws	18



Notes:

1. Coordinate System: UTM NAD 83 Zone13
2. Basemap Credits: ERSI, DeLorme, TomTom, Intermap, NRCAN, GeoBase
3. Mine Footprint based on PFS Design

srk consulting

Job No: 1CT022.004

Filename: BostonDeepGroundTemperatures.pptx

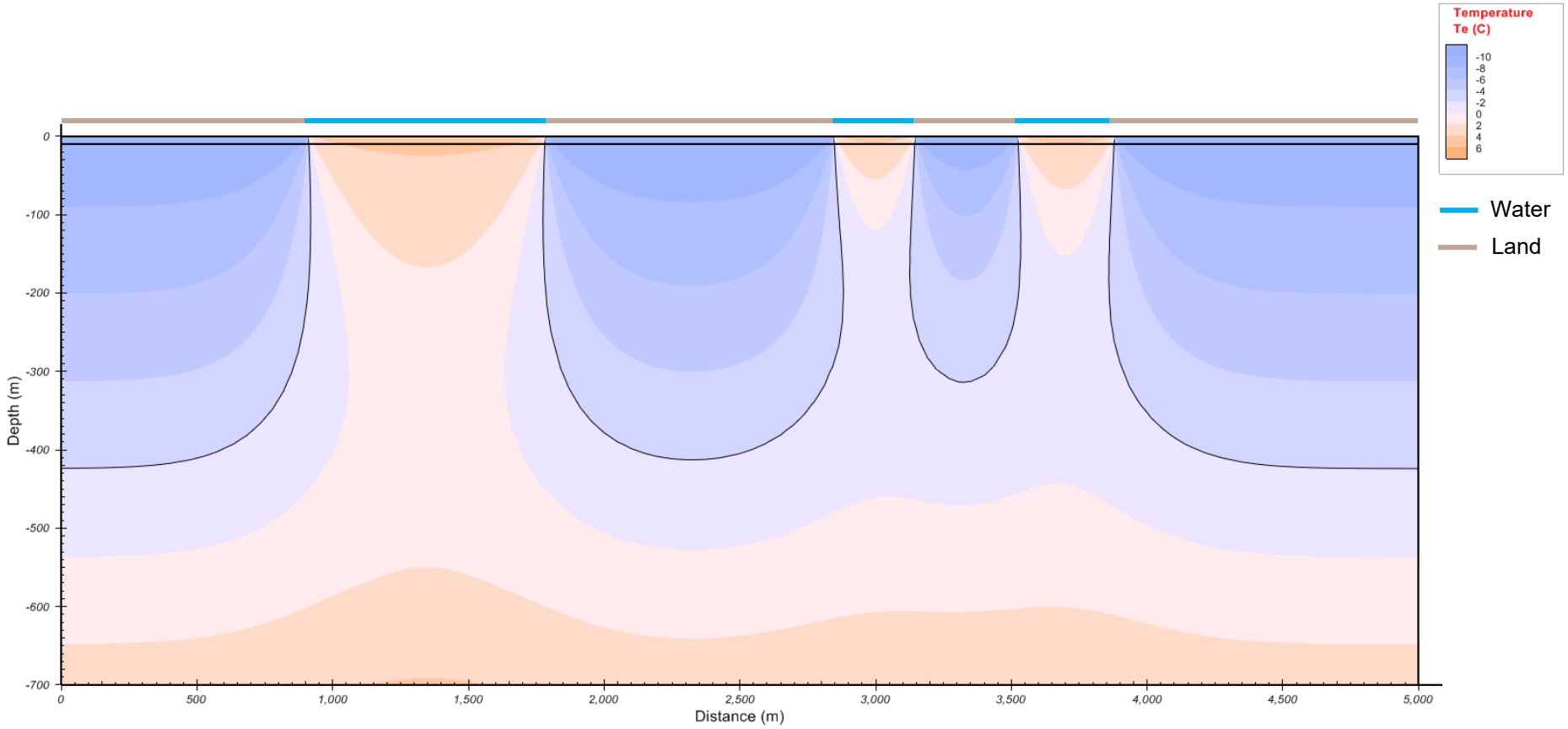
TMAC RESOURCES

HOPE BAY PROJECT

Lake Talik Configuration

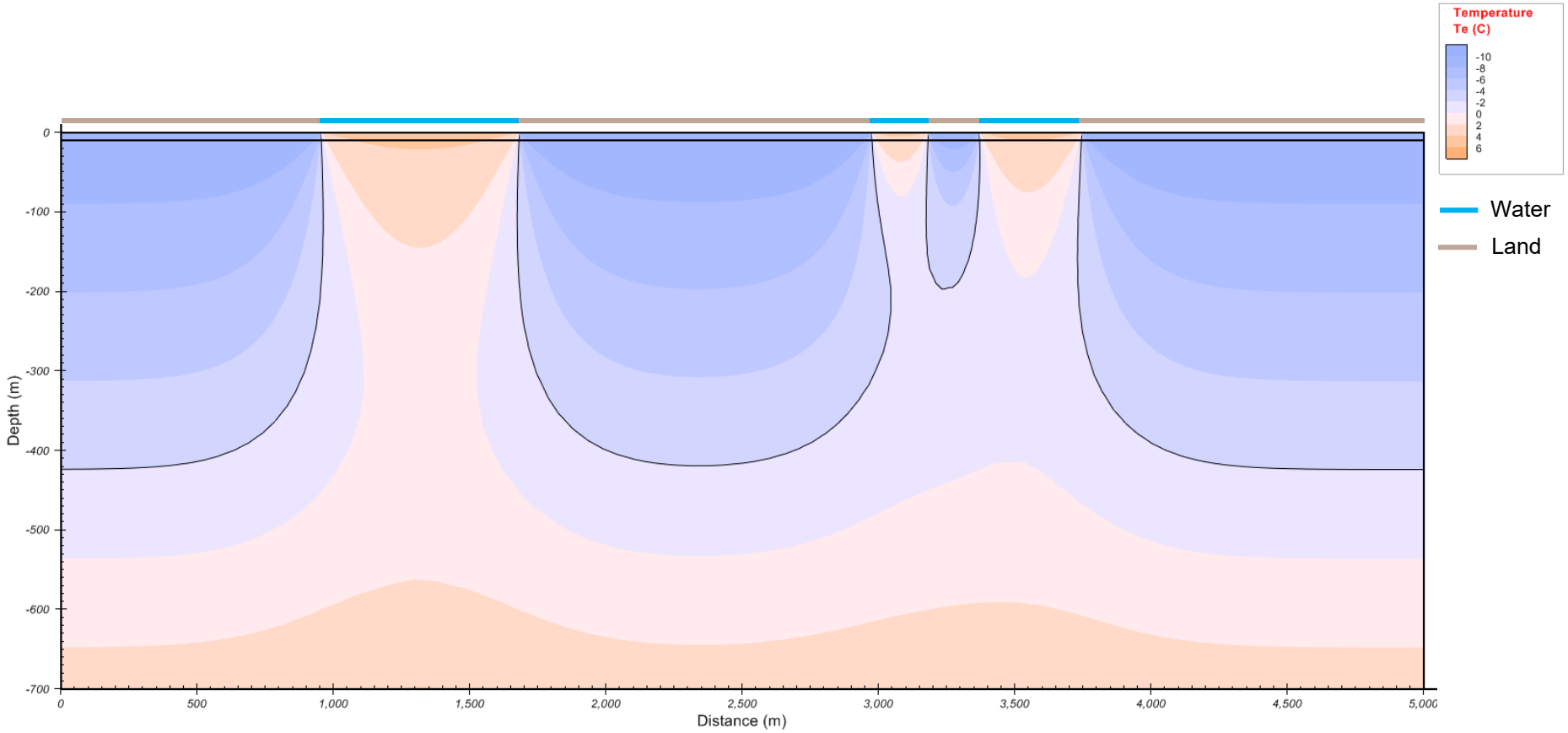
Madrid South Mining Area – Thermistor Site ID TM00141

Date:	Approved:	Figure:
2/12/2016	cws	19



Notes:
1. -2°C isotherm indicated with solid black line
2. Model section extends from west to east

srk consulting	TMAC RESOURCES	Lake Talik Configuration
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	**Madrid North Mining Area – 2D Model Section T1**
		Date: 2/12/2016 | Approved: cws | Figure: **20**



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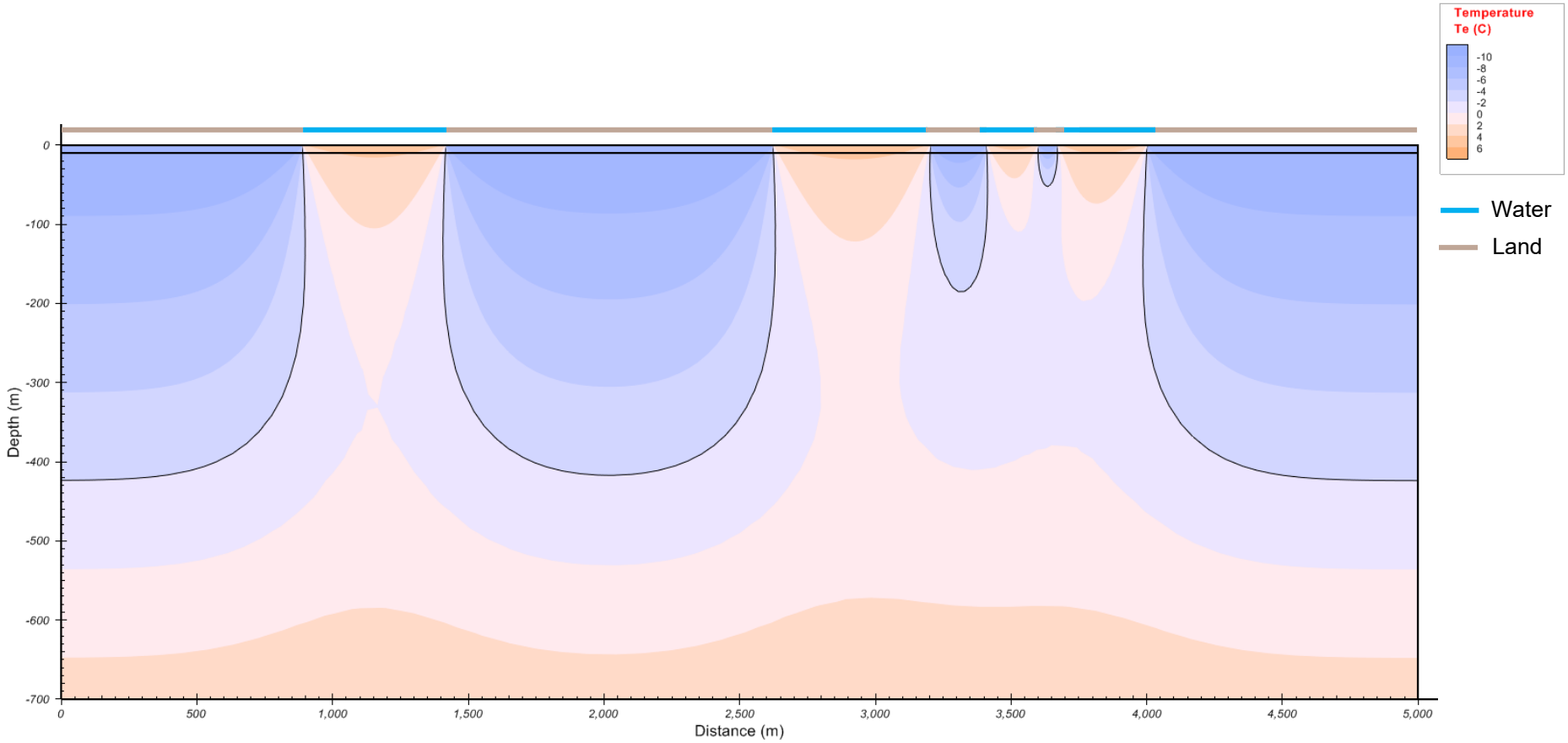
1. -2°C isotherm indicated with solid black line
2. Model section extends from west to east

srk consulting	TMAC RESOURCES	Lake Talik Configuration
		Madrid North Mining Area – 2D Model Section T2
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	Date: 2/12/2016 | Approved: cws | Figure: **21**



Notes:
1. -2°C isotherm indicated with solid black line
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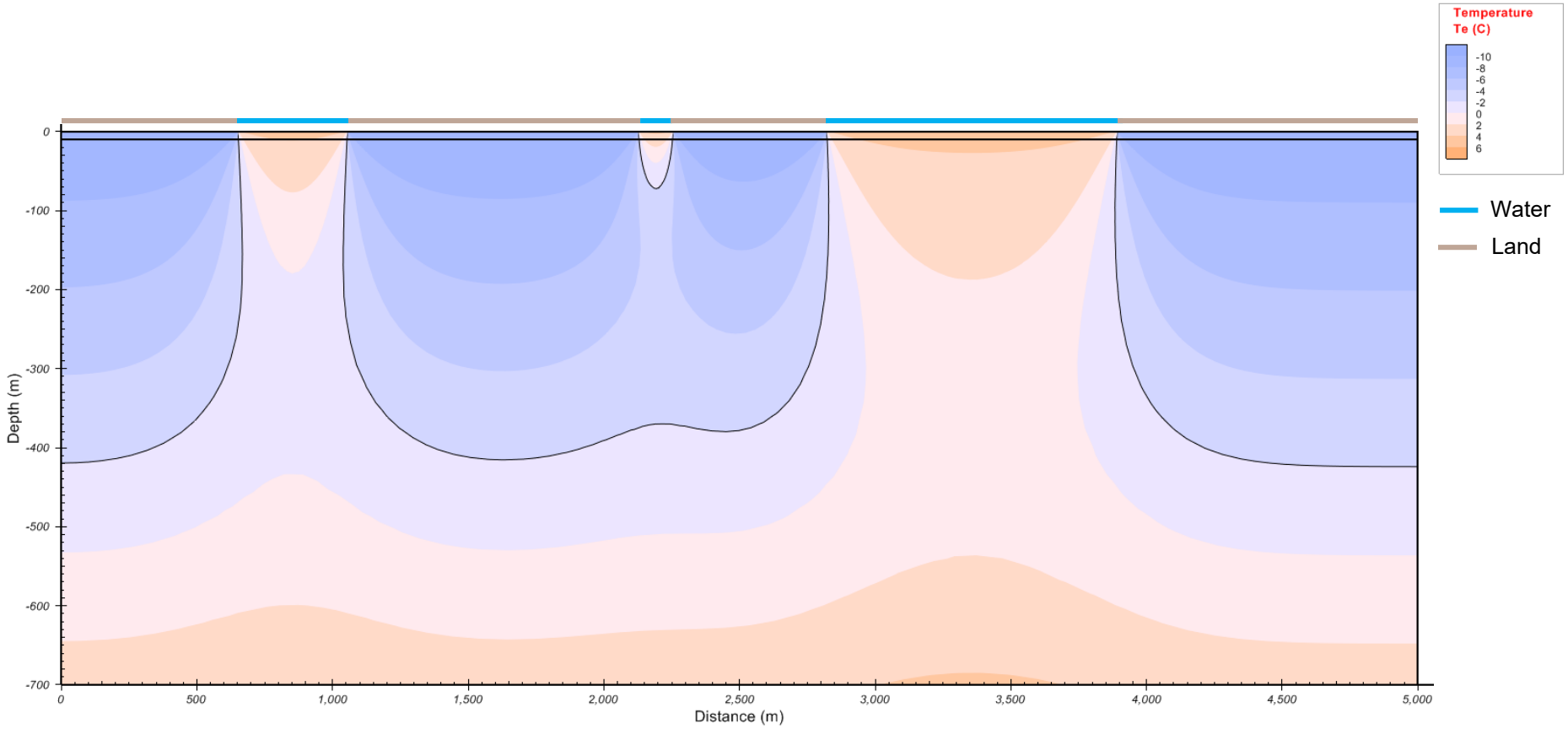
srk consulting	TMAC RESOURCES	Lake Talik Configuration
		Madrid North Mining Area – 2D Model Section T3
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	Date: 2/12/2016 | Approved: cws | Figure: **22**



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1. -2°C isotherm indicated with solid black line
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srk consulting	TMAC RESOURCES	Lake Talik Configuration
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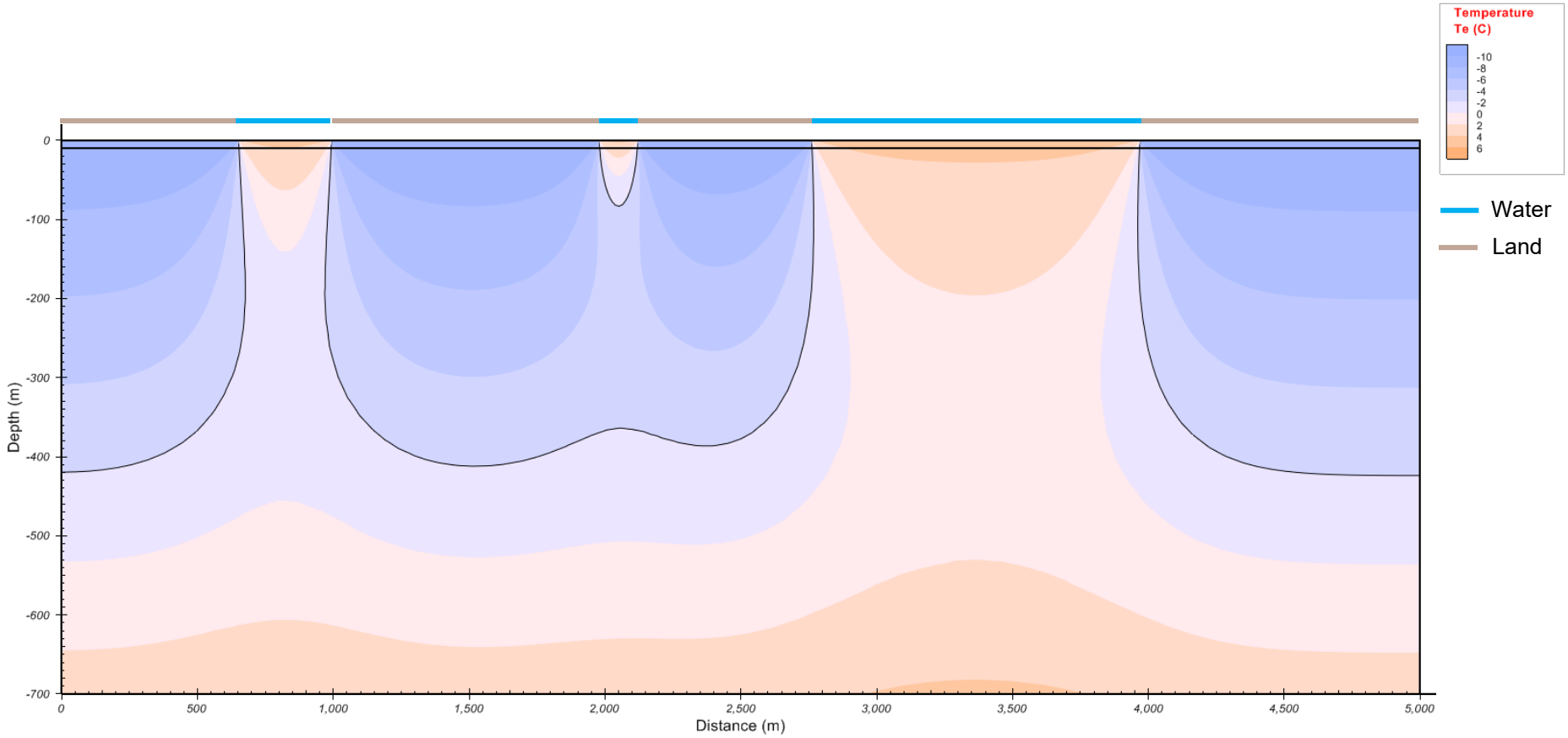
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	Date: 2/12/2016 | Approved: cws | Figure: **23**



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1. -2°C isotherm indicated with solid black line
2. Model section extends from west to east

srk consulting	TMAC RESOURCES	Lake Talik Configuration
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	**Madrid North Mining Area – 2D Model Section T5**
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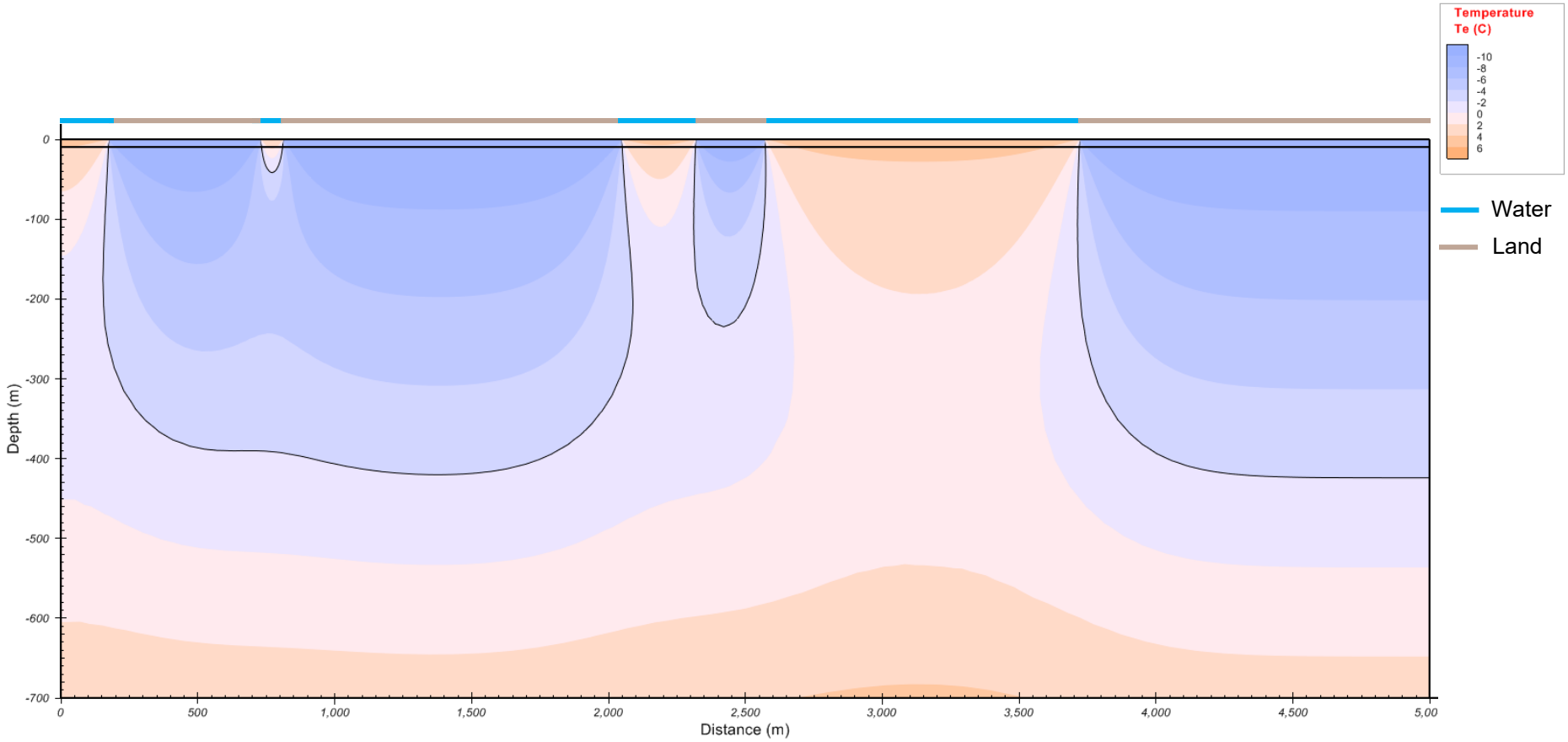
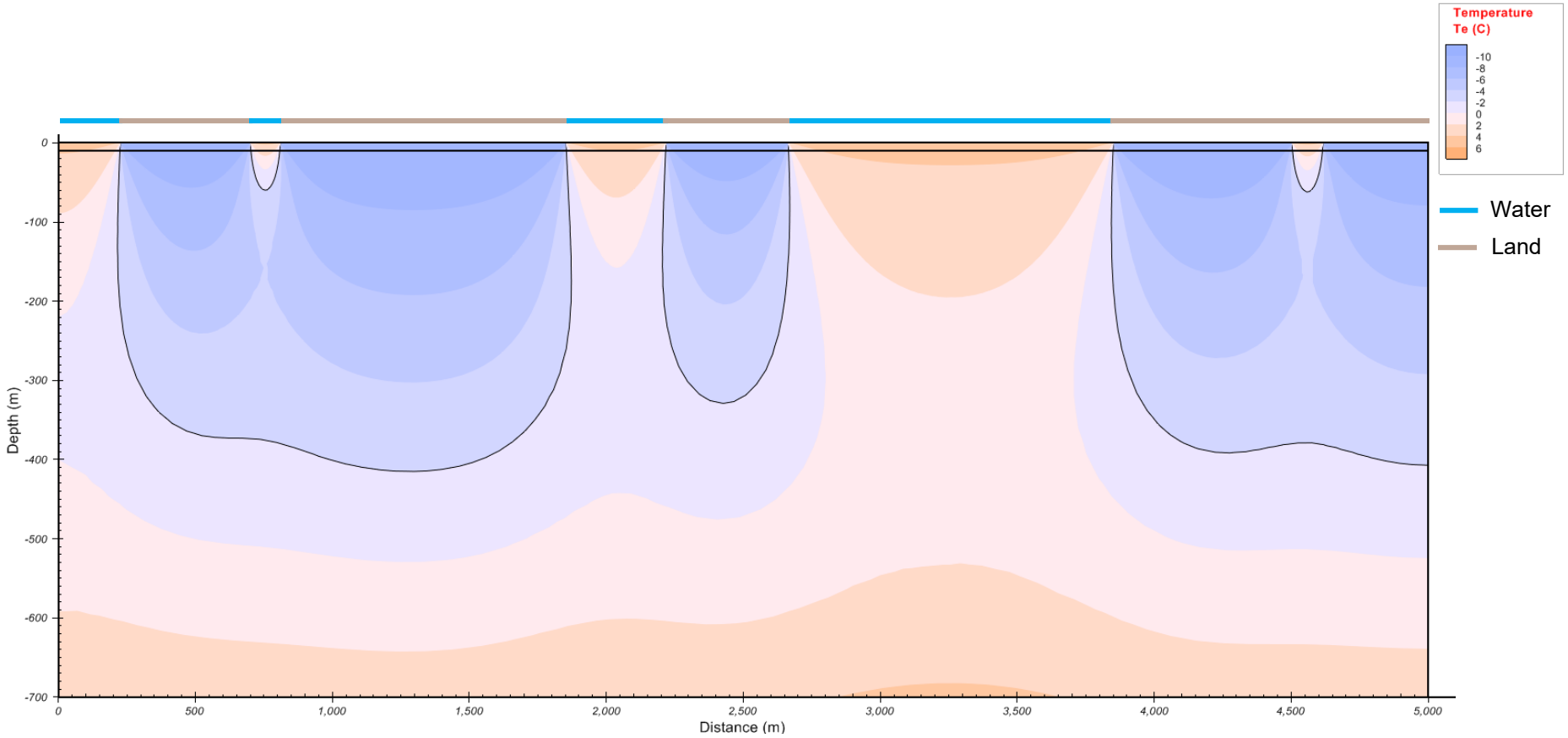


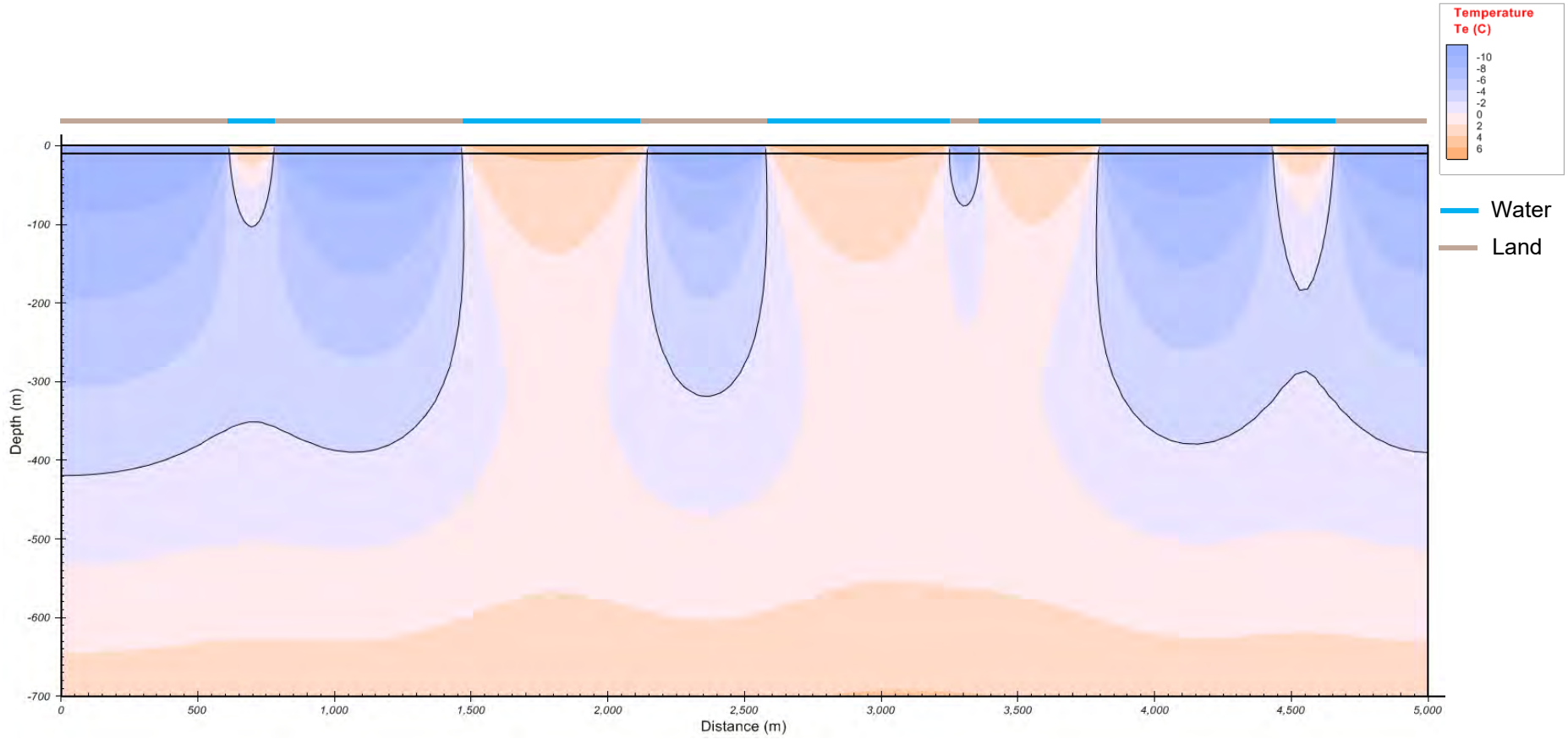
Notes:
1. -2°C isotherm indicated with solid black line
2. Model section extends from west to east

srk consulting	TMAC RESOURCES	Lake Talik Configuration
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	**Madrid South Mining Area – 2D Model Section T1**
		Date: 2/12/2016 | Approved: cws | Figure: **25**



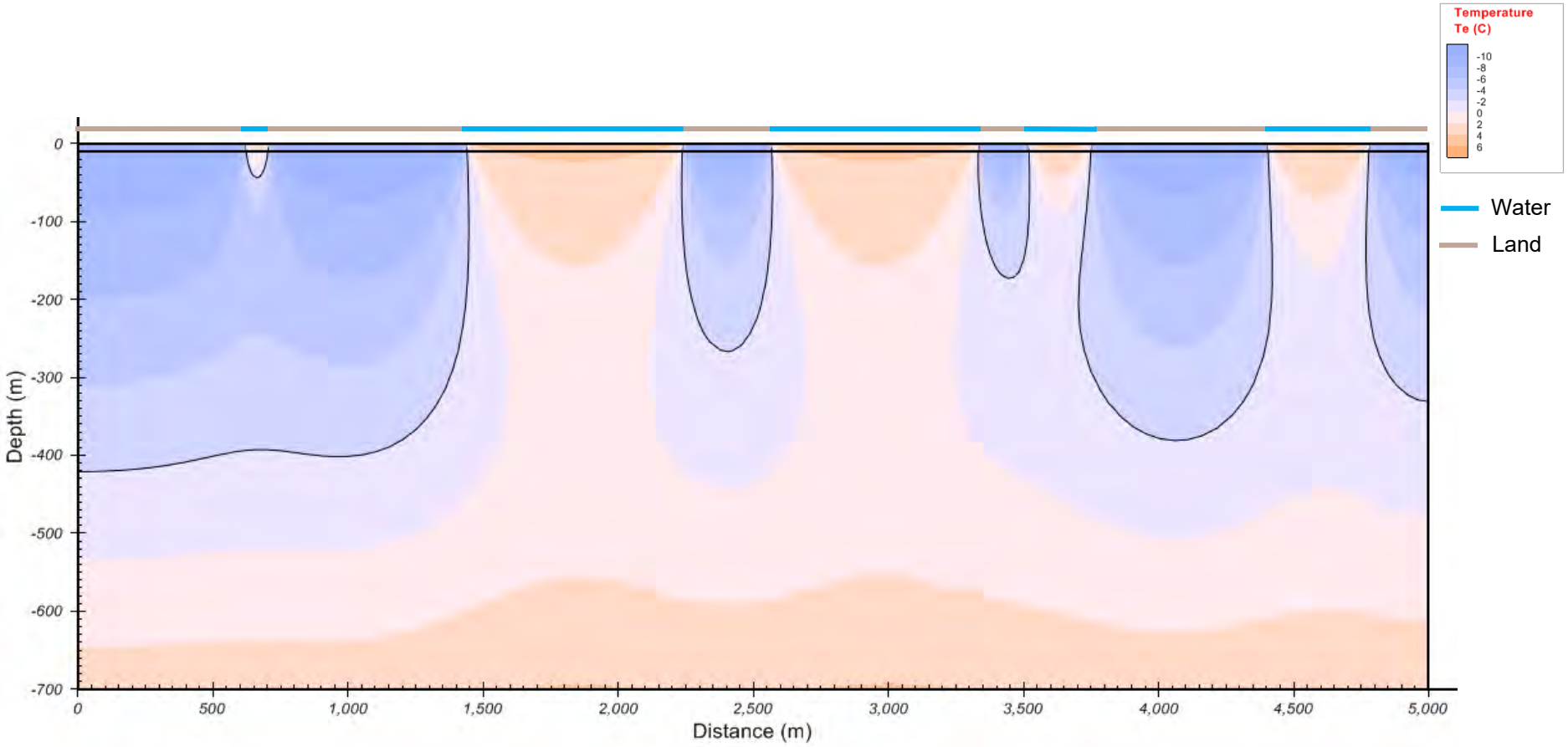
Notes:
1. -2°C isotherm indicated with solid black line
2. Model section extends from west to east

srk consulting	TMAC RESOURCES	Lake Talik Configuration
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	**Madrid South Mining Area – 2D Model Section T2**
		Date: 2/12/2016 | Approved: cws | Figure: **26**



Notes:
1. -2°C isotherm indicated with solid black line
2. Model section extends from west to east

srk consulting	TMAC RESOURCES	Lake Talik Configuration
		Madrid South Mining Area – 2D Model Section T3
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	Date: 2/12/2016 | Approved: cws | Figure: **27**



Notes:
1. -2°C isotherm indicated with solid black line
2. Model section extends from west to east

srk consulting	TMAC RESOURCES	Lake Talik Configuration
		Madrid South Mining Area – 2D Model Section T4
Job No: 1CT022.004 Filename: BostonDeepGroundTemperatures.pptx	HOPE BAY PROJECT	Date: 2/12/2016 | Approved: cws | Figure: **28**

Appendix H – 2020-2022 Doris Inflow Data

Project: Hope Bay Mine
Number: CAPR001915

Source: HopeBay_MineWaterSummary_CAPR001959_R00_ajb.xlsx
email from Andrea Bowie dated Dec14th 2022

Date	Total Doris Mine inflow (m^3/day)	Month Avg. Chloride (mg/L)	Month Avg. Chloride Load (kg/d)
01-Jan-18	0	20700	0
01-Feb-18	98	22575	2214
01-Mar-18	299	22100	6604
01-Apr-18	251	21767	5456
01-May-18	229	18400	4211
01-Jun-18	325	17860	5804
01-Jul-18	361	16975	6134
01-Aug-18	316	16440	5192
01-Sep-18	226	14665	3310
01-Oct-18	611	14125	8630
01-Nov-18	735	14700	10810
01-Dec-18	653	13650	8914
01-Jan-19	649	14350	9308
01-Feb-19	678	13000	8814
01-Mar-19	1091	12800	13966
01-Apr-19	781	12825	10017
01-May-19	828	12350	10221
01-Jun-19	912	10615	9684
01-Jul-19	914	10673	9760
01-Aug-19	947	11260	10664
01-Sep-19	1014	10923	11071
01-Oct-19	1016	11167	11344
01-Nov-19	1338	9890	13233
01-Dec-19	2352	9640	22671
01-Jan-20	2766	8690	24035
01-Feb-20	2171	8945	19417
01-Mar-20	2268	9345	21197
01-Apr-20	1979	10203	20194
01-May-20	1427	9173	13085
01-Jun-20	1201	9413	11305
01-Jul-20	1569	8730	13694
01-Aug-20	1258	8200	10314
01-Sep-20	1513	8053	12188
01-Oct-20	1607	8058	12946
01-Nov-20	1900	7788	14796
01-Dec-20	1348	7900	10650
01-Jan-21	1281	7300	9351
01-Feb-21	1540	7200	11088
01-Mar-21	1570	8473	13300
01-Apr-21	1822	7547	13752
01-May-21	1477	8906	13155
01-Jun-21	1934	8285	16027
01-Jul-21	1083	8028	8692
01-Aug-21	1106	7255	8023
01-Sep-21	729	6785	4946
01-Oct-21	1170	7677	8979
01-Nov-21	800	6740	5392
01-Dec-21	1577	6153	9705
01-Jan-22	1699	6735	11440
01-Feb-22	1720	6460	11113
01-Mar-22	1789	#N/A	#N/A
01-Apr-22	1618	#N/A	#N/A
01-May-22	1460	6193	9045
01-Jun-22	1535	4216	6472
01-Jul-22	1033	7030	7265
01-Aug-22	1360	6005	8169
01-Sep-22	1021	5293	5405

APPENDIX G
DFO CORRESPONDENCE

Fisheries and Oceans Canada | Pêches et Océans Canada

Fisheries and Oceans Canada
Fish and Fish Habitat Protection Program
Arctic Region Program
301-5204 50th Ave (Franklin)
Yellowknife NT X1A 1E2

Pêches et Océans Canada
Programme de protection du poisson et de son habitat
Région de l'Arctique
301-5204 50th Ave (Franklin)
Yellowknife NT X1A 1E2

Your file *Votre référence*

April 25, 2023

Our file *Notre référence*
22-HCAA-02496

Nancy Duquet Harvey
Agnico Eagle Mines Limited – Hope Bay Mine
145 King Street East, Suite 400
Toronto, Ontario M5C 2Y7

Subject: Madrid-Boston Project, Hope Bay Mine – Application for Authorization under the *Fisheries Act* Required, but Prohibited Effects on Listed Aquatic Species at Risk Are Not Likely.

Dear Nancy Duquet-Harvey:

The Fish and Fish Habitat Protection Program (the Program) of Fisheries and Oceans Canada (DFO) received your proposal on January 17, 2023. We understand that you propose to:

- Build six road crossings over freshwater watercourses along all-weather access roads
- Install a water intake pipeline in Windy Lake and a water intake and discharge pipeline below the high-water mark in Aimaokatalok Lake
- Alter the surface flow and hydrological conditions of a number of streams and lakes within the project area from water withdrawal:
  - Shallow Lake: Imniagut Lake
  - Small Intermittent Stream: Imniagut Outflow
  - Large Streams (wetted width < 10m): P.O. and Stickleback Outflows
  - Large Streams (wetted width > 30m): Patch, Doris and Little Roberts Outflows, and Ogama Inflow and Outflow
- Construct a Marine Cargo Dock or modify the existing Jetty in the intertidal and subtidal zones of the Roberts Bay Marine Environment

Our review considered the following information:

- Request for Review, submitted 16 January 2023 by email
- Appendix A1 - Locations of Anticipated Effects on Fish and Fish Habitat
- Appendix A2 - Summary of Anticipated Effects on Freshwater Fish and Fish Habitat
- Appendix A3 - Summary of Anticipated Effects on Marine Fish and Fish Habitat
- Appendix B1 – Summary of Road and Stream Crossings
- Appendix B2 – All-weather Road Design and Construction
- Appendix B3 – Marine Cargo Dock Access Road Design and Construction
- Appendix B4 – Tailings Impoundment Area Road Design and Construction
- Appendix C1 – Freshwater Intake Pipe Design
- Appendix C2 – Water Management Design
- Appendix C3 – Water and Load Balance Model
- Appendix D – Marine Cargo Dock Design and Construction
- Appendix E – Fish Communities of Lakes and Streams in the Project Area
- IR response Received February 21, 2023

Your proposal has been reviewed to determine whether it is likely to result in:

- the death of fish by means other than fishing and the harmful alteration, disruption or destruction of fish habitat which are prohibited under subsections 34.4(1) and 35(1) of the *Fisheries Act*; and
- effects to listed aquatic species at risk, any part of their critical habitat or the residences of their individuals in a manner which is prohibited under sections 32, 33 and subsection 58(1) of the *Species at Risk Act*.
- the introduction of aquatic species into regions or bodies of water frequented by fish where they are not indigenous, which is prohibited under section 10 of the *Aquatic Invasive Species Regulations*.

The aforementioned outcomes are prohibited unless authorized under their respective legislation and regulations.

Based on the review of the above information, the Program has concluded that the following work, undertaking or activity is likely to result in the death of fish by means other than fishing, and/or the harmful alteration, disruption or destruction of fish habitat:

- The Alteration of the surface flow and hydrological conditions to Imniagut Lake, Imniagut Outflow, P.O. and Stickleback Outflows, Patch, Doris and Little Roberts Outflows, and Ogama Inflow and Outflow from water withdrawal; and
- The construction of a new Marine Cargo Dock in the intertidal and subtidal zones of the Roberts Bay Marine Environment.

It is also our understanding that the following work is necessary in order to prevent the importation, possession, transportation or release of aquatic invasive species set out in Part 2 of the schedule of the *Aquatic Invasive Species Regulations*; and/or the introduction of aquatic species into regions or bodies of water frequented by fish where they are not indigenous:

- AIS monitoring program to evaluate changes to marine habitat and organisms and to monitor for non-native introductions resulting from Project-related construction and shipping in the marine environment.

Your proposal requires authorization pursuant to paragraphs 34.4(2)(b) and 35(2)(b) of the *Fisheries Act* in order to proceed. As your proposal is not likely to result in prohibited effects on listed aquatic species at risk, no permit will be required under the *Species at Risk Act.*

Please submit the following information and documents to apply for a *Fisheries Act* authorization:

- a completed Application Form for the Issuance of an Authorization under Paragraphs 34.4(2)(b) and 35(2)(b) of the *Fisheries Act* (Non-Emergency Situations) (http://www.dfo-mpo.gc.ca/pnw-ppe/reviews-revues/request-review-demande-d-examen-005-eng.html);
- the required information and documentation set out in the *Authorizations Concerning Fish and Fish Habitat Protection Regulations* (the Regulations) (http://www.gazette.gc.ca/rp-pr/p2/2019/2019-08-21/html/sor-dors286-eng.html); and
- an irrevocable letter of credit (for requirements see: http://www.dfo-mpo.gc.ca/pnw-ppe/reviews-revues/applicants-guide-candidats-eng.html#131) to cover the cost of offsetting plan, if you are not exempted from providing one as set out in subsection 2(2) of the Regulations.

Should you choose to relocate or redesign your proposal, this could reduce the potential impacts of your proposal to a level where the aforementioned prohibited effects to fish and fish habitat can be avoided and authorization under the *Fisheries Act* would no longer be required. If you choose to modify your proposal to avoid a need for authorization, please submit your revised Request for Review form.

Please note that information submitted to DFO will be shared with Indigenous peoples with whom DFO is consulting in relation to the Crown's Duty to Consult if it is determined that the decision to authorize or not your proposed work(s), undertaking(s) or activity(ies) may adversely affect Aboriginal or treaty rights.

As you are aware, Bill C-68 included new provisions (sections 42.2 to 42.5) in the *Fisheries Act* that require the Minister of Fisheries and Oceans to establish a public registry to facilitate public access to certain records, including amongst other items, authorizations issued pursuant to paragraphs 34.4(2)(b) and 35(2)(b) of the *Fisheries Act.* While the public registry provisions of the *Fisheries Act* are not yet in force, the

Department has begun to post a list of authorizations issued since August 28, 2019, when amendments to the fish and fish habitat protection provisions of the Act came into force.

If DFO issues such an authorization at the end of its review of your proposed works, undertakings or activities taking place in or near water, information pertaining to this authorization will be posted to the *Fisheries Act* Registry and accessible from the Department's website at https://www.dfo-mpo.gc.ca/pnw-ppe/registry-registre-eng.html as well as from the Open Government Portal at: https://open.canada.ca/data/en/dataset/2c09d2fd-9a8e-4d8c-b5af-95747e36eaac and the Common Project Search at https://common-project-search.canada.ca/. Information and data will be updated as the Department continues to develop the *Fisheries Act* Registry.

Any disclosure of information will be conducted in accordance with the *Access to Information Act* and the *Privacy Act*. Should you have any documents that contain sensitive or proprietary information that you believe should be protected from public disclosure, please contact us prior to providing them to DFO to discuss whether and how the information may be protected.

Please be advised that any unauthorized work, undertaking or activity that violates sections 34.4 and 35 of the *Fisheries Act*, sections 32, 33 and/or subsection 58(1) of the *Species at Risk Act* or sections 6, 7, 8, 9 and 10 of the *Aquatic Invasive Species Regulations* could lead to corrective action such as enforcement.

If you have any questions with the content of this letter, please contact Christopher Shapka at our Yellowknife office at (867) 445-1394, or by email at Christopher.Shapka@dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

José Audet-Lecouffe

José Audet-Lecouffe
Senior Biologist
Fish and Fish Habitat Protection Program
Fisheries and Oceans Canada

CC: Alasdair Beattie (Alasdair.Beatte@dfo-mpo.gc.ca), José Audet-Lecouffe (Jose.Audet-Lecouffe@dfo-mpo.gc.ca)

APPENDIX H
EOS BASELINE AND OFFSETTING REPORTS

[Double-click to import client logo]

TMAC Resources Inc.

The Hope Bay Project

2018 Fisheries Offsetting Summary Report

Date (08 February 2019)

Project No.: 0394395-0205

The business of sustainability

ERM

EXECUTIVE SUMMARY

The Hope Bay Project (the Project) is a gold mining development owned by TMAC Resources Inc. (TMAC) in the West Kitikmeot region of mainland Nunavut. The Madrid and Boston developments are part of the Hope Bay Project and TMAC is seeking to develop these areas jointly (as Madrid-Boston) having recently received a Project Certificate (No. 009) from the Nunavut Impact Review Board (NIRB) in November 2018 and amended Type A Water Licence (2AM-DOH1335) from the Nunavut Water Board (NWB) in December 2018.

Project activities for Madrid-Boston are predicted to impact freshwater and marine fish and fish habitat through changes in water quantity in lakes and streams (e.g., reduction in available fish habitat, change in flow timing and duration of open-water season) and from in-water infrastructure footprints (e.g., marine cargo dock). According to the Fisheries and Oceans Canada (DFO) Fisheries Protection Policy Statement, if a project is likely to cause serious harm to fish after the application of avoidance and mitigation measures, then the proponent must develop a Fisheries Offsetting Plan to undertake offsetting measures to counterbalance the unavoidable residual serious harm to fish (DFO 2013b). Based on anticipated fisheries losses and commitments made by TMAC, Fisheries Offsetting Plan(s) are to be developed in collaboration with DFO and relevant stakeholders including the Kitikmeot Inuit Association (KIA) and the Inuit Environmental Advisory Committee (IEAC).

TMAC initiated work towards a Fisheries Offsetting Plan as part of the Final Environmental Impact Statement (FEIS) for Madrid-Boston and continued this work in 2018. TMAC held a Fisheries Offsetting Workshop in Cambridge Bay, NU with participation by DFO and relevant stakeholders in June 2018. A reconnaissance field program at candidate offsetting sites was undertaken in July, August, and September 2018. Perspectives, priorities, and Traditional Knowledge (TK) expressed and provided by stakeholders that participated in the Fisheries Offsetting Workshop were incorporated into the design and implementation of the reconnaissance field program. Preliminary options for candidate offsetting sites for Madrid-Boston were identified and investigated using information from a variety of sources. These included desktop analyses using satellite imagery freely available online, high-level field scouting surveys on behalf of TMAC for potential offsetting options within the vicinity of the Hope Bay Project completed in 2016, engagement with researchers from DFO and academic institutions, and traditional and local knowledge holders who participated in a fisheries mapping exercise during the Fisheries Offsetting Workshop where sites that may benefit from offsetting or enhancement were identified.

Field reconnaissance surveys were conducted at eight candidate fisheries offsetting options in 2018, five sites in the Hope Bay Project area and three sites in the Cambridge Bay area. Each of the candidate offsetting sites visited in 2018 are lake-headed stream systems. The majority of the evaluated streams are directly connected to the marine environment, with one site located upstream of a large lake system that is connected to the marine environment by a relatively short outflow channel. Reconnaissance surveys included fish habitat assessments of outflow streams with a focus on migratory potential, visual surveys and targeted angling to collect information on the fish community, and manual discharge measurements to assess streamflow. In addition to candidate offsetting sites visited during field reconnaissance surveys in 2018, one conceptual offsetting option was described and evaluated. This option described the potential to construct rock shoals in the marine environment, in a location that is still to be determined.

Opportunities for offsetting projects were identified at six of the eight candidate fisheries offsetting options visited in 2018 and for the conceptual marine shoals option. Overall, each of these candidate offsetting options has the potential to meet the objectives outlined in DFO's Fisheries Productivity Investment Policy

(DFO 2013a) and to meet goals for offsetting expressed by stakeholders at the Fisheries Offsetting Workshop in June 2018. Each of these options provides good opportunities for incorporation of traditional knowledge (TK) and Inuit Qaujimajatugangit in decision making processes. Due to their proximity to the community, two sites in the Cambridge Bay area (i.e., Grenier Lake East Outflow and Aggiak Outflow) have greater potential to support local/regional fisheries management objectives related to education, stewardship, and capacity building, and to involve local youth and Elders. Three sites in the Hope Bay area (Tahiluyguak Outflow, Iqalulialuk Outflow, and the Omingmaktok Area Lake Outflow) provide opportunities to employ non-invasive, manual construction techniques which are preferred by TK holders, for the implementation of offsets.

Field reconnaissance surveys and initial evaluations completed in 2018 provide important information on the potential for the candidate offsetting options to meet the objectives for offsetting set out by DFO and Project stakeholders (ERM 2018). However, the potential fisheries productivity benefits from offsets at each candidate site have not yet been quantified. As defined in the Fisheries Productivity Investment Policy, the objective of offsetting is to counterbalance unavoidable serious harm to fish and the loss of fisheries productivity resulting from a project (DFO 2013a). Offset measures selected should support the goals of the Fisheries Protection Policy by supporting or enhancing the ongoing productivity of commercial, recreational, and Aboriginal fisheries. Therefore, a key criterion for selecting an offsetting option for the Project will be the quantification of the potential fisheries productivity benefits for candidate sites and determination of whether they are commensurate with potential Project-associated losses. Additional baseline information is required to carry out these analyses and it is recommended that a subset of candidate site(s) be selected for baseline studies in 2019.

The next step is to engage DFO and relevant stakeholders regarding the proposed candidate fisheries offsetting options included in this report and the proposed offsetting approach for each. Feedback will inform the selection of sites for further investigation in 2019, the design of baseline studies, as well as the planning and implementation of an offsetting project.

ACKNOWLEDGEMENTS

This report was prepared for TMAC Resources Inc. (TMAC) by ERM Consultants Canada Ltd. (ERM). The fieldwork was conducted by ERM scientists Kathryn Kuchapski (M.Sc., P.Biol.), Geneviève Morinville (Ph.D.), and Cameron Evans (B.A.Sc.). Fieldwork was completed with the support of TMAC field assistants Cedar Metatawabin and Willie Nakashook. Site selection and investigation was guided by Traditional Knowledge and logistical contributions made by participants of the Fisheries Offsetting Workshop for the Hope Bay Project held in Cambridge Bay, NU in June 2018 including Jason Akoluk, George Angohiatok, Mary Avalak, David Epilon, George Hakongak, Jimmy Haniliak, Clarence Kaiyogana, and Joseph Tikhak. Joseph Tikhak also contributed Traditional Knowledge and advice during on-site fieldwork activities through conversations with Kathryn Kuchapski on July 30, 2018. The report was written by Kathryn Kuchapski and was reviewed by Geneviève Morinville and Kerry Marchinko (Ph.D., R.P.Bio.). The program was managed by Nicole Bishop (B.Sc.) and Marc Wen (M.Sc., R.P.Bio.) was the Partner in Charge. Graphics production was coordinated by Jason Widdes, Geographical Information System (GIS) production was coordinated by Pieter van Leuzen (M.Sc.), and report publishing was coordinated by Agnes Untz (B.A.).

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ACRONYMS AND ABBREVIATIONS

ATV	All-terrain Vehicle
DFO	Fisheries and Oceans Canada
ERM	ERM Consultants Canada Ltd.
FEIS	Final Environmental Impact Statement
FHAP	Fisheries Habitat Assessment Protocol
GIS	Geographical Information System
GN	Government of Nunavut
HEP	Habitat Evaluation Procedure
HTO	Hunters and Trappers Organization
HU	Habitat Unit
IEAC	Inuit Environmental Advisory Committee
IFMP	Integrated Fisheries Management Plan
IQ	Inuit Qaujimajatugangit
KIA	Kitikmeot Inuit Association
NIRB	Nunavut Impact Review Board
NTKP Report	*Inuit Traditional Knowledge for TMAC Resources Inc., Hope Bay Project, Naonaiyaotit Traditional Knowledge Project (NTKP) Report* (Banci and Spicker 2016)
NU	Nunavut
The Project	The Hope Bay Project
TK	Traditional Knowledge
TMAC	TMAC Resources Inc.

1. BACKGROUND

The Hope Bay Project (the Project) is a gold mining development owned by TMAC Resources Inc. (TMAC) in the West Kitikmeot region of mainland Nunavut. The Project property is approximately 153 km southwest of Cambridge Bay on the southern shore of Melville Sound and contains a greenstone belt (the Belt) that runs 80 km in a north-south direction varying in width between 7 km and 20 km.

The Project area has been actively explored and developed since the late 1980s and consists of three developments: Doris, Madrid, and Boston (Figure 1-1). Doris is the northernmost development situated near Roberts Bay and contains the operating Doris Mine. The Madrid and Boston developments are in the north-central and southernmost parts of the Belt, respectively. TMAC is seeking to develop these areas jointly (as Madrid-Boston) having recently received a Project Certificate (No. 009) from the Nunavut Impact Review Board (NIRB) in November 2018 and amended Type A Water Licence (2AM-DOH1335) from the Nunavut Water Board (NWB) in December 2018.

Project activities for Madrid-Boston are predicted to impact freshwater and marine fish and fish habitat through changes in water quantity in lakes and streams (e.g., reduction in available fish habitat, change in flow timing and duration of open-water season) and from in-water infrastructure footprints (e.g., marine cargo dock). According to the Fisheries and Oceans Canada (DFO) Fisheries Protection Policy Statement, if a project is likely to cause serious harm to fish after the application of avoidance and mitigation measures, then the proponent must develop a Fisheries Offsetting Plan to undertake offsetting measures to counterbalance the unavoidable residual serious harm to fish (DFO 2013b).

Included in the Madrid-Boston Project Certificate are commitments that were confirmed by parties at the Madrid-Boston (i.e., Phase 2) Hope Bay Belt Project Final Hearing. These include commitments made by TMAC associated with freshwater and marine fisheries offsetting which are summarized in Table 1-1. Based on anticipated fisheries losses and commitments made by TMAC, Fisheries Offsetting Plan(s) are to be developed in collaboration with DFO and relevant stakeholders including the Kitikmeot Inuit Association (KIA) and the Inuit Environmental Advisory Committee (IEAC).

In the Final Environmental Impact Statement (FEIS) for Madrid-Boston (TMAC 2017), TMAC's approach to offsetting freshwater and marine fisheries losses was presented (Appendices V5-6AA and V5-10G). This approach outlined TMAC's intent to pursue offsetting, as deemed necessary by DFO, that satisfies requirements of the Fisheries Protection Policy Statement (DFO 2013b) and federal *Fisheries Act* (1985) through the following steps:

1. Assessment of fish habitat availability and quality in potentially impacted waterbodies (lakes, streams, and marine environment);
2. Assessment of fish populations and their abundance in potentially impacted waterbodies (lakes, streams, and marine environment);
3. Assessment of the amount of fish habitat (in m^2) to be lost/altered in freshwater and marine environments and application of a Habitat Evaluation Procedure (HEP) to assign quality as well as quantity to lost/altered habitat;
4. Identification of offsetting options in line with DFO guidance on offsetting and in collaboration with DFO and relevant stakeholders;
5. Development of Fisheries Offsetting Plan(s) in collaboration with DFO and relevant stakeholders; and
6. Implementation and monitoring of offsets.

This approach was initiated as part of the effects assessment in the FEIS (TMAC 2017). Assessments of fish habitat availability and quality, and of fish populations and their abundance in potentially impacted waterbodies, were summarized using results of Project baseline studies. The amount of freshwater and marine fish habitat (in m^2) that may potentially be lost/altered through changes in water quantity and through the construction of Madrid-Boston infrastructure was also calculated and presented. Finally, the application of a HEP to marine fish habitat losses was initiated.

In 2018, following submission of the FEIS, TMAC has continued development and application of a HEP to marine and freshwater fish habitat losses, held a Fisheries Offsetting Workshop with participation by DFO and relevant stakeholders, and undertaken a reconnaissance field program at candidate offsetting sites. Perspectives, priorities, and Traditional Knowledge (TK) expressed and provided by stakeholders that participated in the Fisheries Offsetting Workshop in June 2018 were incorporated into the design and implementation of the reconnaissance field program in July, August, and September 2018.

This report continues to build on TMAC's efforts towards the development of a Fisheries Offsetting Plan for Madrid-Boston by describing and evaluating candidate options for fisheries offsetting. The regulatory framework for fisheries offsetting is outlined and candidate offsetting options are described. Description of candidate offsetting options includes site selection, methods and results of 2018 field reconnaissance surveys, assessment of the potential and feasibility of each option, and recommendations for next steps. Each candidate offsetting site has been considered with respect to its potential to feasibly and adequately offset the anticipated fisheries losses associated with Madrid-Boston, to meet regulatory requirements for implementation and monitoring, to meet fisheries objectives expressed by DFO and relevant stakeholders, and to satisfy TMAC's commitments in the Madrid-Boston Project Certificate.

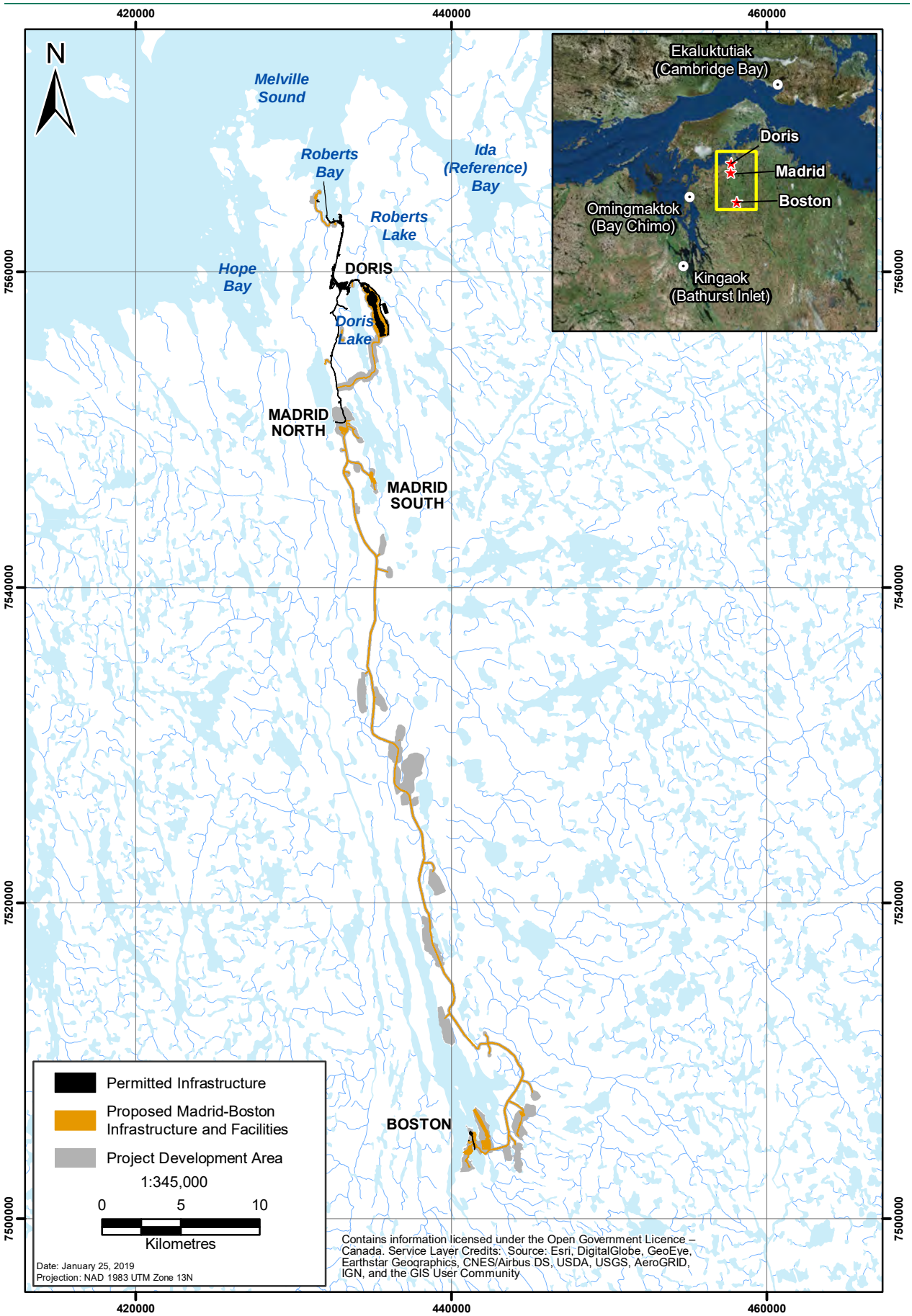


Figure 1-1: Hope Bay Project Location

Table 1-1: Fisheries Commitments from the Phase 2 Hope Bay Belt Project Final Hearing

Number	Subject	Header
10 and 11	Fisheries Offsetting (Freshwater)	■ TMAC will work with DFO, the KIA, and IEAC to identify candidate offsetting options with a preference for developing a community-based offsetting program located near Cambridge Bay. ■ TMAC will undertake field surveys in summer 2018 to ground-truth preliminary offsetting site options, and refine objectives, constraints, and opportunities associated with each site. These activities will contribute to preliminary gain calculations in support of the development of a Fisheries Offsetting Plan.
20	Fisheries Offsetting (Marine)	■ TMAC will work with DFO, the KIA, and IEAC to develop and finalize a marine offsetting plan which is acceptable to all parties, and complies with the Fisheries Protection Policy Statement and the Fisheries Productivity Policy: A Proponent's Guide to Offsetting. ■ Representative fish species of each trophic level and their habitat utilization will be analyzed using Habitat Unit Equivalence methods to ensure that all potential residual serious harm to fish and fish habitat that are part of or support commercial, recreational or Aboriginal fisheries as a result of the project are accounted for and adequately offset.

DFO = Fisheries and Oceans Canada; KIA = Kitikmeot Inuit Association; IEAC = Inuit Environmental Advisory Committee

2. REGULATORY AND POLICY FRAMEWORK

2.1 Fisheries Act and Species at Risk Act

2.1.1 Fisheries Act

Fish and fish habitat are protected under the federal the *Fisheries Act* (1985). The *Fisheries Act* prohibits "serious harm to fish" that are part of a commercial, recreational, or Aboriginal fishery, or to fish that support such a fishery. "Serious harm" is defined as the killing of fish by means other than fishing, and includes permanent alteration of fish habitat and destruction of fish habitat.

Under Section 35(2) of the Fisheries Act (1985), any project or activity that causes serious harm to fish may require an Authorization. Prior to issuing an Authorization, the Minister must consider four factors listed in Section 6 of the Act:

- the contribution of the relevant fish to the ongoing productivity of commercial, recreational, or Aboriginal fisheries;
- fisheries management objectives;
- whether there are measures or standards to avoid, mitigate, or offset serious harm to fish; and
- the public interest.

Serious harm to fish as the result of habitat degradation or loss and/or flow alteration (DFO 2013b) should be avoided or mitigated where possible. If serious harm to fish or fish habitat cannot be avoided or mitigated, any residual impact should be addressed by offsetting. Offset measures are those that are taken to replace or enhance fisheries productivity to compensate for unavoidable impacts with the goal of maintaining the productivity of commercial, recreational, or Aboriginal fisheries.

2.1.2 Species at Risk Act

The federal *Species at Risk Act* (SARA; 2002) is intended to prevent Canadian indigenous species, subspecies, and distinct populations from becoming extirpated or extinct. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses and identifies species at risk. COSEWIC is designated under SARA to assess species according to their level of conservation concern: *extinct*, *extirpated*, *endangered*, *threatened*, *special concern*, *not at risk* or *data deficient*. Only those wildlife species that have been designated by COSEWIC and are subsequently listed in Schedule 1, may qualify for legal protection and recovery under SARA. The Act prohibits the killing, harming, harassing, capturing or taking of an individual of a wildlife species that is listed in Schedule 1 as *extirpated*, *endangered* or *threatened* by SARA (section 32(1)). SARA also protects the residence of species listed as *extirpated*, *endangered* or *threatened* from being damaged and destroyed as specified in Section 33. A Species at Risk Public Registry (Government of Canada 2019) is available online and includes an up to date List of Wildlife Species at Risk (i.e., Schedule 1 species), and status reports produced by COSEWIC.

No fish species listed under SARA Schedule 1 have been captured in freshwater or marine habitats in baseline studies at the Hope Bay Project. A single Bering Wolffish (*Anarhichas orientalis*) individual was captured in the marine environment in 2017. COSEWIC assessed the Bering Wolffish as “data deficient” in 2002 and this species is listed under SARA Schedule 3, Special Concern, and thus does not qualify for legal protection and recovery under SARA. Therefore, there are no potential effects on SARA-listed species anticipated as a result of the Project.

2.2 Fisheries Protection Policy

The Fisheries Protection Policy (DFO 2013b) supports DFO and other departments when administering the fisheries protection provisions of the *Fisheries Act*. The Fisheries Protection Policy focuses on the management of impacts to fish resulting from habitat degradation or loss and from alterations to fish passage and flow. Through development of a Fisheries Offsetting Plan, TMAC aims to meet the goals and objectives of the Fisheries Protection Policy, which are to provide for the sustainability and ongoing productivity of commercial, recreational, and Aboriginal fisheries, and to comply with the fisheries protection provisions of the *Fisheries Act*.

2.3 Fisheries Productivity Investment Policy

The Fisheries Productivity Investment Policy: A Proponent’s Guide to Offsetting (DFO 2013a) provides guidance on undertaking effective measures to offset serious harm to fish that are part of, or, that support a commercial, recreational, or Aboriginal fishery. The policy provides an overview of applying offsetting measures for fisheries protection, including objectives, guiding principles, and types of measures for offsetting.

2.3.1 Objectives

As defined in the Fisheries Productivity Investment Policy, the objective of offsetting is “to counterbalance unavoidable serious harm to fish and the loss of fisheries productivity resulting from a project” (DFO 2013a). Offset measures selected should support the goals of the Fisheries Protection Policy by supporting or enhancing the ongoing productivity of commercial, recreational, and Aboriginal fisheries.

2.3.2 Guiding Principles

The Fisheries Productivity Investment Policy (DFO 2013a) describes four guiding principles for the consideration of fisheries offsetting projects:

1. Offsetting measures must support fisheries management objectives or local restoration priorities.

2. Benefits from offsetting measures must balance project impacts.
3. Offsetting measures must provide additional benefits to the fishery.
4. Offsetting measures must generate self-sustaining benefits over the long term.

2.3.3 Types of Offsetting Measures

Offsetting may be accomplished through a variety of methods, which include the following, ranked in order of DFO preference:

- habitat restoration or enhancement;
- habitat creation;
- chemical or biological manipulations; and
- complementary measures such as funding scientific research.

Habitat enhancement and creation are generally preferred over chemical and biological manipulations and complementary measures; however, the latter may be considered when enhancement or creation opportunities are particularly rare across a landscape. In situations where offsets are realized away from a project site, a robust rationale is required and should be communicated to potentially affected parties.

There is flexibility in the selection of offsetting measures provided they are focused on improving fisheries productivity. Offsets are most likely to balance losses when they benefit the specific fish populations and areas that are affected by a development site. When determining the location for offsetting, offsets that occur within the vicinity of the site or within the same watershed for the same fish species are preferable; these are referred to as ‘in-kind’ offsets. Offsetting measures can also be undertaken in water bodies or for fish species other than those affected by the site (“out-of-kind” offsets), provided the measures are supported by clear fisheries management objectives or regional restoration priorities.

To reduce the amount of time between an impact occurring and the offset being effective at replacing lost productivity, the construction and establishment of the offset project(s) should be scheduled to occur prior to any effects of the Project on fish and fish habitat. By timing offset activities early, overall impacts to fisheries productivity are reduced.

3. IDENTIFICATION OF CANDIDATE FISHERIES OFFSETTING SITES

3.1 Sources for Identifying Candidate Fisheries Offsetting Sites

Preliminary options for candidate offsetting sites for Madrid-Boston were identified and investigated using information from a variety of sources. Firstly, desktop analyses were undertaken using Google Earth and other satellite imagery freely available online to identify and investigate potential offsetting locations. In 2016, ERM undertook high-level field scouting surveys on behalf of TMAC for potential offsetting options within the vicinity of the Hope Bay Project. Sites identified during these surveys were considered in 2018. TMAC and ERM engaged with researchers from DFO and academic institutions who provided information on current research, local knowledge of sites with enhancement potential, and fisheries management objectives. Finally, TMAC held a Fisheries Offsetting Workshop in June 2018 during which traditional and local knowledge holders participated in a fisheries mapping exercise where sites that may benefit from offsetting or enhancement were identified.

3.2 Incorporation of Traditional and Local Knowledge

Traditional Knowledge information was gathered by the Kitikmeot Inuit Association (KIA) in a report titled *Inuit Traditional Knowledge for TMAC Resources Inc., Hope Bay Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (Banci and Spicker 2016). This report (i.e., the NTKP report) provides recorded and georeferenced TK pertaining to the Hope Bay Project by means of interviews conducted between 1997 and 2000, regional and site-specific studies, the *Inuit Land Use Occupancy Study*, focused workshops in Kugluktuk and Cambridge Bay in 2013, and studies of anadromous Lake Trout from Roberts Lake by Dr. Heidi Swanson of the University of Waterloo. The NTKP report was reviewed for information on fish and fish habitat and contributed to the preliminary selection of candidate offsetting sites.

Building on information in the NTKP report that was collected at the regional-level for the Hope Bay Project, (Banci and Spicker 2016), a Fisheries Offsetting Workshop was held in Cambridge Bay, NU from June 26 to 27, 2018. Participants included knowledge holders, KIA participants, a DFO observer, an interpreter, ERM facilitators and an ERM fisheries biologist (ERM 2018; Appendix A). The selection of participants began with members of the IEAC and additional knowledge holders were then selected to be representative of the land users from Omingmaktok, Kingaok, and Cambridge Bay. These participants are or have been active land users near the Project and are recognized within the community as having considerable knowledge of the Project area.

The workshop incorporated presentations and group discussions, group work, and daily summaries of results. The objectives of the workshop and the activities undertaken to meet these objectives included:

- Share information on Hope Bay fish studies: TMAC presented a summary of the various fisheries studies (baseline, impact assessment, and compliance monitoring) completed to date at Hope Bay for both freshwater and marine environments. A summary of predicted impacts associated with the Madrid-Boston Project and their relevance to fisheries offsetting were also described.
- Develop a shared understanding of what fisheries offsetting is and why it may be required: An overview of fisheries offsetting was presented centered on defining fisheries offsetting and why it may be needed. A description of the regulatory framework and the steps towards the development of a Fisheries Offsetting Plan was also discussed.
- Understand participants' views on offsetting goals and constraints: To obtain input on desired goals/objectives for fisheries offsetting, workshop exercises were conducted where participants were asked what goals they had and what constraints they saw for fisheries offsetting in both freshwater and marine environments for the Hope Bay Project. They were also asked if there were any specific objectives they would like to see achieved through fisheries offsetting at Hope Bay. Participants were initially divided into groups to answer the focus questions for the marine and freshwater environments. Following the break-out group discussions, everyone discussed their responses together.
- Share and get feedback on examples of fisheries offsetting programs: Participants were asked to provide feedback on three examples of completed fisheries offsetting projects at Hope Bay and elsewhere. These included the Roberts Lake Outflow Fisheries Offset Project (freshwater; i.e., construction of migration channels; Hope Bay Project; ERM 2016), the Roberts Bay Jetty Fisheries Offset Project (marine; i.e., construction of rock shoals; Hope Bay Project; Rescan 2010b), and the Nulahugyuk Creek Fisheries Offset Project (freshwater; i.e., construction of "low-flow channels" or rock weirs; Back River Project; Golder Associates Ltd. 2013).
- A fisheries mapping exercise: A fisheries mapping exercise was completed with workshop participants using freely available Google Earth satellite imagery projected onto a screen. Participants were asked to identify known areas where fish passage may be impeded, locations where fish habitat

degradation has been observed, or locations where fish habitat may require improvement. They were also asked to share any other fisheries-related information they felt was relevant to the discussion.

Throughout the workshop comments, discussion, and feedback from participants were recorded. Complete results of the workshop are presented in Appendix A (ERM 2018). Key topics emphasized by participants and participants' views on fisheries offsetting goals and constraints are summarized as follows.

One key concern expressed throughout the workshop was the number of streams for which decreasing water levels have been observed over time in the Arctic and the impact that decreasing water levels may have on fish passage. There was consensus that more fish successfully returning to spawn and overwinter in lakes would provide benefits to local fish populations by improving fisheries productivity. Keeping fish passages clear was identified as a goal for fisheries offsetting. A preference for the use of manual techniques during implementation of habitat enhancement activities was also highlighted (i.e., habitat modification by hand rather than blasting or use of equipment). Manual techniques have historically been undertaken by local Inuit to facilitate fish passage, as noted by one workshop participant.

Another key message expressed by workshop participants was the importance of youth and Elder involvement during decision-making processes associated with the selection of an offsetting project. The selection of appropriate sites ("to provide equal habitat offset"), and the incorporation of Inuit Qaujimajatugangit (IQ) and TK during habitat enhancement planning and design was emphasized. Other considerations discussed included the need to create long-term local engagement, capacity building, and training opportunities, the need to educate locals on good fishing practices, and the need for ongoing funding for long-term monitoring of an offsetting program.

Results of the fisheries mapping exercise contributed to the creation of a preliminary list of candidate offsetting sites. Participants' views on fisheries offsetting goals and constraints, as well as their feedback on example offsetting projects that have been undertaken at Hope Bay and at other locations in Nunavut contributed to consideration and selection of candidate fisheries offsetting sites for further investigation in 2018.

3.3 Local and Regional Fisheries Management Objectives

3.3.1 DFO Integrated Fisheries Management Plan

DFO uses integrated fisheries management plans (IFMP) to guide the conservation and sustainable use of marine resources. These plans support the management of sustainable fisheries and combine science and TK on fish species with industry data to determine best practices for fish harvest. The only IFMP for a fishery in the area of the Hope Bay Project, is for the Cambridge Bay Arctic Char commercial fishery (DFO 2019). The IFMP for the Cambridge Bay Arctic Char Commercial Fishery, Nunavut Settlement Area (DFO 2014) identifies the main objectives and requirements for the Cambridge Bay Arctic Char commercial fishery, as well as the management measures planned to achieve these objectives.

There are five key commercial waterbodies on Victoria Island, NU that comprise the current Cambridge Bay Arctic Char fishery. Three of these rivers are located west of Cambridge Bay and terminate in Wellington Bay including, Ekalluktok River (Wellington River), Halokvik River (Thirty-Mile River), and Paliryuak River (Surrey River). The Palik River (Lauchlan River) is located further west and terminates in the Dease Strait, west of Wellington Bay. The Jayco River is located northeast of Cambridge Bay and terminates in Albert Edward Bay on the eastern side of the Victoria Strait.

The co-management organizations of the Cambridge Bay Arctic Char commercial fishery include the Nunavut Wildlife Management Board, Ekaluktutuiak Hunters and Trappers Organization (HTO), and DFO. Management issues for the fishery identified in the IFMP include the need for updated stock abundance

estimates to support management decisions, timely and consistent harvest reporting, and ensuring the long-term viability of the commercial fishery. The IFMP outlines long-term objectives for the fishery to address these management issues which are categorized as stock conservation, ecosystem, shared stewardship, social, cultural and economic, and compliance objectives. These long-term objectives are supported by short-term objectives. Several of the short-term objectives identified in the IFMP have the potential to be supported by a Fisheries Offsetting Plan for the Project as described in Table 3.3-1. The objectives of the Cambridge Bay Arctic Char Commercial Fisheries IFMP and the potential for an offsetting program to support them were considered in the selection of candidate offsetting sites.

Table 3.3-1 Potential to Support Objectives of the Cambridge Bay Arctic Char Commercial Fishery Integrated Fisheries Management Plan through Fisheries Offsetting

IFMP Objectives[1]			Potential Support through Fisheries Offsetting
Category	Long-term Objective	Short-term Objective	
Stock Conservation	Conserve Arctic Char stocks through sustainable use and effective fishery management	Improve knowledge of Arctic Char biology and stock discrimination	Data collected in baseline and monitoring programs could contribute to knowledge of Arctic Char biology in the region.
Shared Stewardship	Promote collaboration, participatory decision making, and shared responsibility with resource users, co-management organizations, and other stakeholders.	Secure funding for monitoring programs for commercial, recreational, and food fisheries.	Long-term monitoring datasets may be produced as a result of baseline and monitoring programs.
		Transition commercial monitoring program to fisher-based monitoring and reporting of total removals.	Involvement of local youth and Elders in baseline and monitoring programs could build capacity through experience with data collection and reporting techniques.
Social, Cultural, and Economic	Promote an economically viable and self-sufficient fishery based on high quality that maximizes social and economic benefits, while ensuring stocks remain healthy and abundant for future generations.	Maintain and conserve local and traditional fishing activities.	Fisheries offsetting measures could be targeted to improve fisheries productivity at local and/or traditional fishing locations.
Compliance	Promote compliance with legislation, regulations, and management measures to achieve conservation and sustainable use.	Promote compliance through education and shared stewardship.	Involvement of local youth and Elders in offsetting planning, implementation, and monitoring could provide opportunities for education and technical capacity building.

IFMP = Integrated fisheries management plan

[1]DFO (2014)

3.3.2 Local Fisheries Management Priorities

During the Fisheries Offsetting Workshop in June 2018 local fisheries management priorities were identified in the context of the participants' views on fisheries offsetting goals and constraints for the Hope Bay Project. These local priorities and the potential for a fisheries offsetting program to support them are summarized inTable 3.3-2. Some of the local fisheries management priorities described at the workshop were associated with the effects of discharge (i.e., from mines) on the food chain, impacts from marine traffic, and fisheries regulations (i.e., monitoring and enforcement). These topics are related to legislation that is outside the scope of fisheries offsetting under the Fisheries Act and were not considered in Table 3.3-2. However, complete results of workshop exercises on these topics are provided in Appendix A (Sections 3.1.4 and 3.1.7; ERM 2018). Local fisheries management priorities and the potential for an offsetting program to support them were considered in the selection of candidate offsetting sites.

Table 3.3-2 Potential to Support Local Fisheries Management Priorities through Fisheries Offsetting

Local Priorities[1]			Potential Support through Fisheries Offsetting
Topic	Objectives	Constraints	
Protect Habitat	■ Promote youth and Elder camps to protect fish habitat and for environmental protection	■ Funding	Involvement of local youth and Elders in offsetting planning, implementation, and monitoring could provide opportunities for input on habitat and environmental protection.
Keep fish passages clear/better infrastructure for fish passage	■ For spring and fall migration of char ■ Monitor land erosion impacts from weather ■ Remove culverts and put in more natural bridges ■ Keep and improve local fish populations	■ Overflow: high rain or snow ■ Funding ■ Manpower, contractor	Selection of offsetting measures where the objective for increasing fisheries productivity is through enhancement or restoration of migratory habitats.
Improve access for fishing	■ Repair access to community fishing locations ■ Easier access for Elders in the fall		Fisheries offsetting measures could be targeted to improve fisheries productivity at local and/or traditional fishing locations.
Higher food chain impacts	■ Increase spawning fish to create healthy fish and waterfowl populations	■ People resources ■ Training ■ Planning ■ Gear and equipment	Consider potential higher food chain effects of increases in fisheries productivity resulting from offsetting measures.
Provide education of fishing	■ Education on good fish netting practices to improve local knowledge	■ Language barrier ■ Ignorance [of community members] ■ Resources (HTOs, schools)	Involvement of local youth and Elders in offsetting planning, implementation, and monitoring could provide opportunities for education and technical capacity building.

Provide equal habitat offset	■ When fish habitat is damaged, new habitat is created equally ■ Keep balance on local habitat loss	■ Identifying the area ■ Funding ■ Leadership/ coordination ■ Access	Follow guiding principles of the Fisheries Protection Investment Policy[2].

HTO = Hunters and Trappers Organization

[1]ERM (2018); [2]DFO (2013a)

3.4 Candidate Fisheries Offsetting Options

A total of eight candidate fisheries offsetting options were identified for further investigation, including field reconnaissance surveys undertaken during the 2018 open-water season. Candidate options were all located within approximately 150 km of the Project (Figure 3.4-1), in one of two general areas: Hope Bay Project Vicinity (mainland Nunavut, five sites) and Cambridge Bay Vicinity (Victoria Island; three sites). Each of the candidate offsetting sites visited in 2018 are lake-headed stream systems. The majority of the evaluated streams are directly connected to the marine environment, with one site (Aggiak Outflow) located upstream of a large lake system (Ferguson Lake) that is connected to the marine environment by a relatively short outflow channel. Site names, locations, and identifying sources are listed in Table 3.4-1.

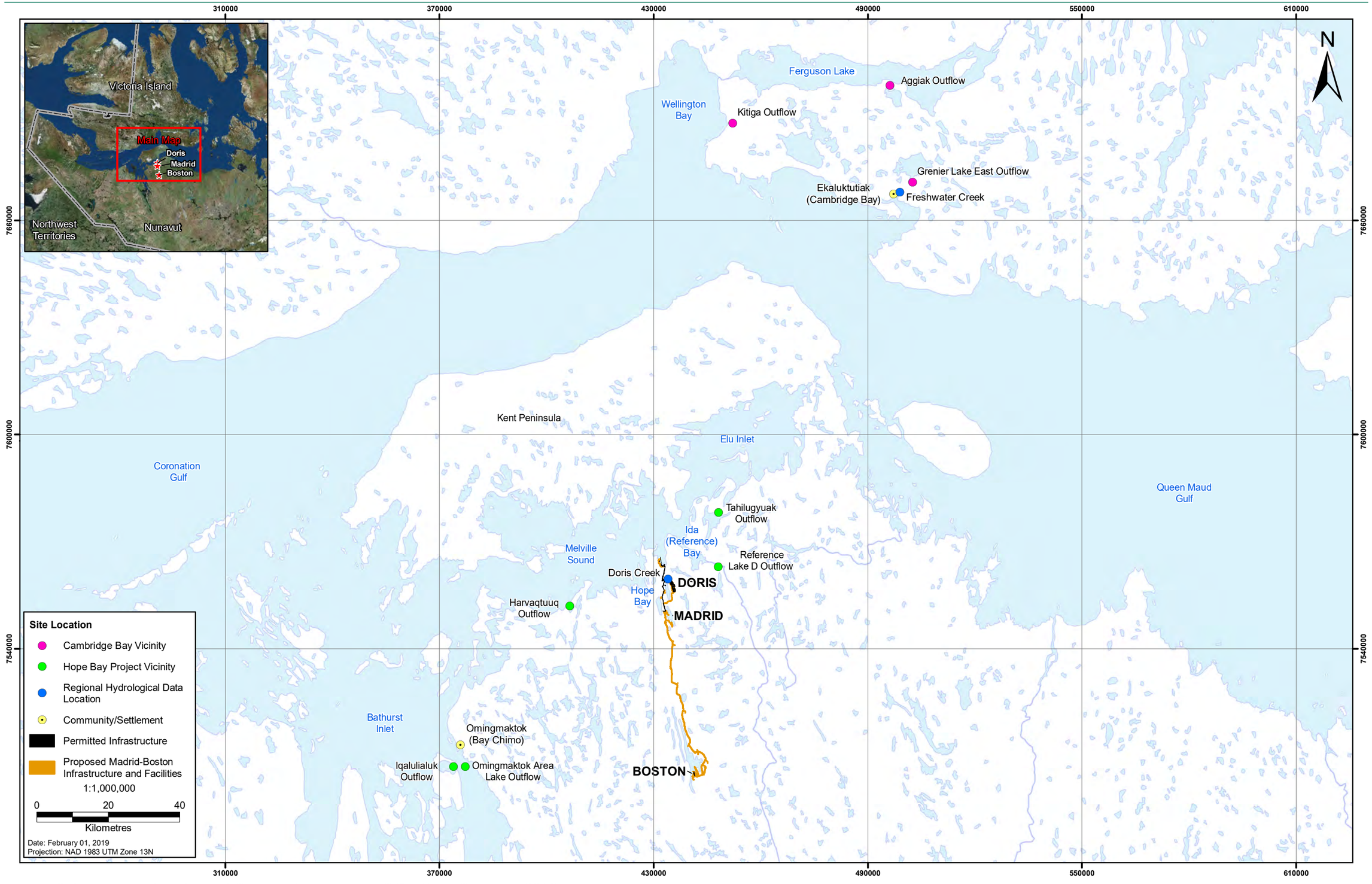


Figure 3.4-1: Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Table 3.4-1: Hope Bay Project Candidate Fisheries Offsetting Options

Area	Site	UTM			Source
		Zone	Northing	Easting	
Hope Bay Project	Tahilugyuak Outflow	13	7578127	448163	2016 Scouting Survey
	Harvaqtuuq Outflow	13	7551602	406519	Fisheries Offsetting Workshop Participants
	Reference Lake D Outflow	13	7562741	448077	2016 Scouting Survey
	Iqalulialuk Outflow	13	7506965	374003	Fisheries Offsetting Workshop Participants
	Omingmaktok Area Lake Outflow	13	7506692	382270	Fisheries Offsetting Workshop Participants
Cambridge Bay	Grenier Lake East Outflow	13	7672587	503787	Fisheries Offsetting Workshop Participants
	Kitiga Outflow	13	7684209	464405	Academic Researchers[1]
	Aggiak Outflow	13	7697347	496611	DFO[2] and Academic Researchers[3]

[1]J.-S. Moore (Laval University, Quebec City; personal communication, May 2018); [2]L. Harris (Fisheries and Oceans Canada, Winnipeg; personal communication, July 2018); [3]M. Gilbert (University of British Columbia, Vancouver; personal communication, July 31, 2018)

4. FIELD RECONNAISSANCE SURVEY METHODS

The methods used during field reconnaissance visits in July, August, and September 2018 varied according to available background information, site access, stream characteristics, and stream conditions on the survey date. Hope Bay Project Vicinity sites were accessed by helicopter from the Doris Mine site, whereas Cambridge Bay Vicinity sites were accessed by all-terrain vehicle (ATV) from Cambridge Bay.

Fish habitat was assessed and described through incorporation of traditional and local knowledge, aerial surveys, detailed fish habitat surveys (Fisheries Habitat Assessment Protocol; FHAP; N. T. Johnston and Slaney 1996), and surveys of migratory potential. Fish communities were described through traditional and local knowledge, available background information (e.g., Hope Bay Project baseline reports), visual observations, and targeted angling. Streamflow conditions were assessed using manual discharge measurements and comparisons were made with streams located near the candidate options for which annual hydrographs were available. Table 4.2-1 summarizes reconnaissance methods applied at each candidate offsetting site.

Table 4.2-1: Fisheries Offsetting Field Reconnaissance Methods, 2018

Area	Site	Fish Habitat				Fish Community			Streamflow
		TK	Aerial	FHAP	Migratory Potential	TK	Visual	Angling	Manual Discharge
Hope Bay Project	Tahilugyuak Outflow	X	July, Sept	July, Sept	July, Sept	X	July, Sept	Sept	July, Sept
	Reference Lake D Outflow		July	July	July		July		July
	Harvaqtuuq Outflow	X	July, Sept	July, Sept	July, Sept	X	July, Sept	Sept	Sept
	Iqalulialuk Outflow	X	July	July	July	X	July		July
	Omingmaktok Area Lake Outflow	X	July		July	X	July		July
Cambridge Bay	Grenier Lake East Outflow	X			Aug, Sept	X	Aug	Aug	Aug
	Kitiga Outflow	X			Aug	X	Aug		
	Aggiak Outflow	X			Aug, Sept	X	Aug		Aug

Notes:

TK = Traditional and Local Knowledge and includes descriptions of Fish Habitat (i.e., site characteristics) and/or Fish Community (i.e., fish species presence and fishing effort by local land users) provided by traditional and local knowledge holders or NKTP report;
FHAP = Fish Habitat Assessment Protocol according to N. T. Johnston and Slaney (1996);
Migratory Potential = visual survey identifying and describing locations where fish passage may be compromised;
Survey Dates = July: July 26 – 31, 2018; Aug: August 1 – 3, 2018; Sept: September 20 – 28, 2018

Traditional and Local Knowledge

The NTKP report (Banci and Spicker 2016), was reviewed for existing information on fish and fish habitat at the candidate fisheries offsetting sites. This information was incorporated into descriptions of each candidate offsetting option with respect to fish habitat, fish community, or other information such as use for fishing by local land users.

During the fisheries mapping exercise at the Fisheries Offsetting Workshop, information on fish habitat quality and fish community composition at candidate offsetting options was provided by participating knowledge holders (ERM 2018; Appendix A). During the period in July 2018 when reconnaissance surveys were conducted at Hope Bay Project Vicinity options, additional information was recorded through discussions on July 30, 2018 between ERM scientists and a traditional knowledge holder, Joseph Tikkak, employed by TMAC at the Doris Mine site. Finally, during both August and September surveys conducted at Cambridge Bay Vicinity options, ERM scientists were accompanied by a local guide, Willie Nakashook, employed by TMAC, who provided local and traditional knowledge of the sites visited. Information provided by knowledge holders was incorporated into the field assessment approach and results for each candidate option.

Fish Habitat

For sites that were accessed by helicopter, an aerial survey was conducted and aerial photos were taken along the entire length of the stream. The quantity and quality of habitat in each stream was assessed, particularly at locations where fish passage may be compromised. Where feasible based on stream size, access, and conditions on the survey date, habitats along the entire length of the stream of interest were surveyed using FHAP methods (N. T. Johnston and Slaney 1996). Habitats units were classified as:

- Cascade: high-energy, steep (gradient > 4%) sections of stream typically dominated by bedrock, boulders, and cobbles;
- Riffle: less steep than cascades, but still with turbulent, fast-flowing water. Riffles are usually shallow in water depth with gravel or cobble substrates that project above the water surface, causing surface turbulence;
- Glide: sections of stream with flowing, non-turbulent water. Glides have relatively flat bottoms in cross-section;
- Pool: relatively deep, slow flowing sections of stream with a concave longitudinal streambed profile and a surface gradient near 0%; and
- Boulder Garden: large boulders, usually only partially submerged, distributed through the stream channel.

In FHAP surveys, individual habitat units were measured for length, width (channel), depth (wetted), gradient, substrate composition (% abundance of bedrock, boulders, cobble, gravel, and fines), bank texture and stability, and riparian and instream cover. The boundaries of each habitat unit were marked using a handheld GPS unit and representative photographs were taken. Barriers or seasonal restrictions to fish migration were noted and measured, where present. Habitat suitability for spawning, rearing, migration, and overwintering was classified according to the rankings in Table 4.1-1.

Table 4.1-1. Criteria for Ranking Overall Fish Habitat Quality

	Habitat Quality Ranking Criteria			
	Good	Fair	Poor	None
Spawning	The presence of high-value spawning habitat (e.g., locations with an abundance of suitably sized spawning substrates for the fish species present).	The presence of suitable spawning habitat (e.g., locations with some suitably sized spawning substrates for the fish species present).	The presence of suitable spawning habitat but where another factor may limit spawning potential (e.g., access to suitably sized spawning substrates is limited by flow conditions).	The absence of suitable spawning habitat (e.g., little or no suitably sized spawning substrates for the fish species present).
Rearing	The presence of high-value rearing habitat (e.g., an abundance of rearing cover such as deep pools, undercut banks, or stable debris).	The presence of suitable rearing habitat (e.g., some locations that provide rearing cover such as deep pools, undercut banks, or stable debris).	The presence of suitable rearing habitat but where another factor may limit rearing potential (e.g., suitable flow conditions but limited cover).	The absence of suitable rearing habitat (e.g., water depth or flow conditions not suitable for rearing).
Migration	Stream conditions (e.g., depth, velocity, water quality, presence of barriers, etc.) allow for unimpeded fish passage on the survey date.	Stream conditions are generally suitable for fish passage on the survey date (e.g., some impediments but no barriers; successful passage by the majority of fish).	Stream conditions are generally unsuitable for fish passage on the survey date (e.g., inadequate depth or flow; impediments or barriers that would prevent passage for the majority of fish).	The absence of suitable migration habitat on the survey date (e.g., no defined channel, dry channel, temporary or permanent barrier).

FHAP surveys were not undertaken when the full stream length could not be feasibly surveyed on the survey date because of access issues or other logistical constraints. For example, complete FHAP surveys were not undertaken if stream characteristics prevented access to the channel or made access unsafe (e.g., high flows, steep banks, etc.), conditions prevented measurement on the survey date (e.g., frozen/snow covered), or time for the survey was constrained due to access method (e.g., ATV). For these streams, the habitat assessment was refined to focus on migratory potential for fish. Locations where fish passage may be compromised were identified during aerial surveys where sites were accessed by helicopter, or were identified by visual surveys where sites were accessed by ATV. These methods allowed for effort to be focused on locations of interest for potential fisheries offsetting or enhancement. The location of each potential migratory barrier was marked using a handheld GPS unit and representative photographs were taken. Information such as the length and estimated permanence of the barrier were also collected.

Fish Community

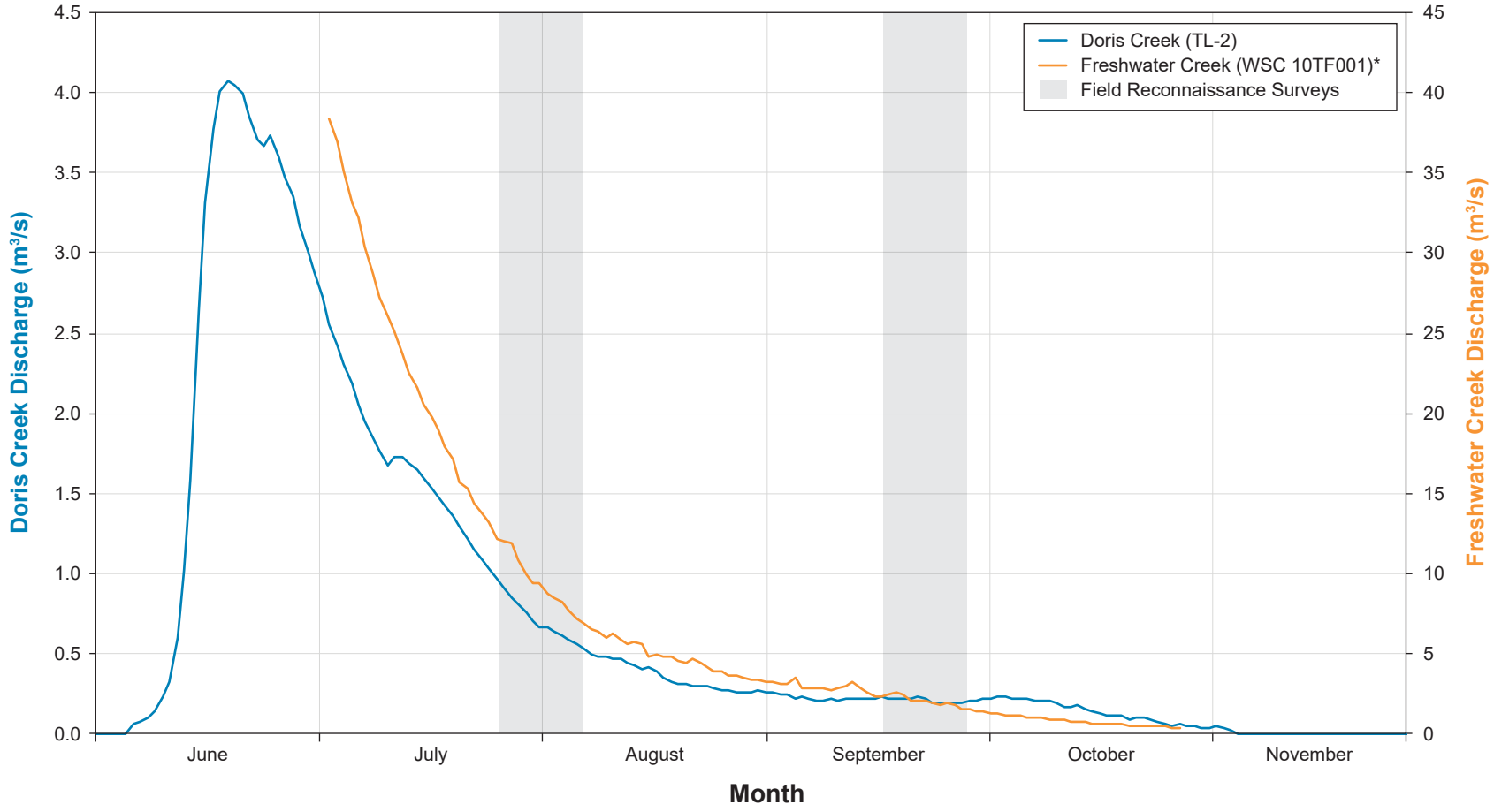
Fish community information collected during 2018 field reconnaissance visits was limited to visual observations of fish recorded during habitat assessments and targeted angling to confirm species identification when fish were observed. Additional information on fish community composition at candidate

offsetting sites was inferred from the location of the sites relative to known nearby fisheries and locations with available fish community composition data (e.g., Hope Bay Project baseline reports), and/or the presence of evidence of use for fishing (e.g., weirs, fishing nets, etc.). Traditional and local knowledge of fish species composition and use for fishing by local land users was also recorded prior to and during field surveys.

Flow

Discharge measurements were performed following the mid-section velocity area method outlined in *British Columbia Manual of Standard Operating Procedures for Hydrometric Surveys* (RISC 2009). Annual 2018 hydrographs for two streams, Freshwater Creek and Doris Creek, which are located in the same hydrological region as the candidate offsetting sites, were also developed. These hydrographs were used for comparison with manual discharge measurements and overall flow conditions observed at candidate fisheries offsetting options on the survey dates.

Data for Water Survey of Canada station Freshwater Creek 10TF001 were received from Environment Canada (A. Pippy, personal communication, January 9th, 2019). Doris Creek data were measured using a seasonal hydrometric monitoring station located at monitoring location TL-2 from June 20, 2018 to September 23, 2018. Data from June 5 to June 19 and September 24 to November 5 were estimated using a linear regression with data collected at the year-round Doris Lake level monitoring station. The locations of Freshwater Creek and Doris Creek as regional hydrometric data sites are presented in Figure 3.4-1. The 2018 hydrographs for Freshwater Creek and Doris Creek are presented in Figure 4.1-1, with the July/August and September field reconnaissance survey dates represented for comparison.



*Note: * WSC (Personal Communication), Provisional daily flow data for Freshwater Creek (10TF001) received from WSC via email on January 9, 2019.*

Figure 4.1-1: Hydrographs for Doris Creek (TL-2) and Freshwater Creek (WSC 10TF001), 2018

5. CANDIDATE OFFSETTING OPTIONS

5.1 Hope Bay Project Vicinity Options

5.1.1 Tahilugyuak Outflow

5.1.1.1 Site Description

Tahilugyuak is located approximately 25 km northeast of the Doris Mine site and approximately 100 km southwest of Cambridge Bay. Tahilugyuak Outflow flows northeast into a bay in Elu Inlet (Figure 5.1-1). The length of the outflow stream is approximately 2.5 km with no tributaries that provide fish habitat. Tahilugyuak has an area of approximately 2,200 ha. Along the Tahilugyuak Outflow channel, approximately 500 m downstream from Tahilugyuak, there is a small lake (approximately 2 ha; Figure 5.1-1). The depth of this small lake has not been confirmed but aerial surveys suggest that it may be sufficient for providing overwintering habitat to fish. During a field scouting survey in August of 2016, areas along the channel where fish passage may be compromised by low flow barriers were identified. According to TK information, Lake Trout are present in Tahilugyuak and the downstream bay in Elu Inlet (Banci and Spicker 2016).

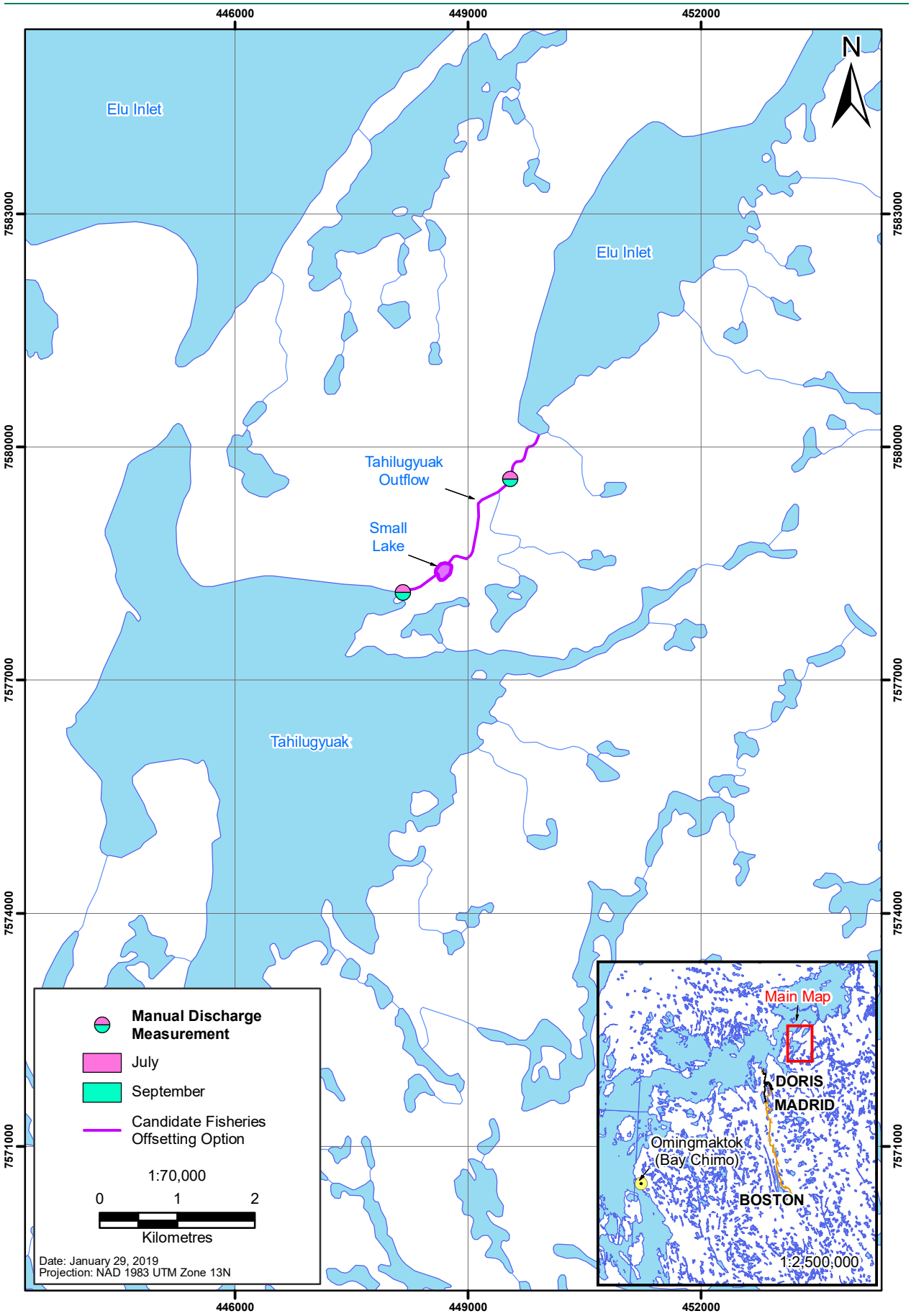


Figure 5.1-1: Tahilugyuak Outflow

5.1.1.2 Assessment Details

An aerial survey was performed and photos taken along the length of Tahilugyuak Outflow on July 29 and September 21, 2018. FHAP assessments were conducted along the entire length of the channel on July 27, 2018, and September 20 and 21, 2018. The September FHAP survey was modified because the channel was partially frozen and thus some measurements could not be taken (e.g., depth, substrate composition). Visual surveys for fish were conducted concurrently with FHAP assessments. Fish were observed in the small pond along the stream channel on September 21, 2018 and angling was conducted to confirm species presence. Manual discharge measurements were taken on July 29, 2018, and September 20 and 21, 2018 at each of two locations along the channel, one directly downstream of Tahilugyuak and one near the confluence with the marine environment (Figure 5.1-1).

5.1.1.3 Results and Observations

Traditional and Local Knowledge

Tahilugyuak (or Tahilokyuak) and the downstream bay in Elu Inlet were identified as Inuit fishing places in the NTKP report (Banci and Spicker 2016). According to the NTKP report, the majority of rivers which flow to the ocean contained Arctic Char and many, if not all, of the lakes connected to the ocean had overwintering char. Lake Trout were specifically identified as present in Tahilugyuak and in the bay in Elu Inlet, directly downstream of Tahilugyuak.

Tahilugyuak Outflow was identified as a candidate offsetting option during 2016 field scouting surveys performed by ERM biologists. Although site-specific local and traditional knowledge was sought through engagement activities in 2018, knowledge holders that were asked about the site did not provide any site-specific local or traditional knowledge.

Fish Habitat

Complete FHAP data collected in Tahilugyuak Outflow are presented in Appendix B (Table B-1) with photos of potential and observed barriers to fish passage presented in Appendix C. In July, the channel consisted of long glides and pools, interspersed by shorter cascades and riffles with each habitat type comprising a similar total length of the channel (Figure 5.1-2). In September, lower water levels resulted in less turbulent flow and a greater proportion of glide and pool habitat. At lower flows in September, many of the riffle and cascade sections contained boulder garden features that had been submerged at higher flows. In both survey periods, stream cover was provided almost exclusively by boulders, with a limited number of the pool habitat units also providing deep pool cover.

In July, over 90% of the habitat units (HUs) in Tahilugyuak Outflow demonstrated either fair (42%) or good (50%) quality migration habitat (Figure 5.1-2). Although the majority of habitats were suitable for fish passage, one HU was assessed as having poor migration potential. This was an area of low flow through a boulder garden that resulted in a temporary barrier to upstream fish passage located directly upstream of the small lake along the channel (Photo 5.1-1). Due to this barrier, the majority of fish would not have been able to migrate unimpeded between the marine environment and Tahilugyuak on the survey date (July 27, 2018). The barrier was considered temporary as it is unlikely to impede fish passage at higher flow conditions however, it is estimated to act as a fish passage barrier beginning in mid-July and remaining until the stream freezes in the fall. In addition to this temporary barrier, nine locations were identified that had the potential to act as barriers as water levels recede over the remainder of the open-water season (Figure 5.1-3; Photo 5.1-2).

In September, flows had receded such that 33% of habitat units had no or poor migratory potential (Figure 5.1-2). Eight habitat units were considered temporary barriers to fish passage due either to boulder garden features or to low flow resulting in insufficient water depth for passage (Figure 5.1-3;

Photo 5.1-3). Another four locations were considered to have the potential to act as barriers at lower water level/flow.

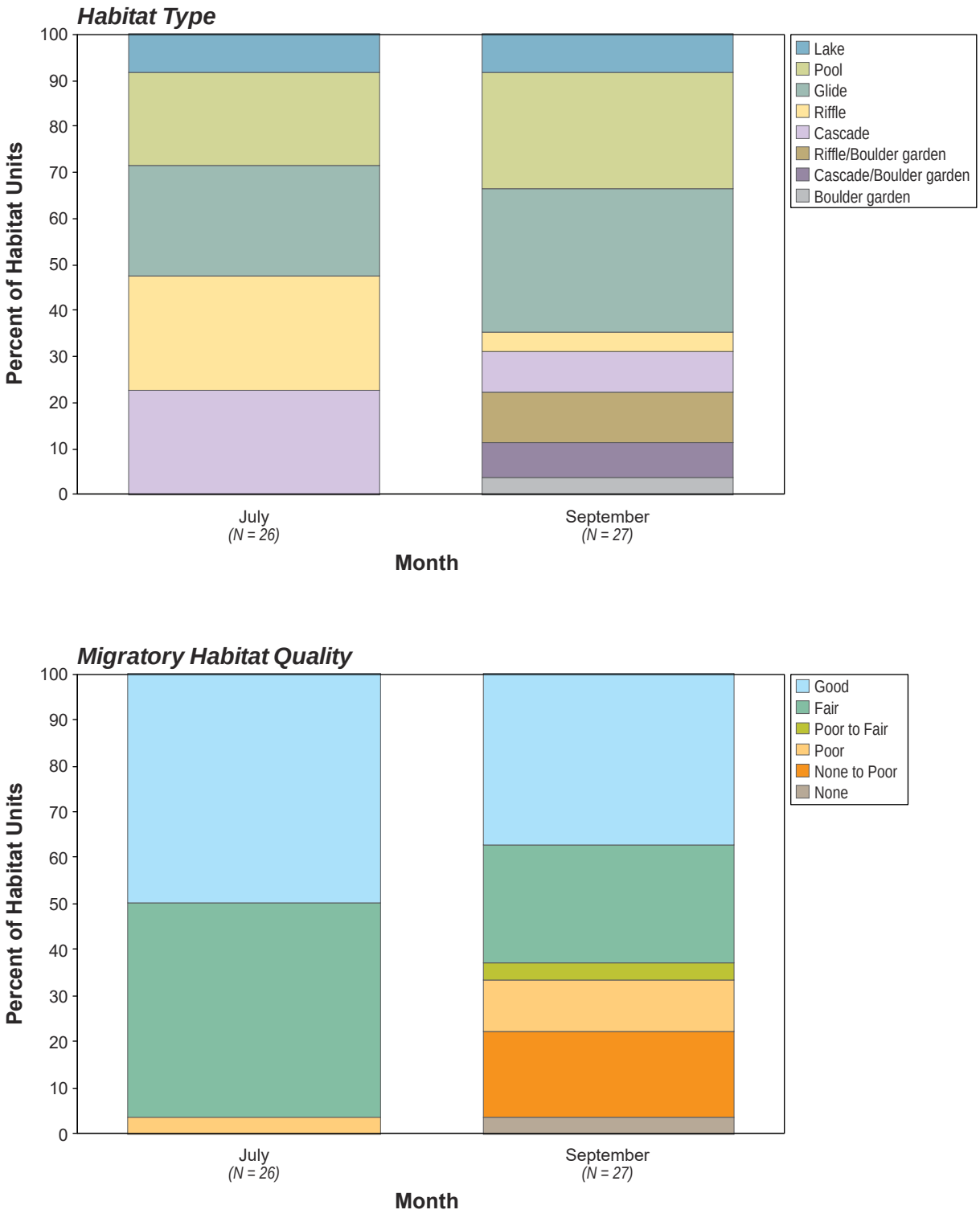


Figure 5.1-2: Stream Habitat Type and Migratory Habitat Quality for Fish, Tahilugyuak Outflow, July and September 2018

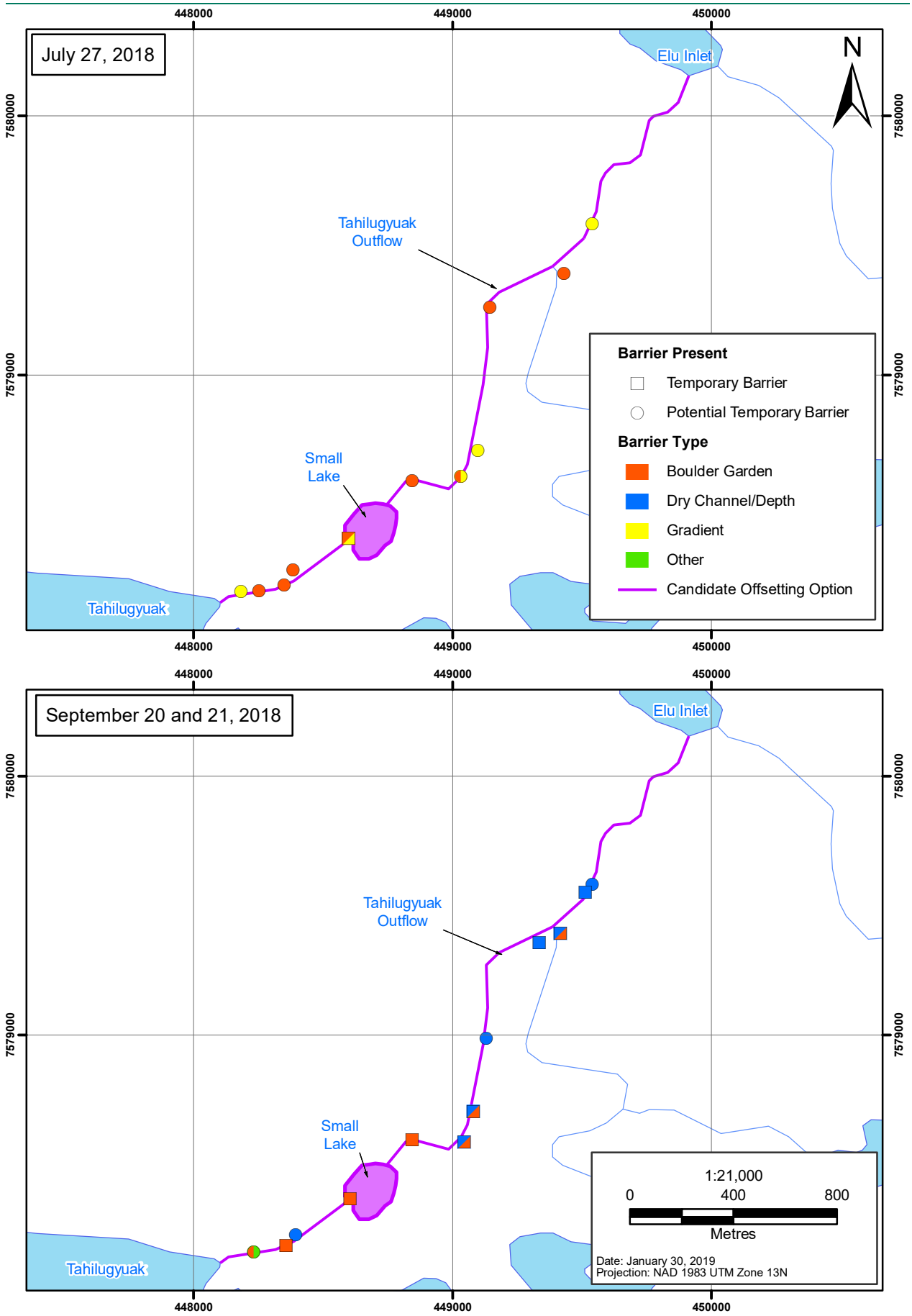


Figure 5.1-3: Fish Passage Barrier Assessment, Tahilugyuak Outflow, 2018

Photo 5.1-1: Aerial view of boulder garden barrier to fish passage (HU 21) in Tahiluyguak Outflow, directly upstream of the small lake. Flow direction from left to right. (July 29, 2018; UTM 13 7578366 448598).

Photo 5.1-2: Examples of potential temporary barriers to fish migration, Tahiluyguak Outflow. Clockwise from top left: HU 5, HU 7, HU 25, and HU 14 facing across channel from right bank. (July 27, 2018).

Photo 5.1-3: Examples of temporary barriers to fish migration, Tahiluyguak Outflow. Clockwise from top left: HU 2 facing across from right bank, HU 8 facing across from left bank, HU 25 facing upstream, and HU 16 facing across from left bank (September 20 and 21, 2018).

Fish Community

On July 27, 2018 one adult Arctic Char was observed attempting to migrate upstream at the temporary boulder garden barrier directly upstream of the small lake (Figure 5.1-3; Photo 5.1-4). It was unsuccessful at moving upstream through the boulder garden feature during the time survey crews were present but may have successfully moved upstream at a later time. On July 29, a juvenile salmonid (Lake Trout or Arctic Char) was observed at the outlet of Tahilugyuak during a manual stream discharge measurement.

On September 21, 2018, four Arctic Char and six Lake Trout between approximately 25 and 45 cm in length were captured by angling in the small lake, directly downstream of the boulder garden feature, which at the time of sampling acted as a full barrier to fish passage. These fish were stranded in the small lake as downstream passage was also blocked by temporary boulder garden and flow barriers, as well as frozen stream conditions. If the depth of the small lake is insufficient to provide overwintering habitat, fish stranded in the small lake would have been lost (i.e., freezing or winterkill).

Photo 5.1-4: Arctic Char attempting to migrate upstream through boulder garden (HU 21) in Tahilugyuak Outflow (July 27, 2018; UTM 13 7578366 448598).

Given the locations of fish observed and captured, it is unknown if Arctic Char and Lake Trout belong to anadromous populations migrating upstream from the marine environment, resident populations in upstream Tahilugyuak, and/or resident populations in the small lake along the channel. However, based on fish habitat assessments, it is anticipated that fish can pass unimpeded from Elu Inlet to Tahilugyuak for at least part of the open-water season. Therefore, an anadromous populations are assumed along with the potential for one or more resident populations. In the NTKP report, Lake Trout were identified as being present in Tahilugyuak (Banci and Spicker 2016). Additionally, it was noted that Lake Trout are often in small lakes where fish may not be expected, although their presence depends on the lake's depth (Banci and Spicker 2016). Therefore, available TK supports the potential for the small lake, depending on depth, to support a resident Lake Trout population.

Flow

Results of manual discharge measurements taken at two locations along the channel during each of the July and September surveys are presented in Appendix D (Tables D-1 to D-4). Assuming the annual flow pattern in Tahilugyuak Outflow reflects conditions in other streams in the region (i.e., Freshwater Creek and Doris Creek; Figure 4.1-1), flow peaked in early June and by the time of the July survey had likely already receded to less than a quarter of its peak discharge. Therefore, despite a temporary barrier to fish passage that was identified in the July survey, higher flows earlier in the season would have provided a period of unimpeded fish passage. Both conditions on the survey dates, and comparison with the Freshwater Creek and Doris Creek hydrographs indicate the onset of freeze-up conditions at the time of the September survey.

5.1.1.4 Proposed Approach to Offsetting

The objective of a fisheries offsetting project at Tahilugyuak Outflow would be to enhance the migratory potential of anadromous Arctic Char and Lake Trout between the marine environment (Elu Inlet) and spawning and overwintering habitats in Tahilugyuak upstream. The fish community of Tahilugyuak has not been inventoried but it is assumed to support anadromous Arctic Char and Lake Trout populations based on fish passage potential quantified during FHAP assessments, in addition to fish observed and captured along the outlet channel in 2018. Resident populations of both species may also be present in Tahilugyuak.

Based on the number of locations along the channel where migratory potential is or may be compromised, enhancements in Tahilugyuak Outflow are not anticipated to result in unimpeded migration by fish during the entire open water season. Instead the intent of enhancements would be to select locations along the channel that could be enhanced in order to extend the period over which migration is possible and/or to improve migration success.

The proposed method for improving migratory potential and success in Tahilugyuak Outflow would be through construction of migration channels. These channels would be constructed in areas where water depth is insufficient for fish passage or where boulder garden habitat features block passage under certain flow conditions. A similar approach using the construction of migration channels through a boulder garden feature has been effectively used to improve migratory success for Arctic Char at the Roberts Lake Outflow near the Hope Bay Project (Figure 1-1; ERM 2016). Construction of migration channels by manually moving rocks in stream channels has also been used by land users to improve the potential for fish passage (J. Tikkak, personal communication, July 30, 2018; ERM 2018; Appendix A).

The intent is for the locations and design of the migration channels to incorporate TK through consultation with knowledge holders during the design and construction phases. The channels would be engineered for permanence, with the objective of maintaining stability over time despite flow, snow, and ice influences. Channel design would also consider how these influences may be changing over time (e.g., due to climate change). Based on initial assessments of substrates at potential and temporary barrier locations, heavy or specialized machinery are not anticipated to be required for construction of the enhancements. However, in locations where larger boulders are present, micro-blasting may be necessary to reduce the size of rocks so that they may be moved manually. This approach was employed during enhancement construction at the Roberts Lake Outflow (Rescan 2012; ERM 2016). However, based on feedback provided at the Fisheries Offsetting Workshop micro-blasting would be less preferred relative to strictly manual techniques (ERM 2018; Appendix A).

It is anticipated that improving migratory potential and success for Arctic Char and Lake Trout in Tahilugyuak Outflow will result in increases in fisheries production in the Tahilugyuak system. The fisheries benefits anticipated from this candidate offsetting option rely on the assumption that migratory potential between the marine environment and Tahilugyuak acts as a limiting factor to fisheries productivity. The observation of impeded passage as early as July and the presence of fish remaining in the small lake in late September 2018 suggest that fisheries losses result from fish that are unsuccessful in reaching Tahilugyuak during the limited period of the open-water season during which fish passage is unobstructed (June and July).

5.1.1.5 Community Involvement

This candidate offsetting option provides opportunities for some degree of community involvement in all stages of the offsetting program. Traditional knowledge input would be required during the planning and design phases. Elders and other knowledge holders would be consulted regarding the selection of locations for migration channels and regarding design characteristics such as their lengths, widths, and

required water depths. Input would also be sought for the implementation of any necessary mitigation measures during or after construction and for the planning of construction timing.

Due to the remote location of the site relative to nearby communities (i.e.,100 km from Cambridge Bay), the potential for community involvement during construction, maintenance, and monitoring of the migration channels may be more limited. Employing manual construction techniques for the migratory channels will require a team on-site during construction, thus there is the potential for a small number of local youth to assist as well as for Elders or other knowledge holders to be present to act in advisory roles. Elders would provide oversight to teams working from design plans allowing their suggestions for improvements and modifications to be implemented throughout the construction process. As suggested by participants during the Fisheries Offsetting Workshop in June 2018, if present on site, Elders could indicate which rocks should be moved and where to place rocks to maximize fish passage in migration channels (ERM 2018). Local youth could assist in the manual construction process as well as helping to implement any necessary mitigation measures (e.g., erosion or sedimentation control).

Local youth could also be trained to assist technical staff during the post-enhancement monitoring program. This work would provide opportunities to build skills such as data recording techniques, quantitative fisheries monitoring and fish handling methods, fish habitat assessment, stream hydrology, and water quality sampling. Youth involvement would build capacity for fisheries management and environmental monitoring in the region.

5.1.1.6 Next Steps

If an offsetting option at Tahilugyuak Outflow is pursued further, the next step would be to engage with stakeholders and seek feedback on the proposed offsetting approach. This feedback will inform the design of baseline studies as well as the planning, and implementation of an enhancement project. Field surveys should be continued in 2019 and may include site visits by traditional knowledge holders, an engineering assessment, fish community, and additional fish habitat surveys.

Site visits by Elders and other traditional knowledge holders could be conducted to gather further information on site suitability for implementation of enhancements and monitoring as well as feedback on anticipated fisheries benefits. A survey of the entire stream channel by a fisheries habitat restoration engineer may be used to assess the technical feasibility of constructing functional and permanent migratory channels and help to define the construction techniques that may be required. Fish community and fish habitat surveys in 2019 would constitute the first year of formal baseline data collection. Fish community surveys may include gillnetting surveys in Tahiluyguak and the small lake along the outlet channel, and monitoring of fish migration and habitat use in Tahiluyguak Outflow using fish fences, tagging, and/or electrofishing surveys. Lake fish habitat surveys may include bathymetric, littoral, and sublittoral habitat surveys in Tahilugyuak and the small lake along the outlet channel. Stream fish habitat surveys may include installation of a hydrometric station to collect baseline streamflow data and detailed habitat assessments under different flow conditions in Tahiluyguak Outflow.

Results of baseline surveys will contribute to the quantification of the potential fisheries benefit of an offsetting program in Tahiluyguak Outflow. The potential fisheries benefit of an offsetting project must be quantified in order to ensure that offsets are commensurate with anticipated losses.

5.1.2 Harvaqtuuq Outflow

5.1.2.1 Site Description

Approximately 28 km southwest of the Doris Mine site and approximately 145 km southwest of Cambridge Bay, Harvaqtuuq Outflow flows north into Melville Sound (Figure 5.1-4). The length of the outflow stream is approximately 960 m with no contributing tributaries that provide fish habitat.

Harvaqtuuq has an area of approximately 134 ha. The next upstream lake in the watershed is over 400 ha and is separated from Harvaqtuuq by a 400 m inflow channel. Along the Harvaqtuuq Inflow there is a waterfall that is three to four meters in height that creates an impassible permanent barrier to upstream fish migration. According to TK, Harvaqtuuq is known to contain both anadromous Arctic Char and potentially anadromous Lake Trout while the lake upstream of the falls is known to support a landlocked resident Arctic Char population and a resident Lake Trout population (J. Tikkak, personal communication, July 30, 2018; Banci and Spicker 2016).

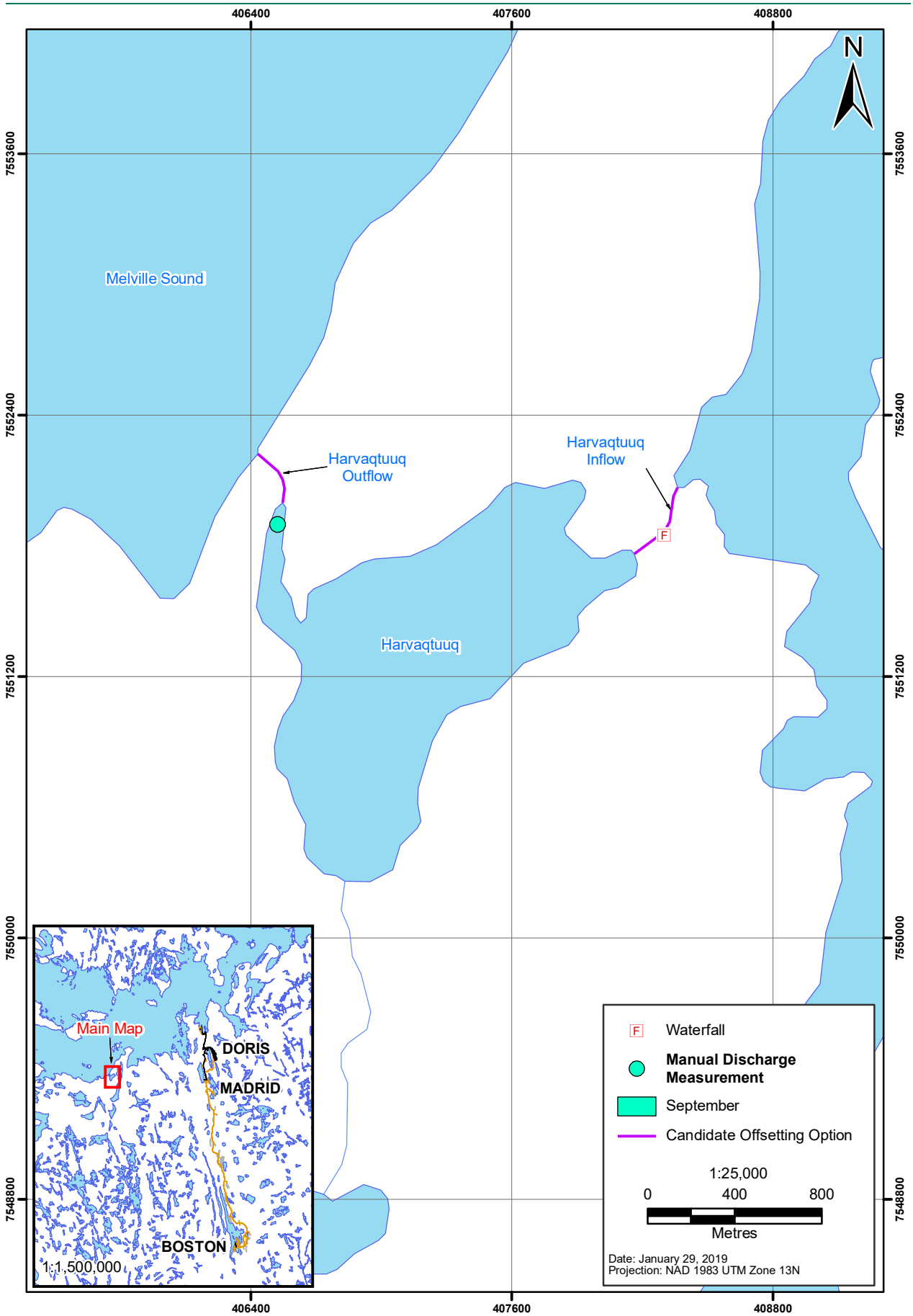


Figure 5.1-4: Harvaqtuuq Outflow

5.1.2.2 Assessment Details

An aerial survey was performed and photos taken along the length of Harvaqtuuq Outflow and Inflow on July 28 and September 22, 2018. FHAP assessments were conducted along the entire length of the channel on July 28, 2018 and September 22, 2018. Visual surveys for fish were conducted concurrently with FHAP assessments. Streamflow was too high to safely complete manual discharge measurements during the site visit in July, but discharge was measured on September 22, 2018 (Figure 5.1-4).

5.1.2.3 Results and Observations

Traditional and Local Knowledge

Harvaqtuuq (or Hakvaktok) and the chain of lakes upstream were identified as Inuit fishing places in the NTKP report (Banci and Spicker 2016). As described in the NTKP report, Harvaqtuuq was used for fishing during the Arctic Char fall migration when Inuit would spear fish or use baskets to scoop them up. Lake Trout were also specifically identified as present in Harvaqtuuq and the lake directly upstream, while Arctic Char were identified as present in lakes further upstream.

Harvaqtuuq Outflow was identified as a candidate offsetting option by knowledge holders at the Fisheries Offsetting Workshop in June 2018 (ERM 2018; Appendix A). Participants noted that water levels have been decreasing in this outflow and that this may limit fish passage towards the lake. They also described a decline in Arctic Char at the site and said that there seems to be more Lake Trout than previously observed. Following the field reconnaissance visit on July 28, 2018, the site was further discussed with a traditional knowledge holder that was present and employed at the Doris Mine site. This knowledge holder identified the presence of a landlocked Arctic Char population in the lake upstream of Harvaqtuuq that was separated from the marine environment due to the waterfall on its outflow stream (J. Tikkak, personal communication, July 30, 2018).

Fish Habitat

Complete FHAP data collected in Harvaqtuuq Outflow and Harvaqtuuq Inflow are presented in Appendix B (Table B-1) with photos of potential and observed barriers to fish passage and other notable features presented in Appendix C. In both July and September, the majority of the length of Harvaqtuuq Outflow was comprised of riffle habitats (50% and 55% of the stream length, respectively). The lower section of the stream, nearest to the marine environment was dominated by an approximately 180 m long cascade. During both surveys, it was noted that this cascade had the potential to result in a barrier to fish passage under certain flow conditions based on its gradient (9 – 13%; Photo 5.1-5). However, it was not considered an impediment to fish passage on either of the survey dates. On both survey dates, stream cover was provided almost exclusively by boulders, with a limited number of glide habitat units also providing deep water cover in July only.

In July, all habitat units in Harvuqtuuq Outflow demonstrated either fair (18%) or good (82%) quality migration habitat and 96% of habitat units demonstrated either fair (57%) or good (39%) quality rearing habitat. In September, flows had receded and migratory habitat quality improved to good in all habitat units while rearing habitat also improved (fair in 40% of habitat units and good in 60% of habitat units). Overall, fish were considered able to move unimpeded from the ocean to Harvuqtuuq throughout the 2018 open-water season, and the outflow channel provided abundant rearing habitat for juvenile fish.

An FHAP assessment was performed on Harvuqtuuq Inflow, from Harvuqtuuq upstream to the waterfall. Directly upstream of Harvuqtuuq, a 75 m long riffle/boulder garden habitat was considered to have the potential to obstruct fish passage at lower flow conditions. However, conditions in September were such that fish would not have been prevented from moving upstream through the boulders. Approximately 170

m upstream of Harvuqtuuq, a three to four meter high waterfall creates a permanent barrier to upstream fish passage (Figure 5.1-4; Photo 5.1-6).

Photo 5.1-5: Cascade habitat (HU 3), facing upstream, Harvaqtuuq Outflow (Left: July 28, 2018 and Right:September 22, 2018; UTM 13 7552144 406524).

Photo 5.1-6: Waterfall creating permanent barrier to upstream fish passage, Harvaqtuuq Inflow (Left top facing upstream and bottom facing downstream: July 28, 2018 and Right top facing upstream and bottom facing downstream: September 22, 2018; UTM 13 7551848 408299).

Fish Community

During fish habitat surveys on July 28, 2018, multiple juvenile salmonids were observed rearing in slower water along the length of a riffle habitat near Harvaqtuuq. A fish weir was present in this habitat unit (Photo 5.1-7) and juvenile salmonids were observed in the open structure. On September 22, 2018, a single fish (a salmonid approximately 25 cm in length) was observed in the glide habitat upstream of the weir. Remnants of fishing nets were present along the shoreline of Harvaqtuuq near the outflow location. Based on traditional and local knowledge that was shared about the site, anadromous Arctic Char and Lake Trout are present and fished for in Harvaqtuuq, with landlocked Arctic Char and resident Lake Trout present in the larger lake upstream (J. Tikkak, personal communication, July 30, 2018; Banci and Spicker 2016).

Photo 5.1-7: Fish weir in riffle habitat (HU 7) facing downstream, Harvaqtuuq Outflow (July 28, 2018; UTM 13 7551895 406513).

Flow

Results of the manual discharge measurement taken at Harvuqtuuq Outflow in September are presented in Appendix D (Table D-5). Assuming the annual flow pattern in Harvuqtuuq Outflow reflects conditions in other streams in the region (i.e., Freshwater Creek and Doris Creek; Figure 4.1-1), flow peaked in early June and by the time of the July survey had already likely receded to less than a quarter of its peak discharge. Based on the high flow conditions observed and migratory habitat quality recorded during the July survey, higher flow through steep cascade and riffle sections of Harvuqtuuq Outflow early in the season could result in challenging upstream migration conditions for fish. However, as flows recede they provide adequate habitat for fish to move from the marine environment upstream to Harvuqtuuq.

5.1.2.4 Proposed Approach to Offsetting

Results of the field reconnaissance surveys conducted in 2018 suggest that migratory potential in Harvuqtuuq Outflow is good over the majority of the open-water period. Good quality rearing habitat for juvenile fish was also abundant in the stream. Therefore, reconnaissance surveys failed to identify areas in Harvuqtuuq Outflow that would be suitable for the implementation of fish habitat enhancements to provide fisheries benefits to either migrating or rearing life stages.

Another proposed approach at this candidate option would be to create access to spawning and overwintering habitat in the lake upstream of Harvuqtuuq for anadromous Arctic Char and Lake Trout (if present in Harvaqtuuq). The upstream lake supports a resident landlocked Arctic Char population and potentially a resident Lake Trout population. Fish passage upstream to the lake from Harvuqtuuq and the marine environment is prevented by the waterfall located on Harvuqtuuq Inflow.

The proposed method for creating access for anadromous fish upstream of Harvuqtuuq would be through engineering and blasting steps into the channel at the existing waterfall to create a fish ladder. The design of the fish ladder would incorporate traditional knowledge through consultation with knowledge holders during the design and construction phases. Blasting would be necessary to modify the existing bedrock around the waterfall. Removal of excess blasted rock may be possible by manual methods or may require some specialized machinery. Based on feedback provided at the Fisheries Offsetting Workshop, techniques involving blasting and machinery are less preferred relative to manual techniques (ERM 2018; Appendix A).

It is anticipated that creating access for anadromous Arctic Char and Lake Trout to the lake upstream of Harvuqtuuq will have the primary benefit of providing spawning and overwintering habitat to anadromous Arctic Char and Lake Trout from Melville Sound. Additionally, allowing migrating Arctic Char and Lake Trout to access the lake may initiate a stable, long-term, yearly influx of marine nutrients from Melville Sound to the lake and as a consequence, to downstream Harvuqtuuq. This influx of nutrients is anticipated to increase the productive capacity of the entire ecosystem, and the Arctic Char and Lake Trout populations in particular.

In the Canadian Arctic, distinct subspecies of Arctic Char (and Lake Trout) may be either anadromous or ‘freshwater resident’ within single lakes. Up to four different ecomorphs of freshwater Arctic Char co-occur in some Arctic or sub-Arctic lakes (Skúlason and Smith 1995). Within individual aquatic ecosystems, these ecomorphs are often distinct from one another in terms of morphology, resource use, growth rate, physiology, and genetics (Gulseth and Nilssen 2001; I. A. Johnston et al. 2004; Wilson et al. 2004). Allowing anadromous fish access upstream of Harvuqtuuq could pose potential risks to freshwater resident Arctic Char and/or Lake Trout populations. Freshwater resident populations in the upstream lake are currently isolated and do not face competition for spawning sites and resources with anadromous fish of the same or other species. Introduction of anadromous fish could negatively impact the population size or genetic integrity of freshwater residents through competition for limited resources and gene flow through hybridization (spawning) with anadromous fish. Alternatively, the eventual outcome could be that freshwater resident and anadromous Arctic Char and/or Lake Trout subpopulations coexist, as observed in some coastal Arctic lakes (Jonsson and Jonsson 1993; Swanson, Kidd, and Reist 2010). Collection of baseline data can help determine the value of introducing anadromous Arctic Char and Lake Trout upstream of Harvuqtuuq and potential risks of an introduction to freshwater resident fish populations currently inhabiting the lake.

The fisheries benefits anticipated from this candidate offsetting option rely on the assumption that the existing landlocked Arctic Char and/or Lake Trout populations in the lake upstream of Harvuqtuuq are limited by the productivity and food resources available in the lake, rather than spawning or overwintering habitat. It is also assumed that adult Arctic Char and Lake Trout will respond to the enhancement as predicted and will move upstream from Harvuqtuuq if a fish ladder is created.

5.1.2.5 Community Involvement

This candidate offsetting option provides opportunities for community involvement though these opportunities may be limited by the site location. Traditional knowledge input would be required during the planning and design phases. Elders and other knowledge holders would be consulted regarding the design of the fish ladder including characteristics such as the location, number, and height of steps. Input would also be sought for the implementation of any necessary mitigation measures during or after construction and for the planning of construction timing.

Due to the remote location of the site relative to nearby communities, the potential for community involvement during construction, maintenance, and monitoring of the program would be more limited. The engineered nature of the offset and the construction techniques required (e.g., blasting and rock removal) would limit the potential for community members to contribute during construction. However, there is the potential for a small number of local youth to assist as well as for Elders or other knowledge holders to be present to act in advisory roles. Elders could provide oversight to teams working from design plans allowing their suggestions for improvements and modifications to be implemented throughout the construction process. Local youth could assist in any manual aspects of the construction process (e.g., the removal of blasted rock) as well as help to implement any necessary mitigation measures (e.g., erosion or sedimentation control).

Local youth could also be trained to assist technical staff during the post-enhancement monitoring program. This work would provide opportunities to build skills such as data recording techniques, quantitative fisheries monitoring and fish handling methods, fish habitat assessment, stream hydrology, and water quality sampling. Youth involvement would build capacity for fisheries management and environmental monitoring in the region.

5.1.2.6 Next Steps

If an offsetting option at Harvaqtuuq is pursued further, the next step would be to engage with stakeholders and seek feedback on the proposed offsetting approach. This feedback will inform the design of baseline studies as well as the planning, and implementation of an enhancement project. Field surveys should be continued in 2019 and may inlcude site visits by traditional knowledge holders, an engineering assessment, fish community, and additional fish habitat surveys.

Site visits by Elders and other traditional knowledge holders could be conducted to gather further information on site suitability for implementation of enhancements and monitoring as well as feedback on anticipated fisheries benefits. A survey of the entire Harvaqtuuq Inflow channel, particularly the waterfall, by a fisheries habitat restoration engineer may be used to assess the technical feasibility of constructing a functional and permanent fish ladder to allow upstream fish passage. This visit may also help to define the construction techniques that would be required, including the need for blasting and specialized mechanical equipment.

Fish community and fish habitat surveys in 2019 would constitute the first year of formal baseline data collection. Fish community surveys may include gillnetting surveys in Harvaqtuuq and the upstream lake, and monitoring of fish migration and habitat use in Harvaqtuuq Inflow and potentially in Harvuqtuuq Outflow using fish fences, tagging, and/or electrofishing surveys. Genetic sampling of Arctic Char and Lake Trout populations in both lakes may be used to delineate anadromous and freshwater resident population presence and extent in the lakes. Lake fish habitat surveys may include bathymetric, littoral, and sublittoral habitat surveys in Harvaqtuuq and the upstream lake. Stream fish habitat surveys may include installation of hydrometric station(s) to collect baseline streamflow data and detailed habitat assessments under different flow conditions in Harvaqtuuq Inflow and potentially in Harvuqtuuq Outflow.

Results of baseline surveys would contribute to the quantification of the potential fisheries benefit of an offsetting program in the Harvaqtuuq system. The potential fisheries benefit of an offsetting project must be quantified in order to ensure that offsets are commensurate with anticipated losses.

5.1.3 Reference Lake D Outflow

5.1.3.1 Site Description

Approximately 15 km east of the Doris Mine site and approximately 115 km southwest of Cambridge Bay, Reference Lake D Outflow flows north to the Angimajuq River, approximately 2.5 km upstream of its confluence with Ida (Reference) Bay (Figure 5.1-5). The length of the outflow stream is approximately 1.7 km with no contributing tributaries that provide fish habitat. Reference Lake D has an area of approximately 60 ha and supports populations of Lake Trout, Lake Whitefish, and cisco (Lake Cisco and/or Least Cisco; Rescan 2011b).

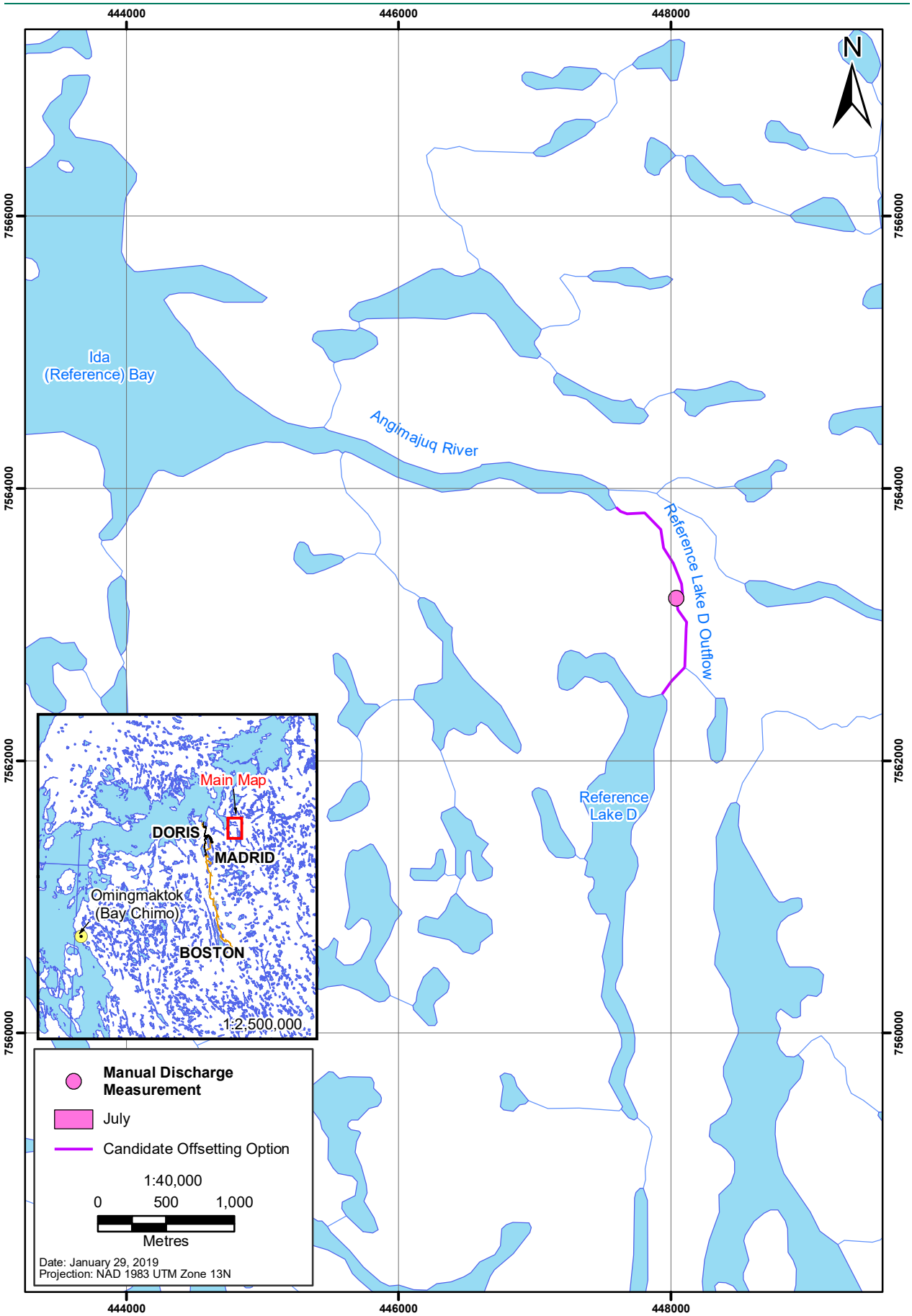


Figure 5.1-5: Reference Lake D Outflow

5.1.3.2 Assessment Details

Reference Lake D Outflow was visited on July 26 and 28, 2018. An aerial survey was performed and photos taken along the length of Reference Lake D Outflow. An FHAP assessment was also conducted along the entire length of the channel. Visual surveys for fish were conducted concurrently with FHAP assessments. A manual discharge measurement was performed approximately 800 m downstream of Reference Lake D on July 28, 2018 (Figure 5.1-5).

5.1.3.3 Results and Observations

Traditional and Local Knowledge

Reference Lake D Outflow was identified as a candidate offsetting option during 2016 field scouting surveys performed by ERM biologists. According to the NTKP report, the majority of rivers which flow to the ocean contain Arctic Char and many, if not all, of the lakes connected to the ocean have overwintering Char although no specific information regarding Reference Lake D or its outflow were provided. The downstream Angimajuq (or Angimayak) River was identified as a fishing place but additional details, such as the fish species present, were not described (Banci and Spicker 2016). Although site-specific local and traditional knowledge was sought through engagement activities in 2018, knowledge holders that were asked about the site did not provide any site-specific local or traditional knowledge.

Fish Habitat

Complete FHAP data collected in Reference Lake D Outflow are presented in Appendix B (Table B-1) with photos of notable features presented in Appendix C. During the July habitat survey dates, over half the length of the outflow stream was comprised of glide habitat, primarily located in the first kilometer downstream of Reference D Lake. Downstream of this slower, less turbulent section of the stream there was a 160 m long cascade/riffle section with steep, willow-covered banks (Photo 5.1-8). The stream channel was difficult to safely access in this section, however flow and gradient conditions were suitable for upstream fish passage. All habitat units in Reference Lake D Outflow demonstrated either fair (4%) or good (96%) quality migration and rearing habitat on the survey date. Overall, fish were considered to have the potential move unimpeded from the Angimajuq River to Reference Lake D throughout the 2018 open-water season and the outflow channel provided abundant rearing habitat for juvenile fish. Because habitat conditions in Reference Lake D Outflow in July were deemed good for both rearing and migration of the fish species anticipated to be present, and no potential barriers to fish passage were identified, the site was not revisited in September.

Photo 5.1-8: Cascade/riffle habitat (HU 8) with steep, willow covered banks, facing downstream, Reference Lake D Outflow (July 28, 2018; UTM 13 7563692 447916).

Fish Community

Baseline fish community sampling conducted in Reference Lake D in 2010 captured Lake Trout, Lake Whitefish, and cisco (Lake Cisco and/or Least Cisco) in gillnets (Rescan 2011b). During fish habitat surveys on July 28, 2018, one juvenile salmonid was observed rearing in a riffle habitat near Reference Lake D. Multiple fry were also observed near the confluence of the Angimajuq River. The species of the fry could not be conclusively determined in the field but they may have been Lake Whitefish or cisco based on the known fish community composition of Reference Lake D. Finally, the remnants of a dead Lake Whitefish (scales and bones) were found on a rock along the stream bank.

Flow

Results of the manual discharge measurement taken at Reference Lake D Outflow in July are presented in Appendix D (Table D-6). Assuming the annual flow pattern in Reference Lake D Outflow reflects conditions in other streams in the region (i.e., Freshwater Creek and Doris Creek; Figure 4.1-1), flow peaked in early June and by the time of the July survey had likely already receded to less than a quarter of its peak discharge. Based on the high flow conditions observed and migratory habitat quality recorded during the July survey, higher flow through the steep cascade/riffle section of Reference Lake D Outflow early in the season could result in challenging upstream migration conditions for fish. However, early in the season, fish are expected to be moving downstream from Reference Lake D to rear in the outflow channel, the Angimajuq River, or the marine environment (i.e., anadromous Lake Trout, if present). Additionally, based on FHAP results, as flows recede they provide good habitat for migrating and rearing fish, allowing fish to move back upstream to reach overwintering habitat in Reference Lake D later in the open-water season.

5.1.3.4 Proposed Approach to Offsetting

Results of the field reconnaissance surveys conducted in 2018 suggest that migratory potential in Reference Lake D Outflow is good over the open-water period. Good quality rearing habitat for juvenile fish was also abundant in the stream. Therefore, reconnaissance surveys failed to identify areas in Reference Lake D Outflow that would be suitable for fisheries offsetting through the implementation of fish habitat enhancements either for migration or rearing life stages. Therefore, Reference Lake D Outflow is considered a low potential candidate offsetting site as no opportunities for enhancement were identified that could increase fisheries productivity such that it would adequately offset potential fisheries losses associated the Project.

5.1.3.5 Community Involvement

Given that no enhancement opportunities were identified in Reference Lake D Outflow, the potential for community involvement in the planning, implementation, and monitoring of an offsetting project at this site has not been further considered.

5.1.3.6 Next Steps

No opportunities for development of an offsetting option at Reference Lake D Outflow were identified based on 2018 field reconnaissance surveys. However, the next step will be to engage with stakeholders and seek feedback on the results of the 2018 field surveys at this site as this feedback may provide additional information for the development of an offsetting program at other candidate sites.

5.1.4 Iqalulialuk Outflow

5.1.4.1 Site Description

Approximately 80 km southwest of the Doris Mine site and approximately 6 km southwest of Omingmaktok (Bay Chimo), Iqalulialuk flows east into Bathurst Inlet (Figure 5.1-6). The length of the outflow stream is approximately 400 m with no contributing tributaries that provide fish habitat. Upstream, Iqalulialuk has an area of approximately 1,400 ha. Iqalulialuk is known to support anadromous Arctic Char and traditional knowledge describes a diverse fish community that includes both freshwater and marine species (e.g., Arctic Char, Lake Trout, and cod; Banci and Spicker 2016).

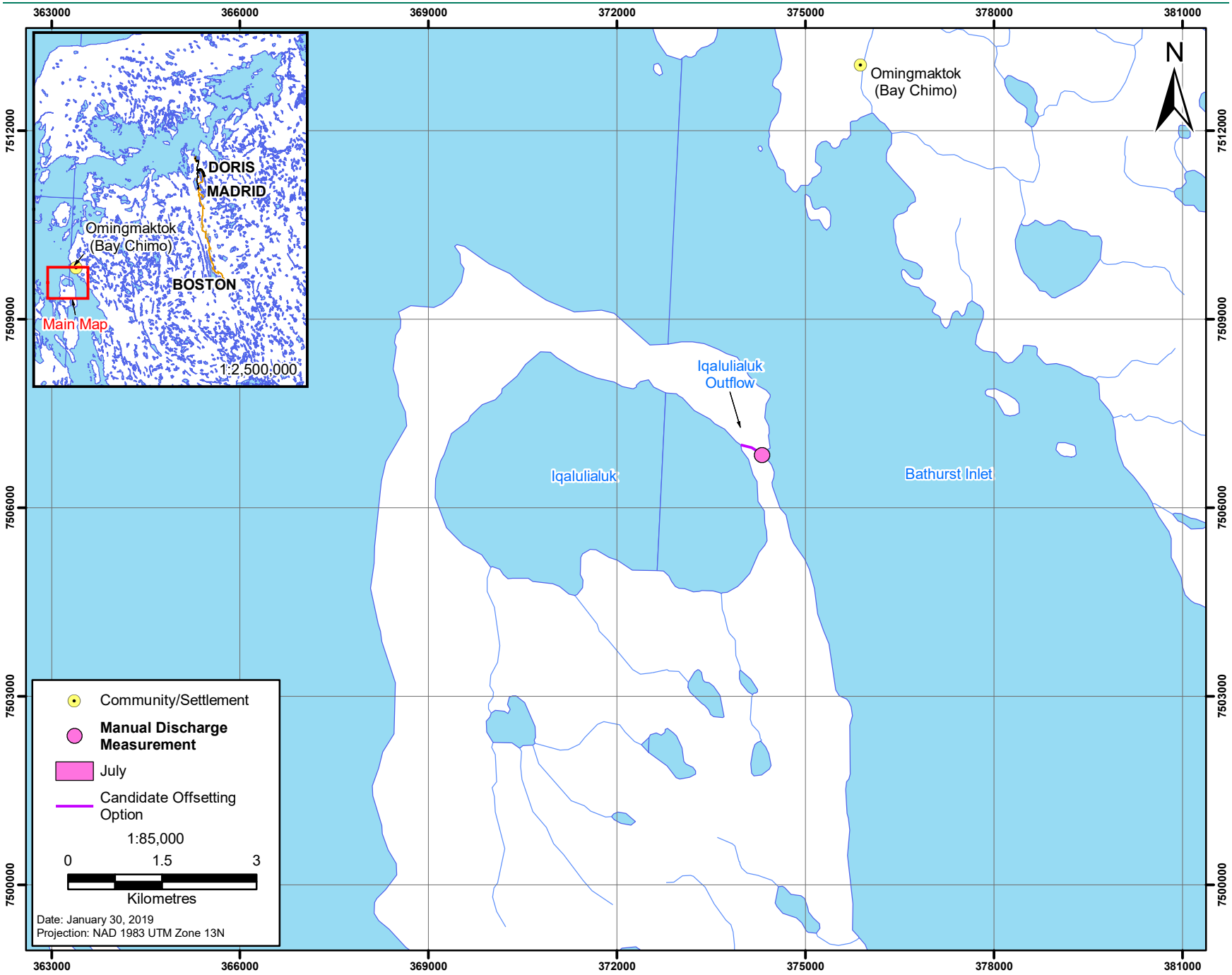


Figure 5.1-6: Iqalulialuk Outflow

5.1.4.2 Assessment Details

Iqalulialuk was visited on July 30, 2018. An aerial survey was performed and photos taken along the length of Iqalulialuk Outflow. An FHAP assessment was conducted along the entire length of the channel and visual surveys for fish were conducted concurrently with FHAP assessments. A manual discharge measurement was performed approximately 40 m upstream of the confluence with Bathurst Inlet (Figure 5.1-6).

5.1.4.3 Results and Observations

Traditional and Local Knowledge

Iqalulialuk and its outflow were identified as Inuit fishing places in the NTKP report (Banci and Spicker 2016) where the name Iqalulialuk (or Ekalolialok) was used to identify both the lake and the island on which it is located. As described in the NTKP report, Iqalulialuk was used for fishing for sea-run Arctic Char. These fish migrate to the lake in the fall and return to the sea in the spring. It was noted that at Iqalulialuk, there are lots of cracks in the rocks and that some fish get struck or become injured trying to go up or downstream (Banci and Spicker 2016).

Iqalulialuk Outflow was identified as a candidate offsetting option by knowledge holders at the Fisheries Offsetting Workshop in June 2018 (ERM 2018; Appendix A). Participants noted that low water levels have been observed in the outflow that connects the lake to the ocean. Following the field reconnaissance visit on July 30, 2018, the site was further discussed with a traditional knowledge holder that was present and employed at the Doris Mine site. This knowledge holder had lived in Omingmaktok and was familiar with the site. The lake was described as salty but not as salty as the ocean. It was noted that the water level in the outflow channel can get very low. Prior to when the knowledge holder left Omingmaktok around 2000, there had been some years where the stream dried up. Based on photographs taken on July 30, 2018, he considered flow conditions in Iqalulialuk high compared to other years when he had seen it. The knowledge holder described how local land users have moved rocks within the channel so that fish can pass upstream when water levels get low. The migratory channels created by moving rocks have to be maintained because ice moves the rocks back together over time. Therefore, land users would go back and open the channels each year (J. Tikkak, personal communication, July 30, 2018).

Fish Habitat

Complete FHAP data collected in Iqalulialuk Outflow are presented in Appendix B (Table B-1) with photos of potential and observed barriers to fish passage presented in Appendix C. On July 30, 2018, over half the length of the outflow stream was comprised of riffle habitat. Glide habitats with gravel and cobble substrates dominated at the lower end of the stream, near the ocean. Nearer to the lake, the stream gradient increased and substrate composition shifted to being cobble and boulder dominated resulting in faster and more turbulent flow conditions (i.e., riffle and cascade habitat units).

All habitat units in Iqalulialuk Outflow demonstrated either fair (71%) or good (29%) quality migration habitat. Although all habitats were suitable for fish passage on the survey date, the boulder garden features in three habitat units were deemed as having the potential to be temporary barriers to fish passage, where passage would be impeded at lower flows. Migration channels constructed by local land users were visible through each of these habitat units and extended upstream almost to Iqualulialuk (Photos 5.1-9 and 5.1-10). Overall, rearing habitat was considered either fair (43%) or good (57%) in all habitat units. All riffle sections contained boulder garden features that provided the majority of instream cover.

The July 30, 2018 fish habitat survey at Iqalulialuk, in addition to descriptions of the site provided by knowledge holders, were considered sufficient for assessing the potential for offsetting enhancements at the site. Therefore, the site was not revisited in September.

Photo 5.1-9: Migratory channel constructed through riffle habitat (HU 5), facing upstream, Iqalulialuk Outflow (July 30, 2018; UTM 13 7506893 374178).

Photo 5.1-10: Aerial view of migratory channel constructed through riffle habitat (HU 5), Iqalulialuk Outflow (July 30, 2018; UTM 13 7506893 374178).

Fish Community

During fish habitat surveys on July 30, 2018, a juvenile salmonid (unconfirmed species) of approximately 25 cm in length and multiple small-bodied fish (potentially Ninespine Stickleback) were observed in the glide habitat unit adjacent to Bathurst Inlet. Based on the traditional and local knowledge that was shared about the site, anadromous Arctic Char are, as well as multiple other species, both freshwater and marine (Banci and Spicker 2016). The lake name, Ikalulialuk, was described by one knowledge holder as meaning “place with lots of fish” because of all the different species present in it (J. Tikkak, personal communication, July 30, 2018). This knowledge holder also indicated that adult fish (Arctic Char) would be expected to be migrating into Iqalulialuk from the marine environment at approximately the end of August.

Flow

Results of the manual discharge measurement taken at Iqalulialuk Outflow in July are presented in Appendix D (Table D-7). Assuming the annual flow pattern in Iqaluliakluk Outflow reflects conditions in other streams in the region (i.e., Freshwater Creek and Doris Creek; Figure 4.1-1), flow peaked in early June and by the time of the July survey, had already likely receded to less than a quarter of its peak discharge. Given the migratory habitat conditions observed during the July survey, high early season flow through the steeper riffle and cascade sections of the stream nearer to Iqalulialuk would likely provide good quality migration habitat early. However, based on the hydrographs of other regional streams, water levels in Iqalulialuk are expected continue to decline later in the season. This suggests that potential barriers to fish passage identified during the July survey could impede fish passage, particularly in late August when Arctic Char are expected to be migrating upstream to Iqalulialuk.

5.1.4.4 Proposed Approach to Offsetting

The objective of a fisheries offsetting project at Iqaluliakluk Outflow would be to build on habitat enhancements initiated by local land users by enhancing migratory potential for anadromous Arctic Char and potentially Lake Trout between the marine environment (Bathurst Inlet) and spawning and overwintering habitats in Iqalulialuk upstream. The fish community of Iqalulialik has not been formally inventoried but it is known to support anadromous Arctic Char and potentially anadromous Lake Trout populations based on TK of the fish community and fish passage potential quantified during FHAP assessments. Resident populations of both species and other freshwater and/or marine species may also be present in the upstream lake.

Due to the short length of Iqalulialuk Outflow and the small number of locations that my require enhancements, it is anticipated that the period over which migration is possible could be extended and migration success could be improved. It is possible that enhancements could result in unimpeded fish passage over the majority of the open-water season and particularly during periods when fish are migrating upstream to access spawning and overwintering habtiats. Traditional knowledge indicates that snow and ice conditions in Iqalulialuk Outflow act by pushing rocks back into migratory channels such that the channels require maintenance to remain effective over time. As there are no longer people that permanently reside at Omingmaktok, land user access to Iqalulialuk Outflow is assumed to be more limited, thus resulting in fewer opportunities for channel maintenance.

The proposed method for improving migratory potential and success in Iqalulialuk Outflow would be through enhancement of existing migratory channels constructed by local land users and potentially construction of some new migration channels. Enhancements to existing migratory channels would be designed and engineered for permanence, with the objective of maintaining stability over time despite flow, snow, and ice influences. Channel design would also consider how these influences may be changing over time (e.g., due to climate change). Modifications to existing migration channels would incorporate TK through consultation with knowledge holders during the planning, design, and construction phases. Based on initial assessments of substrates in the existing channels, heavy or specialized machinery are not anticipated to be required for construction of the enhancements though localized micro-blasting may be used to move larger rocks. Based on feedback provided at the Fisheries Offsetting Workshop micro-blasting would be less preferred relative to strictly manual techniques (ERM 2018; Appendix A). However, the use of micro-blasting may allow for larger rocks to be moved which may in turn ultimately increase the permanence and stability of the channels. Micro-blasting was successfully employed during the construction of migration channels at the Roberts Lake Outflow near the Hope Bay Project (Rescan 2012; ERM 2016).

If necessary, new channels could also be constructed to supplement existing channels. New channels could be located in previously unaltered areas where current water depth is insufficient for fish passage or where boulder garden habitat features block passage under certain flow conditions. Implementation of any new migration channels would also incorporate traditional knowledge through consultation with knowledge holders during the planning, design, and construction phases. Construction techniques are anticipated to be similar to those used for modifications to existing channels (i.e., manual techniques and potential micro-blasting of large rocks). However, based on feedback provided at the Fisheries Offsetting Workshop micro-blasting would be less preferred relative to strictly manual techniques (ERM 2018; Appendix A).

It is anticipated that enhancing migratory potential and success for Arctic Char and potentially Lake Trout and other species in Iqaluliakluk Outflow will result in some increases in fisheries production in the Iqalulialuk system. The fisheries benefits anticipated from this candidate offsetting option are the creation of high quality migration habitats to replace habitats lost as a result of Project activities. Similar enhancements to migratory habitat at the Roberts Lake Outflow have been demonstrated to increase

migration success for anadromous Arctic Char from an mean successful migration rate of 62% pre-enhancement based on five years of baseline data to between 93 and 96% in the first three post-enhancement monitoring years (ERM 2016). It is also assumed that fisheries productivity in the Iqalulialuk system is limited to some extent by migratory potential between the marine environment and Iqalulialuk, which is supported by traditional knowledge of reduced fish migration resulting in land user construction of migration channels (Banci and Spicker 2016; ERM 2018).

5.1.4.5 Community Involvement

This candidate offsetting option provides opportunities for some degree of community involvement in all stages of the offsetting program. Traditional knowledge input would be required during planning and design phases. Elders and other knowledge holders would be consulted regarding modifications to existing migration channels. Additionally, input would be sought regarding the selection of locations for new migration channels as well as their design characteristics such as their lengths, widths, and required water depths. Elders and other knowledge holders could also contribute information for implementation of any necessary mitigation measures during or after construction and for the planning of construction timing.

Because there are no longer permanent residents at Omingmaktok, the location of the site is remote relative to nearby communities. Therefore, the potential for community involvement during construction, maintenance, and monitoring phases of an offsetting program may be more limited due to logistics related to accessing the site. Employing manual construction techniques for the migratory channels will require a team on-site during construction, thus there is the potential for a small number of local youth to assist as well as for Elders or other knowledge holders to be present to act in advisory roles. Elders would provide oversight to teams working from design plans allowing their suggestions for improvements and modifications to be implemented throughout the construction process. As suggested by participants during the Fisheries Offsetting Workshop in June 2018, if present on site, Elders could indicate which rocks should be moved and where to place rocks to maximize fish passage in migration channels (ERM 2018). Local youth would assist in the manual construction process as well as helping to implement any necessary mitigation measures (e.g., erosion or sedimentation control).

Local youth could also be trained to assist technical staff during the post-enhancement monitoring program.This work would provide opportunities to build skills such as data recording techniques, quantitative fisheries monitoring and fish handling methods, fish habitat assessment, stream hydrology, and water quality sampling. Youth involvement would build capacity for fisheries management and environmental monitoring in the region.

5.1.4.6 Next Steps

If an offsetting option at Iqalulialuk Outflow is pursued further, the next step would be to engage with stakeholders and seek feedback on the proposed offsetting approach. This feedback will inform the design of baseline studies as well as the planning, and implementation of an enhancement project. Field surveys should be continued in 2019 and may include site visits by traditional knowledge holders, an engineering assessment, fish community, and additional fish habitat surveys.

Site visits by Elders and other traditional knowledge holders could be conducted to gather further information on site suitability for implementation of enhancements and monitoring as well as feedback on anticipated fisheries benefits. A survey of Iqalulialuk Outflow, including the existing migratory channels, by a fisheries habitat restoration engineer may be used to assess the technical feasibility of constructing more permanent migratory channels and help to define the construction techniques that would be required. Fish community and fish habitat surveys in 2019 would constitute the first year of formal baseline data collection. Fish community surveys may include gillnetting surveys in Iqalulialuk, and

monitoring of fish migration and habitat use in Iqalulialuk Outflow using fish fences, tagging, and/or electrofishing surveys. Lake fish habitat surveys may include bathymetric, littoral, and sublittoral habitat surveys in Iqalulialuk. Stream fish habitat surveys may include installation of a hydrometric station to collect baseline streamflow data and detailed habitat assessments under different flow conditions in Iqalulialuk Outflow. Results of baseline surveys will contribute to the quantification of the potential fisheries benefit of an offsetting program in Iqalulialuk Outflow. The potential fisheries benefit of an offsetting project must be quantified in order to ensure that offsets are commensurate with anticipated losses.

5.1.5 Omingmaktok Area Lake Outflow

5.1.5.1 Site Description

Approximately 75 km southwest of the Doris Mine site and approximately 6 km south of Omingmaktok (Bay Chimo), the outflow of an approximately 650 ha lake (Omingmaktok Area Lake) flows west into Bathurst Inlet (Figure 5.1-7). The length of the outflow stream is approximately 2.8 km with no contributing tributaries that provide fish habitat. Anadromous Arctic Char and potentially anadromous Lake Trout have been described as present the Omingmaktok Area Lake by traditional and local knowledge holders.

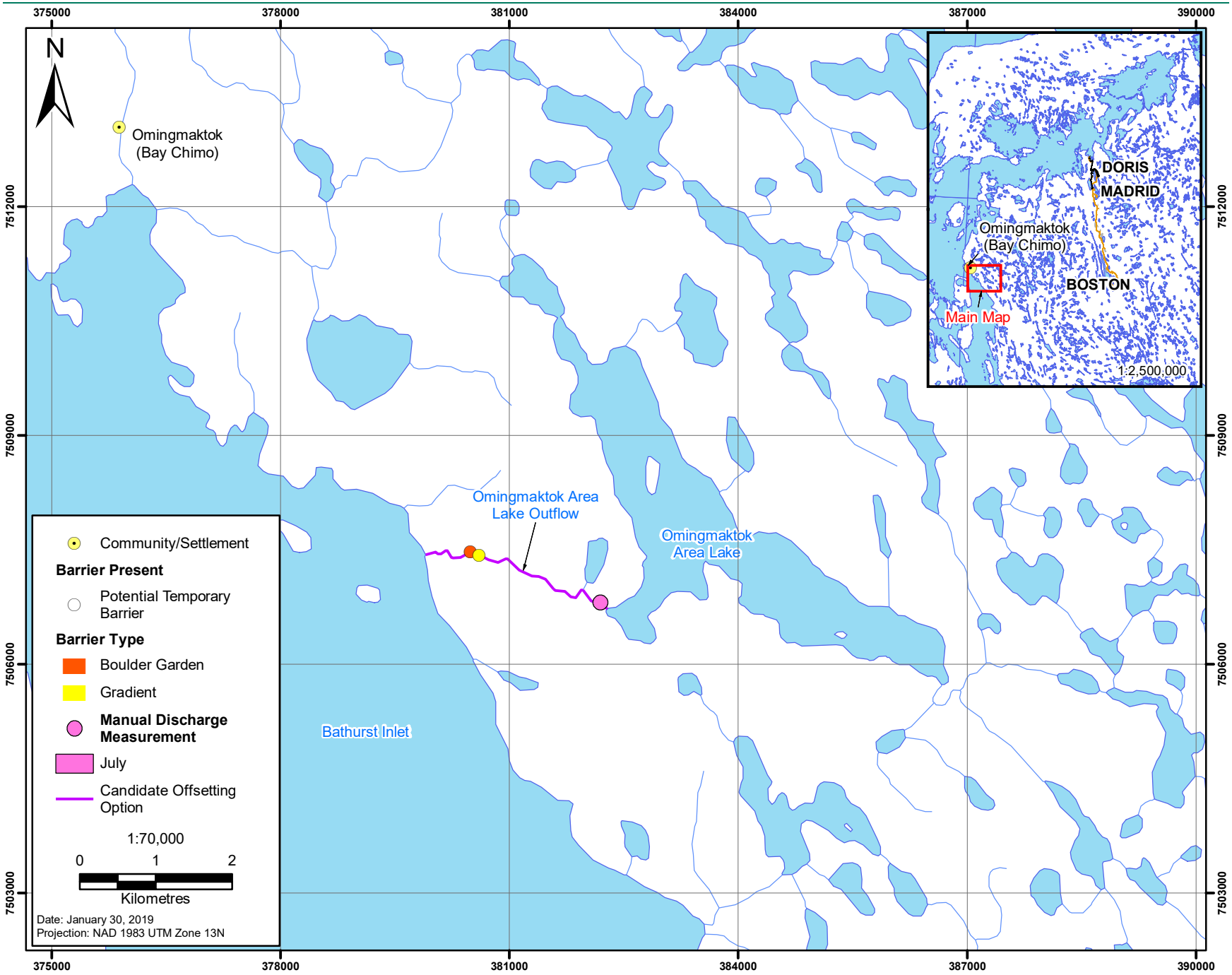


Figure 5.1-7: Omingmaktok Area Lake Outflow

5.1.5.2 Assessment Details

The Omingmaktok Area Lake Outflow was visited on July 30, 2018. An aerial survey was performed and photos taken along the length of the outflow channel. An assessment of migratory potential was conducted during the aerial survey and locations that were considered to have the potential to act as barriers to fish passage were assessed by detailed surveys of the channel. Visual surveys for fish were conducted during the aerial survey and migratory potential assessments and any observed fish were noted. A manual discharge measurement was performed approximately 100 m downstream of the lake outflow (Figure 5.1-7).

5.1.5.3 Results and Observations

Traditional and Local Knowledge

The Omingmaktok Area Lake (or Kilanaktokvik as named in Banci and Spicker 2016) and its outflow were identified as Inuit fishing places in the NTKP report (Banci and Spicker 2016). It is implied in the NTKP report that the Omingmaktok Area Lake was used for fishing for sea-run Arctic Char. It was noted that, like at Iqalulialuk, there are lots of cracks in the rocks and that some fish get struck or become injured trying to go up or downstream (Banci and Spicker 2016). Lake Trout and whitefish were also specifically identified as present in the Omingmaktok Area Lake.

The Omingmaktok Area Lake Outflow was identified as a candidate offsetting option by knowledge holders at the Fisheries Offsetting Workshop in June 2018 (ERM 2018; Appendix A). Participants noted that streams near Omingmaktok (Bay Chimo) are getting too shallow and that fish will not be able to get back into upstream lakes, however, specific streams were not identified. Upon arrival in the area on July 30, 2018 a general aerial survey was performed near Bay Chimo to identify any streams where fish passage may be compromised. The Omingmaktok Area Lake was the only stream identified that was considered to have potential to be a candidate offsetting site.

Following the field reconnaissance visit on July 30, 2018, lakes in the area were further discussed with a traditional knowledge holder that was present and employed at the Doris Mine site. This knowledge holder had lived in Omingmaktok and was familiar with the area. Based on photographs taken during July 2018 surveys, flow conditions in the lakes were considered high compared to other years when he had seen them. In some years the stream had dried up. He commented that there was lots of white water in the stream and water flowing through the grass and that the high water levels would be good for fish. With respect to the Omingmaktok Area Lake, he indicated that there are lots of fish in the lake and that there was lots of fishing there but that fishing has not been as good since the time when the stream dried up (J. Tikkak, personal communication, July 30, 2018).

Fish Habitat

Migratory assessment data collected in the Omingmaktok Area Lake Outflow are presented in Appendix B (Table B-2) with photos of potential and observed barriers to fish passage presented in Appendix C. On the habitat survey date in July, two locations were identified that were considered to have the potential to act as barriers to fish passage under certain flow conditions (Figure 5.1-7). One was an approximately 370 m long cascade with an estimated gradient greater than 10% (Photo 5.1-11 and 5.1-12). Access to the channel in the cascade section was limited on the survey date to due high flows and steep willow-covered banks. Large boulders and bedrock were the dominant substrates present in the cascade section. When asked about fish passage through the cascade, the traditional knowledge holder consulted indicated that fish are able to swim up the cascade when the water is deep enough that fish can take a run at any step to “push” themselves up. On the survey date, high flow through the main part of the

cascade was complimented by slow water habitats along the margins of the stream and migratory potential was considered fair.

Directly downstream of the cascade section is an approximately 80 m long boulder garden (Photo 5.1-11 and 5.1-13). This habitat unit was identified as having the potential to impede fish passage at lower flow, though on the survey date, flows were sufficient to allow for upstream fish passage.

Photo 5.1-11: Aerial view of boulder garden (HU 1) and cascade (HU 2) habitats identified as potential barriers to fish migration, Omingmaktok Area Lake Outflow (July 30, 2018; UTM 13 7507469 380487).

Photo 5.1-12: Downstream end of cascade (HU 2) identified as potential barrier to fish migration, facing upstream, Omingmaktok Area Lake Outflow (July 30, 2018; UTM 13 7507426 380602).

Photo 5.1-13: Boulder garden (HU 1) identified as potential barrier to fish migration, facing upstream, Omingmaktok Area Lake Outflow (July 30, 2018; UTM 13 7507469 380487).

Fish Community

During aerial habitat surveys on July 30, 2018, multiple large adult salmonids were observed in the stream channel. Several of these fish were observed in glide habitats within approximately 300 m of Bathurst Inlet while others were observed in glide habitats within 900 m downstream of the lake. The species of fish observed during the aerial survey could not be confirmed and no fish were observed during migratory potential assessments in the channel. A grizzly bear and two cubs were observed when approaching the site in the helicopter and substantial evidence of bear activity was noted near the boulder garden that was identified as a potential fish passage barrier (e.g., paths through the willows, diggings, scat). The jaw bone of an Arctic Char was found in this area during the habitat survey, likely consumed by bears. Based on the traditional and local knowledge that was shared about the site, there are lots of fish in the Omingmaktok Area Lake and a lot of fishing activity has been focused there. The NTKP report described the lake as an Inuit fishing location, specifically describing the presence of Lake Trout and whitefish, and implying the presence of anadromous Arctic Char (Banci and Spicker 2016).

Flow

Results of the manual discharge measurement taken at the Omingmaktok Area Lake Outflow in July are presented in Appendix D (Table D-8). Assuming the annual flow pattern in the outflow reflects conditions in other streams in the region (i.e., Freshwater Creek and Doris Creek; Figure 4.1-1), flow peaked in early June and by the time of the July survey had likely already receded to less than a quarter of its peak discharge. Based on the high flow conditions observed and migratory habitat quality recorded during the July survey, higher flow through the steep cascade and boulder garden habitats assessed could result in challenging upstream migration conditions for fish. However, as flows recede they provide adequate habitat for fish to move from the marine environment upstream as noted at the time of the survey. Based on the hydrographs of other regional streams, water levels in in the Omingmaktok Area Lake Outflow are expected to be lower than observed during the July survey later in the season resulting in potential barriers to fish passage at locations identified during the July survey.

5.1.5.4 Proposed Approach to Offsetting

The objective of a fisheries offsetting project at the Omingmaktok Area Lake Outflow would be to enhance the migratory potential of anadromous Arctic Char and potentially Lake Trout between the marine environment (Bathurst Inlet) and spawning and overwintering habitats in the lake upstream. The fish community of the lake has not been formally inventoried but it is assumed to support anadromous Arctic Char and potentially Lake Trout populations based on fish passage potential quantified during habitat assessments, fish observations along the outlet channel in 2018, and traditional knowledge. Resident populations of Trout and whitefish are known to be present in the upstream lake (Banci and Spicker 2016). .

The proposed method for improving migratory potential and success in the Omingmaktok Area Lake Outflow would be through construction of migration channels through the approximately 80 m long boulder garden habitat unit. The potential for fish passage to be impeded in the cascade habitat unit upstream of the boulder garden was also identified in July 2018, but the steep gradient and banks and large substrates in the cascade are likely to limit the feasibility of construction of migration channels. There is limited potential to safely access the channel in the cascade section for construction and monitoring. Additionally, manipulation of large substrates (boulders and bedrock) would likely require heavy/specialized machinery and fast flows over the steep gradient could influence the permanence or stability of constructed enhancements. Although both the boulder garden and the cascade were identified as potential barriers, based on conditions in July 2018, the boulder garden is likely to begin to impede passage more frequently and earlier in the open-water season each year (i.e., at higher flows than the

cascade). Therefore, fisheries benefits of enhancing migratory habitat in the boulder garden may still be attained if the cascade remains unaltered.

Migration channels through the boulder garden feature would be constructed in areas where water depth is insufficient for fish passage or where boulders block passage under certain flow conditions. A similar approach using the construction of migration channels through a boulder garden feature has been effectively used to improve migratory success for Arctic Char at the Roberts Lake Outflow near the Hope Bay Project (Figure 1-1; ERM 2016). Construction of migration channels by manually moving rocks in stream channels has also been used by land users to improve the potential for fish passage (J. Tikkak, personal communication, July 30, 2018; ERM 2018; Appendix A).

The locations and design of the migration channels would incorporate TK through consultation with knowledge holders during the design and construction phases. The channels would be engineered for permanence, with the objective of maintaining stability over time despite flow, snow, and ice influences. Channel design would also consider how these influences may be changing over time (e.g., due to climate change). Based on initial assessments of substrates in the boulder garden, heavy or specialized machinery are not anticipated to be required for construction of the enhancements. However, micro-blasting may be necessary to reduce the size of rocks so that they may be moved manually. This approach was employed during enhancement construction at the Roberts Lake Outflow (Rescan 2013; ERM 2016). However, based on feedback provided at the Fisheries Offsetting Workshop micro-blasting would be less preferred relative to strictly manual techniques (ERM 2018; Appendix A).

It is anticipated that improving migratory potential and success for Arctic Char and Lake Trout in the Omingmaktok Area Lake Outflow will result in increases in fisheries production in the lake system. The fisheries benefits anticipated from this candidate offsetting option rely on the assumption that migratory potential between the marine environment and the lake acts as a limiting factor to fisheries productivity. Additionally, enhancements in the boulder garden feature would only be effective if the natural migratory potential in the upstream cascade remained sufficient to allow upstream passage during the period when migration channels would be used.

5.1.5.5 Community Involvement

This candidate offsetting option provides opportunities for some degree of community involvement in all stages of the offsetting program. Traditional knowledge input would be required during the planning and design phases. Elders and other knowledge holders would be consulted regarding the selection of locations for migration channels and regarding design characteristics such as their lengths, widths, and required water depths. Input would also be sought for the implementation of any necessary mitigation measures during or after construction and for the planning of construction timing.

Because there are no longer permanent residents at Omingmaktok, the location of the site is remote relative to nearby communities. Therefore, the potential for community involvement during construction, maintenance, and monitoring phases of an offsetting program may be more limited due to logistics related to accessing the site. Employing manual construction techniques for the migratory channels will require a team on-site during construction, thus there is the potential for a small number of local youth to assist as well as for Elders or other knowledge holders to be present to act in advisory roles. Elders would provide oversight to teams working from design plans allowing their suggestions for improvements and modifications to be implemented throughout the construction process. As suggested by participants during the Fisheries Offsetting Workshop in June 2018, if present on site, Elders could indicate which rocks should be moved and where to place rocks to maximize fish passage in migration channels (ERM 2018). Local youth would assist in the manual construction process as well as helping to implement any necessary mitigation measures (e.g., erosion or sedimentation control).

Local youth could also be trained to assist technical staff during the post-enhancement monitoring program. This work would provide opportunities to build skills such as data recording techniques, quantitative fisheries monitoring and fish handling methods, fish habitat assessment, stream hydrology, and water quality sampling. Youth involvement would build capacity for fisheries management and environmental monitoring in the region

5.1.5.6 Next Steps

If an offsetting option at the Omingmaktok Area Lake Outflow is pursued further, the next step would be to engage with stakeholders and seek feedback on the proposed offsetting approach. This feedback will inform the design of baseline studies as well as the planning, and implementation of an enhancement project. Field surveys should be continued in 2019 and may include site visits by traditional knowledge holders, an engineering assessment, fish community, and additional fish habitat surveys.

Site visits by Elders and other traditional knowledge holders could be conducted to gather further information on site suitability for implementation of enhancements and monitoring as well as feedback on anticipated fisheries benefits. A survey of the Omingmaktok Area Lake Outflow by a fisheries habitat restoration engineer may be used to assess the technical feasibility of constructing functional and permanent migratory channels in the boulder garden (and potentially the cascade) and help to define the construction techniques that would be required. Fish community and fish habitat surveys in 2019 would constitute the first year of formal baseline data collection. Fish community surveys may include gillnetting surveys in the Omingmaktok Area Lake, and monitoring of fish migration and habitat use in the outflow using fish fences, tagging, and/or electrofishing surveys. Lake fish habitat surveys may include bathymetric, littoral, and sublittoral habitat surveys. Stream fish habitat surveys may include installation of a hydrometric station to collect baseline streamflow data and detailed habitat assessments under different flow conditions. Habitat surveys throughout the open-water season in the stream will contribute to assessment of the relative quality of migratory habitat in the boulder garden and cascade habitat units. This in turn, will help determine if an enhancement in the boulder garden only would be effective at maintaining migratory potential between Bathurst Inlet and the upstream lake.

Results of baseline surveys will contribute to the quantification of the potential fisheries benefit of an offsetting program in the Omingmaktok Area Lake. The potential fisheries benefit of an offsetting project must be quantified in order to ensure that offsets are commensurate with fisheries losses.

5.2 Cambridge Bay Vicinity Options

5.2.1 Grenier Lake East Outflow

5.2.1.1 Site Description

Approximately 2 km outside of Cambridge Bay and approximately 125 km northeast of the Doris Mine site, the Grenier Lake East Outflow (East Outflow) flows south into the Freshwater Creek Estuary located in the Dease Straight (Figure 5.2-1). The length of the outflow stream is approximately 8 km and it is comprised, particularly in its upstream half, of multiple ponds and small lakes connected by stream habitat. Upstream, Grenier Lake has an area of approximately 3,400 ha. Fish from Grenier Lake, including Lake Trout and Arctic Char, have the potential to access the East Outflow.

The East Outflow is one of two outflow streams between Grenier Lake and the Freshwater Creek Estuary. The other outflow, Freshwater Creek, is located to the northwest. Freshwater Creek is an important subsistence fishery for fishers from Cambridge Bay (DFO 2004). A commercial fishery operated on Freshwater Creek starting in 1960 but due to declining stocks it was recognized that it could not support both a subsistence and commercial fishery and commercial fishing ceased in 1962 (DFO 2004). The

Freshwater Creek fishery was discussed at the Fisheries Offsetting Workshop and the locations of historical weirs in Grenier Lake and in Freshwater Creek were identified (ERM 2018; Appendix A). The historical weir in Freshwater Creek was described as having lots of fish in the 1950s and 1960s.

The road from Cambridge Bay to Ovayok Territorial Park runs between Freshwater Creek and the East Outflow (Figure 5.2-1). At the location where the road crosses the East Outflow there are multiple perched culverts.

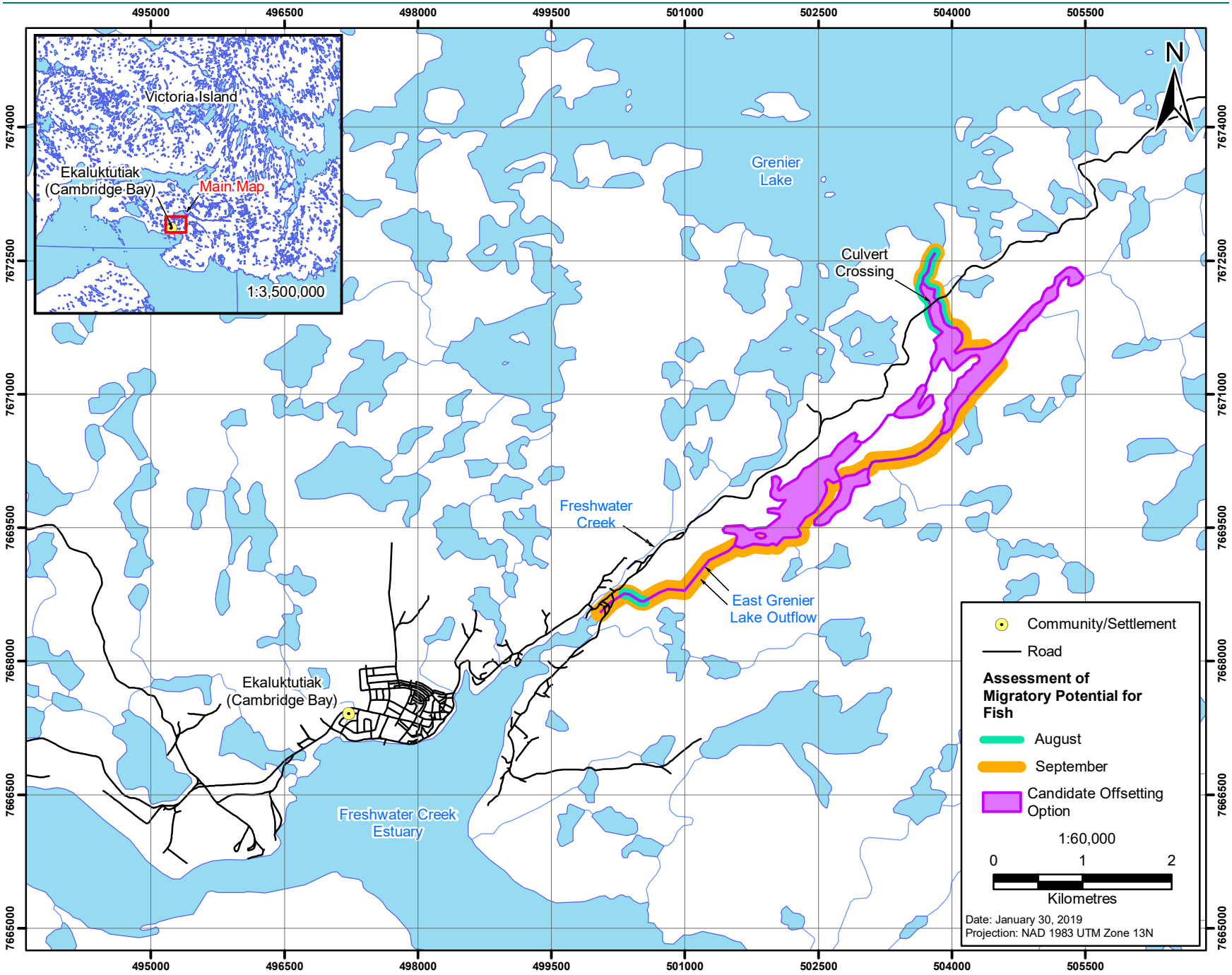


Figure 5.2-1: Grenier Lake East Outflow

5.2.1.2 Assessment Details

The East Outflow was visited on June 25, 2018, August 1, 2018 and September 26, 2018. In June, the multi-culvert crossing (UTM 13W 503780 7672011) was visited to determine the potential for fish passage through the culverts. In August and September, the East Outflow was accessed by ATV from Cambridge Bay and due to the length of the stream, fish habitat along the entire stream could not be feasibly assessed by FHAP methods. Instead, in August, assessments of migratory potential along the first kilometer of the channel downstream of Grenier Lake and the first 600 m of the channel upstream from the Freshwater Creek Estuary were conducted (Figure 5.2-1). Locations considered to have the potential to act as barriers to fish passage, including the culvert crossing (Figure 5.2-1), were assessed by detailed surveys of the channel and any fish observed were noted. Fish were observed in a small pond along the stream channel, directly downstream of the culvert crossing on August 1, 2018, and angling was conducted to confirm species presence. Streamflow at the assessed locations was low on August 1, 2018 and an appropriate transect for a manual discharge measurement was not identified on the survey date.

The onset of freeze-up conditions during the September survey generally prevented detailed assessment of stream habitats. However, the entire length of the channel between the Freshwater Creek Estuary and Grenier Lake was visually assessed by travelling along the stream by ATV and, where possible, habitat features were identified and assessed. Frozen stream conditions on September 26, 2018 prevented manual discharge measurement.

5.2.1.3 Results and Observations

Traditional and Local Knowledge

The Grenier Lake East Outflow was identified as a candidate offsetting option by participants at the Fisheries Offsetting Workshop in June 2018 (ERM 2018; Appendix A). The culvert crossing was identified as an issue for fish passage. The road used to wash out at that location and years ago new culverts were placed across the width of the channel. Lower water levels have also been noted in this outflow. The field reconnaissance visit on August 1, 2018 was conducted with the support of a local guide from Cambridge Bay. He indicated that local land users from Cambridge Bay sometimes fish near the culvert crossing location, more frequently for Lake Trout than for Arctic Char. The extent to which the East Outflow is used for fishing by local land users was unknown, and it was noted that the majority of people fish in Freshwater Creek instead (W. Nakashook, personal communication, August 1, 2018).

Fish Habitat

Migratory assessment data collected in Grenier Lake East Outflow are presented in Appendix B (Table B-2) with photos of potential and observed barriers to fish passage presented in Appendix C. The culvert crossing was first visited on June 25, 2018. The culvert crossing is comprised of eight, 0.8 m diameter culverts, placed across the channel along the length of the road crossing (Photo 5.2-1). High streamflow resulted in sufficient flow through culverts for downstream passage of fish. However, at their downstream ends, six of the eight culverts were perched with a drop of up to approximately 0.3 – 0.4 m to the downstream water surface level. Additionally, culvert sizing resulted in fast, confined flow through the approximately 15 m length of the culverts. Both the drop between culvert and stream elevation at the downstream end of the culverts and/or the rate of flow through the culverts were considered impediments, and potentially complete barriers to upstream fish passage on the survey date.

On the habitat survey date in early August, fish habitat was assessed at six locations along the East Outflow near Grenier Lake. All were rated as having no (66%) or poor (33%) migratory potential and all were considered temporary (i.e., dry channel) or permanent (i.e., the culvert) barriers to fish passage (Figure 5.2-2; Photo 5.2-2 and 5.2-3). An additional five locations along the East Outflow near the

Freshwater Creek Estuary were also assessed for migratory potential in early August. These were rated as having no (20%), poor (40%), and fair (40%) migration habitat. Three locations were temporary dry channel barriers to fish passage (Photo 5.2-4). Between the migratory habitat assessment locations, multiple small ponds/large pools were observed along the length of the East Outflow channel (Figure 5.2-1). The depth of the ponds was not measured on the survey date but it is possible that some of these ponds have sufficient depth to act as overwintering habitats for fish (i.e., approximately 3 m).

On the habitat survey date in late September, stream habitat was assessed at ten locations along the complete length of the East Outflow. These assessments were primarily located at areas between ponds, where the channel narrowed into stream habitat. The survey took place during the onset of freeze-up conditions and, as expected in Arctic streams that freeze to the bottom in winter, there was no migratory potential between the Freshwater Creek Estuary and Grenier Lake through the East Outflow (Photo 5.2-4). Due to frozen stream conditions, migratory habitat quality could only be assessed by methods consistent with the August survey at seven locations (i.e., where gaps in the ice allowed water depth and substrate composition to be determined). The migratory potential at all seven locations was rated as poor or none and each was considered a temporary barrier to fish passage, primarily due to maximum water depths of less than 20 cm and average water depths less than 10 cm (Photo 5.2-5). Overall, it appears that stream flows connecting the ponds located along the length of the East Outflow decline throughout the open water season, potentially resulting in fish stranding in the deep pond areas.

Photo 5.2-1: Culvert crossing (HU 8), facing upstream/across from right bank, Grenier Lake East Outflow (June 25, 2018; UTM 13 7671996 503802).

Photo 5.2-2: Culvert Crossing (HU 8), facing upstream from near right bank, Grenier Lake East Outflow (August 1, 2018; UTM 13 7671996 503802).

Photo 5.2-3: Temporary dry channel barrier to fish passage (HU 10) upstream of culvert crossing, facing upstream, Grenier Lake East Outflow (August 1, 2018; UTM 13 7672345 503654).

Photo 5.2-4: Temporary dry channel barrier to fish passage (HU 1), facing upstream from right bank, Grenier Lake East Outflow (August 1, 2018 and September 26, 2018; UTM 13 7668774 500299).

Photo 5.2-5: Temporary low flow barrier to fish passage (HU 5), facing across from left bank, Grenier Lake East Outflow (September 26, 2018; UTM 13 7563812 447856).

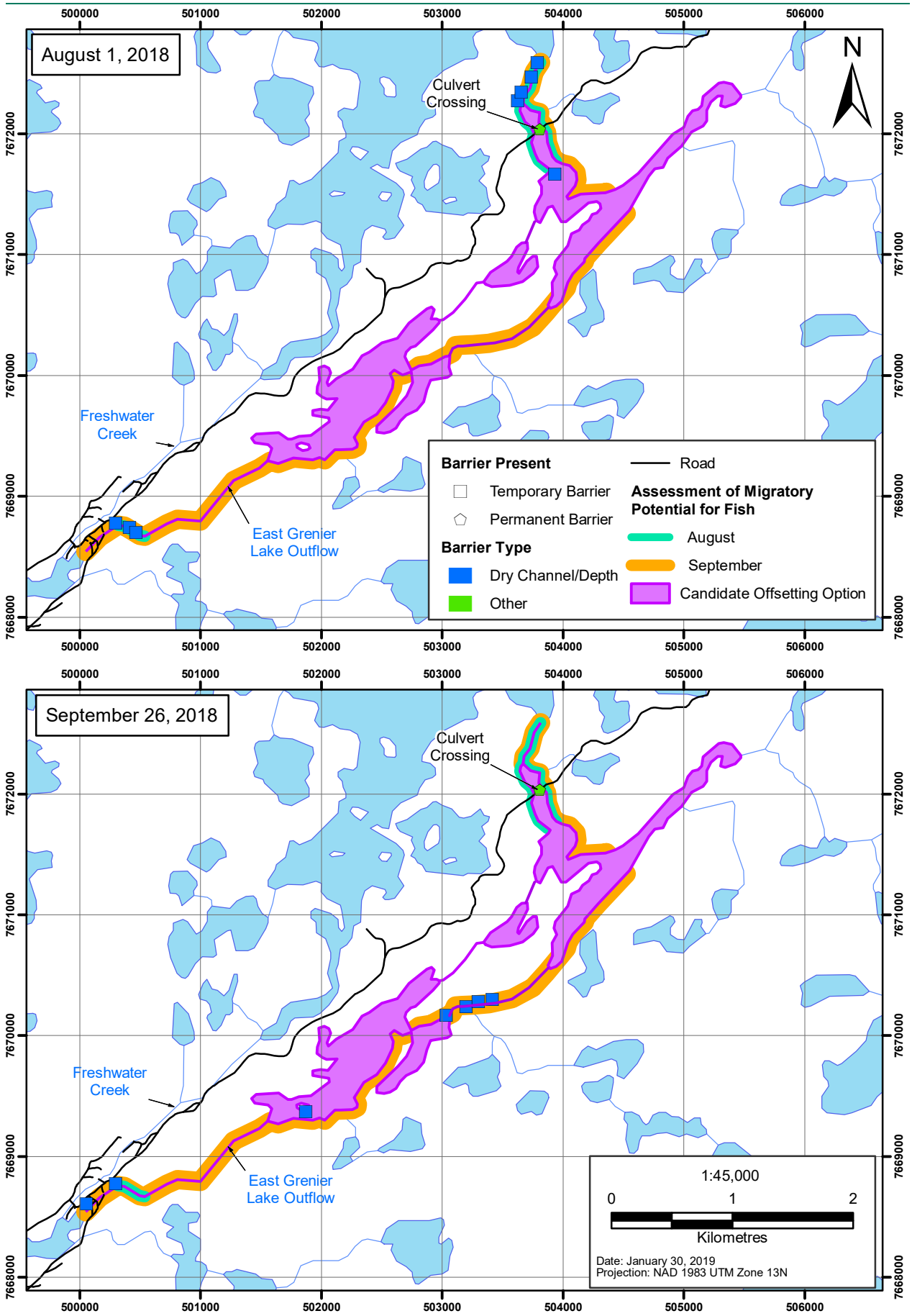


Figure 5.2-2: Fish Passage Barrier Assessment, Grenier Lake East Outflow, 2018

Fish Community

Fish were observed in a small pond along the channel directly downstream of the culvert crossing during the fish habitat survey on August 1, 2018. Angling was performed to confirm species presence and one Arctic Char, approximately 40 cm in length, was captured. Fish from Grenier Lake, including Lake Trout and Arctic Char, have the potential to access the East Outflow. Local knowledge suggested that fishing in the East Outflow more frequently targets Lake Trout than Arctic Char (W. Nakashook, personal communication, August 1, 2018).

Flow

No manual discharge measurements were performed in the Grenier Lake East Outflow. Assuming the annual flow pattern in the East Outflow reflects conditions in nearby Freshwater Creek (Figure 4.1-1), flow peaked in early June 2018 and by the time of the early August survey had likely already receded to less than a quarter of its peak discharge. In June, flows through the culvert were high allowing downstream fish passage. However, the water level at the downstream ends of the culverts was such that the culverts were perched, preventing fish from moving upstream. By the time of the early August survey, flow conditions had receded in the East Outflow to the extent that multiple dry channel barriers to fish passage were identified in the surveyed sections.

5.2.1.4 Proposed Approach to Offsetting

The objective of a fisheries offsetting project in the Grenier Lake East Outflow would be to enhance migratory potential for Arctic Char and Lake Trout. The fish community of Grenier Lake supports Arctic Char (anadromous) and Lake Trout (resident and potentially anadromous) populations. Based on field reconnaissance surveys, perched culvert and dry channel barriers resulting from low flows create impediments to migration for multiple life stages of these fish species. Anadromous fish migrating from the marine environment are prevented from reaching spawning and overwintering habitats in Grenier Lake. Juvenile fish that migrate out of Grenier Lake to utilize rearing habitats in the stream system may also be prevented from migrating back to overwintering habitats.

Based on the number of locations along the channel where migratory potential is or may be compromised, enhancements in the East Outflow are not anticipated to result in unimpeded migration between the marine environment and Grenier Lake during the entire open water season. Instead the intent of enhancements would be to select locations along the channel that could be enhanced in order to extend the period over which migration is possible and/or to improve migration success for specific life stages of fish (e.g., juvenile fish returning to overwintering habitats in the fall).

Based on fish migration and flow timing in region, the primary objective in the East Outflow would not be to enhance migratory habitat for anadromous Arctic Char (and potentially Lake Trout) during their migrations to and from the marine environment. Migrations from freshwater to saltwater generally occur early in the open-water season and coincide with the period of highest streamflow (Moore, Harris, and Tallman 2014). Therefore, outmigration potential is not likely to be impeded such that it is a primary limiting factor to fisheries productivity. Anadromous fish in the region return to freshwater habitats generally at the end of August and beginning of September (this may range from late-July to early-October depending on the year and location; Moore et al. 2016). Based on observed habitat and flow conditions in the East Outflow in 2018, by this time during the open-water season, the number and extent of barriers to fish passage are extensive and enhancement efforts would not be able to create unimpeded passage as far upstream as Grenier Lake.

Instead enhancement locations would be selected to improve access for juvenile fish (Arctic Char and Lake Trout) between rearing and overwintering habitats in the East Outflow. Some juvenile Arctic Char and Lake Trout migrate in the spring from overwintering habitats in lakes to rearing habitats in inflow and

outflow streams. Streams can provide refuge from predators due to high structural complexity allowing fish to use cover to avoid predation. However, because streams in the region freeze to the bottom in winter, these fish must return to deeper overwintering habitats prior to freeze-up in the fall. Grenier Lake is a known location of overwintering habitat but depending on their size and depth, multiple ponds along the length of the East Outflow channel also have the potential to act as overwintering habitats for juvenile fish.

In 2018, upstream passage to Grenier Lake was confirmed to be impeded at the culvert crossing location beginning in late June and several dry channel barriers were identified upstream of the culvert crossing in early August. Based on these assessments, upstream access to overwintering habitat in Grenier Lake would likely require extensive enhancements to address passage issues at and upstream of the culvert crossing location. Depending on the amount and locations of overwintering habitat provided by ponds along the East Outflow, enhancements could be constructed that allow access to these habitats from areas in the East Outflow where fish currently become stranded.

Depending on the enhancement location(s) selected, proposed methods for improving migratory potential and success in the East Outflow would be through construction of migration channels and/or potentially through modifications to perched culverts at the road crossing location. Migration channels would be constructed in areas where water depth is insufficient for fish passage under certain flow conditions. The locations and design of the migration channels would incorporate TK through consultation with knowledge holders during the design and construction phases. The channels would be engineered for permanence, with the objective of maintaining stability over time despite flow, snow, and ice influences. Channel design would also consider how these influences may be changing over time (e.g., due to climate change). Because not all potential and temporary barriers locations were identified and assessed in 2018, construction techniques that may be required to create migration channels are unknown. Depending on the characteristics of the barriers (e.g., type, length, permanence, etc.) manual techniques, heavy or specialized machinery, and/or blasting may be required for construction of the enhancements.

Modification to the road crossing location would require an engineered design that would be based on measured and modelled stream flows. It would allow for fish passage under all flow conditions and prevent wash out of the road. The new design may employ culverts or a bridge structure. The locations and design of a new crossing structure will incorporate traditional knowledge through consultation with knowledge holders during the design and construction phases. Construction will require heavy and specialized machinery.

According to DFO’s Fisheries Productivity Investment Policy, proposed offsets should not address environmental damage for which another person or organization is clearly responsible. The restoration of orphaned sites (those with no known responsible party or owner or with no possibility of restoration due to company closure, bankruptcy, or other similar circumstance) may be considered an appropriate offsetting measure. In order to evaluate whether modification to the culverts on the Ovayok Territorial Park road to improve migratory habitat for fish would constitute an appropriate offsetting measure, consideration of the ownership of/party responsible for the culverts and the potential for the current owner/responsible party to rectify fish passage issues resulting from the culverts, is required.

The road at the culvert location is within the municipal boundary of the Hamlet of Cambridge Bay on Commissioner’s Land. This is land owned and administered by the Government of Nunavut (GN) on behalf of the community. The GN can only dispose of Commissioner’s Land with the municipalities’ consent. Therefore, the Hamlet of Cambridge Bay is involved in the management of the road by means of decisions on its ownership. However, overall the owner/responsible party for the road (and culvert crossing) is likely the GN Department of Community and Government Services through their Planning and Lands Division. Given that the road terminates in a Territorial Park, and the main interest in the road is for

park development, the GN Department of Economic Development and Transportation would also likely be a key client department with respect to any modifications to the road/culvert crossing.

Further investigation into the potential for the GN to undertake activities to restore fish passage at the culvert crossing would be necessary to determine the potential of enhancement activities at the site to be used as offsetting. Additionally, on-going ownership/responsibility, following any enhancement activities would have to be considered including requirements and responsibility for monitoring and long-term maintenance.

It is anticipated that improving migratory access between rearing and overwintering habitats for Arctic Char and Lake Trout in the East Grenier Lake Outflow will result in increases in fisheries production in the Grenier Lake system. The fisheries benefits anticipated from this candidate offsetting option rely on the assumption that migratory potential for juvenile fish rearing in the East Outflow to reach overwintering habitats acts as a limiting factor to fisheries productivity. Fish passage in the East Outflow was impeded at multiple locations as early as August 1, 2018 and fish were observed to be stranded in a small pond downstream of the culvert crossing at that time. These observations suggest that fisheries productivity losses may result from fish that become stranded and are unsuccessful in returning to overwintering habitats during the limited period of the open-water season (June and July) during which fish passage is unobstructed.

5.2.1.5 Community Involvement

This candidate offsetting option provides local opportunities for community involvement in all stages of the offsetting program. Traditional knowledge input would be required during the selection of locations for migration channels and/or the design of modifications to the road crossing. Elders and other knowledge holders would be consulted regarding the selection of locations for migration channels and regarding design characteristics such as their lengths, widths, and required water depths. Additionally, input would be sought regarding the selection and design of a road crossing structure (i.e., culvert vs. bridge) such that it would be appropriate for maintaining fish passage and access to fishing locations for land users. Elders and other knowledge holders could also contribute information for implementation of any necessary mitigation measures during or after construction and for the planning of construction timing.

Due to the proximity of the candidate site to Cambridge Bay, there is also potential for local community involvement during construction, maintenance, and monitoring of the program. Elders or other knowledge holders could be present during construction to act in advisory roles. Elders would provide oversight to teams working from design plans allowing their suggestions for improvements and modifications to be implemented throughout the construction process. As suggested by participants during the Fisheries Offsetting Workshop in June 2018, if present on site, Elders could indicate which rocks should be moved and where to place rocks to maximize fish passage in migration channels (ERM 2018). Local youth would assist in manual construction process as well as helping to implement any necessary mitigation measures (e.g., erosion or sedimentation control).

Local youth could also be trained to assist technical staff during the post-enhancement monitoring program. This work would provide opportunities to build skills such as data recording techniques, quantitative fisheries monitoring and fish handling methods, fish habitat assessment, stream hydrology, and water quality sampling. Youth involvement would build capacity for fisheries management and environmental monitoring in the region.

5.2.1.6 Next Steps

If an offsetting option at in the Grenier Lake East Outflow is pursued further, the next step would be to engage with stakeholders and seek feedback on the proposed options for the offsetting approach. This feedback will inform the design of baseline studies as well as the planning, and implementation of an

enhancement project. Specifically, engagement with DFO is recommended regarding the ownership of/party responsible for the culvert crossing and the potential for enhancement efforts at this location to be accepted toward meeting offsetting requirements. Potential field survey needs in 2019 and may include site visits by traditional knowledge holders, an engineering assessment, fish community, and additional fish habitat surveys.

Site visits by Elders and other traditional knowledge holders could be conducted to gather further information on site suitability for implementation of enhancements and monitoring as well as feedback on anticipated fisheries benefits. A survey of the East Outflow by a fisheries habitat restoration engineer may be used to assess the technical feasibility of constructing functional and permanent migratory channels and help to define the construction techniques that would be required. Fish community and fish habitat surveys in 2019 would constitute the first year of formal baseline data collection. Fish community surveys may include gillnetting surveys in Grenier Lake and in the ponds along the East Outflow channel. Monitoring of fish migration and habitat use in the outflow using fish fences, tagging, and/or electrofishing surveys may be performed. Fish habitat surveys in ponds along the East Outflow may include bathymetric, littoral, and sublittoral habitat surveys to quantify overwintering habitat potential. Stream fish habitat surveys may include installation of a hydrometric station to collect baseline streamflow data and detailed habitat assessments under different flow conditions. Results of baseline surveys will contribute to the quantification of the potential fisheries benefit of an offsetting program in the Grenier Lake East Outflow system. The potential fisheries benefit of an offsetting project must be quantified in order to ensure that offsets are commensurate with fisheries losses.

5.2.2 Kitiga Outflow

5.2.2.1 Site Description

Approximately 50 km northwest of Cambridge Bay and approximately 125 km north of the Doris Mine site, Kitiga Outflow flows west into Wellington Bay (Figure 5.2-3). The length of the outflow stream is approximately 17 km with multiple small tributaries that have the potential to provide fish habitat. A small falls (Kitiga Falls) is located approximately 3 km upstream from Wellington Bay but does not act as a permanent barrier to upstream fish passage. Upstream, Kitiga has an area of approximately 11,000 ha. Anadromous Arctic Char are harvested from Kitiga and the Kitiga Outflow by local land users.

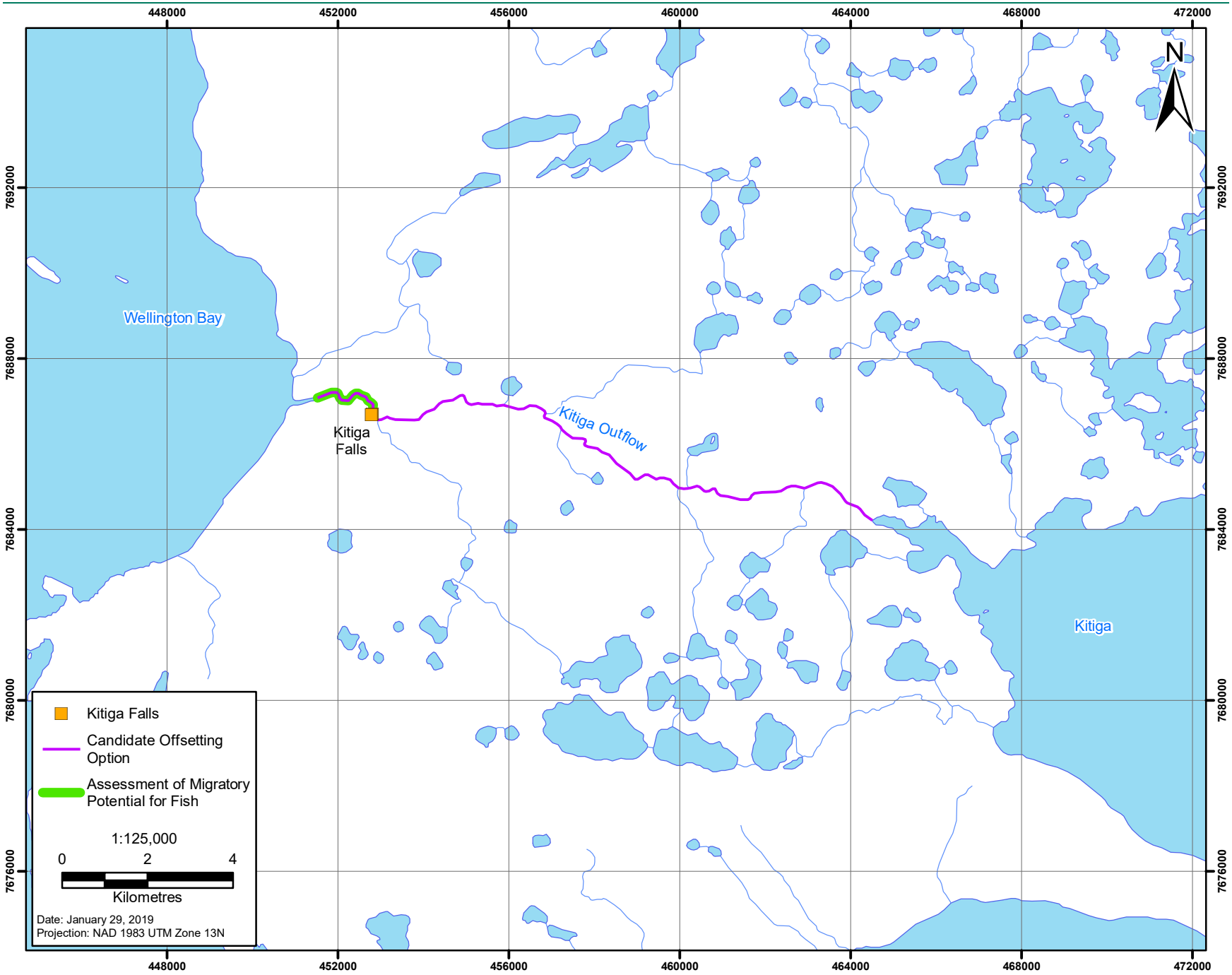


Figure 5.2-3: Kitiga Outflow

5.2.2.2 Assessment Details

Kitiga Outflow was visited on August 2, 2018. Kitiga was accessed by ATV from Cambridge Bay and due to the distance travelled to reach the site and the length of the Kitiga Outflow, fish habitat along the entire stream could not be feasibly assessed by FHAP methods. Additionally, flow and water depth conditions on the site prevented detailed assessment measurements of the channel as it was not safe to wade across, nor walk down the steep banks along certain sections. Instead, a visual assessment of migratory potential along the 3 km of the channel between Wellington Bay and Kitiga Falls was conducted by travelling along the channel by ATV (Figure 5.2-3). Locations considered to have the potential to act as barriers to fish passage were assessed by detailed surveys of the channel and any fish observed were noted. Streamflow in Kitiga Outflow was too high to safely perform a manual discharge measurement on the survey date.

5.2.2.3 Results and Observations

Traditional and Local Knowledge

Kitiga Outflow was identified as a candidate offsetting option by academic researchers performing work on migratory Arctic Char populations in the area. In particular, it was suggested that Kitiga Falls may be acting as a potential barrier to upstream fish migration as flows recede later in the open-water season (J.-S. Moore, personal communication, May 2018). The field reconnaissance visit on August 2, 2018 was conducted with the support of a local guide from Cambridge Bay. He indicated that many local land users from Cambridge Bay fish at weirs in Kitiga Outflow each year in the first week of July (i.e., Canada Day holiday weekend; W. Nakashook, personal communication, August 2, 2018). At this time, Arctic Char in the rivers that flow into Wellington Bay are anticipated to be transitioning from freshwater to marine environments (Moore et al. 2016).

Fish Habitat

Migratory assessment data collected in Kitiga Outflow are presented in Appendix B (Table B-2) with photos of notable features presented in Appendix C. On the habitat survey date in early August, migratory habitat was rated as good throughout the survey reach. Although a drop in stream surface elevation was observed at Kitiga Falls, it was not considered sufficient to prevent upstream fish passage. Additionally, small steps at locations across the channel and along the right bank would have facilitated passage over the drop (Photo 5.2-6). Large weirs that spanned the majority of the channel width were located approximately 200 m and 400 m downstream of Kitiga Falls (Photo 5.2-7). Due to logistical constraints, the site was not revisited in September. Therefore, the migratory potential at Kitiga Falls later in the open-water season in 2018 was not directly assessed.

Photo 5.2-6: Kitiga Falls (HU 8), facing across from left bank, Kitiga Outflow (August 2, 2018; UTM 13 7686708 452799).

Photo 5.2-7: Fish weirs (HU 2, facing across from left bank, Kitiga Outflow (August 2, 2018; UTM 13 7687045 452710).

Fish Community

No fish were observed during the fish habitat survey on August 2, 2018 but multiple fish weirs had been constructed by local land users in the surveyed reach. These weirs and local knowledge demonstrate the importance of Kitiga Outflow as a fishing location for local land users. The local knowledge provided suggests that fishing in Kitiga Outflow frequently targets fish migrating in early July, while the level and frequency of fishing activity later in the season was unknown (W. Nakashook, personal communication, August 2, 2018).

Flow

Streamflow and water depth in Kitiga Outflow was too high to safely perform a manual discharge measurement on the survey date. Assuming the annual flow pattern in Kitiga Outflow reflects conditions in other streams in the region (i.e., Freshwater Creek and Doris Creek; Figure 4.1-1), flow peaked in early June 2018 and by the time of the early August survey had likely already receded to less than a quarter of its peak discharge. Based on the conditions observed and migratory habitat quality recorded during the early August survey, flows provided adequate habitat for fish to move from the marine environment upstream past Kitiga Falls. The site was not revisited in September, and therefore migratory potential was not confirmed.

5.2.2.4 Proposed Approach to Offsetting

Field reconnaissance surveys conducted in early August 2018 identified no barriers to fish passage on Kitiga Outflow, from Wellington Bay up to and including Kitiga Falls. Therefore, reconnaissance surveys failed to identify areas in Kitiga Outflow for the implementation of fish habitat enhancements for migrating fish. Further, at the time of the survey, Kitiga Outflow was too deep and wide to wade across. Instream fish habitat assessment measurements and manual discharge measurements were not taken in the surveyed reach because access would not have been safe. Given the size and morphology of Kitiga Outflow, the implementation of permanent enhancements using manual techniques (preferred over use of equipment or blasting) may not be technically feasible. Further, work in Kitiga Outflow may result in access and safety challenges. Overall, the potential to implement a fisheries offsetting program at Kitiga Outflow is considered low at this time.

5.2.2.5 Community Involvement

Given that no enhancement options were identified in Kitiga Outflow, the potential for community involvement in the planning, implementation, and monitoring of an offsetting project at this site has not been further considered at this time.

5.2.2.6 Next Steps

No opportunities for development of an offsetting option at Kitiga Outflow were identified based on 2018 field reconnaissance surveys. However, the next step will be to engage with stakeholders and seek feedback on the results of the 2018 field surveys at this site. This feedback may provide additional information on factors limiting fisheries productivity in the Kitiga system and further consideration of the site as a candidate offsetting option.

5.2.3 Aggiak Outflow

5.2.3.1 Site Description

Approximately 30 km north of Cambridge Bay and approximately 150 km northeast of the Doris Mine site, Aggiak Outflow flows north into Ferguson Lake (Figure 5.2-4). Ferguson Lake is connected to the marine

environment where it flows into Wellington Bay, approximately 50 km west of Aggiak. The length of the Aggiak Outflow stream is approximately 3 km with no tributaries that provide fish habitat. Upstream, Aggiak has an area of approximately 1,300 ha. Anadromous Arctic Char utilize spawning and overwintering habitat in Aggiak by migrating from Wellington Bay through Ferguson Lake. Arctic Char that use Ferguson Lake (and potentially Aggiak) are harvested as part of a commercial fishery that operates in the Ekalluk River which connects Ferguson Lake to the marine environment (DFO 2014).

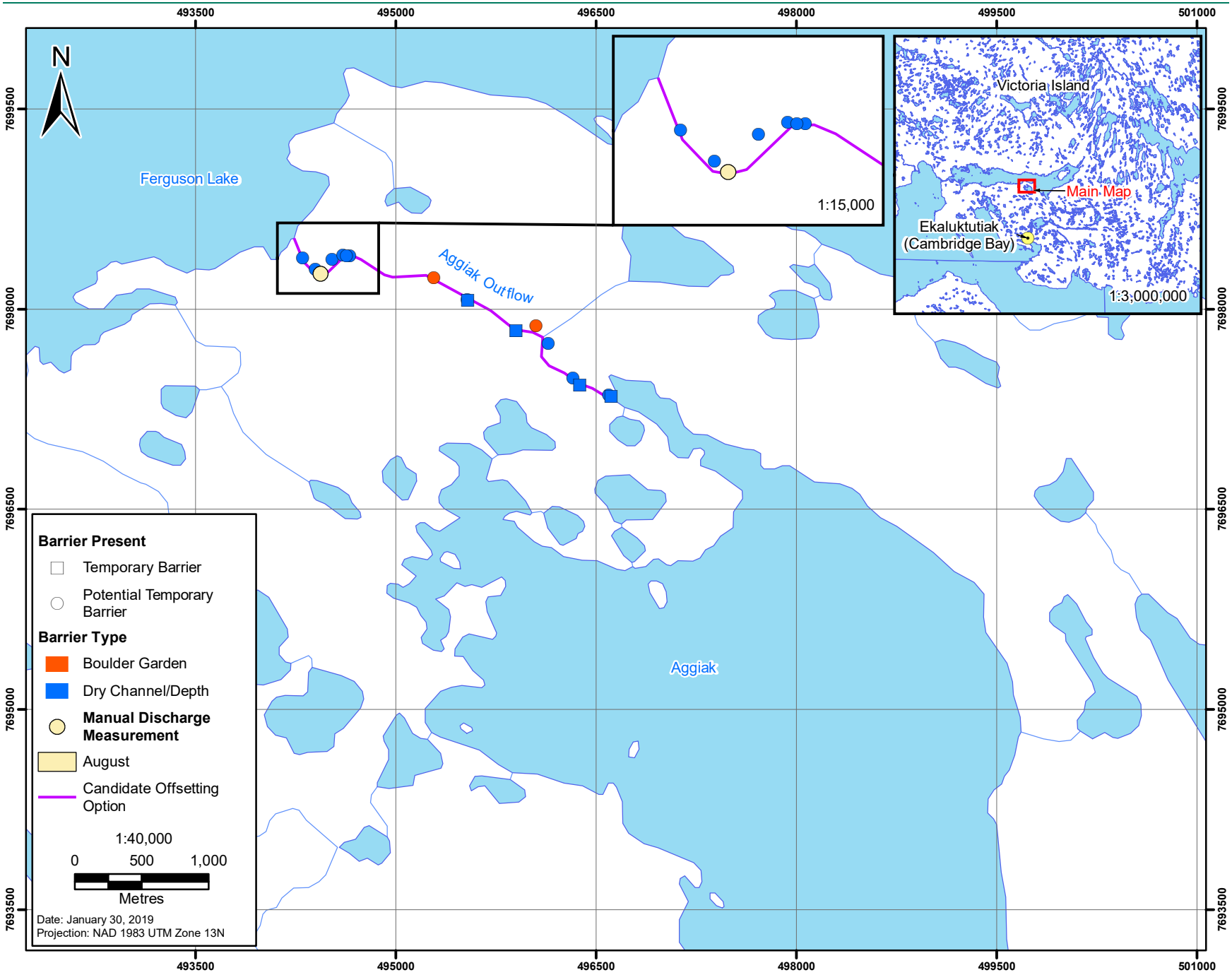


Figure 5.2-4: Aggiak Outflow

5.2.3.2 Assessment Details

Aggiak Outflow was visited on August 3, 2018 and on September 27, 2018. Aggiak was accessed by ATV from Cambridge Bay and because of the distance travelled to reach the site and the length of the Aggiak Outflow, fish habitat along the entire length of stream could not be feasibly assessed by FHAP methods on the survey dates. Instead, an assessment of migratory potential along the entire channel between Ferguson Lake and Aggiak was conducted on each survey date by travelling along the stream by ATV. In August, locations considered to have the potential to act as barriers to fish passage were assessed by detailed surveys of the channel and any fish observed were noted. The onset of freeze-up conditions during the September survey generally prevented detailed assessment of stream habitats however, where possible, habitat features were identified and assessed. A manual discharge measurement was performed on August 3, 2018, 340 m upstream from Ferguson Lake (Figure 5.2-4). Frozen stream conditions on September 27, 2018 prevented manual discharge measurement.

5.2.3.3 Results and Observations

Traditional and Local Knowledge

Aggiak Outflow was identified as a candidate offsetting option by DFO researchers performing work on migratory Arctic Char populations in Ferguson Lake and Aggiak. In particular, it was indicated that there is a limited period early in the open-water season during which upstream migration between Ferguson Lake and Aggiak is possible for returning anadromous Arctic Char (L. Harris, personal communication, July 2018; M. Gilbert, personal communication, July 31, 2018). DFO is conducting on-going research at Aggiak, including bathymetry and telemetry studies in 2018 and 2019 and information about the fish community in Aggiak, as provided by a DFO research collaborator, is summarized in the following sections. (M. Gilbert, personal communication, July 31, 2018). No additional traditional or local knowledge was collected during field reconnaissance surveys in 2018.

Fish Habitat

Migratory assessment data collected in Aggiak Outflow are presented in Appendix B (Table B-2) with photos of potential and observed barriers to fish passage presented in Appendix C. On the habitat survey date in early August, migratory potential was assessed at 16 locations along the outflow channel where it was rated as good in 37% and fair in 63%. Twelve of the locations were assessed as having the potential to act as barriers to fish passage at lower flow conditions; nine due to low flows resulting in insufficient water depth for fish migration and three due to boulder garden features that could block fish passage (Figure 5.2-4; Photo 5.2-8). On the habitat survey date in late September, stream habitat was assessed at 13 locations along Aggiak Outflow. The survey took place during the onset of freeze-up conditions and, as expected in Arctic streams that freeze to the bottom in winter, there was no migratory potential between Ferguson Lake and Aggiak (Photo 5.2-9). Due to frozen stream conditions, migratory habitat quality could only be assessed by methods consistent with the August survey at four locations (i.e., where gaps in the ice allowed water depth and substrate composition to be determined). The migratory potential at all four locations was rated as poor or none and each was considered a temporary barrier to fish passage, primarily due to maximum water depths of less than 15 cm and average water depths less than 10 cm (Photo 5.2-10).

Photo 5.2-8: Riffle habitat (HU 9), identified as potential depth barrier to fish migration, facing upstream, Aggiak Outflow (August 3, 2018; UTM 13 7698398 494628).

Photo 5.2-9: Frozen conditions in Aggiak Outflow (HU 7), facing upstream (September 27, 2018; UTM 13 7697839 495901).

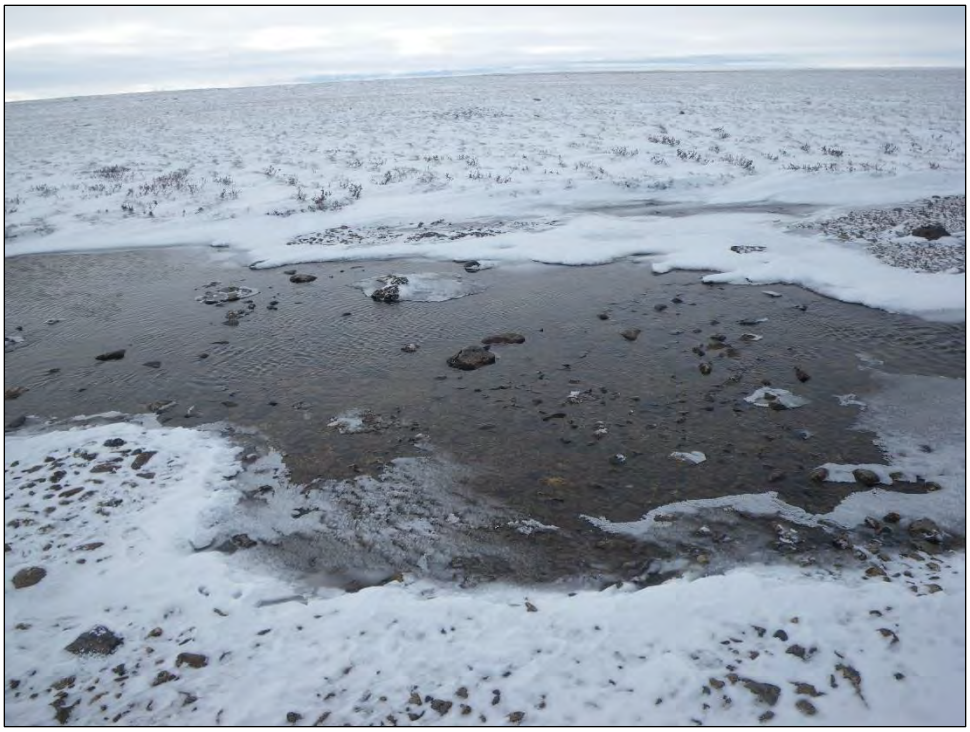


Photo 5.2-10: Glide habitat (HU 5), a temporary depth barrier to fish migration, facing across from right bank, Aggiak Outflow (September 27; UTM 13 7697839 495901).

Fish Community

No fish were observed during fish habitat surveys in Aggiak Outflow. Prior to the August field reconnaissance survey, the following information on the Aggiak Arctic Char population was provided by a DFO research collaborator (M. Gilbert, personal communication, July 31, 2018). Anadromous Arctic Char that spawn in Aggiak have adapted to low flow and water depth conditions in Aggiak Outflow through adaptations to their migration timing. Aggiak is used by anadromous Arctic Char for spawning and fish emerge and rear in Aggiak before migrating to the marine environment at between five and seven years of age. These fish do not return to Aggiak until they are ready to spawn and only overwinter in Aggiak in spawning years. The year prior to spawning they overwinter in Ferguson Lake. Spawning migration thus consists of entering Ferguson Lake in the fall, overwintering in Ferguson Lake, then moving upstream to Aggiak very early the next spring, when flows are sufficient for upstream passage. Fish then remain in Aggiak to spawn in the fall and to overwinter. The following spring, they outmigrate from Aggiak during early season high flows, and return to the ocean through Ferguson Lake. Additional information on the presence and abundance of fish species besides Arctic Char in Aggiak was not available.

Flow

Results of the manual discharge measurement taken at Aggiak Outflow on August 3, 2018 are presented in Appendix D (Table D-9). Assuming the annual flow pattern in Aggiak Outflow reflects conditions in other streams in the region (i.e., Freshwater Creek and Doris Creek; Figure 4.1-1), flow peaked in early June 2018 and by the time of the early August survey had likely already receded to less than a quarter of its peak discharge. Based on the flow conditions observed and migratory habitat quality recorded during the early August survey, it is considered likely that multiple barriers to fish passage would be present in Aggiak Outflow by the time base flows are reached in mid-August.

5.2.3.4 Proposed Approach to Offsetting

Background information and field reconnaissance surveys in 2018 resulted in identification of two potential objectives for a fisheries offsetting project in the Aggiak system. One potential objective is to enhance the migratory potential of Arctic Char between Ferguson Lake and spawning habitats in Aggiak. Another potential objective is to enhance spawning and/or rearing habitats in Aggiak for returning spawners and for juvenile fish. One or both of these objectives may be incorporated into the offsetting approach for Aggiak and defining this approach will rely on engagement with stakeholders, particularly local land users, as well as DFO scientists and collaborators conducting on-going research in Aggiak. Additional studies of the fish population and fish habitat of Aggiak and Aggiak Outflow may also contribute to selection of the offsetting objectives and approach.

The proposed method for improving migratory potential and success in Aggiak Outflow would be through construction of migration channels. These channels will be constructed in areas where water depth is insufficient for fish passage or where boulder garden habitat features block passage under certain flow conditions. A similar approach using the construction of migration channels through a boulder garden feature has been effectively used to improve migratory success for Arctic Char at the Roberts Lake Outflow near the Hope Bay Project (Figure1-1; ERM 2016). The locations and design of the migration channels would incorporate TK through consultation with knowledge holders during the design and construction phases. The channels would be engineered for permanence, with the objective of maintaining stability over time despite flow, snow, and ice influences. Channel design would also consider how these influences may be changing over time (e.g., due to climate change). Based on initial assessments of substrates at potential and temporary barrier locations, heavy or specialized machinery are not anticipated to be required for construction of the enhancements.

Improving migratory potential and success for Arctic Char in Aggiak Outflow may result in increases in fisheries production in the Aggiak system. The fisheries benefits anticipated from this candidate offsetting option rely on the assumption that migratory potential between Ferguson Lake and Aggiak acts as a limiting factor to fisheries productivity. Although the Arctic Char population appears to have adapted to low flow conditions later in the open-water season through alteration to migration timing, it is still possible that some fish stranding occurs resulting in productivity losses. Construction of migration channels may reduce stranding as well as extend the period over which migration is possible with predicted positive effects on productivity. However, extending the migration window between Ferguson Lake and Aggiak could also pose potential risks to fish populations in Aggiak if it also improves migratory success for large fish that may act as predators to rearing juveniles. In general, more baseline information on Arctic Char migration in Aggiak Outflow and the fish community of Aggiak is required to determine the potential benefit of migratory enhancements.

The proposed method for enhancing spawning and rearing habitats in Aggaik would be through construction of rock shoals in lake habitats. Emergent juvenile Arctic Char must migrate from spawning beds to rearing habitats, and then make annual migrations between summer rearing habitats and overwintering locations. Throughout their juvenile life, fish are exposed to predation pressure from larger fish. Adding habitat features that provide cover for juveniles as they migrate between critical habitat areas (e.g., between summer rearing and overwintering habitats, or between spawning beds and rearing habitats) would help improve productivity by reducing predation pressure. Habitat features, such as rock shoals could be used in locations where juveniles are particularly exposed, providing structure and interstitial habitat (i.e., cover) for feeding and hiding. Depending on the bathymetry and substrate composition in Aggiak, gravel beds for spawning Arctic Char, located in deeper water (i.e., below the maximum depth of the winter ice cover of approximately 3 m), may also be limited. If so, providing gravel shoals in these deeper habitats would create appropriate spawning habitat in which eggs can survive over winter.

Rock shoals would be constructed by placing rock substrates at surveyed locations on the ice during winter and letting them settle into place during ice melt. This method was used to construct rock shoals in Roberts Bay as compensation for habitat lost during construction of the Roberts Bay Jetty (Rescan 2009, 2010b). The locations and design of the spawning and/or rearing shoals would incorporate TK through consultation with knowledge holders during the design and construction phases. The size of rock and locations of the shoals would be selected based on the intended enhancement objective of the shoals (i.e., rearing vs. spawning). Specialized equipment will likely be required for moving rock during enhancement construction.

Improving the quantity and quality of spawning and/or rearing habitats for Arctic Char in Aggiak may result in increases in fisheries production in the Aggiak system. The fisheries benefits anticipated from this candidate offsetting option rely on the assumption that quality of and/or access to these habitats act as limiting factors to fisheries productivity. Additional baseline information on the fish community, bathymetry, and substrate composition of Aggiak is required to determine the potential fisheries benefit of enhancements to rearing and/or spawning habitats.

5.2.3.5 Community Involvement

This candidate offsetting option provides local opportunities for community involvement in all stages of the offsetting program. Traditional knowledge input would be required during planning and design phases. Elders and other knowledge holders would be consulted regarding the selection of locations for migration channels and regarding design characteristics such as their lengths, widths, and required water depths. Additionally, input would be sought regarding the location and design of a rock shoals including their placement in the lake (i.e, depth and orientation), the size of substrates used, and the dimensions of each shoal. Elders and other knowledge holders could also contribute information for implementation of any necessary mitigation measures during or after construction and for the planning of construction timing.

Due to the proximity of the candidate site to Cambridge Bay, there is also potential for local community involvement during construction, maintenance, and monitoring of the program. Elders or other knowledge holders could be present during construction to act in advisory roles. Elders would provide oversight to teams working from design plans allowing their suggestions for improvements and modifications to be implemented throughout the construction process. As suggested by participants during the Fisheries Offsetting Workshop in June 2018, if present on site, Elders could indicate which rocks should be moved and where to place rocks to maximize fish passage during the construction of migration channels (ERM 2018). Local youth could assist in the manual construction process as well as helping to implement any necessary mitigation measures (e.g., erosion or sedimentation control). For the construction of shoals, Elders could be present during baseline bathymetric and substrate surveys to provide knowledge of fish habitat use in the lake to contribute to selection of effective locations for shoal placement.

Local youth could also be trained to assist technical staff during the post-enhancement monitoring program. This work would provide opportunities to build skills such as data recording techniques, quantitative fisheries monitoring and fish handling methods, fish habitat assessment, bathymetric surveys, stream hydrology, and water quality sampling. Youth involvement would build capacity for fisheries management and environmental monitoring in the region.

5.2.3.6 Next Steps

If an offsetting option at Aggiak is pursued further, the next step would be to engage with stakeholders and seek feedback on the proposed options for the offsetting approach. This feedback will inform the design of baseline studies as well as the planning, and implementation of an enhancement project. Specifically, engagement with stakeholders would seek feedback on the potential benefits of enhancing migratory access in Aggiak Outflow where Arctic Char have already adapted migration timing to current

flow conditions. Additionally, engagement with DFO on the current state of research in the Aggiak system and potential opportunities for collaboration is recommended. Field surveys should be continued in 2019 but the extent of field efforts may depend on data shared by DFO and their research collaborators. Potential field survey needs in 2019 and may include site visits by traditional knowledge holders, an engineering assessment, fish community, and additional fish habitat surveys.

Site visits by Elders and other traditional knowledge holders could be conducted to gather further information on site suitability for implementation of enhancements and monitoring as well as feedback on anticipated fisheries benefits. A survey of the Aggiak Outflow by a fisheries habitat restoration engineer may be used to assess the technical feasibility of constructing functional and permanent migratory channels and help to define the construction techniques that would be required. Fish community and fish habitat surveys in 2019 would constitute the first year of formal baseline data collection. Fish community surveys may include gillnetting surveys in Aggiak Lake, and monitoring of fish migration and habitat use in the outflow using fish fences, tagging, and/or electrofishing surveys. Lake fish habitat surveys may include bathymetric, littoral, and sublittoral habitat surveys. Stream fish habitat surveys may include installation of a hydrometric station to collect baseline streamflow data and detailed habitat assessments under different flow conditions.

Results of baseline surveys will contribute to the quantification of the potential fisheries benefit of an offsetting program in the Aggiak system. The potential fisheries benefit of an offsetting project must be quantified in order to ensure offsets are commensurate with fisheries losses.

5.3 Additional Conceptual Options

In addition to candidate offsetting sites visited during field reconnaissance surveys in 2018, one conceptual offsetting option is described and evaluated.

5.3.1 Artificial Marine Rock Shoals

5.3.1.1 Site Description

The incorporation of self-offsetting habitat through the consideration of adding riprap/stone armouring around the perimeter at proposed in-water Project infrastructure (i.e., the marine cargo dock in Roberts Bay) or offsetting through the installation of artificial rock shoals in fine sediment subtidal habitats were proposed as part of the FEIS (Appendix V5-10G; TMAC 2017). Construction of artificial marine rock shoals is further considered as part of this report in order to incorporate offsetting options from both marine and freshwater environments. Although self-offsetting would be limited to the area on or adjacent to in-water infrastructure, specific locations for the placement of rock shoals have not yet been identified. These could be located near the potential habitat loss (i.e., near the in-water infrastructure), or in a location further afield that may benefit more greatly from habitat enhancement. Because no specific locations have been identified, potential sites were not visited in 2018. Therefore, no assessment methods or results are presented and the proposed approach to offsetting, potential opportunities for community involvement, and proposed next steps are described without consideration of a specific enhancement location.

5.3.1.2 Proposed Approach to Offsetting

The majority of shallow sub-tidal habitat found in the marine environment near Hope Bay (i.e., in Roberts Bay) consists of non-complex and non-limiting substrates (i.e., fines and mud; Rescan 2010a, 2011a) which provides low structural complexity and uniform habitat for colonization by algae, vegetation, benthic invertebrates and fish. The objective of a fisheries offsetting project in these habitats would be to enhance fisheries productivity through the creation of high quality, diverse, and structurally complex substrates.

The introduction of complex substrates with high surface areas has been demonstrated to be useful in sediment bottom areas where no other hard substrates exist (Sherman, Gilliam, and Speiler 2002). A greater surface area provides enhanced biomass potential because it may support higher densities of algae and invertebrates through a greater area available for colonization. One main benefit of planned, artificial reefs/shoals is to attract local fish to a known location where habitat is suboptimal. Artificial reefs/shoals can create an 'oasis-like' environment that provides shelter from predation, increased feeding efficiency and opportunity, and additional habitat (Smiley 2006).

Generally artificial reefs/shoals are intended to create an ecosystem containing a large diversity of organisms. Habitat complexity, the number of areas occupied by distinct habitat types, is directly related to the diversity of species using artificial reef structures (Protocol/UNEP 2009). Structurally diverse and large reefs (e.g., structures with holes, overhangs, and shadows) provide more opportunity for animals and algae to colonize and thus may lead to a higher local biological diversity (Menge and Sutherland 1976). Cavities provide refuge from predators for a variety of species and life stages. Particularly useful is the creation of ledges, crevices, and similar shelter sites within these artificial structures (Ebata et al. 2011). Gadids (cod) and Cottids (sculpins) are particularly attracted to complex hard substrates (Tupper and Boutilier 1995).

The creation of three-dimensional subtidal habitat as an offsetting measure can take many forms including artificial reefs, habitat skirting, articulating ballast mats, and/or placement of other three-dimensional rock structure configurations. Regardless of the method for creating three dimensional structures, the created habitat provides hard and rough surfaces where algae and invertebrates colonize and provide resources for fish populations, thereby increasing overall ecosystem productivity (Hueckel and Stayton 1982; Hueckel and Buckley 1987; Clynick, Chapman, and Underwood 2007).

The locations and design of the shoals would incorporate TK through consultation with knowledge holders during the design and construction phases. The size of rock and locations of the shoals would be selected based on the fish community at the enhancement site. The incorporation of self-offsetting habitat could be considered through the addition of riprap/stone armouring around the perimeter of in-water marine Project infrastructure (i.e., the proposed marine cargo dock). Habitat additions may also be constructed through installation of artificial rock shoals (artificial rock reefs) in subtidal habitat. Rock shoals would be constructed by placing rock substrates at surveyed locations on the ice during winter and letting them settle into place during ice melt. This method was used to construct rock shoals in Roberts Bay as compensation for habitat lost during construction of the Roberts Bay Jetty (Rescan 2009, 2010b). Specialized equipment will likely be required for moving rock during enhancement construction.

Improving structural complexity in subtidal habitats is anticipated to result in increases in fisheries production through colonization by algae, vegetation, invertebrates, and fish. The successful process of colonization has been documented locally on the Roberts Bay jetty and compensation shoals (Rescan 2009, 2010b). Additional baseline information on the fish community, bathymetry, and substrate composition at the proposed enhancement site would be required to determine the potential fisheries benefit of enhancements.

5.3.1.3 Community Involvement

Depending on the location selected for enhancement, this candidate offsetting option may provide opportunities for community involvement in all stages of the offsetting program. Traditional knowledge input would be required during planning and design phases. Elders and other knowledge holders would be consulted regarding the selection of locations for artificial rock shoals and regarding design characteristics such as depth, orientation, size of substrates used, shape, and the dimensions of each shoal. Elders and other knowledge holders could also contribute information for implementation of any necessary mitigation measures during or after construction and for the planning of construction timing.

There is also potential for local community involvement during construction, maintenance, and monitoring of the program. Elders or other knowledge holders could be present during construction to act in advisory roles. Elders would provide oversight to teams working from design plans allowing their suggestions for improvements and modifications to be implemented throughout the construction process. Local youth could assist in implementation of any necessary mitigation measures. Elders could also be present during baseline bathymetric and substrate surveys to provide knowledge of fish habitat use in the subtidal zone to contribute to selection of effective locations for shoal placement.

Local youth could be trained to assist technical staff during the post-enhancement monitoring program. This work would provide opportunities to build skills such as data recording techniques, quantitative fisheries monitoring and fish handling methods, fish habitat assessment, and bathymetric surveys. Youth involvement would build capacity for fisheries management and environmental monitoring in the region.

5.3.1.4 Next Steps

If an offsetting option constructing shoals in the marine environment is pursued further, the next step would be to engage with stakeholders and seek feedback on the proposed options for the offsetting approach. This feedback will inform the design of baseline studies as well as the planning, and implementation of an enhancement project. Specifically, engagement with stakeholders would seek feedback on the potential locations of marine shoal enhancements (e.g., near the potential habitat losses at the Hope Bay Project, near a community, near another potential offset project). Potential field survey needs in 2019 and may include site visits by traditional knowledge holders, fish community, and fish habitat surveys.

Once a potential site is selected, site visits by Elders and other traditional knowledge holders could be conducted to gather further information on site suitability for implementation of enhancements and monitoring as well as feedback on anticipated fisheries benefits. Depending on the location selected, fish community and fish habitat surveys in 2019 may constitute the first year of formal baseline data collection. Fish community surveys may include gillnetting, crab trapping, minnow trapping, and/or snorkel surveys in the potential enhancement area. Habitat surveys may include bathymetric, intertidal, and subtidal habitat surveys.

Results of baseline surveys will contribute to the quantification of the potential fisheries benefit of an offsetting program through construction of artificial marine rock shoals. The potential fisheries benefit of an offsetting project must be quantified in order to ensure offsets are commensurate with fisheries losses.

6. SUMMARY AND RECOMMENDATIONS

The characteristics of each candidate fisheries offsetting option (including the marine shoals conceptual option) have been summarized and evaluated according to a set of high level criteria (Tables 6 -1 and 6-2). Tables 6-1 and 6-2 include the site location and the objectives and approach to offsetting as presented in Sections 5.1 and 5.2.

The criteria evaluated in Table 6-1 are based on the candidate offsetting project meeting the goals and objectives outlined in the DFO Fisheries Productivity Investment Policy (DFO 2013a) and include the DFO hierarchy for offsetting methods, the potential fisheries benefits, and local/regional fisheries management objectives. The DFO hierarchy for offsetting methods is based on DFO's order of preference for the type of offsetting measures applied as outlined in Section 2.3.2. Habitat restoration/enhancement and habitat creation are generally preferred over chemical/biological manipulations or complimentary measures. The potential fisheries benefits of each candidate offsetting option are summarized based on the target species anticipated to benefit from an offset as well as the anticipated mechanism that will result in an

increase in fisheries productivity. Finally, local/regional fisheries management objectives supported by the candidate option are summarized under two categories including DFO integrated fisheries management plans and local fisheries management priorities (as described in Section 3.3).

The criteria evaluated in Table 6-2 are based on stakeholder feedback expressing key fisheries offsetting goals during the Fisheries Offsetting Workshop in June 2018. These include the potential to incorporate TK and IQ during site selection, planning, and design, opportunities for engagement and capacity building for local youth and Elders, and the use of non-invasive construction methods to implement an offsetting project. Participants at the Fisheries Offsetting Workshop expressed the importance of youth and Elder involvement during decision-making processes associated with the selection of an offsetting project. The selection of appropriate sites “to provide equal habitat offset”, and the incorporation of IQ and traditional knowledge during habitat enhancement planning and design was also emphasized. Another consideration discussed was the need to create long-term local engagement, capacity building, and training opportunities. Finally, a preference for the use of manual techniques during implementation of habitat enhancement activities was highlighted (i.e., habitat modification by hand rather than blasting or use of equipment). The potential for each candidate offsetting site to meet these stakeholder goals is summarized and evaluated in Table 6-2.

Table 6-1: Candidate Offsetting Site Evaluation Criteria: Fisheries Productivity Investment Policy

Area	Site	Location	Offsetting Objective	Offsetting Approach	DFO Hierarchy for Offsetting Method		Potential Fisheries Benefit			Supports Local/Regional Fisheries Management Objectives			
					Method	DFO Preference	Target Species	Benefit	Potential	DFO Integrated Fisheries Management Plans	Potential	Local Fisheries Management Priorities	Potential
Hope Bay Project	Tahilugyuak Outflow	25 km from Doris Mine 100 km from Cambridge Bay	Enhance migratory potential for anadromous Arctic Char and Lake Trout	Construction of migration channels in locations where migratory potential is poor.	Habitat enhancement	Preferred	Arctic Char and Lake Trout	Increase in fisheries production by improving migratory success to existing spawninig and overwintering habitat.	TBD pending addtiional baseline data	1. Improve knowledge of Arctic Char biology. 2. Long-term monitoring of traditional fishery. 3. Education and stewardship capacity building. 4. Improve productivity at traditional fishing location.	1 & 2 = Good 3 & 4 = Limited due to location	1. Maintain, enhance, or restore fish passage. 2. Improve access for fishing. 3. Youth and Elder involvement. 4. Education through capacity building.	1 = Good 2 - 4 = Limited due to location
	Harvaqtuuq Outflow	28 km from Doris Mine 145 km from Cambridge Bay	Create access to spawning and overwintering habitat for anadromous Arctic Char (and potentially Lake Trout) upstream of waterfall	Create a fish ladder by blasting steps into currently impassible waterfall.	Habitat enhancement Habtiat creation	Less Preferred	Arctic Char and potentially Lake Trout	Provide access to spawning and overwintering habitat to anadromous fish. Increase productive capacity of lake ecosystem through introduction of marine nutrients.	TBD pending addtiional baseline data	1. Improve knowledge of Arctic Char biology. 2. Long-term monitoring of traditional fishery. 3. Education and stewardship capacity building. 4. Improve productivity at traditional fishing location.	1 & 2 = Good 3 & 4 = Limited due to location	1. Maintain, enhance, or restore fish passage. 2. Improve access for fishing. 3. Youth and Elder involvement. 4. Education through capacity building.	1 = Good 2 - 4 = Limited due to location
	Reference Lake D Outflow	15 km from Doris Mine 115 km from Cambridge	None identified	-	-	-	-	-	-	-	-	-	-
	Iqalulialuk Outflow	80 km from Doris Mine 6 km from Omingmaktok (Bay Chimo)	Enhance migratory potential for anadromous Arctic Char and potentially Lake Trout	Enhancement of stability and permanence of existing migration channels constructed by local land users. Construction of new migration channels in locations where migratory potential is poor.	Habitat enhancement	More Preferred	Arctic Char and potentially Lake Trout	Increase in fisheries production by improving migratory success to existing spawning and overwintering habitat.	TBD pending addtiional baseline data	1. Improve knowledge of Arctic Char biology. 2. Long-term monitoring of traditional fishery. 3. Education and stewardship capacity building. 4. Improve productivity at traditional fishing location.	1 & 2 = Good 3 & 4 = Limited due to location	1. Maintain, enhance, or restore fish passage. 2. Improve access for fishing. 3. Youth and Elder involvement. 4. Education through capacity building.	1 = Good 2 - 4 = Limited due to location
	Omingmaktok Area Lake Outflow	75 km from Doris Mine 6 km from Omingmaktok (Bay Chimo)	Enhance migratory potential for anadromous Arctic Char and potentially Lake Trout	Construction of migration channels in locations where migratory potential is poor.	Habitat enhancement	More Preferred	Arctic Char and potentially Lake Trout	Increase in fisheries production by improving migratory success to existing spawning and overwintering habitat.	TBD pending addtiional baseline data	1. Improve knowledge of Arctic Char biology. 2. Long-term monitoring of traditional fishery. 3. Education and stewardship capacity building. 4. Improve productivity at traditional fishing location.	1 & 2 = Good 3 & 4 = Limited due to location	1. Maintain, enhance, or restore fish passage. 2. Improve access for fishing. 3. Youth and Elder involvement. 4. Education through capacity building.	1 = Good 2 - 4 = Limited due to location
Cambridge Bay	Grenier Lake East Outflow	125 km from Doris Mine 2 km from Cambridge Bay	Enhance migratory access to overwintering habitats for juvenile Arctic Char and Lake Trout	Construction of migration channels in locations where migratory potential is poor.	Habitat enhancement	More Preferred	Arctic Char and Lake Trout	Increase in fisheries production by improving migratory success to existing overwintering habitats and preventing fisheries losses to stranding.	TBD pending addtiional baseline data	1. Improve knowledge of Arctic Char biology. 2. Long-term monitoring of traditional fishery. 3. Education and stewardship capacity building. 4. Improve productivity at traditional fishing location.	1 - 4 = Good	1. Maintain, enhance, or restore fish passage. 2. Improve access for fishing. 3. Youth and Elder involvement. 4. Education through capacity building.	1 - 4 = Good
	Kitiga Outflow	125 km from Doris Mine 50 km from Cambridge Bay	None identified	-	-	-	-	-	-	-	-	-	-
	Aggiak Outflow	150 km from Doris Mine 30 km from Cambridge Bay	Enhance migratory potential for anadromous Arctic Char and potentially Lake Trout. Enhance spawning and/or rearing lake habitats	Construction of migration channels in locations where migratory potential is poor. Construction of spawning and/or rearing shoals in lake habitats.	Habitat enhancement	More Preferred	Arctic Char and potentially Lake Trout	Increase in fisheries production by improving migratory success. Increase in fisheries production by improving spawning and/or rearing success.	TBD pending addtiional baseline data	1. Improve knowledge of Arctic Char biology. 2. Long-term monitoring of traditional fishery. 3. Education and stewardship capacity building. 4. Improve productivity at traditional fishing location.	1 - 4 = Good	1. Maintain, enhance, or restore fish passage. 2. Improve access for fishing. 3. Youth and Elder involvement. 4. Education through capacity building.	1, 3 & 4 = Good 3 = Limited due to location
TBD	Marine Shoals	TBD	Enhance marine rearing habitats	Construction of shoals in marine habitat.	Habitat enhancement	More Preferred	Multiple marine species	Increase in fisheries production by improving rearing success.	TBD pending selection of location and addtiional baseline data	1. Improve knowledge of Arctic Char biology. 2. Long-term monitoring of traditional fishery. 3. Education and stewardship capacity building. 4. Improve productivity at traditional fishing location.	1 & 2 = Limited as Arctic Char may not be primary target species 3 & 4 = TBD pending selection of location	1. Maintain, enhance, or restore fish passage. 2. Improve access for fishing. 3. Youth and Elder involvement. 4. Education through capacity building.	1 = None 2 - 4 = TBD pending selection of location

Legend:

Higher Preference
Neutral Preference
Lower Preference
TBD = To Be Determined

Reference Lake D Outflow and Kitiga Outflow were considered low potential candidate offsetting sites as no opportunities for offsetting were identified that could increase fisheries productivity such that it would adequately offset potential fisheries losses associated the Project. Therefore, these sites were not evaluated further according to criteria in Tables 6-1 and 6-2.

All other candidate offsetting options employ habitat enhancement which is the offsetting measure that is most preferred by DFO (Table 6-1). However, habitat enhancement at Harvaqtuuq that would allow anadromous fish access upstream of the currently impassable waterfall on Harvaqtuuq Inflow also incorporates habitat creation. Habitat creation is less preferred relative to habitat enhancement because there is more uncertainty that changing one habitat to another will improve productivity (i.e., potentially changing habitat for resident land-locked Arctic Char and Lake Trout to habitat for anadromous Arctic Char and potentially Lake Trout habitat). Therefore, offsetting methods proposed for Harvaqtuuq are slightly less preferred relative to all other candidate offsetting sites.

The relative potential fisheries benefits for each of the candidate fisheries offsetting options could not be quantitatively evaluated at this time (Table 6-1). In sections 5.1 and 5.2 (in the Proposed Approach to Offsetting sections), assumptions associated with the potential fisheries benefits at each site are outlined. Should these assumptions be met, each site is considered to have the potential to offset losses associated with the Project. However, additional baseline studies are required to quantitatively estimate the total fisheries productivity gain anticipated for each offsetting project at the candidate offsetting sites. Results of baseline studies undertaken in 2019, are expected to contribute to the quantification of the potential fisheries benefit of an offsetting program in selected candidate offsetting systems. The potential fisheries benefit of an offsetting project must be quantified in order to ensure offsets are commensurate with fisheries losses.

The potential for offsetting projects to support the fisheries management objectives outlined in the IFMP for the Cambridge Bay Arctic Char commercial fishery (DFO 2014) and to support local fisheries management objectives described at the Fisheries Offsetting Workshop in June 2018 (ERM 2018) is good for all sites but potentially better for sites nearest to Cambridge Bay (i.e., Grenier Lake East Outflow and Aggiak Outlfow; Table 6-1). All sites that were visited in the Hope bay and Cambridge Bay areas have good potential to improve knowledge of Arctic Char biology, to collect data on traditional fisheries through baseline and post-offset monitoring programs, and to maintain, improve, or restore fish passage. For the conceptual marine shoals option, this potential is limited because Arctic Char may not be the primary species targeted to benefit from the offset and the goal of the enhancement is not focused on fish passage.

At Grenier lake East Outflow and Aggiak Outflow, the potential for community involvement is good and increases in fisheries productivity have the potential to improve productivity at traditional fishing locations near the community of Cambridge Bay, thus improving access for fishing. Sites in the Hope Bay area are considered more limited in their potential for community involvement and potential to improve access for fishing due to the travel distances required to reach them. The potential for marine shoals to incorporate community involvement and improve fishing access remains to be determined because potential locations for the construction of marine shoals have not yet been identified. In general, the location of the offsetting project relative to a community influences its potential to contribute to certain aspects of the local/regional fisheries management goals that have been outlined.

Table 6-2: Candidate Offsetting Site Evaluation Criteria: Stakeholder Goals

Area	Site	Location	Offsetting Objective	Offsetting Approach	Incorporation of TK and IQ		Engagement and Capacity Building (Youth and Elder Involvement)		Construction Methods	
					Potential	Method	Potential	Method	Preference	Method
Hope Bay Project	Tahilugyuak Outflow	25 km from Doris Mine 100 km from Cambridge Bay	Enhance migratory potential for anadromous Arctic Char and Lake Trout	Construction of migration channels in locations where migratory potential is poor.	Good	• Design and location of migration channels • Design and implementation of monitoring program.	Limited due to site location	• Local youth and Elders assist and consult during construction. • Local youth trained to assist with monitoring.	Preferred	Primary: Manual Secondary: Potential need for micro-blasting of large boulders
	Harvaqtuuq Outflow	28 km from Doris Mine 145 km from Cambridge Bay	Create access to spawning and overwinter habitat for anadromous Arctic Char (and potentially Lake Trout) upstream of waterfall	Create a fish ladder by blasting steps into currently impassible waterfall.	Good	• Design and location of migration channels • Design and implementation of monitoring program.	Limited due to site location	• Local youth and Elders assist and consult during construction. • Local youth trained to assist with monitoring.	Less Preferred	Primary: Blasting required to create fish ladder. Specialized machinery may be required for removal of blasted rock. Secondary: Manual
	Reference Lake D Outflow	15 km from Doris Mine 115 km from Cambridge Bay	None identified	-	-	-	-	-	-	-
	Iqalulialuk Outflow	80 km from Doris Mine 6 km from Omingmaktok (Bay Chimo)	Enhance migratory potential for anadromous Arctic Char and potentially Lake Trout	Enhancement of stability and permanence of existing migration channels constructed by local land users. Construction of new migration channels in locations where migratory potential is poor.	Good	• Design and location of migration channels • Design and implementation of monitoring program.	Limited due to site location	• Local youth and Elders assist and consult during construction. • Local youth trained to assist with monitoring.	Preferred	Primary: Manual Secondary: Potential need for micro-blasting of large boulders
	Omingmaktok Area Lake Outflow	75 km from Doris Mine 6 km from Omingmaktok (Bay Chimo)	Enhance migratory potential for anadromous Arctic Char and potentially Lake Trout	Construction of migration channels in locations where migratory potential is poor.	Good	• Design and location of migration channels • Design and implementation of monitoring program.	Limited due to site location	• Local youth and Elders assist and consult during construction. • Local youth trained to assist with monitoring.	Preferred	Primary: Manual Secondary: Potential need for micro-blasting of large boulders
Cambridge Bay	Grenier Lake East Outflow	125 km from Doris Mine 2 km from Cambridge Bay	Enhance migratory access to overwintering habitats for juvenile Arctic Char and Lake Trout	Construction of migration channels in locations where migratory potential is poor.	Good	• Design and location of migration channels • Design and implementation of monitoring program.	Good	• Local youth and Elders assist and consult during construction. • Local youth trained to assist with monitoring.	Less Preferred	Primary: Specialized machinery may be required for construction of migration channels. Secondary: Manual
	Kitiga Outflow	125 km from Doris Mine 50 km from Cambridge Bay	None identified	-	-	-	-	-	-	-
	Aggiak Outflow	150 km from Doris Mine 30 km from Cambridge Bay	Enhance migratory potential for anadromous Arctic Char and potentially Lake Trout. Enhance spawning and/or rearing lake habitats	Construction of migration channels in locations where migratory potential is poor. Construction of spawning and/or rearing shoals in lake habitats.	Good	• Design and location of migration channels • Design and implementation of monitoring program.	Good	• Local youth and Elders assist and consult during construction. • Local youth trained to assist with monitoring.	Less Preferred	Primary: Specialized machinery may be required for placement of substrates during construction of shoals. Secondary: Manual
TBD	Marine Shoals	TBD	Enhance marine rearing habitats	Construction of shoals in marine habitat.	Good	• Design and location of migration channels • Design and implementation of monitoring program.	TBD pending selection of locaiton	• Local youth and Elders assist and consult during construction. • Local youth trained to assist with monitoring.	Less Preferred	Primary: Specialized machinery may be required for placement of substrates during construction of shoals. Secondary: Manual

Legend:

Higher Preference
Neutral Preference
Lower Preference
TBD = To Be Determined

All candidate fisheries offsetting options have good potential to incorporate TK and IQ, during the design and planning phases for the offsets and in the design and implementation of monitoring programs (Table 6-2). The potential to involve youth and Elders through engagement and capacity building opportunities is influenced by site location. Sites in the Cambridge Bay area have good potential for youth and Elder involvement during all phases of planning, construction, and monitoring due to proximity and access from the community (Table 6-2). Candidate sites in the Hope Bay area have the potential for some youth and/or Elders to be involved in construction and youth may be trained to support monitoring programs. However, this involvement will likely be limited to some extent by the remoteness of the sites. The potential for youth and Elder engagement and capacity building for a marine shoals project will depend on the location selected for the shoals.

Finally, based on site characteristics during 2018 field reconnaissance surveys, manual techniques (the preferred option expressed by stakeholders at the Fisheries Offsetting Workshop in June 2018; ERM 2018) could be used as the primary construction method at three sites. These include, Tahilugyuak Outflow, Iqalulialuk Outflow, and the Omingmaktok Area Lake Outflow. At these three sites, the need for micro-blasting to move larger substrates may be required. Blasting and/or the use of heavy/specialized equipment is less preferred relative to manual techniques but may be required at each of the remaining sites for offset construction (Table 6-2).

Opportunities for offsetting were identified at six of the eight candidate fisheries offsetting options visited in 2018 and for the conceptual option of marine shoals (Tables 6-1 and 6-2). Overall, each of these candidate offsetting options has the potential to meet the objectives of the Fisheries Productivity Investment Policy (DFO 2013a; Table 6-1) and to meet goals for offsetting expressed by stakeholders at the Fisheries Offsetting Workshop in June 2018 (ERM 2018; Table 6-2). Each of the options provides good opportunities for incorporation of TK and IQ in decision making processes. Due to their proximity to the community, sites in the Cambridge Bay area (i.e., Grenier Lake East Outflow and Aggiak Outflow) have the potential to better support local/regional fisheries management objectives related to education, stewardship, and capacity building, and to involve local youth and Elders due to their proximity to the community. Three sites in the Hope Bay area (Tahiluyguak Outflow, Iqalulialuk Outflow, and the Omingmaktok Area Lake Outflow) provide opportunities to employ non-invasive, manual construction techniques which are preferred by TK holders for the implementation of offsets.

Field reconnaissance surveys and initial evaluations completed in 2018 provide important information on the potential for the candidate offsetting options to meet the objectives for offsetting set out by DFO (DFO 2013a) and Project stakeholders (ERM 2018). However, the potential fisheries productivity benefits from offsets at each candidate site have not yet been quantified. As defined in the Fisheries Productivity Investment Policy, the objective of offsetting is “to counterbalance unavoidable serious harm to fish and the loss of fisheries productivity resulting from a project” (DFO 2013a). Offset measures selected should support the goals of the Fisheries Protection Policy by supporting or enhancing the ongoing productivity of commercial, recreational, and Aboriginal fisheries. Therefore, a key criterion for selecting an offsetting option for the Project will be the quantification of the potential fisheries productivity benefits for candidate sites and determination of whether they are commensurate with potential Project-associated losses. Additional baseline information is required to carry out these analyses and it is recommended that candidate site(s) be selected for baseline studies in 2019.

The next step is to engage DFO and relevant stakeholders (e.g., KIA and IEAC) regarding the proposed candidate offsetting options included in this report and the proposed offsetting approach for each. Feedback will inform the selection of sites for further investigation in 2019, the design of baseline studies as well as the planning, and implementation of an offset project.

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APPENDIX A RESULTS OF FISHERIES OFFSETTING WORKSHOP FOR THE HOPE BAY PROJECT, JUNE 2018

APPENDIX B FISH HABITAT ASSESSMENT RESULTS

Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Table B-1: Fish Habitat Assessment Protocol Results, Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Stream Name	Site Name	Date	Sampling Crew	Habitat Unit (HU)	Habitat Type	Unit Length (m)	Gradient (%)	Channel Width (m)	Wetted Depth (m)	Substrate Composition (%)						Bank Shape		Bank Texture		Barriers								Instream Cover (%)							Riparian Cover		
										O	F	G	C	B	R	LB	RB	LB	RB	F	BG	D	OF	SF	WQ	G	O	Total	OV	IV	DP	U	B	OD	Canopy (%)	Dom Veg L	Dom Veg R
Tahilugyuak Outflow	Tahilugyuak	27-Jul-18	KK, CM	1	G	52	1	16	0.33	0	0	25	50	25	0	S	S	B	B									25	0	0	0	0	25		0	G	G
				2	R	31	2	11	0.56	0	0	25	25	50	0	V	S	R	B									50	0	0	0	0	50		0	N	N
				3	C	61	10	15	0.38	0	0	0	15	85	0	V	S	B	B							PT		85	0	0	0	0	85		0	N	N
				4	P	155	1	40	0.4	0	0	10	20	70	0	S	S	B/R	B									45	0	0	5	0	40		0	N	N
				5	C	130	6	35	0.35	0	0	10	40	55	0	S	S	B/R	B		PT							80	0	0	0	0	80		0	N	N
				6	G	205	1	66	0.68	0	0	10	40	50	0	S	S	R	B									55	0	0	5	0	50		0	G	M
				7	C	41	4	34	0.17	0	0	10	50	40	0	S	S	F	B		PT							40	0	0	0	0	40		0	G	N
				8	P	93	0.5	80	0.6	0	0	30	30	40	0	S	S	B	R									40	0	0	0	0	40		0	N	G
				9	R	89	2	29	0.32	0	0	30	30	40	0	S	S	B	B									40	0	0	0	0	40		0	N	N
				10	G	37	2	29	0.6	0	0	20	50	30	0	S	S	B	B									50	0	0	0	0	50		0	N	N
				11	R	180	4	30	0.25	0	10	30	30	30	0	S	S	B	B									30	0	0	0	0	30		0	N	N
				12	P	85	2	70	0.65	0	20	20	20	35	5	S	S	B	B									30	0	0	0	0	30		0	N	N
				13	R	65	2	33	0.2	0	0	0	20	80	0	S	S	B	B									80	0	0	0	0	80		0	N	N
				14	C	21	8.5	15	-	0	0	0	10	90	0	S	S	B	B							PT		85	0	0	0	0	85		0	N	N
				15	R	112	2	46	0.47	0	0	15	15	70	0	S	S	B	B									90	0	0	0	0	90		0	N	N
				16	C	66	3.5	40	0.18	0	0	0	5	85	10	S	S	R	B		PT					PT		75	0	0	0	0	75		0	N	N
				17	P	144	0.5	-	-	0	0	0	0	0	0	-	-	-	-									-	0	0	0	0	0		0	-	-
				18	R	51	2	45	0.15	0	0	15	35	50	0	S	S	R	R		PT							60	0	0	0	0	60		0	N	N
				19	G	76	1.5	54	0.8	0	0	5	20	75	0	V	S	R	B									85	0	0	10	0	75		0	N	N
				20	Lake	200	-	-	-	0	0	0	0	0	0	-	-	-	-									-	0	0	0	0	0		0	-	-
				21	C	45	9	37	0.25	0	0	5	30	65	0	S	S	B	B		T					T		90	0	0	0	0	90		0	N	N
				22	G	210	0.5	60	0.35	0	10	30	40	20	0	S	S	C	B									40	0	0	0	0	40		0	N	N
				23	R	61	4	50	0.33	0	0	10	15	75	0	S	S	R	F		PT							50	0	0	0	0	50		0	S	G
				24	C	92	5	27	0.33	0	0	0	10	90	0	S	S	F	F		PT							90	0	0	0	0	90		0	S	G
				25	C	70	6.5	36	0.25	0	5	5	10	80	0	S	S	F	F		PT							85	0	0	0	0	85		0	S	G
				26	C	15	9	21	-	0	0	0	30	70	0	S	S	R	R							PT		10	0	0	0	0	10		0	S	G
		20-Sep-18	KK, CE	1	C	40	7	11	0.28	0	0	0	10	90	0	S	S	B	B			PT						90	0	0	0	0	90		0	-	-
				2	C	33	9.5	-	0.21	0	0	0	10	90	0	S	S	B	B			T						90	0	0	0	0	90		0	-	-
				3	P	85	~1	-	-	0	0	0	0	0	0	S	S	B	B									-	0	0	0	0	0		0	-	-
				4	G	17	2	-	0.27	0	0	60	30	10	0	S	S	B	B									25	0	0	0	0	25		0	-	-
				5	P	57	~1	-	-	0	0	0	0	0	0	S	S	B	BR									-	0	0	0	0	0		0	-	-
				6	C/BG	50	5	-	-	0	0	0	10	90	0	S	V	B	BR		T	T						90	0	0	0	0	90		0	-	-
				7	G	40	3.5	-	0.21	0	0	0	40	60	0	S	V	B	BR									60	0	0	0	0	60		0	-	-
				8	C	20	7	-	0.18	0	0	10	60	30	0	S	V	B	BR			T						30	0	0	0	0	30		0	-	-
				9	R	42	0.2	-	0.17	0	0	40	40	20	0	S	S	B	B									20	0	0	0	0	20		0	-	-
				10	P	200	~1	-	-	0	0	0	0	0	0	S	S	B	B									-	0	0	0	0	0		0	-	-
				11	G	44	3.5	-	0.2	0	0	50	30	20	0	S	S	B	B									20	0	0	0	0	20		0	-	-
				12	P	116	~1	-	-	0	0	0	0	0	0	S	S	B	B									-	0	0	0	0	0		0	-	-
				13	G	135	1.5	-	0.3	0	0	10	70	20	0	S	S	B	B									20	0	0	0	0	20		0	-	-
				14	R/BG	127	4.5	-	0.15	0	0	40	50	10	0	S	S	B	B			PT						10	0	0	0	0	10		0	-	-
				15	G	170	~1	-	-	0	0	0	0	0	0	S	S	B	B									-	0	0	0	0	0		0	-	-
				16	C/BG	17	8.5	-	-	0	0	0	0	0	0	S	S	B	B		T	T					PT	-	0	0	0	0	0		0	-	-
				17	G	110	2	-	0.25	0	0	10	30	60	0	S	S	B	B									60	0	0	0	0	60		0	-	-
				18	C/BG	70	5	-	0.3	0	0	0	30	70	0	S	S	B	BR		T	T					PT	70	0	0	0	0	70		0	-	-

Table B-1: Fish Habitat Assessment Protocol Results, Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Stream Name	Site Name	Date	Sampling Crew	Habitat Unit (HU)	Habitat Type	Unit Length (m)	Gradient (%)	Channel Width (m)	Wetted Depth (m)	Substrate Composition (%)						Bank Shape		Bank Texture		Barriers								Instream Cover (%)							Riparian Cover		
										O	F	G	C	B	R	LB	RB	LB	RB	F	BG	D	OF	SF	WQ	G	O	Total	OV	IV	DP	U	B	OD	Canopy (%)	Dom Veg L	Dom Veg R
Tahilugyuak Outflow	Tahilugyuak	21-Sep-18	KK, CE	19	P	146	~1	-	-	0	0	30	40	40	0	S	S	B	B									40	0	0	0	0	40		0	-	-
(cont'd)				20	R/BG	125	2	-	0.1	0	0	25	30	45	0	S	S	B	B		T							45	0	0	0	0	45		0	-	-
				21	Lake	190	~1	-	-	0	80	0	10	10	0	S	S	B	B									70	0	0	60	0	10		0	-	-
				22	C/BG	50	8	-	0.15	0	0	20	50	30	0	S	S	B	B		T							30	0	0	0	0	30		0	-	-
				23	G	222	1.5	-	0.2	0	20	40	20	20	0	V	S	B	BR									30	0	0	0	0	30		0	-	-
				24	R	57	2	-	0.18	0	0	20	40	40	0	V	S	B	F			PT						40	0	0	0	0	40		0	-	-
				25	BG	83	4	-	0.05	0	0	5	70	25	0	S	S	B	B		T							25	0	0	0	0	25		0	-	-
				26	C	52	5	-	0.25	0	10	0	70	20	0	S	S	B	B									20	0	0	0	0	20		0	-	-
				27	C	66	7	-	0.2	0	0	0	60	40	0	S	S	B	B		PT					PT		40	0	0	0	0	40		0	-	-
Harvaqtuuq Inflow	Harvaqtuuq	28-Jul-18	KK, CM	1	R/BG	75	5	100	-	0	0	0	0	0	0	-	-	-	-		PT							-	0	0	0	0	0		0	-	-
				2	C	62	5	14	-	0	0	0	0	0	0	-	-	-	-									-	0	0	0	0	0		0	-	-
				3	F	30	13	14	-	0	0	0	0	0	0	-	-	-	-	P								-	0	0	0	0	0		0	-	-
Harvaqtuuq Outflow	Harvaqtuuq	28-Jul-18	KK, CM	1	R	43	4	17	0.35	0	0	20	35	45	0	V	S	S	B									30	0	0	0	0	30		0	G	G
				2	C	70	11	~30	-	0	0	0	20	80	0	V	S	S	B							PT		80	0	0	0	0	80		0	G	G
				3	C	57	9	13	-	0	0	0	20	80	0	S	S	B	B									90	0	0	30	0	60		0	S	S
				4	C	53	5	16	-	0	0	0	30	70	0	S	S	F	F									70	0	0	20	0	50		0	G	G
				5	R	75	25	33	0.5	0	0	5	45	50	0	S	S	F	F									50	0	0	0	0	50		0	G	G
				6	G	56	1	48	0.45	0	0	5	60	35	0	S	S	F	F									30	0	0	0	0	30		0	G	G
				7	R	120	3	51	0.4	0	0	10	40	50	0	S	S	F	F									50	0	0	0	0	50		0	G	G
		22-Sep-18	KK, CE	1	R	63	4	-	~0.35-0.55	0	0	10	40	50	0	S	S	F	F									50	0	0	0	0	50		0	G	G
				2	C	52	9	-	-	0	0	0	10	90	0	V	S	F	B									80	0	0	0	0	80		0	G	G
				3	C	54	10	-	-	0	0	0	10	90	0	S	V	B	B							PT		90	0	0	0	0	90		0	G	G
				4	C	67	6	-	-	0	0	0	10	90	0	S	V	B	B									90	0	0	0	0	90		0	G	G
				5	R	80	4	-	0.3	0	0	10	60	30	0	S	S	F	F									30	0	0	0	0	30		0	G	G
				6	G	57	1	-	0.4	0	0	5	35	60	0	S	S	F	F									60	0	0	0	0	60		0	G	G
				7	R	133	3	-	0.19	0	0	5	35	60	0	S	S	F	F									60	0	0	0	0	60		0	G	G
Reference Lake D Outflow	Reference Lake D	26-Jul-18	KK, CM	1	G	72	0	20	0.46	0	0	45	40	15	0	S	S	F	F									25	0	0	10	0	15		0	G	S
				2	R	26	1	27	0.33	0	0	60	35	5	0	S	V	F	F									15	0	0	0	0	15		0	S	G
				3	P	26	1	31	-	0	10	10	60	20	0	V	S	F	C									22	0	2	15	0	5		0	S	G
				4	G	39	1	32	0.4	0	0	10	60	20	0	V	S	C	F									30	0	0	0	0	30		0	N	G
				5	C	38	4	29	0.34	0	0	15	65	20	0	S	V	F	G									85	0	0	0	0	85		0	G	S
				6	R	17	3	35	0.4	0	5	5	30	60	0	S	V	F	C									100	0	0	0	0	100		0	S	S
		28-Jul-18	KK, CM	7	C	74	5	20	*	0	0	10	30	60	0	S	S	F	F									80	0	0	0	0	80		0	S	S
				8	C	68	>5	~15	*	0	0	0	20	80	0	V	V	F	F									80	0	0	0	0	80		0	G	G
				9	G	370	2	24	0.6	0	0	65	25	10	0	S	S	F	F									10	0	0	10	0	0		0	G	G
				10	P	32	1	35	-	0	0	0	0	0	0	S	S	F	F									70	0	0	70	0	0		0	G	G
				11	R	15	1.5	31	~.3	0	0	10	40	50	0	S	S	F	F									50	0	0	0	0	50		0	G	G
				12	P	75	1	30	0.5	0	20	40	30	10	0	S	S	F	F									5	0	0	5	0	0		0	G	G
				13	R	27	2	47	0.3	0	0	10	40	50	0	S	S	F	F									60	0	0	0	0	60		0	G	G
				14	G	48	1	37	0.4	0	0	10	30	60	0	S	V	F	F									60	0	0	0	0	60		0	G	G
				15	R	119	2	28	0.3	0	0	10	40	50	0	S	S	F	F									50	0	0	0	0	50		0	G	G
				16	G	161	0	33	0.6	0	20	20	30	30	0	S	S	F	F									40	0	0	10	0	30		0	G	G
				17	R	79	1	57	0.4	0	0	0	60	40	0	S	S	F	F									40	0	0	0	0	40		0	S	S

Table B-1: Fish Habitat Assessment Protocol Results, Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Stream Name	Site Name	Date	Sampling Crew	Habitat Unit (HU)	Habitat Type	Unit Length (m)	Gradient (%)	Channel Width (m)	Wetted Depth (m)	Substrate Composition (%)						Bank Shape		Bank Texture		Barriers								Instream Cover (%)							Riparian Cover		
										O	F	G	C	B	R	LB	RB	LB	RB	F	BG	D	OF	SF	WQ	G	O	Total	OV	IV	DP	U	B	OD	Canopy (%)	Dom Veg L	Dom Veg R
Iqalulialuk Outflow	Iqalulialuk	30-Jul-18	KK, CM	1	G	45	2.5	11	0.19	0	0	60	35	5	0	S	S	G	G									5	0	0	0	0	5		0	G	M
				2	R	34	4	17	0.14	0	0	35	40	25	0	S	S	G	G		PT							5	0	0	0	0	5		0	G	G
				3	G	35	1.5	13	0.33	0	0	15	55	30	0	S	S	C	C									10	0	0	0	0	10		0	G	M
				4	C	54	7	8	0.19	0	0	0	20	80	0	S	S	B	B		PT							65	0	0	0	0	65		0	N	N
				5	R	60	5	22	0.2	0	0	10	40	50	0	S	S	F	F		PT							50	0	0	0	0	50		0	G	G
				6	R	102	4.5	15	0.25	0	0	0	20	80	0	V	S	R	F									50	0	0	0	0	50		0	N	G
				7	G	26	3	17	0.17	0	15	15	20	50	0	V	S	R	F									30	0	0	0	0	30		0	N	G

Notes:
Habitat Type: BG = bouder garden, C = cascade, F = falls, G = glide, P = pool, R = riffle
Substrate: F = fines (< 2 mm), G = gravel (2 - 64 mm), C = cobble (64 - 256 mm), B = boulder (256 - 4000 mm), R = bedrock (> 4000 mm), O = other
Bank: LB = left bank, RB = right bank; both downstream facing
Bank Shape: U = undercut, V = vertical, S = sloping, O = overhanging
Bank Texture: dominant substrate type
Barriers: F = impassable falls, BG = impassable boulder garden, D = dry channel, OF = overland flow, SF = subsurface flow, WQ = water quality barrier, G - gradient, O = other (list in Comments column)
Barrier Classification: list barriers as either PT = potential temporary, PP = potential permanent, T = confirmed temporary, P = confirmed permanent
Instream cover: Total cover = % cover for entire unit
Instream cover types: OV = overhanging vegetation, IV = instream vegetation, DP = deep pool, U = undercut bank, B = boulder, OD = organic debris
Riparian cover: Canopy % = cover within 1m of surface of water, Type = dominant vegetation; G = grass, S = shrub, M = moss, Ma = macrophyte.
Overall Habitat: S = spawning, R = rearing, O = overwintering, M = migration; Classifications: N = none, P = poor, F = fair, G = good
Sampling Crew: KK = Kathryn Kuchapski, CM = Cedar Metatawabin, GM = Geneviève Morinville, WN = Willie Nakashook, CE = Cameron Evans
NA = not applicable
Dashes = data not collected

Table B-1: Fish Habitat Assessment Protocol Results, Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Stream Name	Site Name	Habitat Unit (HU)	Habitat Type	Waypoint No.	UTM			Photo No.			Overall Habitat Quality				Comments
					Zone	Northing	Easting	US	DS	Across	S	R	O	M	
Tahilugyuak Outflow	Tahilugyuak	1	G	8	13	7579648	449595	1882	1884	1883	P	G	N	G	
		2	R	9	13	7579611	449555	1885	1887	1886	P	G	N	G	Some small drops, evaluted for barriers at low flow.
		3	C	-	13	7579583	449540	1888	1898	1891	P	F	N	F	Potential gradient barrier, especially at low flow. Steep cascade, large boulders, would require blasting to move.
		4	P	10	13	7579524	449518	1899	1901	1900	F	G	N	G	BG at D/S end of unit could be a barrier at lower flow but deeper channels along L & R banks may allow for fish passage.
		5	C	11	13	7579392	449431	1902	1905	1903	N	F	N	F	At D/S of unit there is a BG with potential to be barrier.
		6	G	12	13	7579346	449301	1906	1908	1907	F	G	N	G	
		7	C	13	13	7579260	449145	1909	1911	1910	P	F	N	F	Shallow, reduced passage potential.
		8	P	14	13	7579215	449149	1912	1914	1913	F	G	N	G	
		9	R	15	13	7579111	449128	1915	1917	1916	G	G	N	F	Shallow, reduced passage potential.
		10	G	16	13	7579022	449112	1918	1920	1919	G	G	N	G	
		11	R	17	13	7579022	449109	1921	1923	1922	P	G	N	F	Shallow, reduced passage potential. Dry side channel to S.
		12	P	18	13	7578852	449095	1924	1926	1925	F	G	N	G	Still ice covered along LB. Could have some deeper pool habitat in that area.
		13	R	19	13	7578772	449082	1927	1929	1928	P	G	N	G	
		14	C	20	13	7578709	449099	1930	1932	1931	P	P	N	F	Potential gradient barrier, some substantial drops. Steep cascade: one fairly big drop (but not a waterfall).
		15	R	-	13	7578673	449062	1933	1937	1936	P	G	N	G	
		16	C	22	13	7578607	449032	1938-1940	1943	1941/1942	P	P	N	F	Potential gradient/BG barrier. Split into 2 channels S and N. S channel measured, N channel = steeper & shorter
		17	P	-	13	7578559	448984	-	-	-	-	-	N	G	Not assessed due to distance.
		18	R	23	13	7578589	448844	1945	1949	1948	P	P	N	G	Potential BG barrier. Entire R half of channel = BG. Only small riffle area along LB fairly shallow.
		19	G	-	13	7578557	448794	1950	1952	1951	F	G	N	F	
		20	Lake	24	13	7578496	448757	1953	1955	1954	P	G	N	G	
		21	C	25	13	7578367	448599	2256	2261, 2264	2268	N	P	N	P	ARCH observed attempting to move U/S and failing. Ca/BG = steep cascade directly U/S from small lake.
		22	G	26	13	7578358	448561	2271	2273	2272	G	G	N	G	
		23	R	27	13	7578246	448383	2271	2276	2274	P	F	N	F	Shallow.
		24	C	28	13	7578188	448350	2278	2282	2281	P	P	N	F	Potential BG barrier. From D/S end channel along RB comes U/S into a BG dead end. Channel along LB fast but fairly good passage potential at current flow conditions.
		25	C	-	13	7578165	448252	2289	2312	2300	P	P	N	F	Potential BG barrier.
		26	C	29	13	7578162	448183	2230	2234	2322	P	P	N	F	Potential falls barrier. Drop just before lake that may be a gradient barrier.
		1	C	85	13	7579583	449540	1	3	2	N	N	N	F	At time of survey, doesn't appear to be a fish passage barrier.
		2	C	86	13	7579552	449513	4	6	5	N	N	N	P	Steep gradient and shallow water depth between boulders = barrier on survey date. Water depth between boulders only ~0.1-0.2 m in passage areas.
		3	P	87	13	7579525	449510	12	14	13	N	N	N	G	Ice covered - water depth not measured.
		4	G	88	13	7579447	449468	15	17	16	N	N	N	G	
		5	P	89	13	7579436	449455	18	20	19	N	N	N	G	Ice covered - water depth not measured.
		6	C/BG	90	13	7579393	449417	21	23	22	N	N	N	N/P	Ice covered - water depth not measured. BG with most of HU covered in snow and ice so difficult to tell water depth underneath.
		7	G	91	13	7579373	449373	24	26	25	-	-	-	F	Shallow but passable.
		8	C	-	13	7579357	449336	27	69	-	-	-	-	P	Shallow but wide and smaller substrates throughout so although shallow, it's deep enough for fish to pass because not obstructed by boulders. May be a problem at lower flows. Deep channel along RB.
		9	R	92	13	7579348	449317	70	72	71	-	-	-	F	Shallow but passable.
		10	P	93	13	7579333	449283	73	75	74	-	-	-	G	Ice covered.
		11	G	94	13	7579262	449144	76	78	77	-	-	-	F	Shallow but passable. Potential low flow barrier for large fish.
		12	P	95	13	7579218	449141	79	81	80	-	-	-	G	Ice covered.
		13	G	96	13	7579118	449133	82	85	83/84	-	-	-	G	
		14	R/BG	97	13	7578988	449131	86	101	-	-	-	-	F/P	Ice covered in some spots. Potential low flow/BG barrier for large fish, particularily near U/S end. Areas where water depth = 0.05 m over G/C substrates. Wide and shallow would be hard to confine.
		15	G	98	13	7578864	449093	102	105	103/104	-	-	-	G	Mostly ice covered.
		16	C/BG	99	13	7578706	449081	106	110	-	-	-	-	N/P	Ice covered. Steep BG, likely passage barrier can't tell water depth due to snow/ice cover.
		17	G	100	13	7578690	449091	111	113	112	-	-	-	F	Some shallow spots.
		18	C/BG	101	13	7578588	449045	114-116	-	-	-	-	-	N/P	BG D/S of steep cascade. Barrier in BG/cascade.

Table B-1: Fish Habitat Assessment Protocol Results, Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Stream Name	Site Name	Habitat Unit (HU)	Habitat Type	Waypoint No.	UTM			Photo No.			Overall Habitat Quality				Comments
					Zone	Northing	Easting	US	DS	Across	S	R	O	M	
Tahilugyuak Outflow	Tahilugyuak	19	P	114	13	7578544	448997	1	3	2	-	-	-	G	
(cont'd)		20	R/BG	115	13	7578597	448844	4	12	-	-	-	-	N/P	Low flow barriers. BG with flow through rocks. Edges dominated by boulders but main channel in the middle still flowing (Co/Gr).
		21	Lake	-	13	7578421	448686	13	14	-	-	-	-	G	Lake with potential overwintering habitat. Looks >3m deep during aerial survey. Multiple fish observed jumping near inflow.
		22	C/BG	116	13	7578367	448605	15	25	-	-	-	-	N/P	BG to WP017 then Ca is potential barrier to passage U/S. It's a cascade that could have potential low flow barriers - could use a channel.
		23	G	118	13	7578358	448558	26	29	27/28	-	-	-	G	
		24	R	119	13	7578228	448395	30	36	-	-	-	-	F	Potential low flow barrier. Water depth as low as ~0.08m over gravel/cobble in some places by no full obstructions.
		25	BG	120	13	7578188	448357	37	39	38	-	-	-	N	Very wide, shallow with flow between rocks. Complete barrier on survey date.
		26	C	121	13	7578167	448284	40	42	41	-	-	-	F	
		27	C	122	13	7578163	448232	43	58	-	-	-	-	P	Potential gradient barrier. Section directly D/S of lake has 2 steep parts that may be gradient barriers (particularly drop just D/S of lake). Shallow between boulders and fairly steep.
Harvaqtuuq Inflow	Harvaqtuuq	1	R/BG	41	13	7551712	408198	-	2057	-	F	G	N	F	Between Lake and upstream cascade. Potential BG at low flow right at mouth near lake.
		2	C	-	13	7551797	408232	2058	2062	-	P	F	N	G	Full stream not surveyed - only from D/S lake to waterfall.
		3	F	42	13	7551848	408299	2063	2067	2064	N	N	N	N	Falls ~ 6 to 7m drop - impassable
Harvaqtuuq Outflow	Harvaqtuuq	1	R	31	13	7552157	406409	1962	1964	1963	N	P	N	G	Braided - 3 channels enter ocean.
		2	C	32	13	7552153	406465	1965	1977	1966-1976	N	F	N	G	3 channels merge within the HU. East channel is slowest/shallowest with best migration potential. West channel fast/deep cascade. After they merge east side of channel continues to be slower. Potential gradient barrier on west side of channel only.
		3	C	33	13	7552145	406524	1978	1981	1978.198	N	F	N	F	Depth not measured (too fast) but estimated to be over 1m in some locations. Cover = turbulance D/S of large boulders.
		4	C	34	13	7552071	406542	1982	1984	1983	N	F	N	F	Depth not measured (too fast) but estimated to be over 1m in some locations. Cover = turbulance D/S of large boulders.
		5	R	35	13	7552022	406550	1985	1987	1986	F	G	N	G	
		6	G	36	13	7551947	406548	1988	1990	1989	G	G	N	G	
		7	R	37	13	7551896	406514	1991	2001	1992	G	F	N	G	Multiple juvenile salmonids (LKTR or ARCH) observed rearing in slow water on LB of HU and in middle of HU. There is a fish weir constructed and fish were observed inside the weir.
		1	R	155	13	7552154	406412	37	39	38	N	F	N	G	3 channels, assessment on east channel.
		2	C	156	13	7552154	406474	40	42	41	N	F	N	G	Steep and fast but passable. Depth not measured (too fast). Steep cascades but with slower flow along RB that seems to have sufficient depth for fish passage. Even if it is too shallow for passage, then enough area for fish to take refuge before continuing U/S in fast water.
		3	C	157	13	7552149	406525	43	45	44	N	F	N	G	Depth not measured (too fast). Steep cascades but with slower flow along RB that seems to have sufficient depth for fish passage. Even if it is too shallow for passage, then enough area for fish to take refuge before continuing U/S in fast water.
		4	C	158	13	7552092	406544	46	48	47	N	F	N	G	Depth not measured (too fast).
		5	R	159	13	7552030	406551	49	51	50	F	G	N	G	
		6	G	160	13	7551952	406547	52	54	53	G	G	N	G	
		7	R	161	13	7551898	406525	55	58	56	G	G	N	G	Fish weir near U/S end of HU.
Reference Lake D Outflow	Reference Lake D	1	G	-	13	7563823	447654	3	5	4	G	G	N	G	Small fry observed in shallow side channel (potentially whitefish).
		2	R	-	13	7563814	447704	6	9	7	P	F	N	G	
		3	P	-	13	7563813	447740	10	12	11	P	G	N	G	
		4	G	-	13	7563825	447790	13	15	14	F	G	N	G	
		5	C	-	13	7563803	447841	16	22	17	P	G	N	F	Cascade near LB steep + deep. Lower flow near RB with potential passage. Cascade may be a barrier at lower flow. Steep near LB and could be dry near RB.
		6	R	5	13	7563780	447880	23	25	24	P	G	N	G	May be poor for migration at lower flow.
		7	C	44	13	7563752	447871	2070	2073	2071/2072	P	G	N	G	Fast. Remnants of a eaten whitefish at U/S end of HU. Too fast and deep to measure, braided , two main channels and several small side channels. Side channels = ~2m width, riffles, ~0.2m depth.
		8	C	45	13	7563693	447916	2074	2088	2075/2087	P	G	N	G	Fast, steep long cascade. Very steep banks, covered in willows, difficult to access the channel. Gradient was estimated.
		9	G	46	13	7563343	448062	2089	2091	2090	G	G	N	G	
		10	P	48	13	7563236	448084	2092	2094	2093	F	G	N	G	Pool, substrates unknown due to depth and visibility
		11	R	49	13	7563210	448066	2095	2097	2096	F	G	N	G	
		12	P	50	13	7563201	448050	2098	2100	2099	G	G	N	G	
		13	R	51	13	7563123	448034	2101	2103	2102	G	G	N	G	
		14	G	52	13	7563108	448059	2104	2106	2105	F	G	N	G	
		15	R	53	13	7563078	448097	2107	2113	2111	F	G	N	G	
		16	G	54	13	7562959	448121	2114	2118	2117	G	G	N	G	
		17	R	55	13	7562792	448110	-	-	-	G	G	N	G	

Table B-1: Fish Habitat Assessment Protocol Results, Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Stream Name	Site Name	Habitat Unit (HU)	Habitat Type	Waypoint No.	UTM			Photo No.			Overall Habitat Quality				Comments
					Zone	Northing	Easting	US	DS	Across	S	R	O	M	
Iqalulialuk Outflow	Iqalulialuk	1	G	60	13	7506835	374334	2272	2274	2273	G	G	N	F	Shallow. Juvenile salmonid observed ~ 25cm, species unknown.
		2	R	61	13	7506837	374285	2275	2277	2276	F	F	N	F	Very shallow riffle. Small rocks would allow for migration channel to be constructed by hand. Possibly too shallow for Char to pass at time of survey.
		3	G	62	13	7506855	374255	2278	2280	2279	G	G	N	G	Large boulders. Difficult for large fish to pass.
		4	C	63	13	7506868	374223	2281	2283	2282	P	F	N	F	
		5	R	64	13	7506894	374178	2286	2297	2296	P	F	N	F	Multiple constructed channels where rocks have been moved to create migratory passage. Depth in channels = ~30cm. Depth outside of channels ~ 0.15m. 1 fry observed.
		6	R	65	13	7506926	374124	2304	2306	2305	P	G	N	F	Deep channel along BR on LB = ~0.4-0.5m depth. Rest of channel = ~ 0.2m Depth. Majority of channel is rocky riffle habitat but along LB there is a deeper channel that runs along the bedrock.
		7	G	67	13	7506964	374030	2307	2309	2308	F	G	N	G	

Notes:
Habitat Type: BG = bouder garden, C = cascade, F = falls, G = glide, P = pool, R = riffle
Substrate: F = fines (< 2 mm), G = gravel (2 - 64 mm), C = cobble (64 - 256 mm), B = boulder (256 - 4000 mm), R = bedrock (> 4000 mm), O = other
Bank: LB = left bank, RB = right bank; both downstream facing
Bank Shape: U = undercut, V = vertical, S = sloping, O = overhanging
Bank Texture: dominant substrate type
Barriers: F = impassable falls, BG = impassable boulder garden, D = dry channel, OF = overland flow, SF = subsurface flow, WQ = water quality barrier, G - gradient, O = other (list in Comments column)
Barrier Classification: list barriers as either PT = potential temporary, PP = potential permanent, T = confirmed temporary, P = confirmed permanent
Instream cover: Total cover = % cover for entire unit
Instream cover types: OV = overhanging vegetation, IV = instream vegetation, DP = deep pool, U = undercut bank, B = boulder, OD = organic debris
Riparian cover: Canopy % = cover within 1m of surface of water, Type = dominant vegetation; G = grass, S = shrub, M = moss, Ma = macrophyte.
Overall Habitat: S = spawning, R = rearing, O = overwintering, M = migration; Classifications: N = none, P = poor, F = fair, G = good
Sampling Crew: KK = Kathryn Kuchapski, CM = Cedar Metatawabin, GM = Geneviève Morinville, WN = Willie Nakashook, CE = Cameron Evans
NA = not applicable
Dashes = data not collected

Table B-2: Migratory Fish Habitat Assessment Results, Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Stream Name	Site Name	Location Description	Date	Sampling Crew	Barrier/ Potenital Barrier	Habitat Unit (HU)	Habitat Type	Unit Length (m)	Channel Width (m)	Wetted Depth (m)	Substrate Composition (Dominant/ Subdominant)	Migratory Habitat Quality	Barrier Type	Barrier Classification	Waypoint No.	UTM		
																Zone	Northing	Easting
Omingmaktok Area Lake Outflow	Omingmaktok Area	-	30-Jul-18	KK, CM	-	1	BG	82	17	-	B/C	F	BG	PT	71	13	7507470	380487
					-	2	C	-	-	-	B/R	F	G	PT	-	13	7507426	380602
Kitiga Outflow	Kitiga	-	2-Aug-18	KK, GM, WN	-	1	C	-	-	-	-	G			644	13	7687185	452007
					-	2	Weir	-	-	-	-	G			643	13	7687046	452710
					-	3	R	-	-	-	-	G			642	13	7686970	452764
					-	4	Weir	-	-	-	-	G			641	13	7686928	452846
					-	5	C	-	-	-	-	G			635	13	7686778	452828
					-	6	G	-	-	-	-	G			636	13	7686759	452806
					-	7	C	-	-	-	-	G			637	13	7686725	452802
					-	8	F	-	-	-	-	G			638	13	7686709	452799
					-	9	C	-	-	-	-	G			639	13	7686686	452785
Grenier Lake East Outflow	Grenier	Near Estuary	1-Aug-18	KK, GM, WN	1	-	D	-	-	-	C/G	N	D	T	627	13	7668774	500299
					2	-	D	-	-	-	R/C	P	D	T	629	13	7668741	500412
					-	3	G	-	-	-	C/B	F			630	13	7668708	500411
					4	-	G	-	-	-	C/G	P	D	T	632	13	7668698	500465
					-	5	G	-	-	-	G/C	F			633	13	7668720	500534
		Downstream of Culvert 1	1-Aug-18	KK, GM, WN	6	-	G	-	-	-	C/G	P	D	T	626	13	7671665	503933
					-	7	P	-	-	-	-	P			625	13	7671754	503882
		Culvert 1	1-Aug-18	KK, GM, WN	-	8	Culvert	-	47	-	G/C	N	O	P	618	13	7671997	503802
					-	8	Culvert	-	-	-	-	N	O	P	619	13	7672011	503780
					-	8	Culvert	-	-	-	-	N	O	P	620	13	7672035	503807
		Upstream of Culvert 1	1-Aug-18	KK, GM, WN	9	-	G	-	3	0	C/G	N	D	T	621	13	7672271	503626
					10	-	D	-	2	0	G/F	N	D	T	622	13	7672345	503654
					11	-	D	-	35	0	C/F	N	D	T	623	13	7672465	503738
					12	-	Lake	-	-	-	C/G	P	D	T	624	13	7672588	503787
		-	26-Sep-18	KK, CE	1	-	D	167	21	0.05-0.1	C	N	D	T	2	13	7668606	500054
					2	-	D	-	-	0	C	N	D	T	627	13	7668774	500299
					3	-	U	> 300	16	frozen	C	U			4	13	7668836	501012
						4	G	~60	14	< 0.10	C/B	P	D	T	5	13	7669373	501870
					5	-	G	~30	9	0.1-0.2	C	N	D	T	6	13	7670168	503035
					6	-	G	~15	~5	< 0.1	C/G	P	D	T	7	13	7670239	503198
					7	-	G	20	17	0.1-0.2	C/G	P	D	T	8	13	7670281	503299
					8	-	G	35	13	0.05-0.1	C/G/B	P	D	T	9	13	7670304	503415
					9	-	U	> 300	~20	frozen	-	U			10	13	7670423	503652
					10	-	U	73	17	frozen	-	U			11	13	7671493	504174
		Culvert 1	26-Sep-18	KK, CE	-	11	Culvert	-	-	-	-	N	O	P	620	13	7672035	503807
Aggiak Outflow	Aggiak	-	3-Aug-18	KK, GM, WN	-	1	R	-	-	-	C/B	G	D	PT	646	13	7698382	494303
					-	2	R	-	-	-	B/C	G	D	PT	647	13	7698295	494398
					-	3	G	-	-	-	B/C	G			648	13	7698263	494431
					-	4	G	-	-	-	C/B	G			649	13	7698264	494436
					5	-	R	-	-	-	B/C	F			650	13	7698317	494498
					6	-	R	-	-	-	C/B	F	D	PT	651	13	7698370	494521
					7	-	R	-	-	-	C/B	F	D	PT	652	13	7698402	494604
					8	-	R	-	-	-	C/B	F	D	PT	653	13	7698400	494654
					9	-	R	-	-	-	C/B	F	D	PT	654	13	7698399	494629
					-	10	G	-	-	-	C/B	G			655	13	7698247	494902
					11	-	G	-	-	-	-	F	BG	PT	656	13	7698234	495285
					12	-	G	-	-	-	C/B	F	D	PT	657	13	7698070	495533
					13	-	G	-	-	-	-	F	BG	PT	658	13	7697872	496050
					-	14	R	-	-	-	-	G	D	PT	659	13	7697741	496141

Table B-2: Migratory Fish Habitat Assessment Results, Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Stream Name	Site Name	Location Description	Date	Sampling Crew	Barrier/ Potenital Barrier	Habitat Unit (HU)	Habitat Type	Unit Length (m)	Channel Width (m)	Wetted Depth (m)	Substrate Composition (Dominant/ Subdominant)	Migratory Habitat Quality	Barrier Type	Barrier Classification	Waypoint No.	UTM		
																Zone	Northing	Easting
Aggiak Outflow *(cont'd)*	Aggiak	-	3-Aug-18	KK, GM, WN	15	-	R	-	-	-	-	F	D	PT	660	13	7697481	496328
					16	-	G	-	-	-	-	F	D	PT	661	13	7697353	496595
		-	27-Sep-18	KK, WN, CE	-	13	Lake	-	39	frozen	-	U			176	13	7698544	494271
					-	12	U	-	7	frozen	-	U			175	13	7698308	494370
					-	11	U	-	11	frozen	-	U			174	13	7698361	494745
					-	10	U	-	7	frozen	-	U			173	13	7698255	495033
					-	9	U	-	3	0.10, frozen	C/G/B	U			172	13	7698253	495177
					-	8	U	-	21	frozen	-	U			171	13	7698214	495340
					-	7	U	-	-	frozen	-	U			170	13	7698158	495411
					-	6	U	-	10	0.05-0.10	G/C	P	D	T	169	13	7698064	495536
					5	-	G	-	12	0.03-0.1	C/G/B	P/N	D	T	168-2	13	7697839	495901
					-	4	U	-	7	frozen	-	U			168	13	7697839	495901
					-	3	U	-	12	frozen	-	U			167	13	7697586	496167
					-	2	U	-	15	0.15	C/G/B	P	D	T	166	13	7697430	496377
					1	-	G	-	34	0.05	G/C	N/P	D	T	165	13	7697347	496612

Notes:
Habitat Type: BG = bouder garden, C = cascade, D = dry channel, F = falls, G = glide, P = pool, R = riffle, U = unknown; could not be defined on survey date
Substrate: F = fines (< 2 mm), G = gravel (2 - 64 mm), C = cobble (64 - 256 mm), B = boulder (256 - 4000 mm), R = bedrock (> 4000 mm), O = other
Barriers: F = impassable falls, BG = impassable boulder garden, D = depth/dry channel, OF = overland flow, SF = subsurface flow, WQ = water quality barrier, G - gradient, O = other (list in Comments column)
Barrier Classification: PT = potential temporary, PP = potential permanent, T = confirmed temporary, P = confirmed permanent
Migratory Habitat Quality Classifications: N = none, P = poor, F = fair, G = good
Sampling Crew: KK = Kathryn Kuchapski, CM = Cedar Metatawabin, GM = Geneviève Morinville, WN = Willie Nakashook, CE = Cameron Evans
NA = not applicable
Dashes = data not collected

Table B-2: Migratory Fish Habitat Assessment Results, Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Stream Name	Site Name	Barrier/ Potenital Barrier	Habitat Unit (HU)	Habitat Type	Photos				Notes
					Upstream	Across	Downstream	Other	
Omingmaktok Area Lake Outflow	Omingmaktok Area	-	1	BG	2491-2492	-	2497		Long BG that is very steep. Gradient = 11%. Slower velocity along edges seems possible for Char passage. Large adult salmonids observed U/S and D/S of HU (many U/S at multiple locations in glide habitat D/S of lake). No barriers to fish passage observed during aerial survey U/S or D/S of HU 1.
		-	2	C	2496	-	-	2498	Very steep cascade (Probably > 15% gradient). Found a dead Char (eaten by bears) on the side of the stream at this location. Insufficient time to perform FHAP on entire stream.
Kitiga Outflow	Kitiga	-	1	C	113, 115	108-109	107, 110-111	114, 116	Lots of flow and depth for passage.
		-	2	Weir	-	102-105	-	-	
		-	3	R	93	-	94-97	-	
		-	4	Weir	-	-	-	74-91	
		-	5	C	0057	0058	-	-	No migratory barrier on survey date.
		-	6	G	0060	0061	-	-	Fish weir ~500m D/S of falls.
		-	7	C	0064	0065	0063	-	Large system.
		-	8	F	68	67, 69	-	-	Potentially too large of a system to work on.
		-	9	C	72	71	-	-	
Grenier Lake East Outflow	Grenier	1	-	D	2640	2642, 2644	2645	-	Dry channel.
		2	-	D	2646	-	2652	2650-2651	Small drop (~20 cm), would not be a barrier at higher flow but on survey date, not water below for fish to use to get up.
		-	3	G	2654	-	2655	-	Potential temporary barrier.
		4	-	G	2657	2658	2662	-	Shallow glide with boulders throughout, temporary barrier to fish passage.
		-	5	G	2663	-	-	-	Shallow glide, would be dry channel barrier at lower flow.
		6	-	G	2632	2629	2628	-	
		-	7	P	2633	-	-	-	
		-	8	Culvert	2556	2557, 2560	-	2556-2596	Culverts perched, no flow through them. Would allow D/S passage at higher flow but permanent U/S barrier. U/S photos; 1 ARCH; length 395 mm captured D/S of culverts by angling.
		-	8	Culvert	-	-	-	-	Culverts perched, no flow through them. RB on road.
		-	8	Culvert	-	-	-	-	Culverts perched, no flow through them. LB on road; Distance along road bw RB and LB = 38m.
		9	-	G	2601	2602	2603	2604-2605	Temporary barrier at assessment location; NSSB observed.
		10	-	D	2607-2608	-	-	-	Downstream end; temporary barrier at assessment location.
		11	-	D	2615	2616	2620	-	U/S end; multiple dry channel barriers b/w U/S and D/S end; Grenier LK ~ 150 m U/S of U/S WP.
		12	-	Lake	2619	-	-	-	Shore of Grenier Lake. Connectivity to stream habitat very poor.
		1	-	D	1, 6	2,3,5	4	0001-0011	Under bridge completely dry, only ~ 0.05 m water depth. Moving U/S, areas with depth ~ 0.10 m and very little flow. Cobble habitats preventing fish passage. Extends over a long distance > 150 m.
		2	-	D	8	9, 10	11	-	Same location of dry channel barrier in July.
		3	-	U	12	13	-	-	Channel between ponds.
			4	G	16	15	14	-	Upstream lake provides overwintering habitat according to WN.
		5	-	G	19	18	17	-	Short stream channel between ponds, barrier on survey date but probably not at higher flows.
		6	-	G	22	21	20	-	Fish could pass at slightly higher flows.
		7	-	G	25	23	24	-	Passage possible at higher flow, too low now.
		8	-	G	26	27	28	29	Could become barrier earlier in season, some boulder. Directly downstream of Photo # 28 BG drop into small pond Photo #29.
		9	-	U	32	31	30	030-032	Long stretch of channel not broken up by ponds, frozen at time of survey but likely low flow barrier.
		10	-	U	33	34	35	-	Frozen. Possible dry channel barrier, definite low flow barrier.
		-	11	Culvert	-	-	-	-	Culvert crossing location.
Aggiak Outflow	Aggiak	-	1	R	149	155	148	151-154, 156-164	
		-	2	R	166, 168	167	169	-	
		-	3	G	172	-	171	-	
		-	4	G	176, 178	175, 180	174	-	Location of flow measurement.
		5	-	R	184	-	-	-	
		6	-	R	189	188	187	191	Potential low flow barrier through cobble in riffle.
		7	-	R	195, 196	-	-	-	Potential low flow barrier through cobble in riffle.
		8	-	R	202	200, 201	199	-	Potential low flow barrier through cobble in riffle.
		9	-	R	204-206	208, 210	213	211-212, 214-215	Potential low flow barrier through cobble in riffle.
		-	10	G	219	220-221	218, 222	-	Shallow glide.
		11	-	G	227	224-226	-	-	Potential low flow barrier through boulders (BG).
		12	-	G	231, 237	232-234	235, 236	238-242	Shallow glide, potential depth barrier at lower flow.
		13	-	G	-	246-248	-	-	Potential low flow BG barrier.
		-	14	R	253-254	251-252	250	-	Potential low flow barrier through cobble in riffle.

Table B-2: Migratory Fish Habitat Assessment Results, Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Stream Name	Site Name	Barrier/ Potenital Barrier	Habitat Unit (HU)	Habitat Type	Photos				Notes
					Upstream	Across	Downstream	Other	
Aggiak Outflow *(cont'd)*	Aggiak	15	-	R	262-264	259-261	-	-	Potential low flow barrier at D/S end of HU.
		16	-	G	266-267	268-269	-	270	Confluence with Aggiak, very shallow < 10 cm depth. Looks as though stream may dry up at confluence with Aggiak.
		-	13	Lake	037	038	039	-	At Ferguson Lake.
		-	12	U	034	035	036	-	Near location of flow measurements in July.
		-	11	U	031	032	033	-	Wider with larger substrates. Boulder poking out above ice.
		-	10	U	028	029	30	-	Looks like it would be deeper glides but there are sections with gravel bars sticking out. Lot's of bank slumping indicates banks over top at high flow.
		-	9	U	025	026	027	-	Very confined, steeper section so more confined.
		-	8	U	022	023	024	-	Braided area, width = 3 channels and land between. Likely barrier because already low flow is split between multiple channels.
		-	7	U	019	020	021	-	Demonstrates how high freshet flows get (island in middle of stream).
		-	6	U	016	017	018	-	Flow confined to RB. Water is Open. Remainder of channel is gravel bar.
		5	-	G	013	014	015	-	Open water area just D/S of pond. Gravel bars present.
		-	4	U	010	011	012	-	Deeper glide section, 1 other located U/S too. Directly U/S of small pond or channel. Depth unknown but likely > 0.30m .
		-	3	U	007	008	009	-	Steeper section, looks deeper with boulders and gravel bars along outside edge of meanders.
		-	2	U	004	005	006	-	Up to 0.15m depth in thalweg, frozen so unable to tell if other barriers are present.
		1	-	G	001	002	003	-	Gravel bars result in dry channel areas. Still open and flowing along RB. Small fish could pass in open water.

Notes:
Habitat Type: BG = bouder garden, C = cascade, D = dry channel, F = falls, G = glide, P = pool, R = riffle, U = unknown; could not be defined on survey date
Substrate: F = fines (< 2 mm), G = gravel (2 - 64 mm), C = cobble (64 - 256 mm), B = boulder (256 - 4000 mm), R = bedrock (> 4000 mm), O = other
Barriers: F = impassable falls, BG = impassable boulder garden, D = depth/dry channel, OF = overland flow, SF = subsurface flow, WQ = water quality barrier, G - gradient, O = other (list in Comments column)
Barrier Classification: PT = potential temporary, PP = potential permanent, T = confirmed temporary, P = confirmed permanent
Migratory Habitat Quality Classifications: N = none, P = poor, F = fair, G = good
Sampling Crew: KK = Kathryn Kuchapski, CM = Cedar Metatawabin, GM = Geneviève Morinville, WN = Willie Nakashook, CE = Cameron Evans
NA = not applicable
Dashes = data not collected

APPENDIX C FISH HABITAT ASSESSMENT PHOTOS

Hope Bay Project Candidate Fisheries Offsetting Options, 2018

February 2019

HOPE BAY PROJECT

2018 Fisheries Offsetting Summary Report

Appendix C: Fish Habitat Photos

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Appendix C: Fish Habitat Photos

1. HOPE BAY PROJECT VICINITY OPTIONS

1.1 Tahilugyuak Outflow

Photo 1.1-1: Cascade habitat (HU 3), potential gradient barrier, facing upstream, Tahilugyuak Outflow (July 27, 2018; UTM 449540 7579583).

Photo 1.1-2: Cascade habitat (HU 1), potential boulder garden barrier, facing upstream, Tahilugyuak Outflow (September 20, 2018; UTM 449540 7579583).

Photo 1.1-3: Cascade habitat (HU 3), potential gradient barrier, aerial view, Tahilugyuak Outflow (July 29, 2018; UTM 449540 7579583).

Photo 1.1-4: Cascade habitat (HU 1), potential gradient barrier, aerial view, Tahilugyuak Outflow (September 20, 2018; UTM 449540 7579583).

No Photo in July.

Photo 1.1-5: Cascade habitat (HU 2), temporary depth barrier, facing upstream, Tahilugyuak Outflow (September 20, 2018; UTM 449513 7579552).

No Photo in July.

Photo 1.1-6: Cascade habitat (HU 2), temporary depth barrier, aerial view, Tahilugyuak Outflow (September 20, 2018; UTM 449513 7579552).

Photo 1.1-7: Cascade habitat (HU 5), potential boulder garden barrier, facing upstream, Tahilugyuak Outflow (July 27, 2018; UTM 449431 7579392).

Photo 1.1-8: Cascade/boulder garden habitat (HU 6), temporary boulder garden/depth barrier, facing upstream, Tahilugyuak Outflow (September 20, 2018; UTM 449416 7579392).

Photo 1.1-9: Cascade habitat (HU 5), potential boulder garden barrier, aerial view, Tahilugyuak Outflow (July 29, 2018; UTM 449540 7579583).

Photo 1.1-10: Cascade/boulder garden habitat (HU 6), temporary boulder garden/depth barrier, aerial view, Tahilugyuak Outflow (September 20, 2018; UTM 449416 7579392).

No Photo in July.

Photo 1.1-11: Cascade habitat (HU 8), temporary boulder garden/depth barrier, facing upstream, Tahilugyuak Outflow (September 20, 2018; UTM 449336 7579357).

No Photo in July.

Photo 1.1-12: Cascade habitat (HU 8), temporary depth barrier, aerial view, Tahilugyuak Outflow (September 20, 2018; UTM 449416 7579392).

Photo 1.1-13: Cascade habitat (HU 7), potential boulder garden barrier, facing upstream, Tahilugyuak Outflow (July 27, 2018; UTM 449145 7579260).

Photo 1.1-14: Glide habitat (HU 11), facing upstream, Tahilugyuak Outflow (September 20, 2018; UTM 449416 7579392).

Photo 1.1-15: Cascade habitat (HU 7), potential boulder garden barrier, aerial view, Tahilugyuak Outflow (July 29, 2018; UTM 449145 7579260).

Photo 1.1-16: Glide habitat (HU 11), aerial view, Tahilugyuak Outflow (September 20, 2018; UTM 449416 7579392).

Photo 1.1-17: Riffle habitat (HU 11), facing upstream, Tahilugyuak Outflow (July 27, 2018; UTM 449109 7579022).

Photo 1.1-18: Riffle/boulder garden habitat (HU 14), potential depth barrier, facing upstream, Tahilugyuak Outflow (September 20, 2018; UTM 449131 7578988).

Photo 1.1-19: Riffle habitat (HU 11), aerial view, Tahilugyuak Outflow (July 29, 2018; UTM 449109 7579022).

Photo 1.1-20: Riffle/boulder garden habitat (HU 14), potential depth barrier, aerial view, Tahilugyuak Outflow (September 20, 2018; UTM 449131 7578988).

Photo 1.1-21: Cascade habitat (HU 14), potential gradient barrier, facing across from right bank, Tahilugyuak Outflow (July 27, 2018; UTM 449099 7578709).

Photo 1.1-22: Cascade/boulder garden habitat (HU 16), temporary boulder garden/depth barrier, facing across from left bank, Tahilugyuak Outflow (September 20, 2018; UTM 449081 7578706).

Photo 1.1-23: Cascade habitat (HU 14), potential gradient barrier, aerial view, Tahilugyuak Outflow (July 29, 2018; UTM 449099 7578709).

No Photo in September.

Photo 1.1-24: Cascade habitat (HU 16), potential boulder garden/gradient barrier, facing upstream, Tahilugyuak Outflow (July 27, 2018; UTM 449032 7578607).

Photo 1.1-25: Cascade/boulder garden habitat (HU 18), temporary boulder garden/depth barrier, facing upstream, Tahilugyuak Outflow (September 20, 2018; UTM 449045 7578588).

Photo 1.1-26: Cascade habitat (HU 16), potential boulder garden/gradient barrier, aerial view, Tahilugyuak Outflow (July 29, 2018; UTM 449032 7578607).

No Photo in September.

Photo 1.1-27: Riffle habitat (HU 18), potential boulder garden barrier, facing upstream, Tahilugyuak Outflow (July 27, 2018; UTM 448844 7578589).

Photo 1.1-28: Riffle/boulder garden habitat (HU 20), temporary boulder garden barrier, facing upstream, Tahilugyuak Outflow (September 21, 2018; UTM 448844 7578597).

Photo 1.1-29: Riffle habitat (HU 18), potential boulder garden barrier, aerial view, Tahilugyuak Outflow (July 29, 2018; UTM 448844 7578589).

Photo 1.1-30: Riffle/boulder garden habitat (HU 20), temporary boulder garden barrier, aerial view, Tahilugyuak Outflow (September 21, 2018; UTM 448844 7578597).

Photo 1.1-31: Cascade habitat (HU 21), temporary boulder garden/gradient barrier, facing upstream, Tahilugyuak Outflow (July 27, 2018; UTM 448599 7578367).

Photo 1.1-32: Cascade/boulder garden habitat (HU 22), temporary boulder garden barrier, facing upstream, Tahilugyuak Outflow (September 21, 2018; UTM 448605 7578367).

Photo 1.1-33: Cascade habitat (HU 21), temporary boulder garden/gradient barrier, aerial view, Tahilugyuak Outflow (July 29, 2018; UTM 448599 7578367).

Photo 1.1-34: Cascade/boulder garden habitat (HU 22), temporary boulder garden barrier, aerial view, Tahilugyuak Outflow (September 21, 2018; UTM 448605 7578367).

Photo 1.1-35: Riffle habitat (HU 23), potential boulder garden barrier, facing upstream, Tahilugyuak Outflow (July 27, 2018; UTM 448383 7578246).

Photo 1.1-36: Riffle habitat (HU 24), potential depth barrier, facing upstream, Tahilugyuak Outflow (September 21, 2018; UTM 448395 7578228).

Photo 1.1-37: Riffle habitat (HU 23), potential boulder garden barrier, aerial view, Tahilugyuak Outflow (July 29, 2018; UTM 448383 7578246).

Photo 1.1-38: Riffle habitat (HU 24), potential depth barrier, aerial view, Tahilugyuak Outflow (September 21, 2018; UTM 448395 7578228).

Photo 1.1-39: Cascade habitat (HU 24), potential boulder garden barrier, facing upstream, Tahilugyuak Outflow (July 27, 2018; UTM 448350 7578188).

Photo 1.1-40: Boulder garden habitat (HU 25), temporary boulder garden barrier, facing upstream, Tahilugyuak Outflow (September 21, 2018; UTM 448357 7578188).

Photo 1.1-41: Cascade habitat (HU 24), potential boulder garden barrier, aerial view, Tahilugyuak Outflow (July 29, 2018; UTM 448350 7578188).

Photo 1.1-42: Boulder garden habitat (HU 25), temporary boulder garden barrier, aerial view, Tahilugyuak Outflow (September 21, 2018; UTM 448357 7578188).

Photo 1.1-43: Cascade habitat (HU 25), potential boulder garden barrier, facing across from right bank, Tahilugyuak Outflow (July 27, 2018; UTM 448252 7578165).

Photo 1.1-44: Cascade habitat (HU 27), temporary boulder garden barrier, facing upstream, Tahilugyuak Outflow (September 21, 2018; UTM 448232 7578163).

Photo 1.1-45: Cascade habitat (HU 25), potential boulder garden barrier, aerial view, Tahilugyuak Outflow (July 29, 2018; UTM 448252 7578165).

Photo 1.1-46: Cascade habitat (HU 27), temporary boulder garden barrier, aerial view, Tahilugyuak Outflow (September 21, 2018; UTM 448232 7578163).

Photo 1.1-47: Cascade habitat (HU 26), potential gradient barrier, facing upstream, Tahilugyuak Outflow (July 27, 2018; UTM 448183 7578162).

Photo 1.1-48: Cascade habitat (HU 27), temporary boulder garden barrier, facing upstream, Tahilugyuak Outflow (September 21, 2018; UTM 448357 7578188).

Photo 1.1-49: Cascade habitat (HU 26), potential gradient barrier, aerial view, Tahilugyuak Outflow (July 29, 2018; UTM 448183 7578162.

Photo 1.1-50: Cascade habitat (HU 27), temporary boulder garden barrier, aerial view, Tahilugyuak Outflow (September 21, 2018; UTM 448357 7578188).

1.2 Harvaqtuuq Outflow and Inflow

Photo 1.2-1: Cascade habitat (HU 3), potential gradient barrier, facing upstream, Harvaqtuuq Outflow (July 28, 2018; UTM 406465 7552153).

Photo 1.2-2: Cascade habitat (HU 3), potential gradient barrier, facing upstream, Harvaqtuuq Outflow (September 22, 2018; UTM 406525 7552149).

Photo 1.2-3: Cascade habitat (HU 2), potential gradient barrier, aerial view, Harvaqtuuq Outflow (July 29, 2018; UTM 406465 7552153).

Photo 1.2-4: Cascade habitat (HU 3), potential gradient barrier, aerial view, Harvaqtuuq Outflow (September 22; UTM 406525 7552149).

Photo 1.2-5: Riffle habitat (HU 7), fish weir, facing downstream, Harvaqtuuq Outflow (July 28, 2018; UTM 406514 7551896).

Photo 1.2-6: Riffle habitat (HU 7), fish weir, facing upstream, Harvaqtuuq Outflow (September 22, 2018; UTM 406525 7551898).

Photo 1.2-7: Riffle habitat (HU 3), fish weir, aerial view, Harvaqtuuq Outflow (July 29, 2018; UTM 406514 7551896).

Photo 1.2-8: Riffle habitat (HU 7), fish weir, aerial view, Harvaqtuuq Outflow (September 22, 2018; UTM 406525 7551898).

Photo 1.2-9: Riffle/boulder garden habitat (HU 1), potential boulder garden barrier, facing downstream, Harvaqtuuq Inflow (July 28, 2018; UTM 408198 7551712).

Photo 1.2-10: Riffle/ boulder garden habitat (HU 1), potential boulder garden barrier, facing downstream, Harvaqtuuq Inflow (September 22, 2018; UTM 408198 7551712).

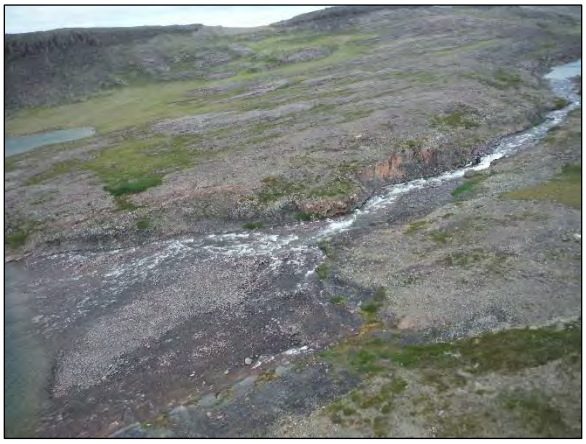

Photo 1.2-11: Riffle/boulder garden habitat (HU 1), potential boulder garden barrier, aerial view, Harvaqtuuq Inflow (July 28, 2018; UTM 408198 7551712).

No Photo in September.

Photo 1.2-12: Falls habitat (HU 3) permanent falls barrier, facing upstream, Harvaqtuuq Inflow (July 28, 2018; UTM 408299 7551848).

Photo 1.2-13: Falls habitat (HU 3), permanent falls barrier, facing upstream, Harvaqtuuq Inflow (September 22, 2018; UTM 408299 7551848).

Photo 1.2-14: Falls habitat (HU 3) permanent falls barrier, aerial view, Harvaqtuuq Inflow (July 28, 2018; UTM 408299 7551848).

No Photo in September.

1.3 Reference Lake D Outflow

Photo 1.3-1: Cascade habitat (HU 5), facing upstream. Reference Lake D Outflow (July 26, 2018; UTM 447841 7563803).

Photo 1.3-2: Cascade habitat (HU 5), aerial view, Reference Lake D Outflow (July 29, 2018; UTM 447841 7563803).

1.4 Iqalulialuk Outflow

Photo 1.4-1: Riffle habitat (HU 2), potential boulder garden barrier, facing upstream, Iqalulialuk Outflow (July 30, 2018; UTM 374285 7506837).

Photo 1.4-2: Riffle habitat (HU 2), potential boulder garden barrier, aerial view, Iqalulialuk Outflow (July 30, 2018; UTM 374285 7506837).

Photo 1.4-3: Cascade habitat (HU 4), potential boulder garden barrier, facing upstream, Iqalulialuk Outflow (July 30, 2018; UTM 374223 7506868).

Photo 1.4-4: Cascade habitat (HU 4), potential boulder garden barrier, aerial view, Iqalulialuk Outflow (July 30, 2018; UTM 374223 7506868).

Photo 1.4-5: Riffle habitat (HU 5), potential boulder garden barrier, facing across from right bank, Iqalulialuk Outflow (July 30, 2018; UTM 374178 7506894).

Photo 1.4-6: Riffle habitat (HU 5), potential boulder garden barrier, aerial view, Iqalulialuk Outflow (July 30, 2018; UTM 374178 7506894).

1.5 Omingmaktok Area Lake Outflow

Photo 1.5-1: Boulder garden habitat (HU 1), potential boulder garden barrier, facing upstream, Omingmaktok Area Lake Outflow (July 30, 2018; UTM 380487 7507470).

Photo 1.5-2: Boulder Garden habitat (HU 1), potential boulder garden barrier, aerial view, Omingmaktok Area Lake Outflow (July 30, 2018; UTM 380487 7507470).

Photo 1.5-3: Cascade habitat (HU 2), potential gradient barrier, facing upstream, Omingmaktok Area Lake Outflow (July 30, 2018; UTM 380602 7507426).

Photo 1.5-4: Cascade habitat (HU 2), potential gradient barrier, aerial view, Omingmaktok Area Lake Outflow (July 30, 2018; UTM 380602 7507426).

2. CAMBRIDGE BAY VICINITY OPTIONS

2.1 Grenier Lake East Outflow

Photo 2.1-1: Dry channel habitat (HU 1), temporary depth barrier, facing upstream, Grenier Lake East Outflow, (August 1, 2018; UTM 500299 7668774).

Photo 2.1-2: Dry channel habitat (HU 2), temporary depth barrier, facing upstream, Grenier Lake East Outflow, (August 1, 2018; UTM 500412 7668741).

Photo 2.1-3: Glide habitat (HU 4), temporary depth barrier, facing upstream, Grenier Lake East Outflow, (August 1, 2018; UTM 500465 7668698).

Photo 2.1-4: Glide habitat (HU 6), temporary depth barrier, facing upstream, Grenier Lake East Outflow, (August 1, 2018; UTM 503933 7671665).

Photo 2.1-5: Culvert (HU 8), permanent culvert barrier, facing upstream, Grenier Lake East Outflow, (August 1, 2018; UTM 503807 7672035).

Photo 2.1-6: Glide habitat (HU 9), temporary depth barrier, facing upstream, Grenier Lake East Outflow, (August 1, 2018; UTM 503626 7672271).

Photo 2.1-7: Dry channel habitat (HU 10), permanent culvert barrier, facing upstream, Grenier Lake East Outflow, (August 1, 2018; UTM 503654 7672345).

Photo 2.1-8: Dry Channel habitat (HU 11), temporary depth barrier, facing upstream, Grenier Lake East Outflow, (August 1, 2018; UTM 503807 7672035).

Photo 2.1-9: Dry channel habitat (HU 1), temporary depth barrier, facing upstream, Grenier Lake East Outflow (September 26, 2018; UTM 500054 7668606).

Photo 2.1-10: Dry channel habitat (HU 2), temporary depth barrier, facing upstream, Grenier Lake East Outflow (September 26, 2018; UTM 500299 7668774).

Photo 2.1-11: Glide habitat (HU 4), temporary depth barrier, facing upstream, Grenier Lake East Outflow (September 26, 2018; UTM 501870 7669373).

Photo 2.1-12: Glide habitat (HU 5), temporary depth barrier, facing upstream, Grenier Lake East Outflow (September 26, 2018; UTM 503035 7670168).

Photo 2.1-13: Glide habitat (HU 6), temporary depth barrier, facing upstream, Grenier Lake East Outflow (September 26, 2018; UTM 503198 7670239).

Photo 2.1-14: Glide habitat (HU 7), temporary depth barrier, facing upstream, Grenier Lake East Outflow (September 26, 2018; UTM 503299 7670281).

Photo 2.1-15: Glide habitat (HU 8), temporary depth barrier, facing upstream, Grenier Lake East Outflow (September 26, 2018; UTM 503415 7670304).

2.2 Kitiga Outflow

Photo 2.2-1: Fish Weir (HU 2), facing across, Kitiga Outflow (August 2, 2018; UTM 452710 7687046).

Photo 2.2-2: Fish Weir (HU 4), facing across, Kitiga Outflow (August 2, 2018; UTM 452846 7686928).

Photo 2.2-3: Kitiga Falls (HU 8), potentially too large of a system to work on, facing across, Kigiga Outflow (August 2, 2018; UTM 452799 7686709).

2.3 Aggiak Outflow

Photo 2.3-1: Riffle habitat (HU 1), potential depth barrier, facing upstream, Aggiak Outflow (August 3, 2018; UTM 494303 7698382).

Photo 2.3-2: Unknown habitat (HU 12), no barriers, facing upstream, Aggiak Outflow (September 27, 2018; UTM 494370 7698308).

Photo 2.3-3: Riffle habitat (HU 2), potential depth barrier, facing upstream, Aggiak Outflow (August 3, 2018; UTM 494398 7698295).

No photo in September.

Photo 2.3-4: Riffle habitat (HU 6), potential depth barrier, facing upstream, Aggiak Outflow (August 3, 2018; UTM 494521 7698370).

Photo 2.3-5: Unknown habitat (HU 12), no barriers, facing upstream, Aggiak Outflow (September 27, 2018; UTM 494745 7698361).

Photo 2.3-6: Riffle habitat (HU 7), potential depth barrier, facing upstream, Aggiak Outflow (August 3, 2018; UTM 494604 7698402).

No Photo in September.

Photo 2.3-7: Riffle habitat (HU 8), potential depth barrier, facing upstream, Aggiak Outflow (August 3, 2018; UTM 494654 7698400).

No Photo in September.

Photo 2.3-8: Riffle habitat (HU 9), potential depth barrier, facing upstream, Aggiak Outflow (August 3, 2018; UTM 494629 7698399).

No Photo in September.

Photo 2.3-9: Glide habitat (HU 11), potential boulder garden barrier, facing upstream, Aggiak Outflow (August 3, 2018; UTM 495285 7698234).

Photo 2.3-10: Unknown habitat (HU 8), no barriers, facing upstream, Aggiak Outflow (September 27, 2018; UTM 495340 7698214).

Photo 2.3-11: Glide habitat (HU 12), potential depth barrier, facing upstream, Aggiak Outflow (August 3, 2018; UTM 495285 7698234).

Photo 2.3-12: Unknown habitat (HU 6), temporary depth barrier, facing upstream, Aggiak Outflow (September 27, 2018; UTM 495536 7698064).

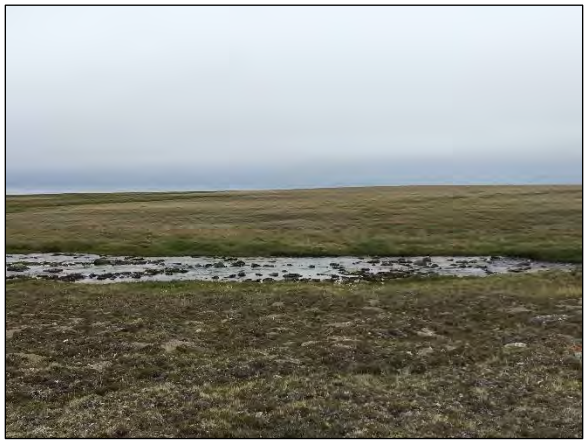

Photo 2.3-13: Glide habitat (HU 13), potential boulder garden barrier, facing across, Aggiak Outflow (August 3, 2018; UTM 495285 7698234).

Photo 2.3-14: Glide habitat (HU 5), temporary depth barrier, facing upstream, Aggiak Outflow (September 27, 2018; UTM 495901 7697839).

Photo 2.3-15: Riffle habitat (HU 14), potential depth barrier, facing upstream, Aggiak Outflow (August 3, 2018; UTM 496141 7697741).

Photo 2.3-16: Unknown habitat (HU 4), no barriers, facing upstream, Aggiak Outflow (September 27, 2018; UTM 495901 7697839).

Photo 2.3-17: Riffle habitat (HU 15), potential depth barrier, facing upstream, Aggiak Outflow (August 3, 2018; UTM 496328 7697481).

Photo 2.3-18: Unknown habitat (HU 2), temporary depth barrier, facing upstream, Aggiak Outflow (September 27, 2018; UTM 496377 7697430).

Photo 2.3-19: Riffle habitat (HU 16), potential depth barrier, facing upstream, Aggiak Outflow (August 3, 2018; UTM 496595 7697353).

Photo 2.3-20: Glide habitat (HU 1), temporary depth barrier, facing upstream, Aggiak Outflow (September 27, 2018; UTM 496612 7697347).

APPENDIX D MANUAL DISCHARGE MEASUREMENT RESULTS

Hope Bay Project Candidate Fisheries Offsetting Options, 2018

Table D-1: 2018 Manual Discharge Measurements at Tahilugyuak Outflow #1 - July

Site Information					
Project Name	Hope Bay				
Station Identification	Tahilugyuak Outflow #1				
Stream Name					
Date Monitored	29-Jul-18				
Time at Site (24 hr)	**Start Time:**		**End Time:**		
Personnel					
Station Cordinates	**Easting**	**Northing**	**Elevation**		
	449542	7579588			
Weather Conditions					

Transducer Information			
DL Model		**PT Serial #**	
Gain		**Offset**	
Status		**Battery**	
# of Records		**Memory Free**	
DL Service Performed		**Crest Gauges**	

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 1		0.000			
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
				0.000	
				0.000	
TBM				0.000	
TBM		0.000		0.000	
BM 1				0.000	
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
0				0.000	
0				0.000	
0					
0					

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 1		0.000	0.000	
BM 2		0.000	0.000	
BM 3		0.000	0.000	

Summary	
Staff Gauge Reading (m)	0.000
Stage from WL Survey (m)	0.000
Pressure Transducer Reading (m)	
Pressure Transducer Elevation (m)	
Discharge (m³/s)	**1.255**
Cross Sectional Area	4.449
Average Velocity	0.282

Discharge Measurement - Mid-Section Method

Measurement Time	**Start**		**End**		**Location**	Downstream end of potential offsetting stream		
Method	Velocity-area (Mid-section)			**Instrument Model**		OTT MF Pro		
Flow Meter Type	Electromagnetic			**Instrument**		TMAC Owned		
Real Time Reading (m)	**Start**	**Reading**		**Time**		**Staff Gauge (m)**		
	End	**Reading**		**Time**		**Time of SG Reading**		

		Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
No.	**Notes**	**(m)**	**(m)**	**(m)**	**(m²)**	**60%**	**20%**	**80%**	**(m³/s)**	**%**
1	RB	3.40	0.00		0.00	0			0.000	0.0
2		5.45	0.17		0.21	-0.007			-0.001	-0.1
3		5.85	0.29		0.17	0			0.000	0.0
4		6.65	0.39		0.23	0.052			0.012	1.0
5		7.05	0.46		0.18	0.107			0.020	1.6
6		7.45	0.49		0.20	0.242			0.047	3.8
7		7.85	0.54		0.22	0.271			0.059	4.7
8		8.25	0.57		0.20	0.294			0.059	4.7
9		8.55	0.45		0.14	0.336			0.045	3.6
10		8.85	0.57		0.17	0.468			0.080	6.4
11		9.15	0.63		0.19	0.491			0.093	7.4
12		9.45	0.53		0.16	0.508			0.081	6.4
13		9.75	0.62		0.17	0.549			0.094	7.5
14		10.00	0.61		0.20	0.506			0.100	8.0
15		10.40	0.39		0.14	0.58			0.079	6.3
16		10.70	0.65		0.20	0.44			0.086	6.8
17		11.00	0.64		0.19	0.444			0.085	6.8
18		11.30	0.46		0.14	0.625			0.086	6.9
19		11.60	0.51		0.15	0.573			0.088	7.0
20		11.90	0.51		0.18	0.42			0.075	6.0
21		12.30	0.49		0.20	0.22			0.043	3.4
22		12.70	0.48		0.22	0.103			0.022	1.8
23		13.20	0.36		0.16	0.034			0.006	0.4
24		13.60	0.40		0.18	-0.013			-0.002	-0.2
25		14.10	0.30		0.15	0.002			0.000	0.0
26		14.60	0.18		0.12	-0.008			-0.001	-0.1
27	LB	15.40	0.00		0.00	0			0.000	0.0
28					0.00				0.000	0.0
29					0.00				0.000	0.0
30					0.00				0.000	0.0
31					0.00				0.000	0.0
32					0.00				0.000	0.0
33					0.00				0.000	0.0
Total Q									**1.255**	**100.0**

General Notes

Table D-2: 2018 Manual Discharge Measurements at Tahilugyuak Outflow #1 - September

Site Information					
Project Name	Hope Bay				
Station Identification	Tahilugyuak Outflow #1				
Stream Name					
Date Monitored	20-Sep-18				
Time at Site (24 hr)	**Start Time:**		**End Time:**		
Personnel	CE				
Station Cordinates	**Easting**	**Northing**	**Elevation**		
	449542	7579588			
Weather Conditions					

Transducer Information			
DL Model		**PT Serial #**	
Gain		**Offset**	
Status		**Battery**	
# of Records		**Memory Free**	
DL Service Performed		**Crest Gauges**	

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 1		0.000			
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
				0.000	
				0.000	
TBM				0.000	
TBM		0.000		0.000	
BM 1				0.000	
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
0				0.000	
0				0.000	
0					
0					

BM#	**Established Elevation (m)**	**Mean Elevation (this date) (m)**	**Difference (m)**	**Notes**
BM 1		0.000	0.000	
BM 2		0.000	0.000	
BM 3		0.000	0.000	

Summary	
Staff Gauge Reading (m)	0.000
Stage from WL Survey (m)	0.000
Pressure Transducer Reading (m)	
Pressure Transducer Elevation (m)	
Discharge (m³/s)	**0.459**
Cross Sectional Area	2.214
Average Velocity	0.207

Discharge Measurement - Mid-Section Method

Measurement Time	**Start**		**End**		**Location**	Downstream end of potential offsetting stream		
Method	Velocity-area (Mid-section)			**Instrument Model**	OTT MF Pro			
Flow Meter Type	Electromagnetic			**Instrument**	TMAC Owned			
Real Time Reading (m)	**Start**	**Reading**		**Time**		**Staff Gauge (m)**		
	End	**Reading**		**Time**		**Time of SG Reading**		

		Station	**Depth**	**Distance**	**Area**	**Velocity (m/s)**			**Q**	**% of Total Q**
No.	**Notes**	**(m)**	**(m)**	**(m)**	**(m²)**	**60%**	**20%**	**80%**	**(m³/s)**	**%**
1	RB	14.70	0.00		0.00	0			0.000	0.0
2		14.40	0.21		0.07	0.019			0.001	0.3
3		14.00	0.15		0.06	-0.01			-0.001	-0.1
4		13.60	0.16		0.06	0.127			0.008	1.8
5		13.20	0.15		0.06	0.183			0.011	2.4
6		12.80	0.23		0.09	0.021			0.002	0.4
7		12.40	0.21		0.08	0.058			0.005	1.1
8	in eddy	12.00	0.42		0.15	0.01			0.001	0.3
9		11.70	0.34		0.10	0.042			0.004	0.9
10		11.40	0.49		0.15	0.109			0.016	3.5
11		11.10	0.47		0.14	0.278			0.039	8.5
12		10.80	0.39		0.12	0.373			0.044	9.5
13		10.50	0.46		0.14	0.336			0.046	10.1
14		10.20	0.37		0.11	0.384			0.043	9.3
15		9.90	0.37		0.11	0.404			0.045	9.8
16		9.60	0.43		0.11	0.426			0.046	10.0
17		9.40	0.43		0.09	0.407			0.035	7.6
18		9.20	0.48		0.10	0.258			0.025	5.4
19		9.00	0.50		0.10	0.391			0.039	8.5
20		8.80	0.35		0.07	0.32			0.022	4.9
21		8.60	0.33		0.08	0.145			0.012	2.6
22		8.30	0.35		0.11	0.092			0.010	2.1
23		8.00	0.19		0.07	0.04			0.003	0.6
24		7.60	0.15		0.05	0.038			0.002	0.4
25	LB	7.30	0.00		0.00				0.000	0.0
26					0.00				0.000	0.0
27					0.00				0.000	0.0
28					0.00				0.000	0.0
29					0.00				0.000	0.0
30					0.00				0.000	0.0
31					0.00				0.000	0.0
32					0.00				0.000	0.0
33					0.00				0.000	0.0
Total Q									**0.459**	**100.0**

General Notes

Table D-3: 2018 Manual Discharge Measurements at Tahilugyuak Outflow #2 - July

Site Information					
Project Name	Hope Bay				
Station Identification	Tahilugyuak Outflow #2				
Stream Name					
Date Monitored	29-Jul-18				
Time at Site (24 hr)	**Start Time:**		**End Time:**		
Personnel					
Station Cordinates	**Easting**	**Northing**	**Elevation**		
	448163	7578128			
Weather Conditions					

Transducer Information			
DL Model		**PT Serial #**	
Gain		**Offset**	
Status		**Battery**	
# of Records		**Memory Free**	
DL Service Performed		**Crest Gauges**	

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 1		0.000			
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
				0.000	
				0.000	
TBM				0.000	
TBM		0.000		0.000	
BM 1				0.000	
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
0				0.000	
0				0.000	
0					
0					
BM#	**Established Elevation (m)**	**Mean Elevation (this date) (m)**		**Difference (m)**	**Notes**
BM 1		0.000		0.000	
BM 2		0.000		0.000	
BM 3		0.000		0.000	

Summary	
Staff Gauge Reading (m)	0.000
Stage from WL Survey (m)	0.000
Pressure Transducer Reading (m)	
Pressure Transducer Elevation (m)	
Discharge (m³/s)	**0.960**
Cross Sectional Area	12.167
Average Velocity	0.079

Discharge Measurement - Mid-Section Method											
Measurement Time		**Start**		**End**		**Location**	Near Tahilugyuak				
Method		Velocity-area (Mid-section)				**Instrument Model**	OTT MF Pro				
Flow Meter Type		Electromagnetic				**Instrument**	TMAC Owned				
Real Time Reading (m)		**Start**	**Reading**		**Time**		**Staff Gauge (m)**				
		End	**Reading**		**Time**		**Time of SG Reading**				
		Station	**Depth**	**Distance**	**Area**	**Velocity (m/s)**			**Q**	**% of Total Q**	
No.	**Notes**	**(m)**	**(m)**	**(m)**	**(m²)**	**60%**	**20%**	**80%**	**(m³/s)**	**%**	
1	RB	34.45	0.00		0.00	0			0.000	0.0	
2		33.15	0.10		0.12	0.248			0.030	3.1	
3		32.05	0.17		0.20	0.041			0.008	0.8	
4		30.85	0.16		0.19	0.03			0.006	0.6	
5		29.65	0.35		0.42	-0.021			-0.009	-0.9	
6		28.45	0.27		0.34	0.046			0.016	1.6	
7		27.10	0.20		0.26	0.088			0.023	2.4	
8		25.85	0.23		0.26	0.238			0.062	6.4	
9		24.85	0.63		0.69	0.098			0.068	7.1	
10		23.65	0.61		0.73	0.138			0.101	10.5	
11		22.45	0.67		0.80	0.103			0.083	8.6	
12		21.25	0.18		0.22	0.055			0.012	1.2	
13		20.05	0.28		0.34	0.078			0.026	2.7	
14		18.85	0.30		0.36	-0.02			-0.007	-0.7	
15		17.65	0.61		0.72	0.024			0.017	1.8	
16		16.50	0.59		0.71	0.05			0.035	3.7	
17		15.25	0.43		0.53	0.006			0.003	0.3	
18		14.05	0.46		0.55	0.047			0.026	2.7	
19		12.85	0.41		0.49	0.098			0.048	5.0	
20		11.65	0.52		0.62	0.104			0.065	6.8	
21		10.45	0.47		0.56	-0.045			-0.025	-2.6	
22		9.25	0.47		0.56	0.308			0.174	18.1	
23		8.05	0.48		0.58	0.203			0.117	12.2	
24		6.85	0.49		0.59	0.163			0.096	10.0	
25		5.65	0.67		0.80	-0.007			-0.006	-0.6	
26		4.45	0.52		0.52	-0.015			-0.008	-0.8	
27	LB	3.65	0.00		0.00	0			0.000	0.0	
28					0.00				0.000	0.0	
29					0.00				0.000	0.0	
30					0.00				0.000	0.0	
31					0.00				0.000	0.0	
32					0.00				0.000	0.0	
33					0.00				0.000	0.0	
Total Q									**0.960**	**100.0**	

General Notes
~80mm juv. ARCH or LKTR obs. Directly US of transect

Table D-4: 2018 Manual Discharge Measurements at Tahilugyuak Outflow #2 - September

Site Information					
Project Name	Hope Bay				
Station Identification	Tahilugyuak Outflow #2				
Stream Name					
Date Monitored	21-Sep-18				
Time at Site (24 hr)	**Start Time:**		**End Time:**		
Personnel	CE				
Station Cordinates	**Easting**	**Northing**	**Elevation**		
	448163	7578128			
Weather Conditions					

Transducer Information			
DL Model		**PT Serial #**	
Gain		**Offset**	
Status		**Battery**	
# of Records		**Memory Free**	
DL Service Performed		**Crest Gauges**	

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 1		0.000			
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
				0.000	
				0.000	
TBM				0.000	
TBM		0.000		0.000	
BM 1				0.000	
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
0				0.000	
0				0.000	
0					
0					

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 1		0.000	0.000	
BM 2		0.000	0.000	
BM 3		0.000	0.000	

Summary	
Staff Gauge Reading (m)	0.000
Stage from WL Survey (m)	0.000
Pressure Transducer Reading (m)	
Pressure Transducer Elevation (m)	
Discharge (m³/s)	**0.265**
Cross Sectional Area	6.101
Average Velocity	0.043

Discharge Measurement - Mid-Section Method

Measurement Time	**Start**		**End**		**Location**	Near Tahilugyuak		
Method	Velocity-area (Mid-section)			**Instrument Model**	OTT MF Pro			
Flow Meter Type	Electromagnetic			**Instrument**	TMAC Owned			
Real Time Reading (m)	**Start**	**Reading**		**Time**		**Staff Gauge (m)**		
	End	**Reading**		**Time**		**Time of SG Reading**		

		Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
No.	**Notes**	**(m)**	**(m)**	**(m)**	**(m²)**	**60%**	**20%**	**80%**	**(m³/s)**	**%**
1	RB	3.00	0.00		0.00	0			0.000	0.0
2	BG	4.10	0.16		0.22	0.003			0.001	0.3
3	BG	5.80	0.11		0.17	0.009			0.001	0.6
4	BG	7.10	0.20		0.32	-0.005			-0.002	-0.6
5	BG	9.00	0.29		0.49	0.043			0.021	8.0
6	BG	10.50	0.16		0.24	0.095			0.023	8.6
7	BG	12.00	0.29		0.46	0.013			0.006	2.3
8	BG	13.70	0.16		0.24	0.088			0.021	8.0
9	BG	15.00	0.10		0.14	0.037			0.005	2.0
10	BG	16.50	0.14		0.18	0.041			0.007	2.7
11	BG	17.50	0.10		0.10	0.026			0.003	1.0
12	BG	18.50	0.11		0.11	-0.012			-0.001	-0.5
13	BG	19.50	0.14		0.18	-0.002			0.000	-0.1
14	BG	21.00	0.17		0.21	0.028			0.006	2.2
15	BG	22.00	0.18		0.27	0.022			0.006	2.2
16	BG	24.00	0.18		0.32	0.04			0.013	4.8
17	end BG	25.50	0.29		0.44	0.079			0.034	13.0
18		27.00	0.31		0.47	0.07			0.033	12.3
19		28.50	0.45		0.68	0.087			0.059	22.2
20		30.00	0.37		0.46	0.044			0.020	7.7
21		31.00	0.30		0.30	0.036			0.011	4.1
22		32.00	0.16		0.12	-0.013			-0.002	-0.6
23	LB	32.50	0.00		0.00	0			0.000	0.0
24					0.00				0.000	0.0
25					0.00				0.000	0.0
26					0.00				0.000	0.0
27					0.00				0.000	0.0
28					0.00				0.000	0.0
29					0.00				0.000	0.0
30					0.00				0.000	0.0
31					0.00				0.000	0.0
32					0.00				0.000	0.0
33					0.00				0.000	0.0
Total Q									**0.265**	**100.0**

General Notes

Table D-5: 2018 Manual Discharge Measurements at Harvaqtuuq Outflow

Site Information					
Project Name	Hope Bay				
Station Identification	Harvaqtuuq Outflow				
Stream Name					
Date Monitored	22-Sep-18				
Time at Site (24 hr)	**Start Time:**		**End Time:**		
Personnel	Kathryn				
Station Cordinates	**Easting**	**Northing**	**Elevation**		
	406524	7551899			
Weather Conditions	mix sun and cloud				

Transducer Information			
DL Model		**PT Serial #**	
Gain		**Offset**	
Status		**Battery**	
# of Records		**Memory Free**	
DL Service Performed		**Crest Gauges**	

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 1		0.000			
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
				0.000	
				0.000	
TBM				0.000	
TBM		0.000		0.000	
BM 1				0.000	
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
0				0.000	
0				0.000	
0					
0					

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 1		0.000	0.000	
BM 2		0.000	0.000	
BM 3		0.000	0.000	

Summary	
Staff Gauge Reading (m)	0.000
Stage from WL Survey (m)	0.000
Pressure Transducer Reading (m)	
Pressure Transducer Elevation (m)	
Discharge (m³/s)	**2.638**
Cross Sectional Area	12.006
Average Velocity	0.220

Discharge Measurement - Mid-Section Method

Measurement Time	**Start**		**End**		**Location**	End of Pool DS of lake outlet		
Method	Velocity-area (Mid-section)			**Instrument Model**		OTT MF Pro		
Flow Meter Type	Electromagnetic			**Instrument**		TMAC Owned		
Real Time Reading (m)	**Start**	**Reading**		**Time**		**Staff Gauge (m)**		
	End	**Reading**		**Time**		**Time of SG Reading**		

		Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
No.	**Notes**	**(m)**	**(m)**	**(m)**	**(m²)**	**60%**	**20%**	**80%**	**(m³/s)**	**%**
1	LB	42.40	0.00		0.00	0			0.000	0.0
2		41.60	0.26		0.31	0.177			0.055	2.1
3		40.00	0.14		0.22	0.293			0.066	2.5
4		38.40	0.29		0.46	0.26			0.121	4.6
5		36.80	0.44		0.66	0.306			0.202	7.7
6		35.40	0.63		0.57	0.178			0.101	3.8
7	Rock	35.00	0.00		0.00	0			0.000	0.0
8		34.30	0.37		0.43	0.266			0.113	4.3
9		32.70	0.46		0.74	0.15			0.110	4.2
10		31.10	0.44		0.70	0.222			0.156	5.9
11		29.50	0.44		0.70	0.314			0.221	8.4
12		27.90	0.43		0.69	0.24			0.165	6.3
13		26.30	0.52		0.91	0.37			0.337	12.8
14		24.40	0.56		0.90	0.143			0.128	4.9
15		23.10	0.47		0.61	0.246			0.150	5.7
16		21.80	0.29		0.45	0.265			0.119	4.5
17		20.00	0.30		0.51	0.413			0.211	8.0
18		18.40	0.32		0.19	0.368			0.071	2.7
19		18.80	0.30		0.48	0.139			0.067	2.5
20		15.20	0.27		0.70	0.333			0.234	8.9
21		13.60	0.13		0.15	0			0.000	0.0
22		12.90	0.15		0.24	0.052			0.012	0.5
23		10.40	0.11		0.29	0.041			0.012	0.4
24		7.70	0.30		0.72	-0.018			-0.013	-0.5
25		5.60	0.25		0.38	0			0.000	0.0
26	RB	4.70	0.00		0.00	0			0.000	0.0
27					0.00				0.000	0.0
28					0.00				0.000	0.0
29					0.00				0.000	0.0
30					0.00				0.000	0.0
31					0.00				0.000	0.0
32					0.00				0.000	0.0
33					0.00				0.000	0.0
Total Q									**2.638**	**100.0**

General Notes

Table D-6: 2018 Manual Discharge Measurements at Reference Lake D Outflow

Site Information					
Project Name	Hope Bay				
Station Identification	Reference Lake D Outflow				
Stream Name					
Date Monitored	28-Jul-18				
Time at Site (24 hr)	**Start Time:**		**End Time:**		
Personnel	KK,CM				
Station Cordinates	**Easting**	**Northing**	**Elevation**		
	448040	7563194			
Weather Conditions					

Transducer Information			
DL Model		**PT Serial #**	
Gain		**Offset**	
Status		**Battery**	
# of Records		**Memory Free**	
DL Service Performed		**Crest Gauges**	

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 1		0.000			
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
				0.000	
				0.000	
TBM				0.000	
TBM		0.000		0.000	
BM 1				0.000	
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
0				0.000	
0				0.000	
0					
0					

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 1		0.000	0.000	
BM 2		0.000	0.000	
BM 3		0.000	0.000	

Summary	
Staff Gauge Reading (m)	0.000
Stage from WL Survey (m)	0.000
Pressure Transducer Reading (m)	
Pressure Transducer Elevation (m)	
Discharge (m³/s)	**5.016**
Cross Sectional Area	13.593
Average Velocity	0.369

Discharge Measurement - Mid-Section Method

Measurement Time	**Start**	15:11	**End**		**Location**	midstream glide	
Method	Velocity-area (Mid-section)			**Instrument Model**		OTT MF Pro	
Flow Meter Type	Electromagnetic			**Instrument**		TMAC Owned	
Real Time Reading (m)	**Start**	**Reading**		**Time**		**Staff Gauge (m)**	
	End	**Reading**		**Time**		**Time of SG Reading**	

		Station	**Depth**	**Distance**	**Area**	**Velocity (m/s)**			**Q**	**% of Total Q**
No.	**Notes**	**(m)**	**(m)**	**(m)**	**(m²)**	**60%**	**20%**	**80%**	**(m³/s)**	**%**
1	LB	26.85	0.00		0.00	0			0.000	0.0
2		25.85	0.53		0.53	0.307			0.163	3.2
3		24.85	0.62		0.64	0.532			0.338	6.7
4		23.80	0.55		0.55	0.542			0.298	5.9
5		22.85	0.50		0.49	0.546			0.266	5.3
6		21.85	0.47		0.47	0.482			0.227	4.5
7		20.85	0.46		0.46	0.446			0.205	4.1
8		19.85	0.29		0.29	0.466			0.135	2.7
9		18.85	0.38		0.38	0.47			0.179	3.6
10		17.85	0.58		0.58	0.352			0.204	4.1
11		16.85	0.65		0.65	0.414			0.269	5.4
12		15.85	0.58		0.59	0.246			0.146	2.9
13	in eddy behind rock	14.80	0.60		0.60	-0.31			-0.186	-3.7
14		13.85	0.69		0.74	0.032			0.024	0.5
15		12.65	0.70		0.75	0.335			0.252	5.0
16		11.70	0.54		0.49	0.286			0.139	2.8
17		10.85	0.48		0.44	0.265			0.118	2.3
18		9.85	0.50		0.50	0.233			0.117	2.3
19		8.85	0.64		0.64	1.98			1.267	25.3
20		7.85	0.64		0.64	0.209			0.134	2.7
21		6.85	0.75		0.75	0.246			0.185	3.7
22		5.85	0.67		0.65	0.23			0.150	3.0
23		4.90	0.60		0.57	0.239			0.136	2.7
24		3.95	0.63		0.65	0.248			0.160	3.2
25		2.85	0.78		0.54	0.167			0.091	1.8
26	RB	2.56	0.00		0.00	0			0.000	0.0
27					0.00				0.000	0.0
28					0.00				0.000	0.0
29					0.00				0.000	0.0
30					0.00				0.000	0.0
31					0.00				0.000	0.0
32					0.00				0.000	0.0
33					0.00				0.000	0.0
Total Q									**5.016**	**100.0**

General Notes

Table D-7: 2018 Manual Discharge Measurements at Iqalulialuk

Site Information					
Project Name	Hope Bay				
Station Identification	Iqalulialuk Outflow				
Stream Name					
Date Monitored	30-Jul-18				
Time at Site (24 hr)	**Start Time:**		**End Time:**		
Personnel					
Station Cordinates	**Easting**	**Northing**	**Elevation**		
	374309	7506833			
Weather Conditions					

Transducer Information			
DL Model		**PT Serial #**	
Gain		**Offset**	
Status		**Battery**	
# of Records		**Memory Free**	
DL Service Performed		**Crest Gauges**	

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 1		0.000			
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
				0.000	
				0.000	
TBM				0.000	
TBM		0.000		0.000	
BM 1				0.000	
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
0				0.000	
0				0.000	
0					
0					

BM#	**Established Elevation (m)**	**Mean Elevation (this date) (m)**	**Difference (m)**	**Notes**
BM 1		0.000	0.000	
BM 2		0.000	0.000	
BM 3		0.000	0.000	

Summary	
Staff Gauge Reading (m)	0.000
Stage from WL Survey (m)	0.000
Pressure Transducer Reading (m)	
Pressure Transducer Elevation (m)	
Discharge (m³/s)	**0.540**
Cross Sectional Area	1.816
Average Velocity	0.298

Discharge Measurement - Mid-Section Method											
Measurement Time		**Start**		**End**		**Location**	Near confluence with marine environent				
Method		Velocity-area (Mid-section)				**Instrument Model**	OTT MF Pro				
Flow Meter Type		Electromagnetic				**Instrument**	TMAC Owned				
Real Time Reading (m)		**Start**	**Reading**			**Time**		**Staff Gauge (m)**			
		End	**Reading**			**Time**		**Time of SG Reading**			
		Station	**Depth**	**Distance**	**Area**	**Velocity (m/s)**				**Q**	**% of Total Q**
No.	**Notes**	**(m)**	**(m)**	**(m)**	**(m²)**	**60%**	**20%**	**80%**		**(m³/s)**	**%**
1	RB	3.75	0.00		0.00	0				0.000	0.0
2		5.00	0.11		0.09	0.138				0.012	2.2
3		5.30	0.16		0.05	0.171				0.008	1.5
4		5.60	0.17		0.05	0.182				0.009	1.7
5		5.90	0.25		0.08	0.189				0.014	2.6
6		6.20	0.27		0.08	0.223				0.018	3.3
7		6.50	0.28		0.08	0.229				0.019	3.6
8		6.80	0.28		0.08	0.358				0.030	5.6
9		7.10	0.32		0.08	0.377				0.030	5.6
10		7.30	0.34		0.07	0.416				0.028	5.2
11		7.50	0.38		0.08	0.442				0.034	6.2
12		7.70	0.40		0.08	0.466				0.037	6.9
13		7.90	0.38		0.08	0.498				0.038	7.0
14		8.10	0.40		0.08	0.502				0.040	7.4
15		8.30	0.41		0.08	0.461				0.038	7.0
16		8.50	0.41		0.08	0.437				0.036	6.6
17		8.70	0.40		0.08	0.422				0.034	6.2
18		8.90	0.38		0.08	0.389				0.030	5.5
19		9.10	0.35		0.07	0.354				0.025	4.6
20		9.30	0.30		0.06	0.287				0.017	3.2
21		9.50	0.29		0.07	0.237				0.017	3.2
22		9.80	0.26		0.08	0.163				0.013	2.4
23		10.10	0.20		0.06	0.102				0.006	1.1
24		10.40	0.15		0.04	0.083				0.003	0.6
25		10.65	0.11		0.15	0.027				0.004	0.7
26	LB	13.05	0.00		0.00	0				0.000	0.0
27					0.00					0.000	0.0
28					0.00					0.000	0.0
29					0.00					0.000	0.0
30					0.00					0.000	0.0
31					0.00					0.000	0.0
32					0.00					0.000	0.0
33					0.00					0.000	0.0
Total Q										**0.540**	**100.0**

General Notes

Table D-8: 2018 Manual Discharge Measurements at Omingmaktok Area Lake Outflow

Site Information				
Project Name	Hope Bay			
Station Identification	Omingmaktok Area Lake Outflow			
Stream Name				
Date Monitored	30-Jul-18			
Time at Site (24 hr)	**Start Time:**		**End Time:**	
Personnel				
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	382193	7506807		
Weather Conditions				

Transducer Information			
DL Model		**PT Serial #**	
Gain		**Offset**	
Status		**Battery**	
# of Records		**Memory Free**	
DL Service Performed		**Crest Gauges**	

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 1		0.000			
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
				0.000	
				0.000	
TBM				0.000	
TBM		0.000		0.000	
BM 1				0.000	
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
0				0.000	
0				0.000	
0					
0					

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 1		0.000	0.000	
BM 2		0.000	0.000	
BM 3		0.000	0.000	

Summary	
Staff Gauge Reading (m)	0.000
Stage from WL Survey (m)	0.000
Pressure Transducer Reading (m)	
Pressure Transducer Elevation (m)	
Discharge (m³/s)	**1.383**
Cross Sectional Area	5.831
Average Velocity	0.237

Discharge Measurement - Mid-Section Method

Measurement Time	**Start**		**End**		**Location**	Glide directly DS of US lake		
Method	Velocity-area (Mid-section)			**Instrument Model**		OTT MF Pro		
Flow Meter Type	Electromagnetic			**Instrument**		TMAC Owned		
Real Time Reading (m)	**Start**	**Reading**		**Time**		**Staff Gauge (m)**		
	End	**Reading**		**Time**		**Time of SG Reading**		

		Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
No.	**Notes**	**(m)**	**(m)**	**(m)**	**(m²)**	**60%**	**20%**	**80%**	**(m³/s)**	**%**
1	RB	22.00	0.00		0.00	0			0.000	0.0
2		19.00	0.12		0.27	0.006			0.002	0.1
3		17.50	0.17		0.26	0.016			0.004	0.3
4		16.00	0.26		0.27	0.004			0.001	0.1
5		15.45	0.37		0.21	0.113			0.024	1.7
6		14.85	0.52		0.30	0.373			0.112	8.1
7		14.30	0.49		0.27	0.302			0.081	5.9
8		13.75	0.51		0.28	0.388			0.109	7.9
9		13.20	0.53		0.29	0.297			0.087	6.3
10		12.65	0.54		0.30	0.361			0.107	7.8
11		12.10	0.55		0.30	0.357			0.108	7.8
12		11.55	0.55		0.30	0.273			0.083	6.0
13		11.00	0.55		0.30	0.38			0.115	8.3
14		10.45	0.51		0.28	0.383			0.107	7.8
15		9.90	0.36		0.20	0.393			0.078	5.6
16		9.35	0.48		0.26	0.36			0.095	6.9
17		8.80	0.50		0.28	0.295			0.081	5.9
18		8.25	0.47		0.26	0.28			0.072	5.2
19		7.70	0.44		0.24	0.248			0.060	4.3
20		7.15	0.39		0.22	0.174			0.039	2.8
21		6.55	0.39		0.22	0.061			0.014	1.0
22		6.00	0.25		0.19	0.002			0.000	0.0
23		5.00	0.18		0.18	0.026			0.005	0.3
24		4.00	0.12		0.14	-0.002			0.000	0.0
25	LB	2.65	0.00		0.00	0			0.000	0.0
26					0.00				0.000	0.0
27					0.00				0.000	0.0
28					0.00				0.000	0.0
29					0.00				0.000	0.0
30					0.00				0.000	0.0
31					0.00				0.000	0.0
32					0.00				0.000	0.0
33					0.00				0.000	0.0
Total Q									**1.383**	**100.0**

General Notes

Table D-9: 2018 Manual Discharge Measurements at Aggiak Outflow

Site Information					
Project Name	Hope Bay				
Station Identification	Aggiak Outflow				
Stream Name					
Date Monitored	3-Aug-18				
Time at Site (24 hr)	**Start Time:**		**End Time:**		
Personnel					
Station Cordinates	**Easting**	**Northing**	**Elevation**		
	494436	7698264			
Weather Conditions					

Transducer Information			
DL Model		**PT Serial #**	
Gain		**Offset**	
Status		**Battery**	
# of Records		**Memory Free**	
DL Service Performed		**Crest Gauges**	

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 1		0.000			
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
				0.000	
				0.000	
TBM				0.000	28.000
TBM		0.000		0.000	
BM 1				0.000	
BM 2				0.000	
BM 3				0.000	
PT				0.000	
WL				0.000	
0				0.000	
0				0.000	
0					
0					

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 1		0.000	0.000	
BM 2		0.000	0.000	
BM 3		0.000	0.000	

Summary	
Staff Gauge Reading (m)	0.000
Stage from WL Survey (m)	0.000
Pressure Transducer Reading (m)	
Pressure Transducer Elevation (m)	
Discharge (m^3/s)	**0.241**
Cross Sectional Area	1.537
Average Velocity	0.157

Discharge Measurement - Mid-Section Method

Measurement Time	**Start**		**End**		**Location**	Appproximately 400 m u/s of Ferguson Lake		
Method	Velocity-area (Mid-section)			**Instrument Model**		OTT MF Pro		
Flow Meter Type	Electromagnetic			**Instrument**		TMAC Owned		
Real Time Reading (m)	**Start**	**Reading**		**Time**		**Staff Gauge (m)**		
	End	**Reading**		**Time**		**Time of SG Reading**		

		Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
No.	**Notes**	**(m)**	**(m)**	**(m)**	**(m^2)**	**60%**	**20%**	**80%**	**(m^3/s)**	**%**
1	RB	1.95	0.00		0.00	0			0.000	0.0
2		2.20	0.24		0.06	0.108			0.006	2.7
3		2.45	0.24		0.06	-0.033			-0.002	-0.8
4		2.70	0.26		0.07	0.076			0.005	2.1
5		2.95	0.30		0.08	0.225			0.017	7.0
6		3.20	0.28		0.07	0.293			0.021	8.5
7		3.45	0.25		0.06	0.257			0.016	6.7
8		3.70	0.20		0.08	0.245			0.018	7.6
9	Rock @ 3.95	4.20	0.28		0.11	0.189			0.020	8.2
10		4.45	0.37		0.09	0.122			0.011	4.7
11		4.70	0.36		0.09	0.151			0.014	5.6
12	Rock @ 5.20	4.95	0.32		0.07	0.127			0.009	3.8
13		5.15	0.32		0.08	0.126			0.010	4.2
14		5.45	0.27		0.07	0.087			0.006	2.7
15		5.70	0.24		0.06	0.125			0.008	3.1
16		5.95	0.24		0.06	0.16			0.010	4.0
17		6.20	0.20		0.05	0.193			0.010	4.0
18		6.45	0.34		0.09	0.138			0.012	4.9
19		6.70	0.32		0.08	0.136			0.011	4.5
20		6.95	0.32		0.08	0.208			0.017	6.9
21		7.20	0.24		0.06	0.198			0.012	4.9
22		7.45	0.14		0.08	0.141			0.011	4.7
23	LB	8.35	0.00		0.00	0			0.000	0.0
24					0.00				0.000	0.0
25					0.00				0.000	0.0
26					0.00				0.000	0.0
27					0.00				0.000	0.0
28					0.00				0.000	0.0
29					0.00				0.000	0.0
30					0.00				0.000	0.0
31					0.00				0.000	0.0
32					0.00				0.000	0.0
33					0.00				0.000	0.0
Total Q									**0.241**	**100.0**

General Notes

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Hope Bay Project

2019 Freshwater Fisheries Offsetting Summary Report

11 February 2020

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EXECUTIVE SUMMARY

The Hope Bay Project (the Project) is a gold mining development owned by TMAC Resources Inc. (TMAC) in the West Kitikmeot region of mainland Nunavut. The Madrid and Boston developments are part of the Hope Bay Project and TMAC is seeking to develop these areas having received a Project Certificate (No. 009) from the Nunavut Impact Review Board (NIRB) in November 2018 and amended Type A Water Licence (2AM-DOH1335) from the Nunavut Water Board (NWB) in December 2018.

Project activities for Madrid and Boston are predicted to impact freshwater fish and fish habitat through changes in water quantity in lakes and streams (e.g., reduction in available fish habitat, change in flow timing and duration of open-water season) and from in-water infrastructure footprints (e.g., water intake and discharge pipes). According to the Fisheries and Oceans Canada (DFO) Fish and Fish Habitat Protection Policy Statement, if a project is likely to cause harmful impacts to fish and fish habitat after the application of avoidance and mitigation measures, then the proponent must undertake offsetting measures to counterbalance the unavoidable death of fish and/or harmful alteration, disruption or destruction of fish habitat (DFO 2019a). Based on anticipated fisheries losses and commitments made by TMAC, a freshwater Fisheries Offsetting Plan is to be developed in collaboration with DFO and relevant stakeholders including the Kitikmeot Inuit Association (KIA) and the Hope Bay Inuit Environmental Advisory Committee (IEAC).

TMAC initiated work towards a Fisheries Offsetting Plan as part of the Final Environmental Impact Statement (FEIS) in 2017. In 2018 and 2019 TMAC continued to develop and apply a Habitat Evaluation Procedure for anticipated freshwater fish habitat losses, held Fisheries Offsetting Workshops with participation by DFO and relevant stakeholders, and undertook reconnaissance and baseline field programs at candidate offsetting sites. Perspectives, priorities, and Traditional Knowledge (TK) expressed and provided by stakeholders that participated in Fisheries Offsetting Workshops held in Cambridge Bay, Nunavut in June 2018 and April 2019 were incorporated into the design and implementation of field programs carried out in 2018 and 2019. The 2019 Freshwater Fisheries Offsetting Baseline Program continued to build on TMAC's efforts towards the development of a freshwater Fisheries Offsetting Plan for Madrid and Boston by collecting baseline data at two candidate offsetting sites: Grenier Lake East Outflow and Tahilugyuak Outflow.

The Grenier Lake East Outflow is located approximately 125 km northeast of the Doris Mine Site and 2 km outside of Cambridge Bay, flowing south into the Freshwater Creek Estuary located in the Dease Straight. The Grenier Lake East Outflow was identified as a candidate offsetting option by participants at the Fisheries Offsetting Workshop in June 2018 (ERM 2019c). Assessments of fish habitat and fish community suggest that enhancement of migratory and overwintering habitats in the system could be effective options for increasing fish habitat and fisheries productivity. Fish community surveys in 2019 captured Ninespine Stickleback in stream and pond habitats and Arctic Char in ponds. The biological characteristics of the fish captured and the depth and habitat characteristics of the streams and ponds suggest that they may be used by Ninespine Stickleback for migration, spawning, and rearing and by Arctic Char for migration and rearing. Water depths in Ponds 4 and 5 suggested overwintering potential for both fish species. Ponds 1, 2, and 3 were considered likely too shallow for overwintering. The next step for development of a Fisheries Offsetting Plan at Grenier Lake East Outflow is to build on fish habitat and community data that were collected in 2019.

Tahilugyuak is located approximately 25 km northeast of the Doris Mine site and approximately 100 km southwest of Cambridge Bay. Tahilugyuak Outflow flows northeast into a bay in Elu Inlet. A small pond (T-Pond) is located within the outflow, approximately 500 m downstream from Tahilugyuak. Tahilugyuak Outflow was identified as a candidate offsetting option during August 2016 field scouting surveys where potential fish passage barriers were identified. Assessments suggest that enhancement of migratory

habitats achieved through the construction of migration channels could be an effective option for increasing fisheries productivity.

In 2019, planned assessments of stream fish habitat and monitoring of the migratory timing and distribution of fish in Tahilugyuak Outflow could not be carried out as the ice cover logistically prevented the installation of fish capture and monitoring equipment. Thus, the collection of fish and fish habitat data at Tahilugyuak Outflow in 2019 were mostly limited to T-Pond. Arctic Char and Lake Trout were captured in T-Pond in late August. Results of the bathymetric and sublittoral substrate survey of T-Pond found that it has a maximum depth of 7 m, and therefore provides migratory, rearing, overwintering, and potentially spawning habitat for Arctic Char and Lake Trout. Data collected in 2019 suggest that a fisheries offsetting project involving enhancement of migratory habitats using migration channels is still potentially a feasible option. However, the annual frequency that ice cover persists in Tahilugyuak Outflow is unknown, but could present difficulties for the implementation and monitoring of a fisheries offset if one were developed at this location. Based on the limited results of baseline studies at Tahilugyuak Outflow in 2019, it is recommended that it continue to be considered as a contingency candidate fisheries offsetting option for Madrid and Boston (as an alternative to Grenier Lake East Outflow) but that additional field studies not be pursued at this time.

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Acronyms and Abbreviations

CPUE	Catch-Per-Unit-Effort
DELT	Deformities, erosions, lesions and tumors
DFO	Fisheries and Oceans Canada
ERM	ERM Consultants Canada Ltd.
FEIS	Final Environmental Impact Statement
FHAP	Fish Habitat Assessment Procedures
HEP	Habitat Evaluation Procedure
IEAC	Inuit Environmental Advisory Committee
KIA	Kitikmeot Inuit Association
NIRB	Nunavut Impact Review Board
NWB	Nunavut Water Board
PIT	Passive Integrated Transponder
TIN	Triangulated Irregular Network
TK	Traditional Knowledge
TMAC	TMAC Resources Inc.
QA/QC	Quality Assurance/Quality Control

1. BACKGROUND

The Hope Bay Project (the Project) is a gold mining development owned by TMAC Resources Inc. (TMAC) in the West Kitikmeot region of mainland Nunavut. The Project property is approximately 153 km southwest of Cambridge Bay on the southern shore of Melville Sound and contains a greenstone belt (the Belt) that runs 80 km in a north-south direction varying in width between 7 km and 20 km (Figure 1-1).

The Project area has been actively explored and developed since the late 1980s and consists of three developments: Doris, Madrid, and Boston. Doris is the northernmost development situated near Roberts Bay and contains the operating Doris Mine. The Madrid and Boston developments are in the north-central and southernmost parts of the Belt, respectively. TMAC is developing these areas having received a Project Certificate (No. 009) from the Nunavut Impact Review Board (NIRB) in November 2018 and amended Type A Water Licence (2AM-DOH1335) from the Nunavut Water Board (NWB) in December 2018.

Project activities for Madrid and Boston are predicted to affect freshwater fish and fish habitat through changes in water quantity in lakes and streams (e.g., reduction in available fish habitat, change in flow timing and duration of open-water season) and from in-water infrastructure footprints (e.g., water intake and discharge pipes). According to the Fisheries and Oceans Canada (DFO) Fish and Fish Habitat Protection Policy Statement, if a project is likely to cause harmful impacts to fish and fish habitat after the application of avoidance and mitigation measures, then the proponent must undertake offsetting measures to counterbalance the unavoidable death of fish and/or harmful alteration, disruption or destruction of fish habitat (DFO 2019a).

Included in the Madrid-Boston Project Certificate are commitments that were confirmed by parties at the Madrid-Boston (i.e., Phase 2) Hope Bay Belt Project Final Hearing. These include commitments made by TMAC associated with freshwater fisheries offsetting which are summarized in Table 1-1. Based on anticipated fisheries losses and commitments made by TMAC, a Fisheries Offsetting Plan is to be developed in collaboration with DFO and relevant stakeholders including the Kitikmeot Inuit Association (KIA) and the Hope Bay Inuit Environmental Advisory Committee (IEAC).

In the Final Environmental Impact Statement (FEIS) for Madrid and Boston (TMAC 2017), TMAC's approach to offsetting freshwater fisheries losses was presented (Appendix V5-6AA of TMAC 2017). This approach outlined TMAC's intent to pursue offsetting, as deemed necessary by DFO, that satisfies requirements of the Fisheries Protection Policy Statement (DFO 2013a; now the Fish and Fish Habitat Protection Policy Statement (DFO 2019a)) and federal *Fisheries Act* (1985) through the following steps:

- Assessment of fish habitat availability and quality in potentially impacted waterbodies (lakes, streams, and marine environment);
- Assessment of fish populations and their abundance in potentially impacted waterbodies (lakes, streams, and marine environment);
- Assessment of the amount of fish habitat (in m^2) to be lost/altered in freshwater environments and application of a Habitat Evaluation Procedure (HEP) to assign quality as well as quantity to lost/altered habitat;
- Identification of offsetting options in line with DFO guidance on offsetting and in collaboration with DFO and relevant stakeholders;
- Development of a Fisheries Offsetting Plan in collaboration with DFO and relevant stakeholders; and
- Implementation and monitoring of offsets.

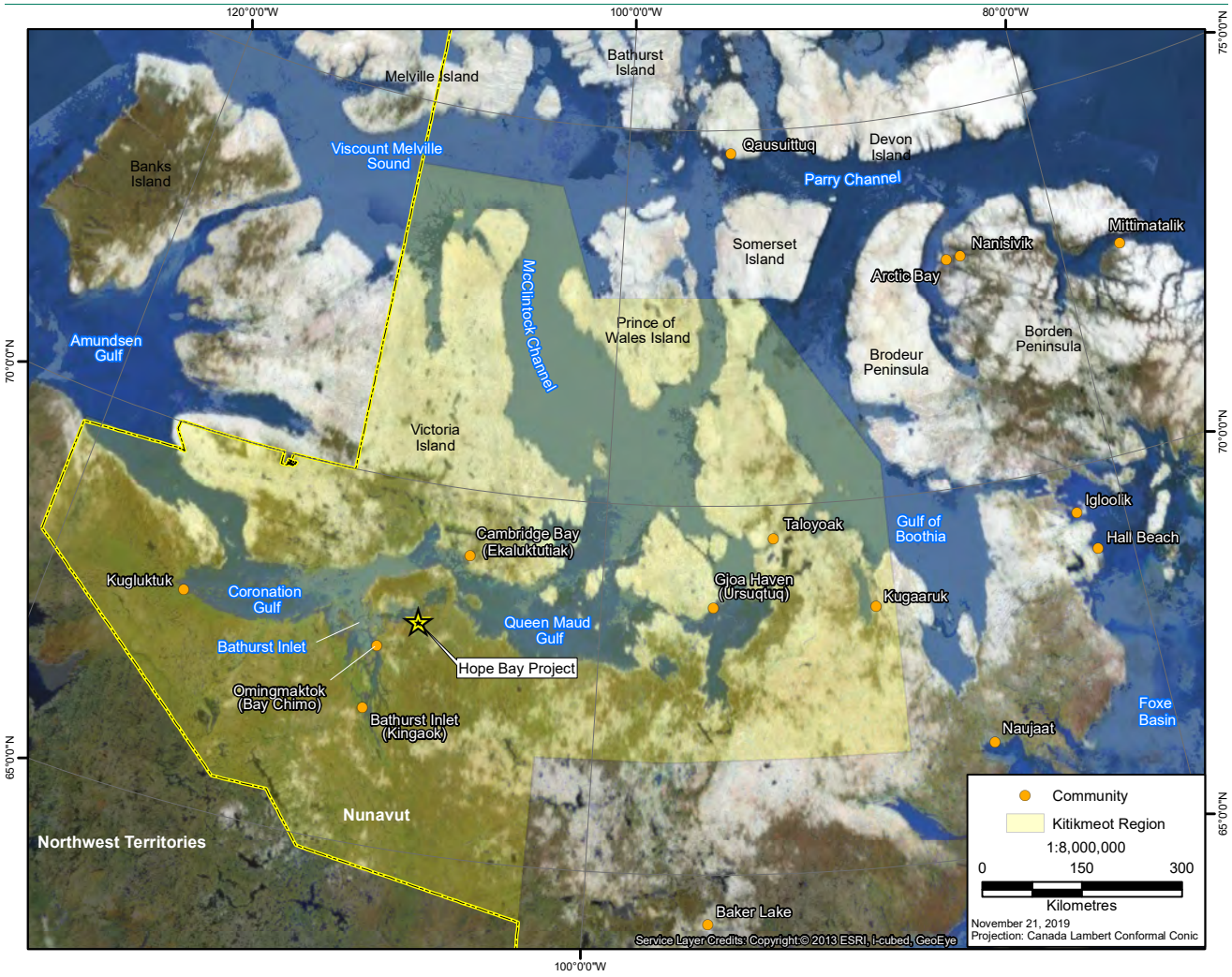


Figure 1-1: Project Location

Table 1-1: Freshwater Fisheries Offsetting Commitments from the Phase 2 Hope Bay Belt Project Final Hearing

Number	Subject	Commitment
10	Fisheries Offsetting (Freshwater)	TMAC will work with DFO, the KIA, and IEAC to identify candidate offsetting options with a preference for developing a community-based offsetting program located near Cambridge Bay.
11	Fisheries Offsetting (Freshwater)	TMAC will undertake field surveys in summer 2018 to ground-truth preliminary offsetting site options, and refine objectives, constraints, and opportunities associated with each site. These activities will contribute to preliminary gain calculations in support of the development of a Fisheries Offsetting Plan.

Notes:

DFO = Fisheries and Oceans Canada
KIA = Kitikmeot Inuit Association
IEAC = Inuit Environmental Advisory Committee

This approach was initiated as part of the effects assessment in the FEIS (TMAC 2017). Assessments of fish habitat availability and quality, and of fish populations and their abundance in potentially impacted waterbodies, were summarized using results of Project baseline studies. The amount of freshwater fish habitat (in m^2) that may potentially be lost/altered through changes in water quantity and through the construction of Madrid and Boston infrastructure was also calculated and presented.

In 2018 and 2019, following submission of the FEIS, TMAC has continued development and application of a HEP to freshwater fish habitat losses, held Fisheries Offsetting Workshops with participation by DFO and relevant stakeholders, and undertaken reconnaissance and baseline field programs at candidate offsetting sites. Perspectives, priorities, and Traditional Knowledge (TK) expressed and provided by stakeholders that participated in Fisheries Offsetting Workshops held in Cambridge Bay, Nunavut in June 2018 and April 2019 were incorporated into the design and implementation of field programs carried out in 2018 and 2019 (ERM 2019c, 2019b).

A 2018 report described and evaluated eight preliminary candidate options for freshwater fisheries offsetting based on identification of potential sites through desktop investigations, high-level field scouting, engagement with researchers and local and Traditional Knowledge holders, as well as reconnaissance field surveys undertaken in 2018 (ERM 2019a). The 2019 Freshwater Fisheries Offsetting Summary Report continues to build on TMAC's efforts towards the development of a Fisheries Offsetting Plan for Madrid and Boston by presenting baseline data collected in 2019 at two candidate options for freshwater fisheries offsetting. Baseline data presented include methods and results of 2019 field surveys, assessment of the potential and feasibility of each site as an offsetting option, and recommendations for next steps.

2. CANDIDATE FISHERIES OFFSETTING OPTIONS

Baseline studies were undertaken at two candidate freshwater fisheries offsetting options in 2019. These options were selected based on the results of the 2018 Hope Bay Project Fisheries Offsetting Program (ERM 2019a) which included the following methods for recommending options:

1. Identifying candidate sites from multiple sources including desktop and high-level field assessments, and engagement with researchers and local and Traditional Knowledge holders.
2. Incorporation of local and Traditional Knowledge from multiple sources including a Fisheries Offsetting Workshop conducted in Cambridge Bay, Nunavut on June 26 and 27, 2018 with participation from the IEAC, the KIA, and DFO (ERM 2019c).
3. Consideration of local and regional fisheries management objectives including DFO integrated fisheries management plans and local fisheries management priorities.
4. Results of 2018 field reconnaissance surveys at candidate freshwater fisheries offsetting sites.

Preliminary candidate site identification provided eight sites that were investigated in 2018. The 2018 field reconnaissance surveys identified opportunities for offsetting at six of the eight preliminary candidate freshwater fisheries offsetting sites (ERM 2019a). In reporting on the 2018 Hope Bay Fisheries Offsetting Program, each of the six remaining opportunities were evaluated based on their potential to meet offsetting requirements under DFO's Offsetting Policy (DFO 2013b, 2019b) and stakeholder goals identified during the Fisheries Offsetting Workshop in June 2018 (ERM 2019c). From this evaluation, two options were identified for further study in 2019 (Figure 2-1):

- Grenier Lake East Outflow (Cambridge Bay vicinity option); and
- Tahilugyuak Outflow (Hope Bay Project vicinity option).

A second Fisheries Offsetting Workshop was conducted in Cambridge Bay, Nunavut on April 30 and May 1, 2019 with participation from the IEAC, the KIA, and DFO (ERM 2019b). Plans for potential offsets and further baseline investigations at Grenier Lake East Outflow and Tahilugyuak Outflow in 2019 were presented and knowledge and feedback shared by participants was incorporated into baseline program design. The candidate options are described and the proposed fisheries offsetting approach at each location is summarized in the following sections.

2.1 Grenier Lake East Outflow

Approximately 2 km outside of Cambridge Bay and approximately 125 km northeast of the Doris Mine site (Figure 2-1), the Grenier Lake East Outflow (East Outflow) flows south into the Freshwater Creek Estuary located in the Dease Straight (Figure 2.1-1). The length of the outflow stream is approximately 8 km and it is comprised, particularly in its upstream half, of multiple ponds/small lakes connected by stream habitat. Upstream, Grenier Lake has an area of approximately 3,400 ha. Fish from Grenier Lake, including Lake Trout (*Salvelinus namaycush*) and Arctic Char (*Salvelinus alpinus*), have the potential to access the East Outflow.

The East Outflow is one of two outflow streams between Grenier Lake and the Freshwater Creek Estuary. The other outflow, Freshwater Creek, is located to the northwest (Figure 2.1-1). Freshwater Creek is an important subsistence fishery for fishers from Cambridge Bay (DFO 2004). A commercial fishery operated on Freshwater Creek starting in 1960 but due to declining stocks it was recognized that it could not support both a subsistence and commercial fishery and commercial fishing ceased in 1962 (DFO 2004).

The road from Cambridge Bay to Ovayok Territorial Park runs between Freshwater Creek and the East Outflow (Figure 2.1-1). At the location where the road crosses the East Outflow there are multiple

perched culverts. The Grenier Lake East Outflow was identified as a candidate offsetting option by participants at the Fisheries Offsetting Workshop in June 2018 (ERM 2019c). The culvert crossing was identified as an issue for fish passage. The road used to wash out at that location and years ago new culverts were placed across the width of the channel. Water levels were also noted to be lower in this outflow than observed historically.

Preliminary migratory assessment data were collected in Grenier Lake East Outflow in 2018 (ERM 2019a). The culvert crossing is comprised of four 0.8 m and four 1.0 m diameter culverts, placed across the channel along the length of the road crossing (Photo 2.1-1). High streamflow observed in June 2018 resulted in sufficient flow through culverts for downstream passage of fish. However, at their downstream ends, six of the eight culverts were perched with a drop of up to approximately 0.3 – 0.4 m to the downstream water surface level. Additionally, culvert sizing resulted in fast, confined flow through the 12 m length of the culverts. Both the drop between culvert and stream elevation at the downstream end of the culverts and/or the rate of flow through the culverts were considered impediments, and potentially complete barriers to upstream fish passage on the survey date.

Photo 2.1-1: Culvert crossing, facing upstream/across from right bank, Grenier Lake East Outflow, June 25, 2018.

In August 2018, fish habitat was assessed at six stream locations along the East Outflow near Grenier Lake (ERM, 2019a). All were rated as having no or poor migratory potential and all were considered temporary (i.e., dry channel) or permanent (i.e., the culverts) barriers to fish passage. Between the migratory habitat assessment locations, multiple large ponds were observed along the length of the East Outflow channel (Figure 2.1-1). It was considered possible that some of these ponds have sufficient depth to act as overwintering habitats for fish (i.e., minimum of approximately 3 m water depth). Overall, it appears that stream flows connecting the ponds located along the length of the East Outflow decline throughout the open water season, potentially resulting in fish stranding in the deeper pond areas.

Figure 2-1: Hope Bay Project Candidate Freshwater Fisheries Offsetting Options, 2019

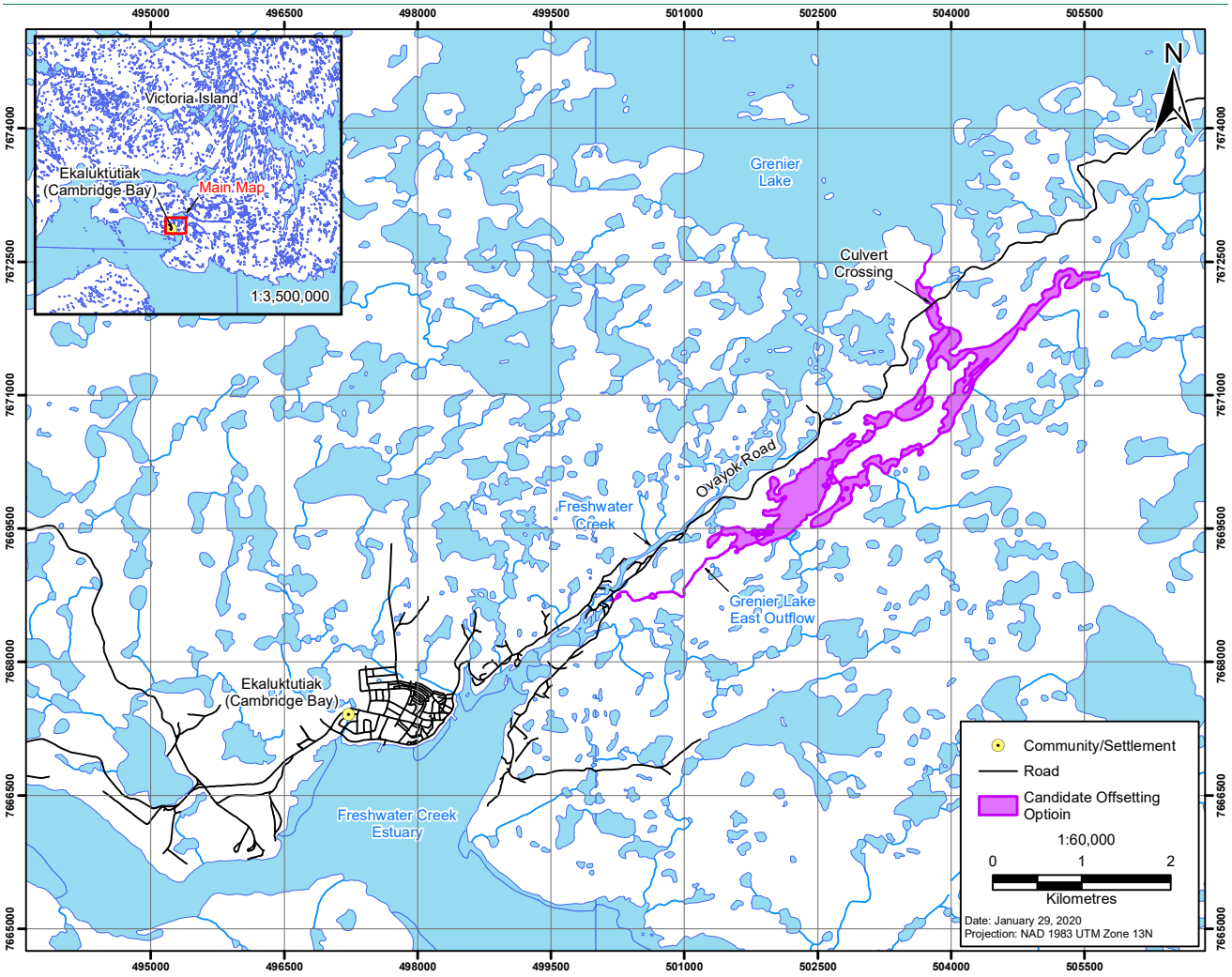


Figure 2.1-1: Grenier Lake East Outflow

The objective of a fisheries offsetting project in the Grenier Lake East Outflow would be to enhance migratory, rearing, and overwintering potential for Arctic Char and potentially Lake Trout in the streams and ponds of the system. The fish community of Grenier Lake supports Arctic Char (anadromous) and Lake Trout (resident and potentially anadromous) populations. Based on 2018 field reconnaissance surveys, perched culverts, and dry channel barriers resulting from low flows create impediments to migration for multiple life stages of these fish species. Anadromous fish migrating upstream from the marine environment would be prevented from reaching spawning and overwintering habitats in Grenier Lake. Fish that migrate out of Grenier Lake to utilize rearing habitats in streams and ponds in the system may also be prevented from migrating back to overwintering habitats.

Given the number of locations along the channel where migratory potential is or may be compromised, enhancements in the East Outflow are not anticipated to result in unimpeded migration between the marine environment and Grenier Lake during the entire open water season. Instead the intent of enhancements would be to select locations along the channel that could be enhanced in order to extend the period over which migration is possible, improve migration success for specific life stages of fish (e.g., juvenile fish moving to overwintering habitats in the late summer/fall), and/or improve rearing and overwintering conditions for fish that use stream/pond habitats in the system.

Prior to the 2019 field program, proposed methods for improving migratory, rearing, and overwintering habitats in the East Outflow included the rehabilitation of perched culverts at the road crossing location and increasing water levels in pond and stream habitats. Modification to the road crossing location would require an engineered design that would be based on measured and modelled stream flows. It would allow for fish passage under all flow conditions and prevent wash out of the road. The new design may employ culverts or a bridge structure. The preliminary modification method suggested to increase water levels in pond and stream habitats would be achieved through the construction of a weir at the outlet of one of the ponds located along the Grenier Lake East Outflow channel. The weir would be engineered to influence water levels in upstream pond and stream habitats such that ponds would be larger and deeper, enhancing rearing and overwintering habitat quality and stream habitats would remain wetted for longer, enhancing migratory potential. The weir would be engineered for permanence, with the objective of maintaining stability over time despite flow, snow, and ice influences. The design would also consider how these influences may be changing over time (e.g., due to climate change).

It is anticipated that improving migratory access, rearing, and overwintering habitats for Arctic Char and potentially Lake Trout in the East Grenier Lake Outflow will result in increases in fisheries production in the Grenier Lake system.

2.2 Tahilugyuak Outflow

Tahilugyuak is located approximately 25 km northeast of the Doris Mine site and approximately 100 km southwest of Cambridge Bay (Figure 2-1). Tahilugyuak Outflow flows northeast into a bay in Elu Inlet (Figure 2.2-1). The length of the outflow stream is approximately 2.5 km with no tributaries that provide fish habitat. Tahilugyuak Outflow was identified as a candidate offsetting option during August 2016 field scouting surveys performed by ERM biologists when areas along the channel where fish passage may be compromised by low flow barriers were identified. Tahilugyuak has an area of approximately 2,200 ha. Along the Tahilugyuak Outflow channel, approximately 500 m downstream from Tahilugyuak, there is a small lake (i.e., T-Pond; approximately 2 ha; Figure 2.2-1). Aerial surveys in 2018 suggested the depth of T-Pond may be sufficient to provide overwintering habitat for fish.

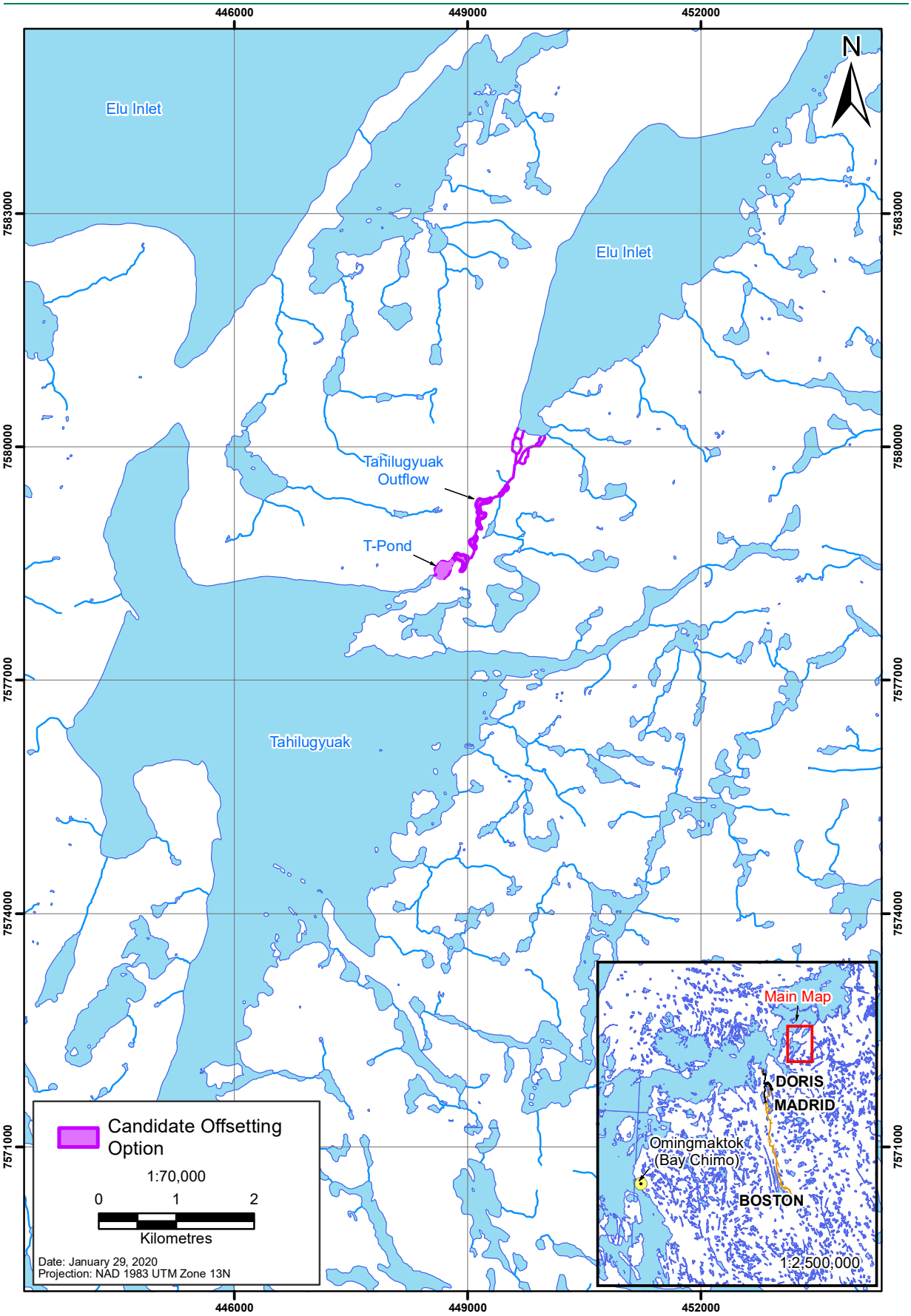


Figure 2.2-1: Tahilugyuak Outflow

Fish habitat quality for migration in Tahilugyuak Outflow was assessed in July 2018 (ERM, 2019a). While the majority of habitats were assessed as suitable for fish passage at that time, one habitat unit was assessed as having poor migration potential. This was an area of low flow through a boulder garden that resulted in a temporary barrier to upstream fish passage located directly upstream of T-Pond (Photo 2.2-1). Due to this barrier, the majority of fish would not have been able to migrate unimpeded between the marine environment and Tahilugyuak on the survey date (July 27, 2018). The barrier was considered temporary as it is unlikely to impede fish passage at higher flow conditions however, it was estimated to act as a fish passage barrier beginning in mid-July and remaining until the stream freezes in the fall. In addition to this temporary barrier, nine other locations were identified in July 2018 that had the potential to act as barriers as water levels receded over the remainder of the open-water season.

Photo 2.2-1: Aerial view of boulder garden barrier to fish passage in Tahiluyguak Outflow, directly upstream of T-Pond. Flow direction from left to right, July 29, 2018.

On July 27, 2018 one adult Arctic Char was observed attempting to migrate upstream at the temporary boulder garden barrier directly upstream of T-Pond (Photo 2.2-2). It was unsuccessful at moving upstream through the boulder garden feature during the time survey crews were present but may have successfully moved upstream at a later time. In September 2018, four Arctic Char and six Lake Trout between approximately 25 and 45 cm in length were captured by angling in T-Pond, directly downstream of the boulder garden feature, which at the time of sampling acted as a full barrier to fish passage (ERM 2019a). These fish were stranded in the small lake as downstream passage was also blocked by temporary boulder garden and flow barriers, as well as frozen stream conditions.

Given the locations of fish observed and captured, it is unknown if Arctic Char and Lake Trout belong to anadromous populations migrating upstream from the marine environment, resident populations in upstream Tahilugyuak, and/or resident populations in T-Pond. However, based on fish habitat assessments, it is anticipated that fish can pass unimpeded from Elu Inlet to Tahilugyuak for at least part of the open-water season. Therefore, anadromous populations are assumed along with the potential for one or more resident populations.

Photo 2.2-2: Arctic Char attempting to migrate upstream through boulder garden in Tahilugyuak Outflow, July 27, 2018.

The objective of a fisheries offsetting project at Tahilugyuak Outflow would be to enhance the migratory potential of anadromous Arctic Char and Lake Trout between the marine environment (Elu Inlet) and spawning and overwintering habitats in Tahilugyuak upstream. Based on the number of locations along the channel where migratory potential is or may be compromised, enhancements in Tahilugyuak Outflow are not anticipated to result in unimpeded migration by fish during the entire open water season. Instead the intent of enhancements would be to select locations along the channel that could be enhanced in order to extend the period over which migration is possible and/or to improve migration success.

The proposed method for improving migratory potential and success in Tahilugyuak Outflow would be through construction of migration channel(s). These would be constructed in areas where water depth is insufficient for fish passage or where boulder garden habitat features block passage under certain flow conditions (for example, at the boulder garden feature immediately upstream of T-Pond). A similar approach using the construction of migration channels through a boulder garden feature has been effectively used to improve migratory success for Arctic Char at the Roberts Lake Outflow near the Hope Bay Project (ERM 2016). Construction of migration channels by manually moving rocks in stream channels has also been used by land users to improve the potential for fish passage (J. Tikkak, personal communication, July 30, 2018; ERM 2018).

The intent is for the locations and design of the migration channels to incorporate TK through consultation with Knowledge holders during the design and construction phases. The channels would be engineered for permanence, with the objective of maintaining stability over time despite flow, snow, and ice influences. Channel design would also consider how these influences may be changing over time (e.g., due to climate change). Based on initial assessments of substrates at potential and temporary barrier locations, heavy or specialized machinery are not anticipated to be required for construction of the enhancements. However, in locations where larger boulders are present, micro-blasting may be necessary to reduce the size of rocks so that they may be moved manually. This approach was employed during enhancement construction at the Roberts Lake Outflow (Rescan 2012; ERM 2016).

It is anticipated that improving migratory potential and success for Arctic Char and Lake Trout in Tahilugyuak Outflow will result in increases in fisheries production in the Tahilugyuak system. The fisheries benefits anticipated from this candidate offsetting option rely on the assumption that migratory potential between the marine environment and Tahilugyuak acts as a limiting factor to fisheries productivity.

3. FISHERIES OFFSETTING BASELINE INVESTIGATIONS

3.1 Objectives

The objectives of the 2019 Freshwater Fisheries Offsetting Baseline Program were based on the results of reconnaissance surveys undertaken in 2018, proposed methods for implementing fisheries offsetting projects at the two candidate sites, and feedback provided by participants at the Fisheries Offsetting Workshop in Cambridge Bay in April 2019 (ERM 2019b). The objectives of the 2019 Fisheries Offsetting Baseline Program at the two fisheries candidate offsetting sites were:

- Grenier Lake East Outflow:
  - Characterize fish habitat in streams and ponds along Grenier Lake East Outflow near Grenier Lake; and
  - Characterize fish community composition in streams and ponds along Grenier Lake East Outflow near Grenier Lake.
- Tahilugyuak Outflow:
  - Characterize fish habitat in Tahilugyuak Outflow and T-Pond; and
  - Determine migratory timing and distribution of fish in Tahilugyuak Outflow and T-Pond.

3.2 Methods

Baseline investigations at candidate fisheries offsetting sites in 2019 included fish habitat and fish community assessments at streams, ponds, lakes, and/or marine habitats located at the offsetting sites. Hydrology data were collected through the installation of hydrometric stations, differential levelling surveys, and streamflow measurements. A hydrological assessment at the culverts that cross Grenier Lake East Outflow was also performed to assess fish passage potential. Fish habitat in streams was quantified using standard visual and physical measurement methods. Hydroacoustic surveys were used in ponds/lakes to survey bathymetry and classify sublittoral substrate types and visual surveys were used to classify littoral substrate types. Fish community composition was surveyed by electrofishing in streams and by gillnetting and/or minnow trapping in ponds, lakes, and marine habitats. Baseline data collection methods and survey locations at Grenier Lake East Outflow and Tahilugyuak Outflow are presented in Table 3.2-1 and on Figures 3.2-1 and 3.2-2, respectively.

To meet the objective of characterizing fish habitat in Tahilugyuak Outflow, stream habitat assessments were planned to be carried out under high and low flow conditions in 2019. To meet the objective of determining migratory timing and fish distribution in Tahilugyuak Outflow, the initial sampling plan for 2019 was to install a fish fence to capture and tag fish with Passive Integrated Transponder (PIT) tags and then to monitor progress through the system by installing PIT tag detection systems. Persistent ice cover in Tahilugyuak Outflow in June and July 2019 prevented stream fish habitat assessments and the installation of the fish fence with appropriate timing to capture fish for migration monitoring. Photo 3.2-1 shows the extent of ice cover in Tahilugyuak Outflow on July 14, 2019.

The fish sampling plan was modified to use gillnetting and angling in ice-free areas around the mouth of Elu Inlet, and at the outflow of Tahilugyuak in mid-July to capture and tag Arctic Char and Lake Trout that may use the Tahilugyuak Lake system as a migratory corridor and then to install PIT tag detection systems to measure use and progress through the system. These methods resulted very low catch rates (i.e., insufficient to make meaningful conclusions about migration patterns). Additionally, ice cover in Tahilugyuak Outflow persisted well into August (Photo 3.2-2), and it was not logistically possible to install PIT tag detection systems or conduct stream habitat assessments. Thus, the objectives of characterizing fish habitat and determining migratory timing and distribution of fish within Tahiluguyak Outflow were not

pursued further in 2019 with the exception of hydrology surveys in Tahilugyuak Outflow and fish habitat and community surveys in T-Pond (Table 3.2-1 and Figure 3.2-2).

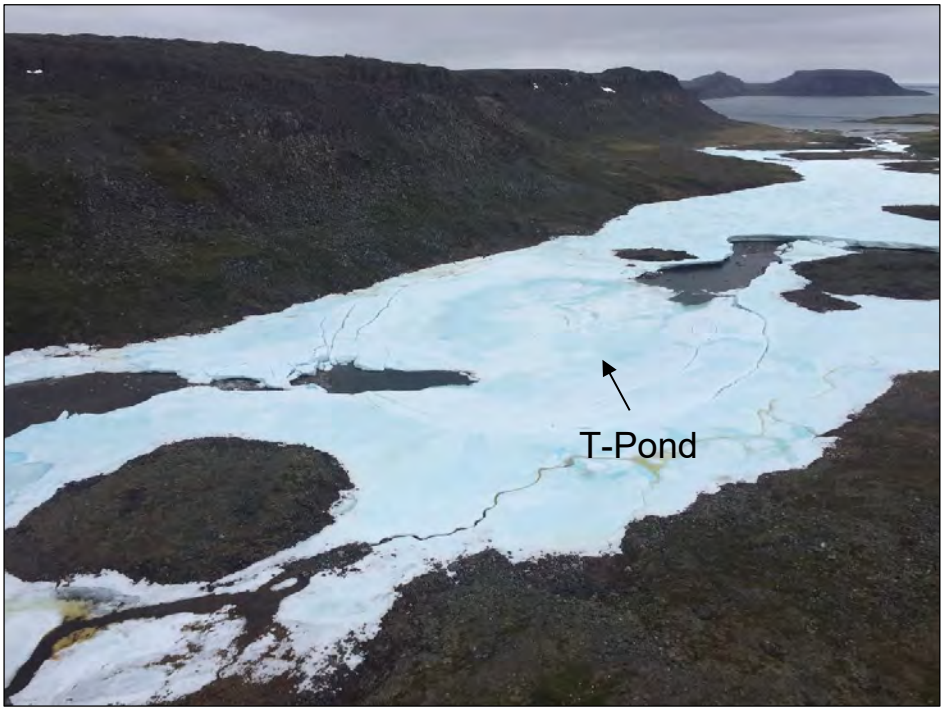


Photo 3.2-1: Ice cover in Tahilugyuak Outflow, facing NE (downstream) from T-Pond to Elu Inlet, July 14, 2019.

Photo 3.2-2: Ice cover in Tahilugyuak Outflow, facing NW (upstream) toward Tahilugyuak, August 24, 2019.

Table 3.2-1: Fish Habitat and Community Sampling Conducted at Grenier Lake East Outflow and Tahilugyuak Outflow, 2019

Candidate Fisheries Offsetting Site	Survey Location	UTM Zone 13 W		Fish Habitat								Fish Community			
				Hydrology				Stream Habitat	Bathymetry	Littoral Habitat	Sublittoral Habitat	Gillnetting	Minnow Trapping	Electrofishing	Angling
		Easting	Northing	Hydrometric Monitoring Station	Water Level Survey	Streamflow	Culvert Assessment								
Grenier Lake East Outflow	Pond 1	503669	7672172		X				X	X	X				
	Pond 2	503798	7671900	X	X	X			X	X	X				
	Pond 3	503932	7671614		X				X	X	X	X			
	Pond 4	504582	7671672		X				X	X	X	X	X		
	Pond 5	502280	7670077						X	X	X	X	X		
	Culverts	503787	7672017				X								
	EO1	503738	7672450					X						X	
	EO2	503664	7672352					X						X	
	EO3	503933	7671668					X						X	
	EO4	504187	7671491					X						X	
Tahilugyuak Outflow	Elu Inlet	449849	7580610									X			X
	T-Pond	448621	7578375						X		X	X			
	Tahilugyuak Outflow	448094	7578150	X		X						X			X

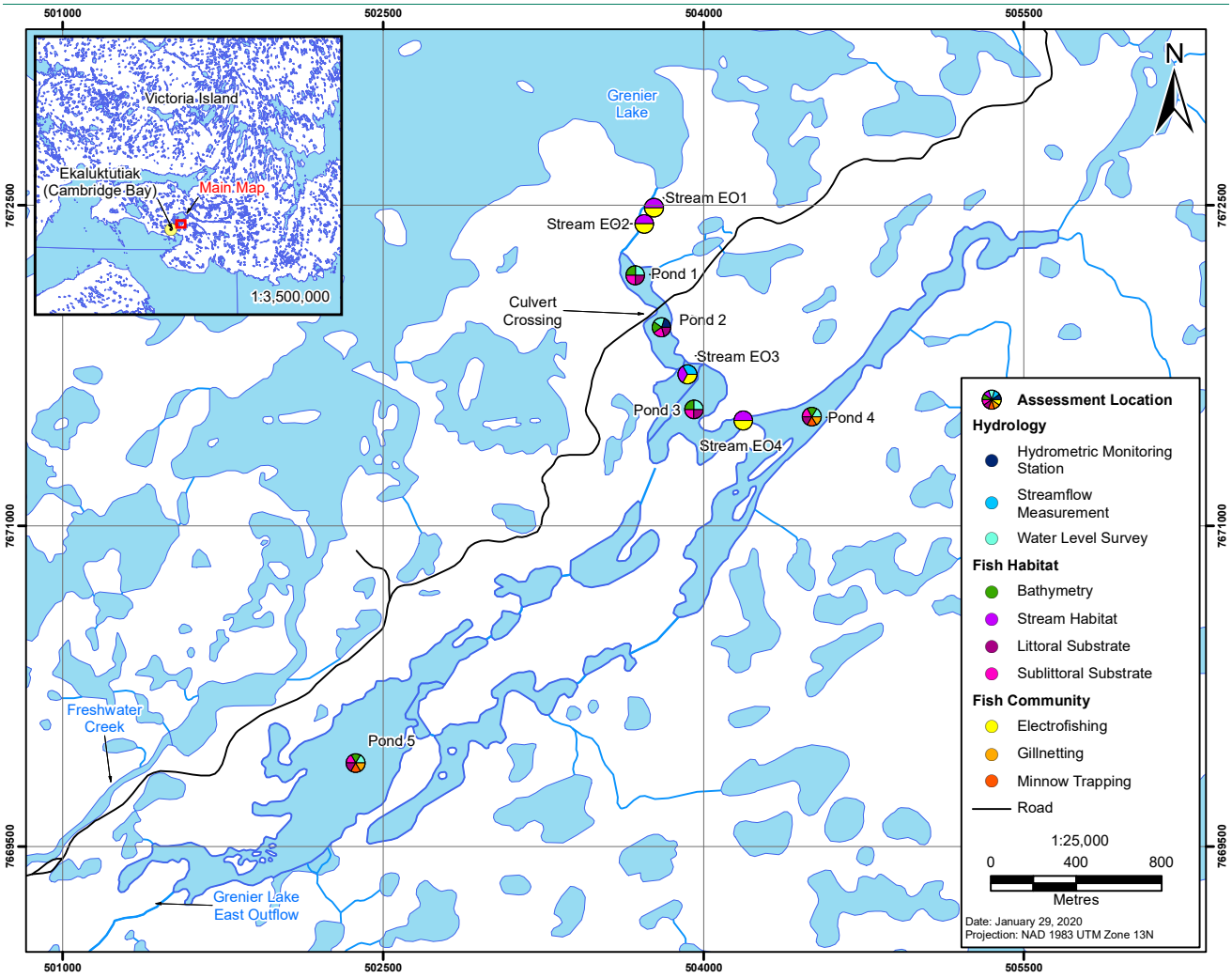


Figure 3.2-1: Fish and Fish Habitat Assessment Locations, Grenier Lake East Outflow, 2019

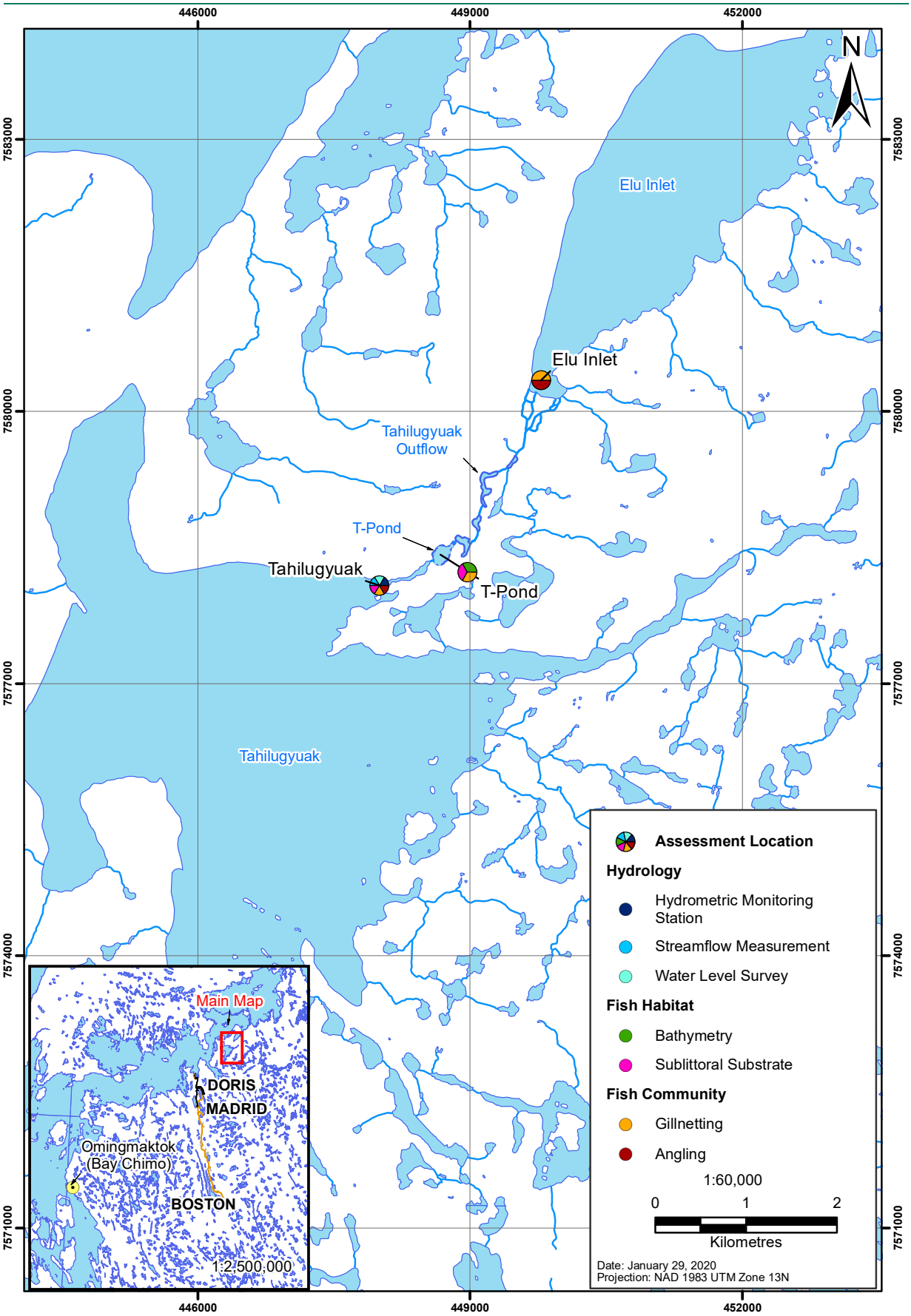


Figure 3.2-2: Fish and Fish Habitat Assessment Locations, Tahilugyuak Outflow, 2019

3.2.1 Hydrology

Baseline hydrological investigations in 2019 consisted of two automated hydrometric stations collecting stage data annually during the open-water season (one at each candidate fisheries offsetting site), differential levelling surveys at each hydrometric station and of the pond water levels on Grenier Lake East Outflow, manual streamflow measurements at one location at each candidate fisheries offsetting site, and a hydrological assessment of the culverts located along Grenier Lake East Outflow.

3.2.1.1 Hydrometric Station Installations

Hydrometric stations were installed in late June/early July and continually operated until late September (Table 3.2-2) when they were demobilized to protect the equipment from damage due to freezing. Each hydrometric station consisted of a PT2x vented pressure and temperature sensor with internal datalogger (Instrumentation Northwest Inc.). The sensors were placed in aluminum conduit to protect the cabling, and a plastic tube mounted vertically in the water to act as a stilling well for the sensor.

Table 3.2-2: Locations and Dates for Hydrometric Stations, 2019

Location	UTM Zone 13 W (m)		Date Installed	Date Demobilized
	Easting	Northing		
Grenier Lake East Outflow (Pond 2)	0503858	7671944	July 11	September 19
Tahilugyuak Outflow	0448183	7578162	June 25	September 20

The PT2x pressure transducers were installed as deep as possible, to allow for continuous monitoring of high, moderate, and low water levels.

The pressure transducers continuously recorded water levels at ten-minute intervals. The elevations of the pressure transducers were surveyed relative to a local arbitrary datum established through surveying of locally installed benchmarks. The benchmarks and datum were used to maintain elevation control at each station where measurements were collected. This allowed the accuracy and precision of the transducers to be assessed and for continuity for future years of monitoring. Surveying the stations relative to local benchmarks also allowed transducers to be moved if required and reinstalled in subsequent years while maintaining accuracy and precision in data collection.

3.2.1.2 Differential Levelling Surveys

To establish and maintain elevation control at the hydrometric stations and measure pond water surface levels, at least three local benchmarks were used at each hydrometric station and in three additional ponds in Grenier Lake East Outflow (Figure 3.2-1). Four ponds were surveyed in the Grenier Lake East Outflow to identify lake level change relationships. There were five measurements taken during the open water season of the ponds and hydrometric station.

One primary benchmark per station was assigned an arbitrary elevation of 100.000 m relative to a local (non-geodetic) datum. All other benchmarks, as well as all recorded water levels were then referenced to the primary benchmark. Simultaneous to streamflow measurements, hydrometric differential levelling surveys were completed and the water levels measured by the pressure transducers were checked and compared to surveyed water levels and the established benchmarks at the site. Surveys were completed using an engineer's rod and level to check whether any change in the position or drift of the transducer signal had occurred.

3.2.1.3 Streamflow Measurement

Standard techniques were employed at site near hydrometric stations to measure streamflow (Terzi 1981). Measurements were taken throughout the open-water season to record a range of flows under different flow conditions. Streamflow (lake discharge) was measured manually at Grenier Lake East Outflow during two site visits in July 2019 by ERM staff. Tahilugyuak Outflow had three streamflow measurements, one each in June, July and September.

Manual streamflow measurement requires measuring water velocity and depth at intervals along a cross-section of the stream. The cross-sectional area of the stream (m^2) and the velocity of the water (m/s) were used to compute flow (m^3/s). Measurements were collected using a hand-held electromagnetic current meter (Hach Model FH950). At each gauging location, a minimum of 20 velocity and depth measurements were typically obtained across the stream cross-section.

Velocity measurements were collected at 60% of the flow depth, which is generally accepted as representing the mean velocity of the vertical water section (Herschy 2009). When water depths were greater than 0.75 m, current velocities were measured at 20% and 80% of the water depth, with the mean of the two readings taken to represent the mean velocity for the vertical. At each vertical water section, a mean velocity was calculated over a measurement time of 40 seconds to represent the flow conditions.

3.2.1.4 Culvert assessment

A field hydrological assessment of the culverts that cross Grenier Lake East Outflow at the Ovayok Road (Figure 3.2-1) was was conducted on July 11, 2019. The field assessment included a survey, using similar methods to those described in Section 3.2.1.2, to collect the inlet and outlet invert elevations of each culvert. Culvert specifications including length and diameter were measured using a measuring tape.

The survey was used to determine the culvert slope based on elevation difference between the inlet and outlet divided by the measured culvert length. Outlet drop was measured from the culvert outlet invert to the water surface on the day of the survey.

Culvert inlet and outlet velocities were measured in the cross sectional centre of the culvert at 60% of the flow depth. Measurements were collected using a hand-held electromagnetic current meter (Hach Model FH950).

To determine if the culverts had the potential for fish passage on the day of the survey, methods from Katapodis and Gervais (2016) were used. Swim capacity information for the *Salmonidae* family was used to represent both Arctic Char and Lake Trout. This method uses water velocity and distance to estimate how long a particular fish, of a particular species and size, will take to fatigue (i.e., time to fatigue) and be no longer able to continue upstream. At the Ovayok Road culverts, the potential for fish to pass through the culverts was assessed based on using the greater of the velocities measured at the inlet and outlet for the each culvert and the distance needed to travel (i.e., culvert length).

Inlet conditions (i.e., culvert outlet drop) were also included as part of the fish passage evaluation to identify if fish could enter a particular culvert.

3.2.2 Fish Habitat

3.2.2.1 Stream Habitat

Stream fish habitat assessments were conducted at four sites in Grenier Lake East Outflow on July 24, 2019 to describe the quantity and quality of fish habitat. Surveys were not repeated in August as flows had receded to the point that channels were dry. Stream locations assessed are represented on Figure 3.2-1.

Habitats were surveyed using methods based on the Fish Habitat Assessment Procedures (FHAP; Johnston and Slaney 1996). Representative sections of each reach of approximately 50 to 100 m in length were assessed. Habitats units were classified using the following classification types:

- Cascade: high-energy, steep (gradient > 4%) sections of stream typically dominated by bedrock, boulders, and cobbles;
- Riffle: less steep than cascades, but still with turbulent, fast-flowing water. Riffles are usually shallow in water depth with gravel or cobble substrates that project above the water surface, causing surface turbulence;
- Glide: sections of stream with flowing, non-turbulent water. Glides have relatively flat bottoms in cross-section;
- Flat: Areas of still, often stagnant water. Substrate usually covered in silt or organic matter; or
- Pool: relatively deep, slow flowing sections of stream with a concave longitudinal streambed profile and a surface gradient near 0%.

Individual habitat units were measured for length, width and depth (bankfull and wetted), gradient, substrate composition (% abundance of bedrock, boulders, cobble, gravel, and fines), residual pool depth, bank stability, and bank height. Stream attributes were marked using a handheld GPS unit and representative photographs were taken. Barriers or seasonal restrictions to fish migration were also noted and measured, where appropriate. A series of digital photos and habitat notes were also collected to document other characteristics that might further describe each habitat unit (e.g., visual observations of fish, presence of unique or critical habitat features).

3.2.2.2 Bathymetry and Sublittoral Habitat

Data Collection

Hydroacoustic methods were used to determine bottom depth and sublittoral habitat (substrate classification or bottom typing) at five ponds within the Grenier Lake East Outflow (Figure 3.2-1), as well as one pond within the Tahilugyuak System (i.e., T-Pond; Figure 3.2-2). The hydroacoustic system used was a BioSonics MX Aquatic Habitat Echosounder. This system can differentiate between bottom substrate types such as mud, sand, gravel, cobble, and larger rock. Visual surveys using an underwater video camera unit (SplashCam Deltavision recording to a Sony VRD-MC6 DVD recorder) were performed to describe and confirm substrate types identified from the hydroacoustic data.

Data were collected between July 25 and July 31, 2019 at ponds within Grenier Lake East Outflow and on August 27, 2019 at T-Pond in Tahilugyuak Outflow. The BioSonics MX Aquatic Habitat Echosounder transducer was linked to an internal differential GPS. The transducer was mounted on the starboard side of the boat, with the face of the transducer secured approximately 16 cm below the surface of the water. The system was controlled by a Panasonic field laptop computer running Visual Acquisition software (BioSonics, Seattle, WA) that displayed electronic echograms for monitoring sounder performance during data collection. The specifications of the hydroacoustic collection equipment used during data collection are presented in Table 3.2-3.

Surveying was performed by piloting the boat with the hydroacoustic system along parallel transects at an average speed of 1.5 m/s. Transect locations were determined in advance of the surveys and shapefiles were uploaded to a handheld GPS unit which was used to navigate the boat along transects during the survey.

Table 3.2-3: Acoustic System Specifications for Collection of Bathymetric and Bottom Type Data

Category	Variable	Value
Echo sounder	Type	BioSonics MX Aquatic Habitat
Transducer	Type	BioSonics Single Frequency
	Sound frequency	204.8 kHz
	Beam angle	8.5°
	Depth of transducer face	0.16 m
Settings	Transmit pulse duration	0.4 ms
	Receiver sensitivity	-89.3 dB
	Maximum data range	20-30 m
	Time varied gain	30 Log R
	Ping rate	5 Hz
DGPS	Type	WAAS-differential
	Datum	NAD83
Other	Average transecting speed	1.4 to 1.9 m/sec

Note: DGPS = differential global positioning system

Surveys included a route that followed the perimeter of each pond as close to the shore as possible (1.0 to 2.0 m water depth), cross-pond transects spaced at equal distances parallel to each other and perpendicular to shore, and an “Exploratory line” (or “E-line”) transect that ran along the greatest fetch of the pond, perpendicular to the cross-pond transects (BC MOE 2009). Transect spacing conformed to guidelines presented in Bathymetric Standards for Lake Inventories (RISC 2009) and Manual of Instructions Bathymetric Surveys (OMNR 2004).

Visual surveys using an underwater camera were performed to validate hydroacoustic classification of the bottom type after hydroacoustic transects were completed. Selection of visual survey sampling locations along the hydroacoustic survey transects were based on a preliminary cluster analysis of the acoustic data, which was conducted in the field and clustered samples into distinct substrate types. The number of clusters used in preliminary analysis of the acoustic data was predicted based on visual assessment of the substrates during the hydroacoustic survey (Table 3.2-4). In this way, the images visually validated the most distinctive and uniform substrates according to the hydroacoustic data. Hence the image and acoustic data were reliably linked.

Sampling locations were randomly selected from the preliminary analysis of hydroacoustic bottom type reports in each of the substrate type clusters. Substrate type at the sampling locations was determined based on visual assessment of estimated grain size. Substrate classes (grain size and bottom firmness) followed the modified Wentworth scale for particle size: fines (less than 2 mm), gravel (2 to 64 mm), cobble (64 to 256 mm), boulder (256 to 4,000 mm) and bedrock (greater than 4,000 mm; Orth 1983).

Data Processing

Bottom depth was determined from the acoustic data using the Rising Edge Method in Visual Habitat MX software (BioSonics 2013). This method analyzes the echo returns from emitted acoustic signals (pings). The first echo return signal that has a higher decibel (dB) value than a specified rising edge threshold is selected as the candidate for the bottom echo. Processing settings used for bottom detection analysis in Visual Habitat MX are listed in Table 3.2-4.

Table 3.2-4: Visual Habitat MX Processing Settings Used to Determine Bottom Depth and Bottom Substrate Type

Analysis Step	Parameter	Site	Setting
Bottom Detection	Domain	All	30 Log R
	Rising Edge Threshold		-40 dB
	Rising Edge Length Criterion		10 cm
	Rising Edge Search Window		100 cm, +/- from previous rising edge
	Rising Edge Min Detection Range		0 m
	Rising Edge Max Detection Range		20-30 m
Bottom Feature Extraction	Bottom Echo – First Part	All	1 times pulse width
	Bottom Echo – Second Part		3 times pulse width
	Reference Depth		10 m
	Fractal Dimension Threshold		- 60 dB
Bottom Type	Energy Filter width	All	10 pings
	Energy Filter threshold		65%
Fuzzy Centroid Means Clustering	Number of Clusters	T-Pond	2
		Pond 1	2
		Pond 2	2
		Pond 3	2
		Pond 4	3
		Pond 5	3

Data were imported into ArcGIS 10 to create bathymetric maps. To minimize interpolation effect on the more widely distributed data and to avoid excessive grouping of closely spaced data, values interpolated from a Triangulated Irregular Network (TIN) were created using 3D Analyst. These interpolated points and the echo sounding survey data were converted in a Topo to Raster tool in the Spatial Analyst extension to create a grid of 2 m by 2 m cells and produce a map of predicted depths. Bathymetry contours were set at intervals of 0.2-0.5 m.

Hydroacoustic bottom-type data were used in combination with visual validation surveys to create a substrate map. Acoustic bottom-type data were analyzed in Visual Habitat MX. In the bottom-type analysis, 15 analysis features are computed for each bottom echo signal. The analysis features are measures of the hardness and roughness of the bottom echo signal and are listed with descriptions in Table 3.2-5. The majority of the analysis features are normalized for depth using the median depth of the surveyed area. This is done in order to compensate for any distortion of the bottom echo signal that occurs at depth and makes bottom echo signals at different depths comparable.

Once the features of each bottom echo signal were calculated, signals were grouped into bottom type reports. Each report has an energy filter width (number of signals grouped into the report) and an energy filter threshold (percent). Each bottom type report represents a bottom substrate type in the survey area. The Visual Habitat MX software can generally differentiate between four bottom substrate types that are combinations of mud, sand, gravel, cobble, and larger rock.

Table 3.2-5: Analysis Features Used in Bottom Substrate Type Analysis in Visual Habitat MX

Feature	Number	Description
Fractal Dimension*	1	A measure of the roughness of the bottom signal, measured from the bottom to the point where the bottom echo signal decreases to below the fractal dimension threshold specified in the processing settings
E1*	1	The energy contained in the first part of the bottom echo, starting at the bottom and extending for the length (in multiples of pulse width) specified in the processing settings
E1	1	The energy contained in the second part of the bottom echo, starting at the end of the first part and extending for the length (in multiples of pulse width) specified in the processing settings
Spectral Moment	12	Computed using the Fast Fournier Transform of the bottom echo (first and second parts; up to 256 samples)

** Indicates features that are not normalized for depth.*

Source: Adapted from BioSonics (2013)

The bottom substrate type (from visual surveys using an underwater camera) at geo-referenced sampling locations was compared to the collected hydroacoustic data. Visual survey transect locations where bottom substrate type was uniform for some distance were used to assign bottom substrate type categories from the interpolated hydroacoustic data.

3.2.2.3 Littoral Habitat

Littoral habitat at five ponds within the Grenier Lake East Outflow was assessed through visual surveys of the shoreline and littoral zone (up to approximately 1 m water depth) between July 27 and August 1, 2019 (Figure 3.2-1). The shoreline was delineated into habitat units with relatively homogenous substrate composition using a handheld GPS unit. Dominant and subdominant substrate types were recorded for each habitat unit. Substrate types were defined by their average particle diameter: fines (less than 2 mm diameter), gravel (2 to 64 mm), cobble (64 to 256 mm), boulder (256 to 4,000 mm), and bedrock (greater than 4,000 mm). Photographs were taken of representative habitat types. Field notes, GPS waypoints, and photographs were used to prepare habitat maps using ArcGIS 10 mapping software (ESRI 2019).

3.2.3 Fish Community

Backpack electrofishing, minnow traps, and gillnets were used to sample the fish community of Grenier Lake East Outflow between July 24 and August 26, 2019 (Figure 3.2-1). The fish community at Tahilugyuak Outflow (including T-Pond) and Elu Inlet was sampled using gillnets and by angling between July 15 and August 27, 2019 (Figure 3.2-2). All captured fish were placed immediately in a holding bin or bucket containing fresh water from the location of capture before being identified to species and enumerated. Biological information was collected from a random subsample of Ninespine Stickleback (*Pungitius pungitius*), and from all Arctic Char and Lake Trout captured. For these individuals, fork length was measured to the nearest 1 mm with a measuring board and wet weight was measured to the nearest 0.1 g using an electronic balance. Where parasites or deformities, erosions, lesions and tumors (DELTs) were observed, this information was recorded. Arctic Char and Lake Trout, were also tagged with a unique PIT tag and each fish captured was scanned to determine whether it was a recapture. Fish were then released back at the location of capture. Additional data (sex, reproductive status, aging structures, assessment of internal parasites, and visual inspection of stomach contents) were collected from incidental mortalities.

For each gear type, catch was standardized for fishing effort by calculating Catch-Per-Unit-Effort (CPUE). CPUE is an index of relative abundance that can be used to compare fish populations among different areas and years. It is defined as the number of fish captured per sampling device per unit of time (Table 3.2-6).

Table 3.2-6: Catch-Per-Unit-Effort Calculations Used in Fish Community Summaries

Sampling Gear	Catch-Per-Unit-Effort (CPUE) Calculation
Electrofisher	No.of fish caught × [100/(electrofishing effort, s)]
Minnow Trap	No. of fish caught × [24 (h) / Set time (h)]
Gillnet	No. of fish caught per net × 100 m^2 / total net area (m^2) / Set time (h)
Angling	No. of fish caught per rod × (1/total no. of rods) × [1 h/(set time, h)]

3.2.3.1 Electrofishing

Backpack electrofishing was used to sample stream fish communities at four sites within the Grenier Lake East Outflow between July 24 and 25, 2019 (Figure 3.2-1). A crew leader operated a Smith-Root LR-24 backpack electrofisher and was accompanied by one dip netter. An anode ring diameter of 28 cm and a dip net diameter of 21 cm with 3.2 mm mesh were used. A systematic sweep sampling approach was conducted moving in an upstream direction that covered the entire wetted width of the stream, including all channels where flow was braided. Electrofishing effort was not pre-determined because the primary objective was to determine whether fish were present in the stream and, if so, determine fish community composition. Electrofisher voltage (V), duty cycle (%) and frequency (Hz) settings were adapted at each site to maximize catch efficacy and minimize harm to fish. Observations of fish that were seen but not captured were recorded.

3.2.3.2 Minnow Trapping

Cylindrical minnow traps (43 cm long, 23 cm in diameter, with 6.5 mm mesh, entrance diameter 3 cm) were employed to sample small-bodied fish in Ponds 4 and 5 in Grenier Lake East Outflow between July 26 and July 30, 2019 (Figures 3.2-3 and 3.2-4). Traps were baited with dry commercial crab bait and immersed for approximately 24 hours before retrieval the day after they were set.

3.2.3.3 Gillnetting

A total of 46 gillnets were set between July 26 and August 26, 2019 at three ponds (Ponds 3, 4, and 5) within the Grenier Lake East Outflow (Figures 3.2-3 to 3.2-5). Both single panelled and multi-panelled sinking gillnets were used. Mesh sizes, panel order, and panel sizes are described in Table 3.2-7. Nets were deployed by boat and set for up to 16.6 hours. Initial set times were short (i.e., less than one hour) but set times were adjusted according to catch rates in order to maximize fish capture while minimizing stress and mortality to fish.

A total of 21 gillnets were set between July 15 and August 27, 2019 in Tahilugyuak and T-Pond (Figure 3.2-6), and in Elu Inlet (Figure 3.2-7). Each gillnet consisted of a standard gang of six panels of different mesh sizes recommended by the Resources Information Standards Committee (25 mm, 76 mm, 51 mm, 89 mm, 38 mm and 64 mm; RISC 2001). Each panel was 15.2 m long, and the panels were sewn together to make a net that was 91.2 m long and 2.4 m deep. All nets were deployed by boat with the exception of two deployed at Tahilugyuak Outflow which were set by wading the net across the length of the outflow. Nets were soaked for up to 1.5 hours before retrieval.

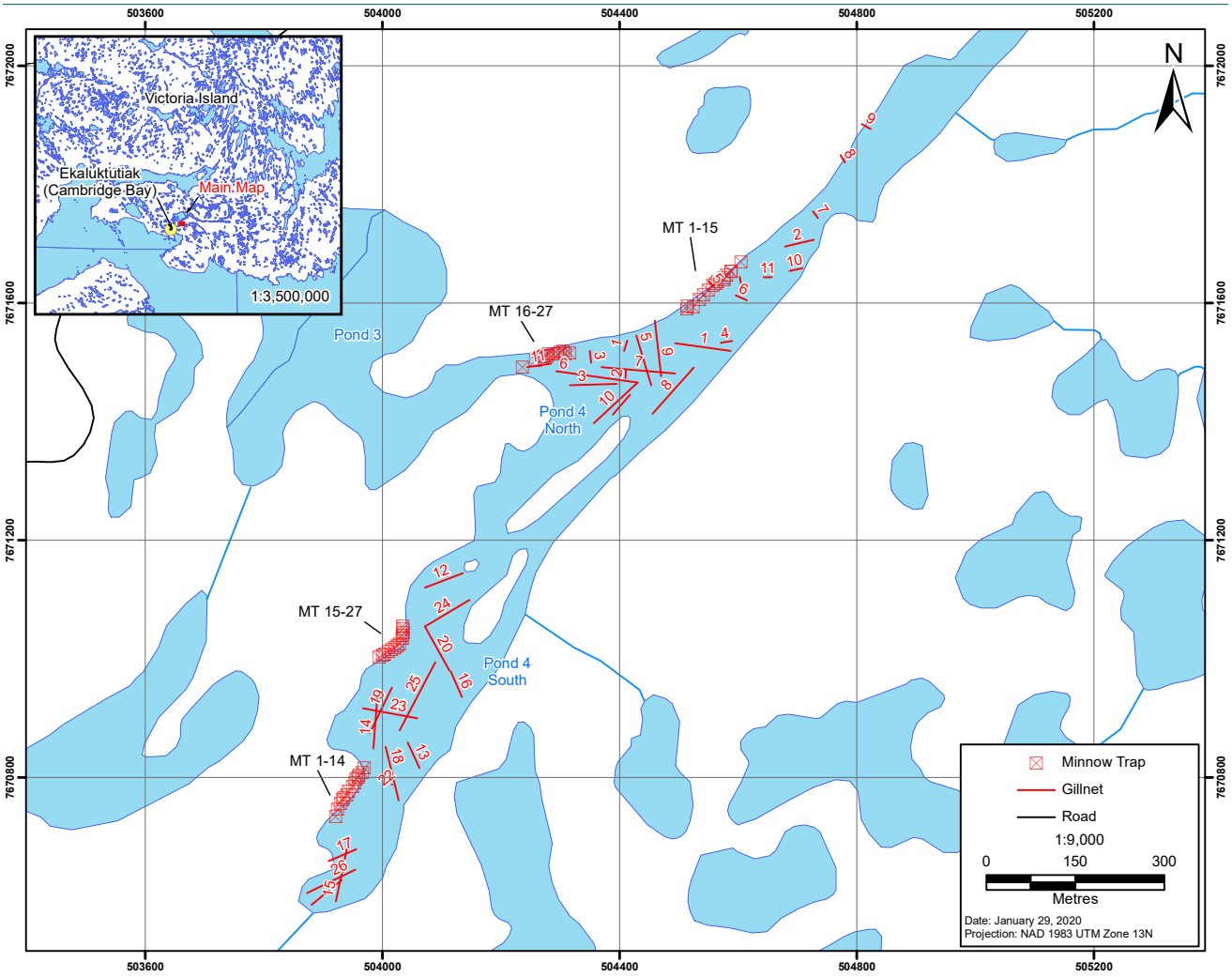


Figure 3.2-3: Fish Community Sampling Locations in Pond 4, Grenier Lake East Outflow, 2019

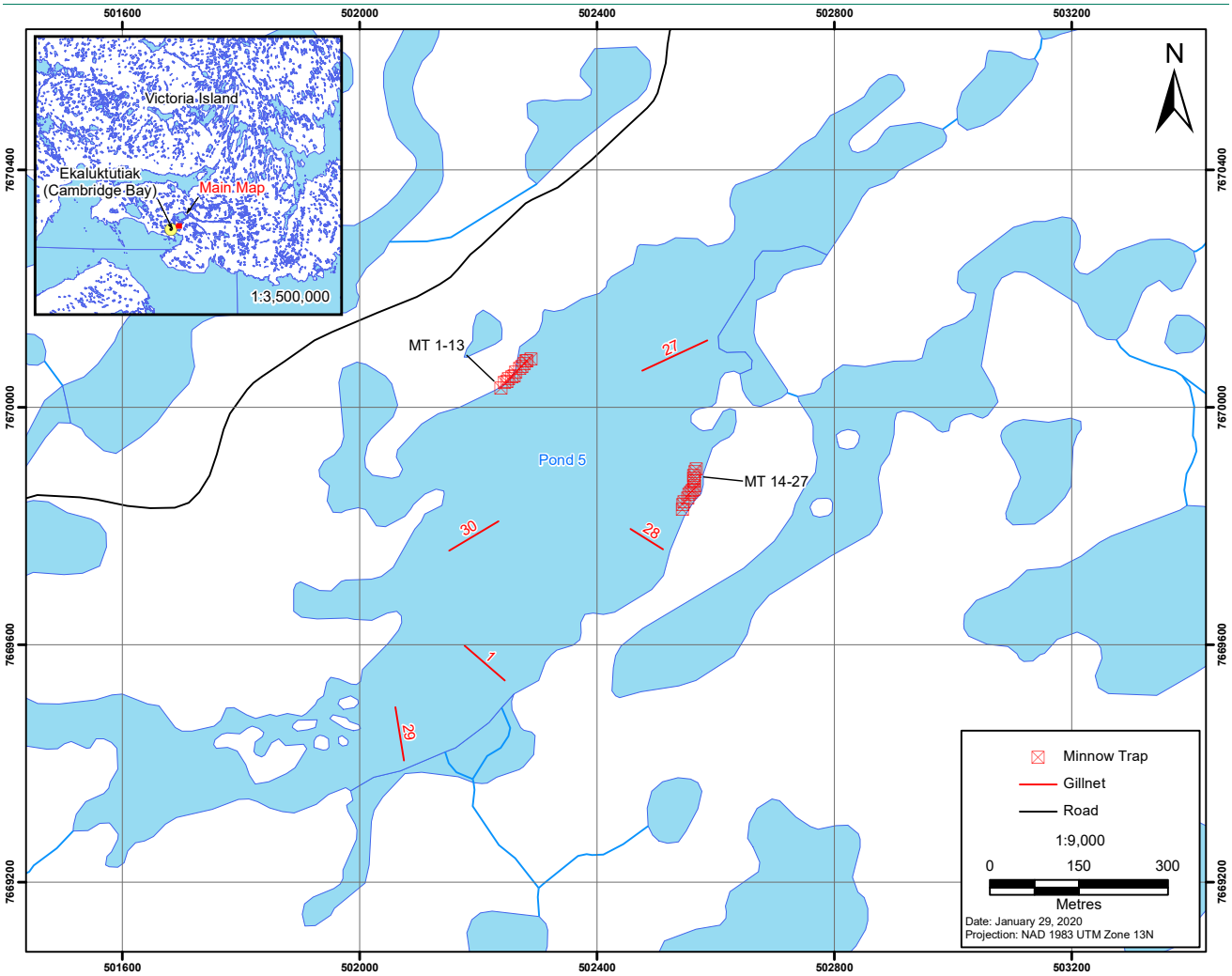


Figure 3.2-4: Fish Community Sampling Locations in Pond 5, Grenier Lake East Outflow, 2019

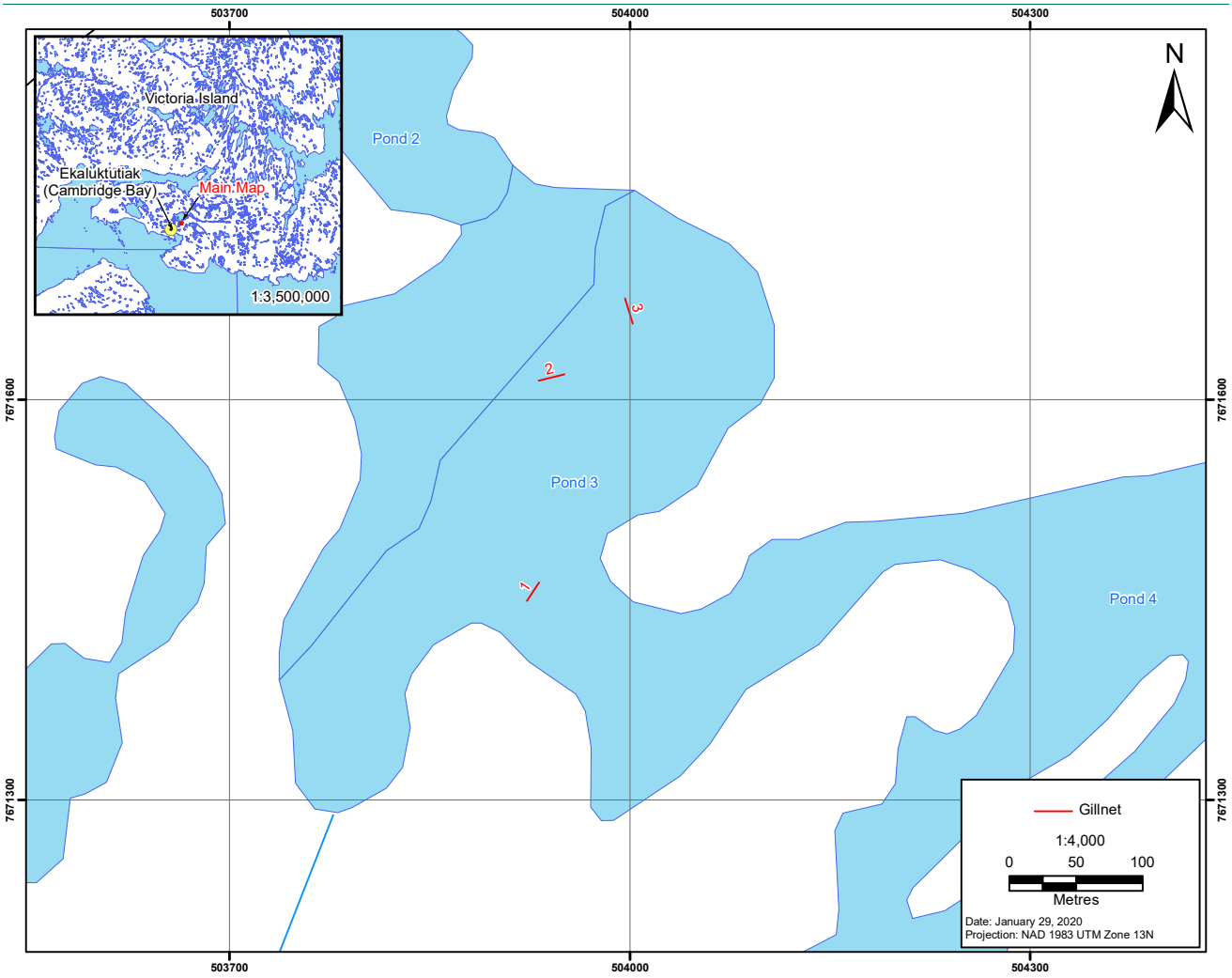


Figure 3.2-5: Fish Community Sampling Locations in Pond 3, Grenier Lake East Outflow, 2019

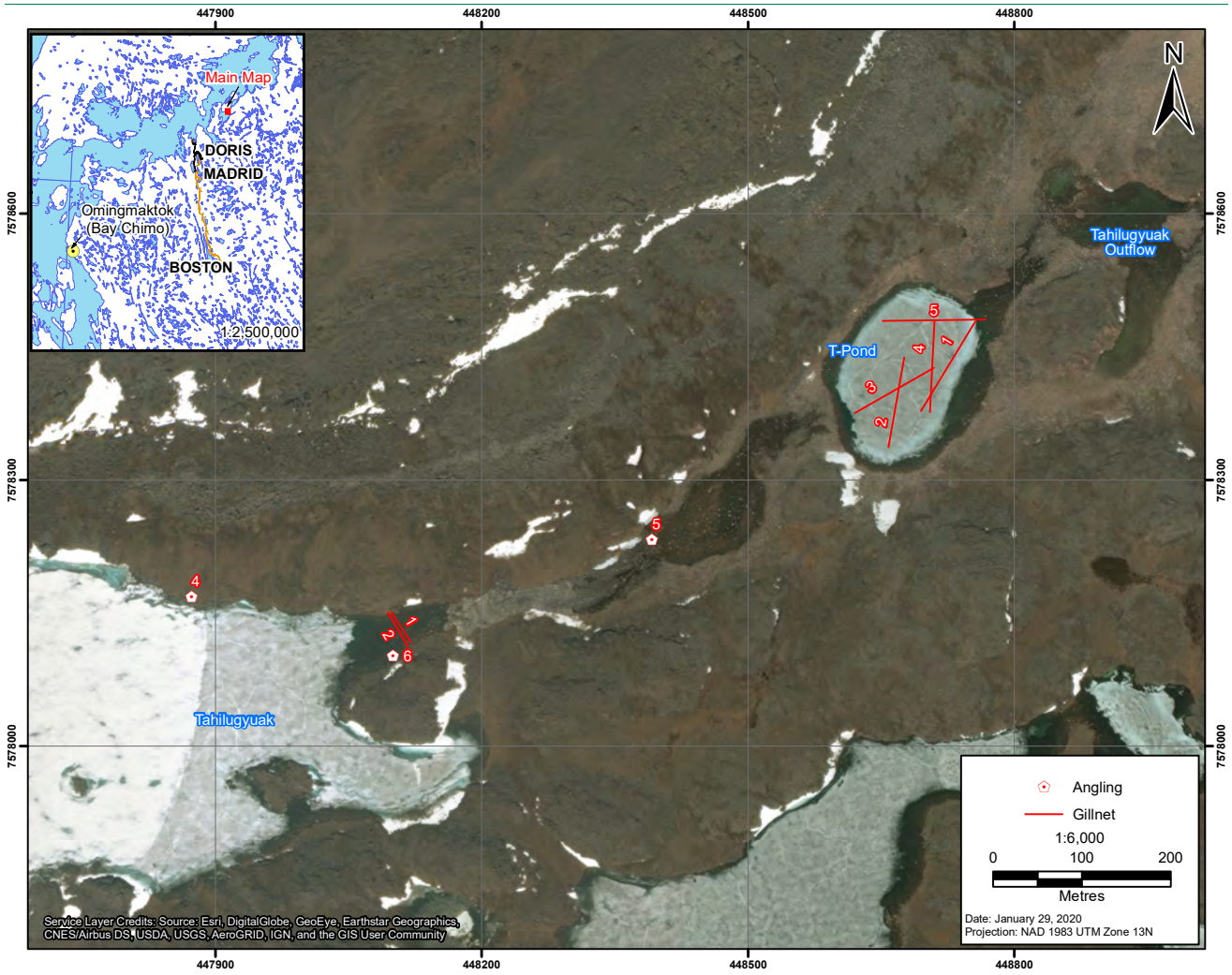


Figure 3.2-6: Fish Community Sampling Locations in Tahilugyuak and T-Pond, Tahilugyuak Outflow, 2019

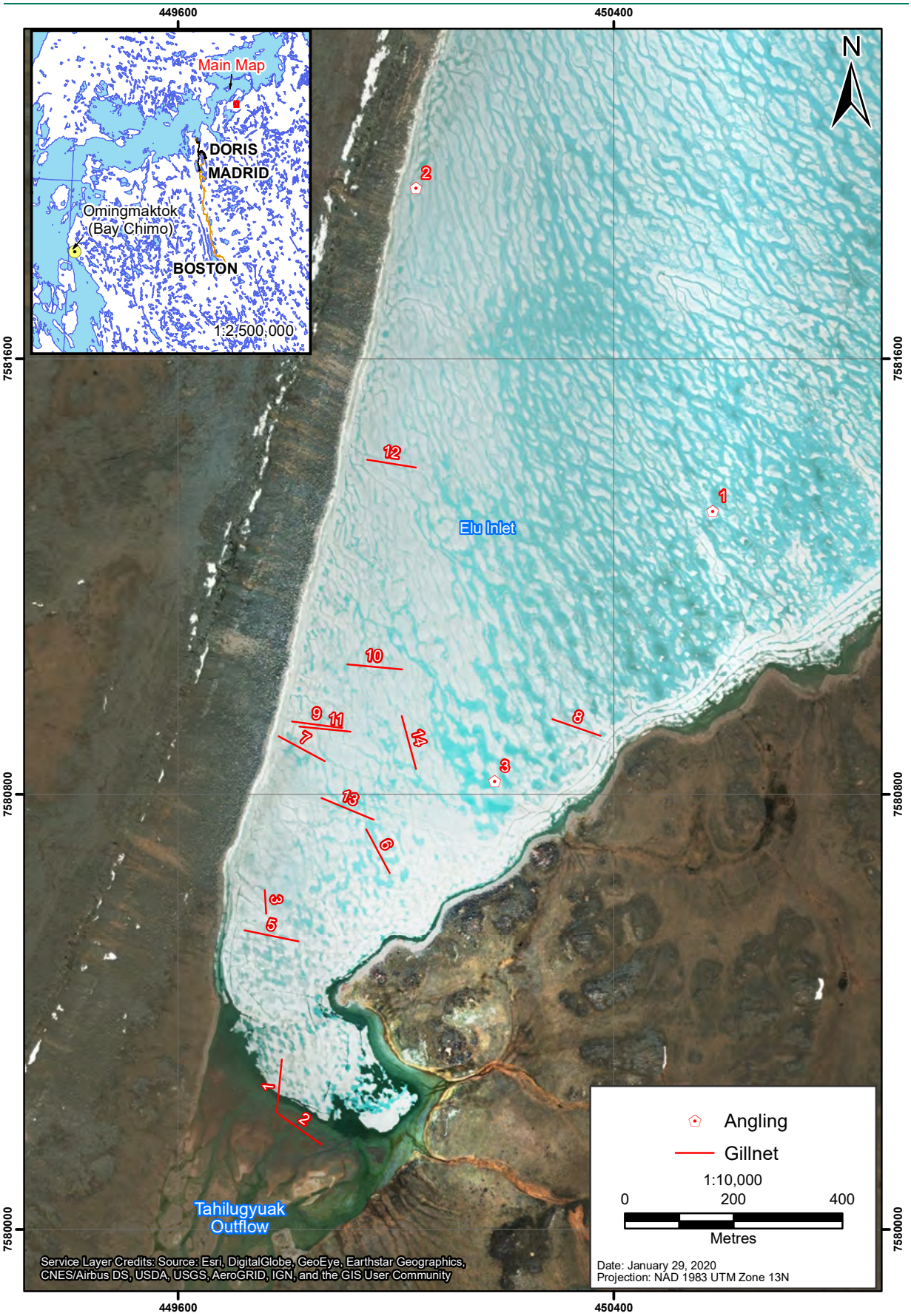


Figure 3.2-7: Fish Community Sampling Locations in Elu Inlet near Tahilugyuak Outflow, 2019

Table 3.2-7: Size Specifications for Single and Multi-panelled Sinking Gillnets Deployed within the Grenier Lake East Outflow, 2019

Net Size ID	Panels	Mesh (mm)	Length (m)	Depth (m)	Area (m^2)
A	1	38	15.24	1.2192	18.58061
B	1	25	15.24	1.2192	18.58061
C	6	25, 76, 51, 89, 38, 64	91.44	2.4384	222.9673
D	3	51, 64, 76	45.72	2.4384	111.4836
E	3	38, 38, 25	45.72	1.2192	55.74182

3.2.3.4 Angling

Angling efforts were conducted at/downstream of Tahilugyuak Lake Outflow, and in Elu Inlet using between one and three rods fishing simultaneously. Fishing locations were marked (Figures 3.2-6 and 3.2-7) and duration of fishing effort at each location was recorded in the field.

3.2.4 Quality Assurance / Quality Control

Quality Assurance / Quality Control (QA/QC) was implemented throughout the field program in order to ensure accurate data collection and analysis. Field balances were calibrated prior to the beginning of the field trip, kept free of excess water and sediment, and regularly tared to maintain accuracy while in use. Field notes were transcribed into electronic spreadsheets once in the office and all transcriptions were checked visually against the field forms and any errors corrected. The data were also plotted to identify any outliers that may have resulted from transcription errors that occurred in the field. Hydroacoustic data files were reviewed at the end of each field day to ensure data were complete and electronically archived appropriately.

3.3 Results and Discussion

3.3.1 Grenier Lake East Outflow

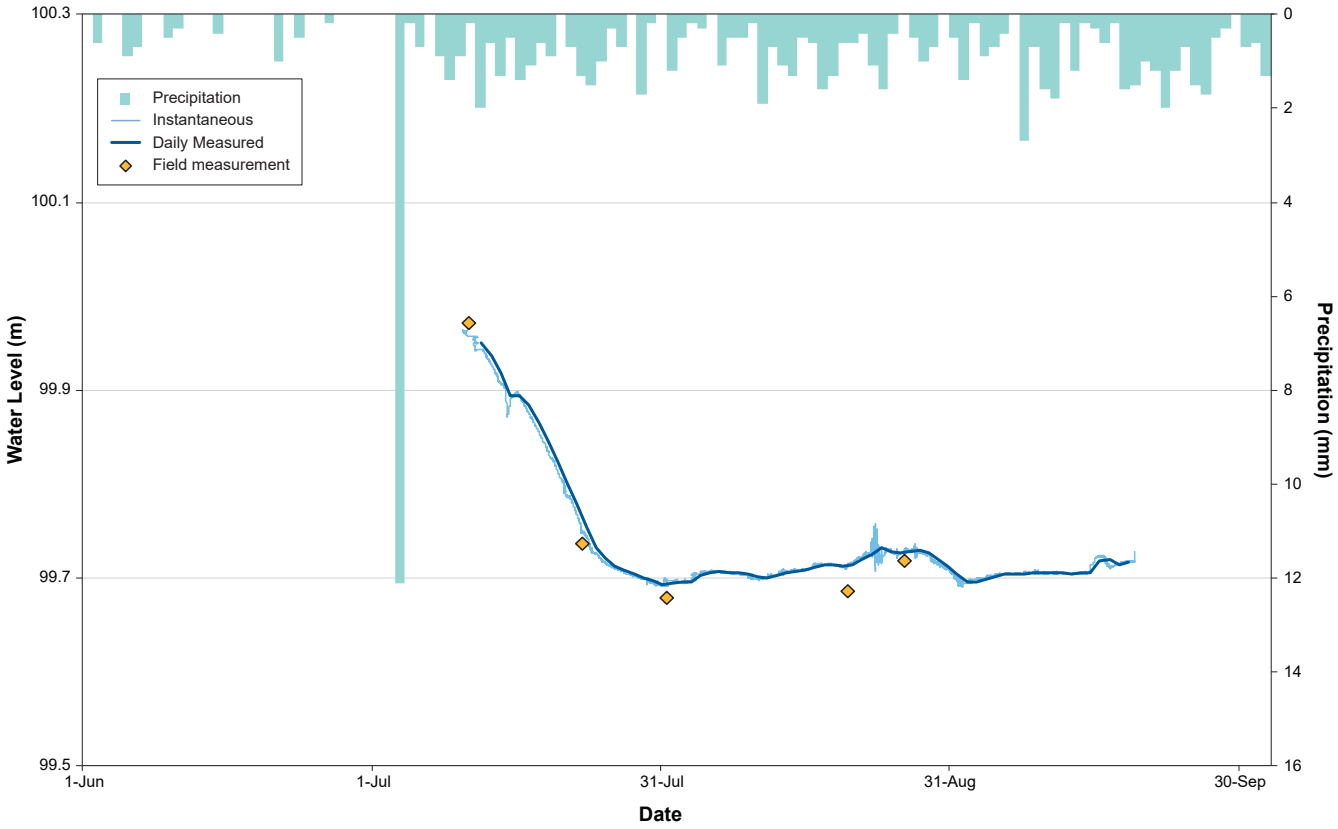
3.3.1.1 Hydrology

Water Level and Streamflow

A hydrometric monitoring station was installed in Pond 2 along Grenier Lake East Outflow on July 11, 2019 (Table 3.2-2; Photo 3.3-1). Freshet occurred early July, 2019 in the Grenier Lake East Outflow, likely between July 9 and 16 when significant rainfall events occurred (Figure 3.3-1). Water levels receded and, by July 24, 2019, the connecting stream channels between ponds downstream of the culverts were wetted but not flowing (Photo 3.3-2). Water levels continued to decline and the majority of evaluated stream channels were dry or impassable for fish due to low water level by the next site visit on August 1, 2019. Relative changes in water surface elevation in Ponds 1 to 5 paralleled each other throughout the open water season, although Pond 1 was influenced by the number of culverts that were passing flow (Figure 3.3-2).

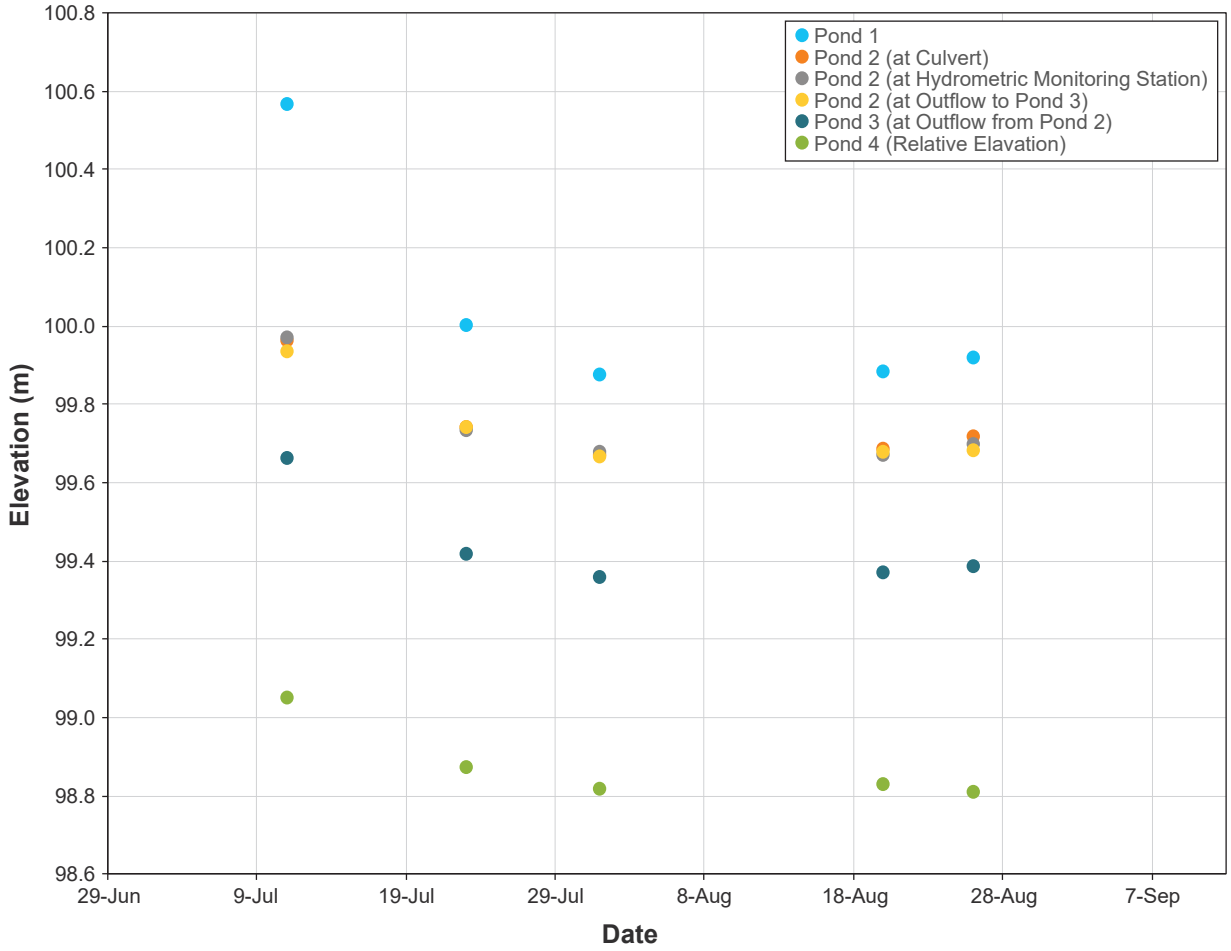
Photo 3.3-1: Grenier Lake East Outflow hydrometric monitoring station downstream of the Ovayok Road culvert crossing (background), July 11, 2019.

Photo 3.3.-2: Streamflow measurement in wetted channel at site EO3 between Pond 2 and Pond 3, Grenier Lake East Outflow, July 23, 2019.



Note: Precipitation data are from Cambridge Bay A Nunavut Station - Climate ID 2400600 (Environment and Climate Change Canada, 2020).

Figure 3.3-1: Grenier Lake East Outflow Hydrometric Station Stage and Regional Precipitation Data



Note: Pond 4 elevations are mesured to benchmarks that are independant from those used for Ponds 1, 2, and 3.

Figure 3.3-2: Relative Elevation Changes in Water Level between Pond 1, Pond 2, Pond 3, and Pond 4

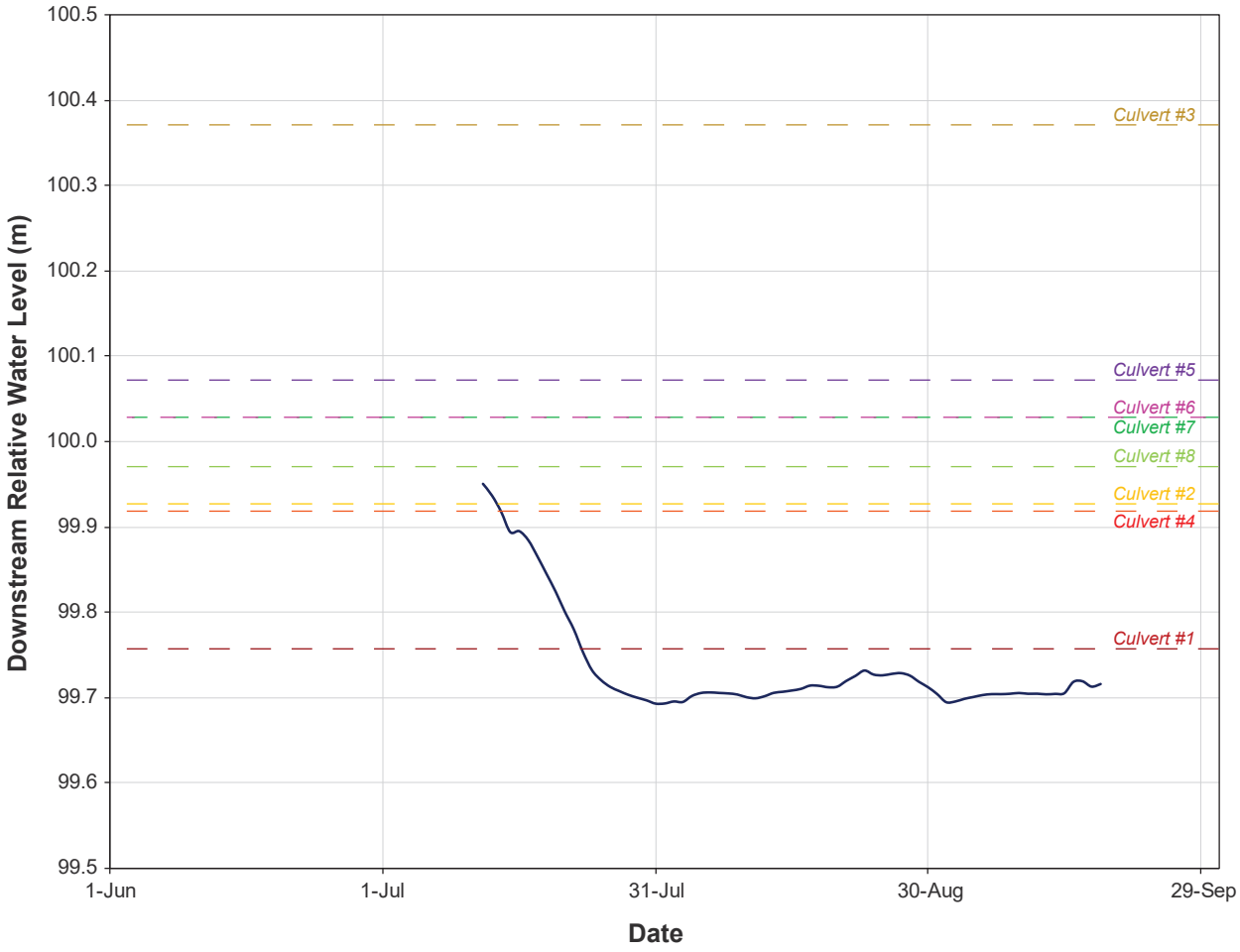
Culvert Assessment

The eight culverts at the Ovayok Road crossing of Grenier Lake East Outflow (Figure 3.3-2; Photo 3.3-3) were assessed on July 11, 2019 for fish passage potential. Based on survey and streamflow measurements and published fish swimming capabilities (Katapodis and Gervais 2016), the crossing was determined to significantly limit fish passage on the survey date (Table 3.3-1). The measured streamflow was 1.35 m^3/s at site EO3, approximately 280 m downstream from the culverts (Figure 3.3-1). There were no other surface flow inputs observed between the culverts and EO3 that were noted to influence the streamflow at this location.

Photo 3.3-1: Culverts #1 to #4 outlets at the Ovayok Road crossing of Grenier Lake East Outflow, facing SW from the left bank, July 11, 2019.

The potential for fish to pass through the culverts was assessed based on the greater of the velocities measured at the inlet and outlet for each culvert. This velocity was then compared to the critical swimming speed for the time to fatigue at that velocity (Table 3.3-1) for *Salmonidae* (Katapodis and Gervais 2016). Based on the assessment, the only culvert that may successfully allow upstream passage by fish 0.3 m in length or larger is Culvert #3; however, there is a 0.43 m drop at the outlet preventing fish from accessing it from downstream (Figure 3.3-3, Table 3.3-1). Culvert #5 may also allow upstream passage for fish greater than 0.5 m in length to pass upstream but has a 0.13 m drop at the outlet. Larger fish (i.e., greater than 0.8 m in length), may be able to swim upstream through the culverts based on the velocities measured on the survey date, but would likely be restricted from accessing the culverts due to the outlet drops and limited depths of jump pools directly below the culvert outlets. None of the culverts would permit upstream passage of fish 0.1 m in length (i.e. juveniles) on the survey date.

The culverts also appear to control the stream flows at high flow in the Grenier Lake East Outflow as the observed water level change between July 11 and July 23, 2019 in Pond 1 (upstream of the culverts) was greater than the water level change in other ponds where water levels were measured and influenced by the number of culverts that remain wetted (Figure 3.3-3). As the water level recede the higher elevations culverts inverts are no longer passing flow and the rate of water level change decreases.



Note: Culvert inlet elevation (not shown) is higher than outlet elevation and controls inflow into culverts and number of culverts flowing based on upstream water elevation in Pond 1.

Figure 3.3-3: Water Level in Pond 2 Downstream of Culverts Relative to Culvert Outlet Elevations

Table 3.3-1: Summary of Culvert Measurements and Calculated Fish Swimming Capacities for Potential Passage through Culverts

Culvert Number	Culvert Diameter (mm)	Culvert Length (m)	Culvert Slope (%)	Culvert Relative Inlet Elevation (m)	Culvert Relative Outlet Elevation (m)	Outlet Drop (m)	Culvert Outlet							Culvert Inlet						
							Velocity (m/s)	Water Depth (m)	Time-to-Fatigue (s)	Critical Swimming Speed (m/s) for a Given Fish Body Length				Velocity (m/s)	Water Depth (m)	Time-to-Fatigue (s)	Critical Swimming Speed (m/s) for a Given Fish Body Length			
										0.8 m Body Length	0.5 m Body Length	0.3 m Body Length	0.1 m Body Length				0.8 m Body Length	0.5 m Body Length	0.3 m Body Length	0.1 m Body Length
1	0.8	12	1.0	99.877	99.759	-0.185	1.93	0.40	6	1.83	1.1	0.69	0.23	0.83	0.65	14	1.49	0.93	0.56	0.19
2	0.8	12	-0.1	99.920	99.927	-0.017	2.08	0.40	6	1.86	1.2	0.70	0.23	1.07	0.64	11	1.58	1.0	0.59	0.20
3	0.8	12	0.5	100.428	100.371	0.427	0.45	0.05	27	1.28	0.80	0.48	0.16	0.19	0.1	63	1.03	0.6	0.39	0.13
4	0.8	12	2.4	100.209	99.919	-0.025	1.48	0.20	8	1.71	1.1	0.64	0.21	0.94	0.3	13	1.53	1.0	0.57	0.19
5	1.0	12	3.0	100.427	100.072	0.128	0.63	0.06	19	1.39	0.87	0.52	0.17	0.24	0.1	50	1.10	0.68	0.41	0.14
6	1.0	12	2.8	100.364	100.029	0.085	1.10	0.12	11	1.59	1.0	0.60	0.20	0.37	0.17	32	1.22	0.76	0.46	0.15
7	1.0	12	1.4	100.198	100.029	0.085	1.57	0.21	8	1.74	1.1	0.65	0.22	0.74	0.32	16	1.44	0.90	0.54	0.18
8	1.0	12	1.5	100.149	99.971	0.027	1.03	0.20	12	1.57	1.0	0.59	0.20	0.4	0.4	30	1.24	0.78	0.47	0.16

Notes:

Shaded cells indicate fish body lengths where the critical swimming speed is great enough to overcome water velocity over the length of the culvert (i.e., fish can potentially pass upstream).

Cells for both inlet and outlet of a culvert must be shaded for fish to potentially pass upstream through the culvert.

Outlet Drop = Culvert Relative Inlet Elevation less Pond 2 Water Elevation on July 11, 2019 of 99.944 m.

Negative value for Outlet Drop means culvert inlet was submerged (i.e., below Pond 2 water level) on July 11, 2019.

3.3.1.2 Fish Habitat

Stream Habitat

A total of four fish habitat assessments were conducted on July 24, 2019 on streams within the Grenier Lake East Outflow. Wetted width ranged from 6 m to 39 m and wetted depth ranged from 0.1 m to 0.8 m. Stream beds were comprised of substrates ranging in size from fines to boulders. In August, flows eventually receded such that channels were dry; therefore, surveys were not repeated. Detailed descriptions of each stream assessed in the Grenier Lake system are presented in Appendix A-1.

Habitat data suggest that there is a period during high water flows in the spring where stream habitats in Grenier Lake East Outflow provide good rearing and migration habitat for larger Arctic Char and Lake Trout, but as flows decline habitat quality declines rapidly. For Ninespine Stickleback, good quality habitat for spawning, rearing and migration remains available for all life stages for a longer period of time, but ultimately disappears when the channels dry up. Although there were no complete barriers to fish passage on the survey date, low water depths at some surveyed locations (i.e., as shallow as 0.1 m at EO2 and EO3) could make passage by larger Arctic Char and Lake Trout difficult.

Bathymetry and Sublittoral Habitat

Pond 1

The water depths measured in Pond 1 during the hydroacoustic bathymetric survey ranged from 0.6 to 1.4 m. The bathymetric contours derived from the hydroacoustic data are shown in Figure 3.3-4.

Sublittoral substrates at Pond 1, determined by hydroacoustics ranged in size from fines to large rock. Fine substrate comprised the largest percentage of the surveyed area at water depths of 1 to 2 m (82.1% of the hydroacoustic survey area; Table 3.3-2). Large rock was the subdominant substrate type at this depth range, representing 17.9% of the overall bottom type of the hydroacoustic survey.

Pond 2

The water depths measured in Pond 2 during the hydroacoustic bathymetric survey ranged from 0.6 to 2 m. The bathymetric contours derived from the hydroacoustic data are shown in Figure 3.3-4.

Sublittoral substrates at Pond 2 determined by hydroacoustics ranged in size from fines to large rock. Large rock substrate comprised the largest percentage of the surveyed area at water depths of 1 to 2 m (97.5% of the hydroacoustic survey area; Table 3.3-2). Fines were the subdominant substrate type at this depth range, representing 2.5% of the overall bottom type of the hydroacoustic survey.

Pond 3

The water depths measured in Pond 3 during the hydroacoustic bathymetric survey ranged from 0.6 to 2.4 m. The bathymetric contours derived from the hydroacoustic data are shown in Figure 3.3-4.

Sublittoral substrates at Pond 3 determined by hydroacoustics ranged in size from fines to large rock. Fine substrate comprised 100% of the surveyed area at water depths greater than 1 m (Photo 3.3-4; Table 3.3-2).

Pond 4

The water depths measured in Pond 4 during the hydroacoustic bathymetric survey ranged from 0.6 to 4.7 m. The bathymetric contours derived from the hydroacoustic data are shown in Figure 3.3-5.

Sublittoral substrates at Pond 4 determined by hydroacoustics ranged in size from fines to large rock (Photo 3.3-5). Mixed substrate (fines, cobble, and boulder) comprised the largest percentage of the surveyed area at depths of 1 to 2 m (47.6% of the hydroacoustic survey area; Table 3.3-2). Large rock and fines were the subdominant substrate types at this depth range, representing 8.2% and 7.1% of the

overall bottom type of the hydroacoustic survey, respectively. Fines made up the largest percentage of the surveyed area at water depths between 2 and 4 m (35.8% of the hydroacoustic survey area; Table 3.3-2). At water depths greater than 4 m, fines were the dominant substrate type, representing 1.2% of the overall bottom area of the hydroacoustic survey (Table 3.3-2).

Table 3.3-2: Sublittoral Substrate Types Identified by Hydroacoustic Surveys, Grenier Lake East Outflow, 2019

Site	Bottom Type	Water Depth (m)	Area (m^2)	Relative Composition (%)
Pond 1	Fines	1-2	1,450	82.1
	Large Rock	1-2	315	17.9
Total			**1,765**	**100**
Pond 2	Fines	1-2	94	2.5
	Large Rock	1-2	3,614	97.5
Total			**3,708**	**100**
Pond 3	Fines	1-2	10,698	95.9
		>2	460	4.1
	Large Rock	1-2	0	0.0
		>2	0	0.0
Total			**11,158**	**100**
Pond 4	Fines	1-2	8,407	7.1
		2-4	42,572	35.8
		>4	1,454	1.2
	Large Rock	1-2	9,759	8.2
		2-4	0	0.0
		>4	0	0.0
	Mixed (Rock and Fines)	1-2	56,597	47.6
		2-4	62	0.1
		>4	0	0.0
Total			**118,852**	**100**
Pond 5	Fines	1-2	64,758	28.3
		2-4	92,073	40.3
		>4	973	0.4
	Large Rock	1-2	9,839	4.3
		2-4	0	0.0
		>4	0	0.0
	Mixed (Rock and Fines)	1-2	60,726	26.6
		2-4	307	0.1
		>4	0	0.0
Total			**228,677**	**100**

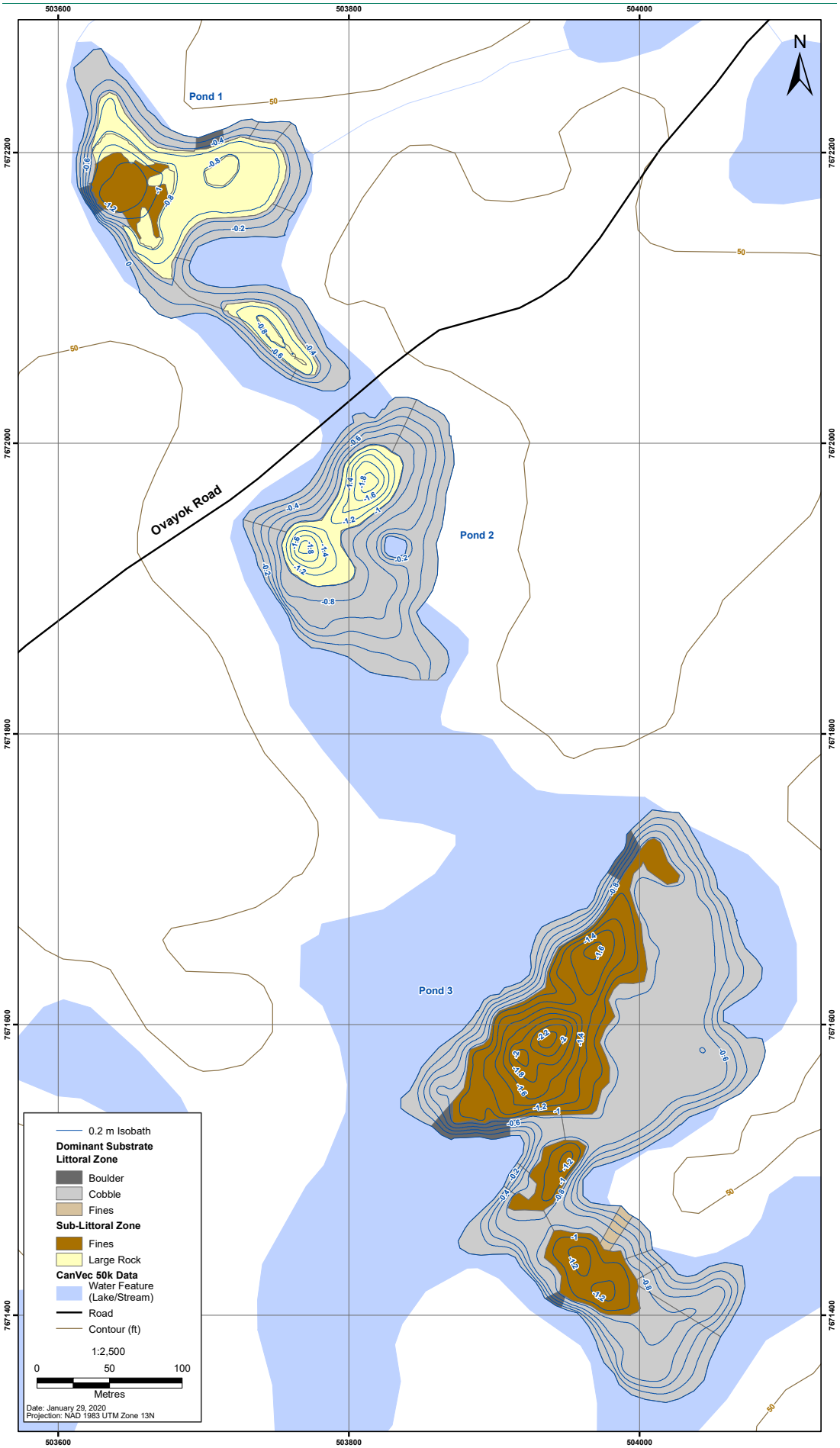


Figure 3.3-4: Bathymetry and Substrate Composition in Pond 1, Pond 2, and Pond 3, Grenier Lake East Outflow, 2019

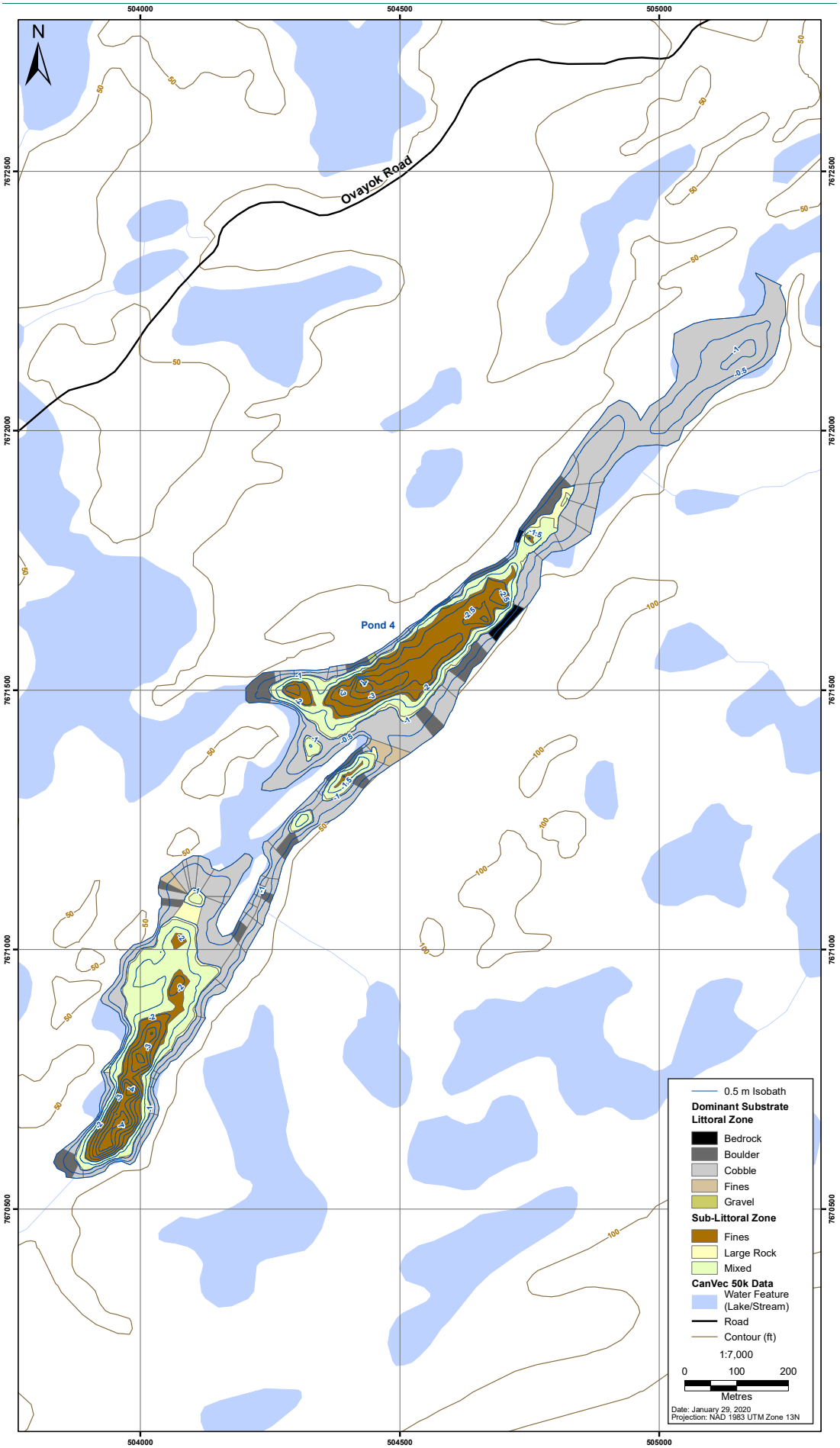


Figure 3.3-5: Bathymetry and Substrate Composition in Pond 4, Grenier Lake East Outflow, 2019

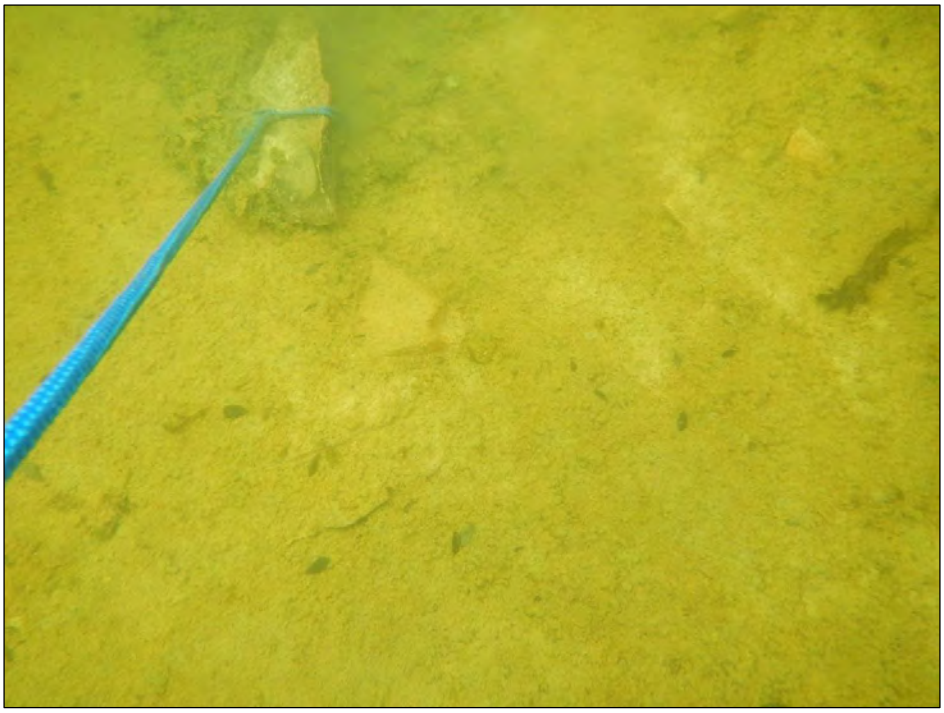


Photo 3.3-4: Fine substrate observed at 1.5 m water depth during underwater video surveys in Pond 3, July 30, 2019.

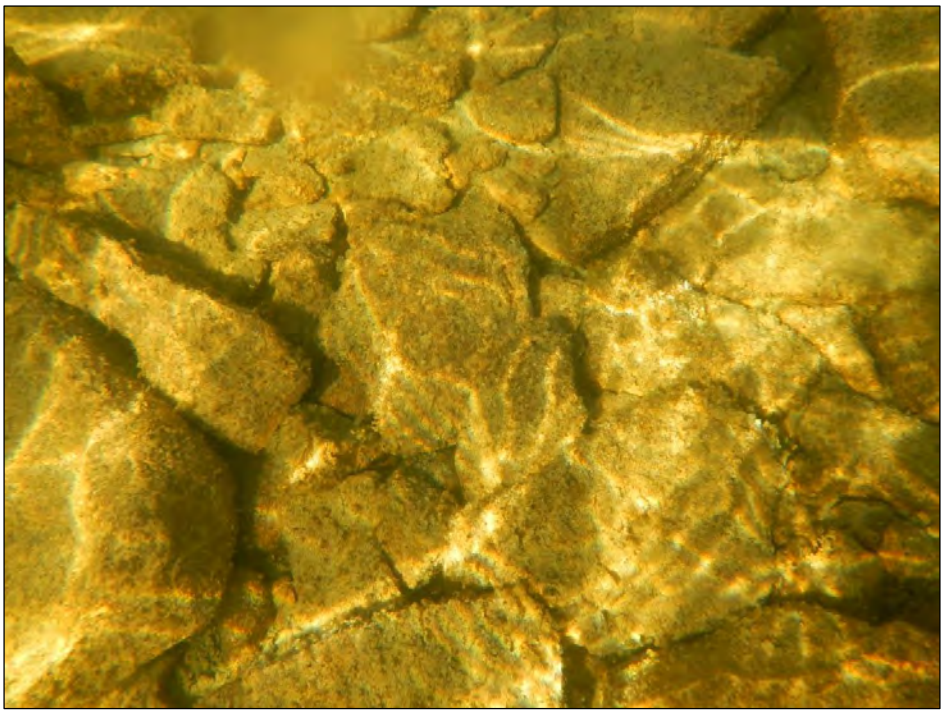


Photo 3.3-5: Large Rock (cobble and boulder) substrates observed at 1 m water depth during underwater video surveys in Pond 4, July 27, 2019.

Pond 5

The water depths measured in Pond 5 during the hydroacoustic bathymetric survey ranged from 0.6 to 4.8 m. The bathymetric contours derived from the hydroacoustic data are shown in Figure 3.3-6.

Sublittoral substrates at Pond 5 determined by hydroacoustics ranged in size from fines to large rock. Fine substrate comprised the largest percentage of the surveyed area at water depths of 1 to 2 m (28.3% of the hydroacoustic survey area; Table 3.3-2). Mixed substrate (fines, cobble, and boulder) was the subdominant substrate type at this depth range, representing 26.6% of the overall bottom type of the hydroacoustic survey (Photo 3.3-6). Large rock comprised 4.3% of the overall bottom area of the hydroacoustic survey at water depths of 1 to 2m. Fines made up the largest percentage of the surveyed area at water depths between 2 and 4 m (40.3% of the hydroacoustic survey area; Table 3.3-2). At water depths greater than 4 m, fines were the dominant substrate type, representing 0.4% of the overall bottom area of the hydroacoustic survey (Table 3.3-2).

Photo 3.3-6: Mixed substrates (fines, cobble, and boulder) at 1 m water depth during underwater video surveys in Pond 5, July 30, 2019.

Littoral Habitat

Pond 1

The littoral habitat of Pond 1 within Grenier Lake East Outflow was categorized based on the distribution of substrates (Figure 3.3-4). The full perimeter of Pond 1, amounting to a total of 844 m of shoreline, was assessed. Eight littoral habitat units were identified, covering an area of approximately 9,679 m^2 (calculated based on the polygon area of each habitat unit). The dominant substrates recorded in the littoral zone were cobble and boulder. Cobble was the dominant substrate type in six of the habitat units. Boulder dominated in two habitat units. Appendix A-2 presents detailed littoral habitat data collected at Pond 1.

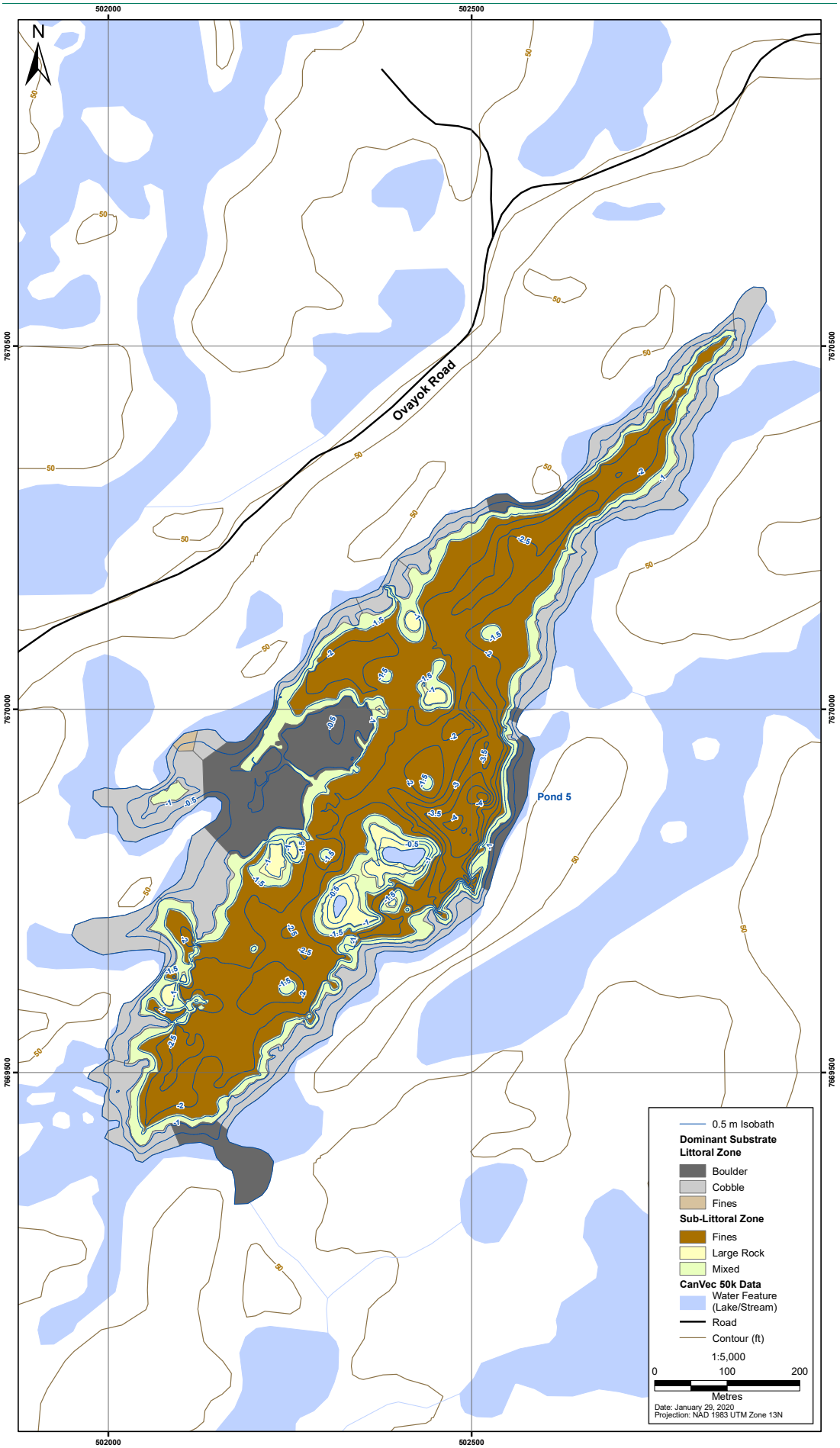


Figure 3.3-6: Bathymetry and Substrate Composition in Pond 5, Grenier Lake East Outflow, 2019

Pond 2

The littoral habitat of Pond 2 within Grenier Lake East Outflow was categorized based on the distribution of substrates (Figure 3.3-4). The full perimeter of Pond 2, amounting to a total of 555 m of shoreline, was assessed. Two littoral habitat units were identified, covering an area of approximately 14,543 m^2 (calculated based on the polygon area of each habitat unit). Cobble substrates dominated in all habitat units. Appendix A-2 presents detailed littoral habitat data collected at Pond 2.

Pond 3

The littoral habitat of Pond 3 within Grenier Lake East Outflow was categorized based on the distribution of substrates (Figure 3.3-4). The full perimeter of Pond 3, amounting to a total of 1,322 m of shoreline, was assessed. Twelve littoral habitat units were identified, covering an area of approximately 34,640 m^2 (calculated based on the polygon area of each habitat unit). The dominant substrates recorded in the littoral zone were cobble, boulder, and fines. Cobble was the dominant substrate type in eight of the habitat units. Boulder and fines dominated in three and one habitat unit(s), respectively. Appendix A-2 presents detailed littoral habitat data collected at Pond 3.

Pond 4

The littoral habitat of Pond 4 within Grenier Lake East Outflow was categorized based on the distribution of substrates (Figure 3.3-5). The full perimeter of Pond 4, amounting to a total of 6,079 m of shoreline, was assessed. 77 littoral habitat units were identified, covering an area of approximately 155,284 m^2 (calculated based on the polygon area of each habitat unit). Cobble was the dominant substrate type in 54 of the habitat units. Boulder dominated at 18 habitat units. Bedrock and fines were dominant in two habitat units each. Gravel was the dominant substrate at one habitat unit. Appendix A-2 presents detailed littoral habitat data collected at Pond 4.

Pond 5

The littoral habitat of Pond 5 within Grenier Lake East Outflow was categorized based on the distribution of substrates (Figure 3.3-6). The full perimeter of Pond 5, amounting to a total of 4,349 m of shoreline, was assessed. 22 littoral habitat units were identified, covering an area of approximately 118,104 m^2 (calculated based on the polygon area of each habitat unit). Cobble was the dominant substrate type in 16 of the habitat units. Boulder dominated at five habitat units. Fines were dominant in one habitat unit. Appendix A-2 presents detailed littoral habitat data collected at Pond 5.

Sublittoral and Littoral Habitat Summary

Bathymetric and habitat surveys in the ponds suggested that Ponds 1, 2, 3, 4, and 5 are of sufficient depth and have habitat characteristics that would provide migration and rearing habitat for both Ninespine Stickleback and Arctic Char. Ninespine Stickleback would also likely be able to spawn in these ponds during the open-water season. Based on the maximum depths of Ponds 1, 2, and 3 (1.4 – 2.4 m), overwintering habitat quality for both species of fish captured in 2019 is expected to be negligible and there is no spawning habitat for Arctic Char. This is due to ice cover during the winter that may be over 2 m thick, limiting the accessible area under the ice and influencing water quality conditions that affect fish and egg survival (e.g., dissolved oxygen). Limited areas of Ponds 4 and 5, were deeper (maximum depths of 4.7 – 4.8 m), suggesting some potential for fish to overwinter, though overwintering success may depend on the duration and extent of ice cover in a given year. However, spawning habitats for Arctic Char were not present as little to no rock substrates (i.e., spawning shoals) were identified in areas with water depths greater than 2 m. Eggs deposited in rocky habitats shallower than 2 m would not be expected to survive due to the effects of ice scour during the winter.

3.3.1.3 Fish Community

Four electrofishing sites were sampled in Grenier Lake East Outflow in 2019. A total of 57 Ninespine Stickleback were captured in 3,354 s of electrofishing effort (CPUE of 1.7 fish/100 s; Table 3.3-3). CPUE was greater at upstream sites closer to Grenier Lake.

Table 3.3-3: Effort and Catch from Electrofishing Surveys in the Grenier Lake East Outflow, 2019

Site	Sampling Date	Total Fishing Effort (s)	Catch (No. of fish)	CPUE (No. of fish/100s)
			NSSB	NSSB
EO1	24-Jul	1112	18	1.62
EO2	25-Jul	721	25	3.47
EO3	25-Jul	990	11	1.11
EO4	24-Jul	531	3	0.56
Total		**3354**	**57**	**1.70**

Notes:
NSSB = Ninespine Stickleback
CPUE=Catch-Per-Unit-Effort

A total of 81 minnow traps were set at Pond 4 and Pond 5 for a total fishing effort of 1,643.8 hours (Appendix A-3). Trap soak times ranged between 17.3 and 24.1 hours. A total of 46 Ninespine Stickleback were captured. Mean CPUE was higher in Pond 4 (0.9 fish/24 h) than Pond 5 (0.3 fish/24 h; Table 3.3-4).

Mean fork length (mm) and weight (g), were calculated for the subsample of Ninespine Stickleback captured in electrofishing and minnow trapping surveys for which biological characteristics were measured (Table 3.3-5). Other biological characteristics of fish sampled are presented in Appendix A-4. Weight-length regressions were used to analyse relative condition in Ninespine Stickleback. The regression was statistically significant (p-values <0.05; Figure 3.3-7), indicating a positive relationship between weight and length. Condition, expressed as the slope of the weight-length relationship (b) was 2.79 (Figure 3.3-7). Length frequency was also plotted using a histogram to visualize the size structure of the population. The majority of fish fell into size classes ranging from 45 to 55 mm (Figure 3.3-8) and distinct year classes were not distinguishable.

Twenty-one fish ranging in size from 51-75 mm and weight from 1.3-4.1 g were infected with a tapeworm parasite (thought to belong to the genus *Schistocephalus*). Infected fish had distended stomachs and dark spots along their bodies. Of the 52 Ninespine Stickleback captured and subsampled in the electrofishing survey, 18 had parasites and of the 26 Ninespine Stickleback captured and subsampled in the minnow trapping survey, 3 had parasites (Appendix A-4).

A total of 46 sinking gillnets were set in three ponds within Grenier Lake East Outflow, including Pond 3 (n = 3), Pond 4 (n = 38), and Pond 5 (n = 5) for a total fishing effort of 3, 102, and 16.5 hours, respectively (Appendix A-5). Arctic Char was the only species captured (n = 21). The majority of fish were captured in Pond 4 (n = 19). Two fish were captured in Pond 5 and no fish were captured in Pond 3. Mean CPUE ranged from 0 fish/100 m^2 of net/h (Pond 3) to 0.1 fish/100 m^2 of net/h (Pond 4 and 5; Table 3.3-6).

Mean fork length (mm) and weight (g), were calculated for Arctic Char captured in Grenier Lake East Outflow ponds (Table 3.3-7). Detailed biological information for each fish caught is presented in Appendix A-6.

Table 3.3-4: Minnow Trap CPUE Summary Statistics, Grenier Lake East Outflow, 2019

Site	Species	n	Standard CPUE (# fish per trap per 24 h)							Bootstrap CPUE (# fish per trap per 24 h)			
			Mean	SD	SE	Min	Max	Lower CI	Upper CI	Mean	SD	Lower CI	Upper CI
Pond 4	NSSB	54	0.856	2.409	0.328	0	15.864	0	5.803	0.857	0.329	0.342	1.599
Pond 5	NSSB	27	0.304	0.69	0.133	0	2.707	0	1.851	0.303	0.131	0.1	0.603

Notes:
CI = 95% confidence interval
n = sample size
SD = standard deviation of the mean
NSSB = Ninespine Stickleback
SE = standard error of the mean
CPUE = Catch-Per-Unit-Effort

Table 3.3-5: Fork Length and Weight Summary Statistics of Ninespine Stickleback Captured in Grenier Lake East Outflow, 2019

Capture Method	Site	Fork Length (mm)								Weight (g)							
		n	Mean	SD	SE	Min	Max	Lower CI	Upper CI	n	Mean	SD	SE	Min	Max	Lower CI	Upper CI
Electrofishing	EO1	18	51.278	8.89	2.095	42	75	42	71.6	18	1.278	0.842	0.198	0.5	4.1	0.542	3.377
	EO2	20	51.05	7.052	1.577	40	64	40.475	63.05	20	1.185	0.416	0.093	0.5	2.1	0.595	1.957
	EO3	11	58.455	6.699	2.02	49	70	49.25	68.75	11	1.909	0.671	0.202	0.6	3.1	0.825	3
	EO4*	3	50.342	3.12	-	43	56	43	56	3	1.231	0.179	-	0.8	1.5	0.8	1.5
Minnow Trapping	Pond 4	20	60.55	7.075	1.582	45	72	48.325	71.05	20	2.04	0.787	0.176	0.9	4	0.948	3.43
	Pond 5	6	54.167	7.627	3.114	45	65	45.125	64.125	6	1.183	0.515	0.21	0.6	2	0.625	1.925

Notes:
n = sample size
SD = standard deviation of the mean
SE = standard error of the mean
CI = 95% confidence interval
** Bootstrapped data due to low sample size.*
Dashes indicate data not available.

Table 3.3-6: Gillnet CPUE Summary Statistics for Arctic Char, Grenier Lake East Outflow, 2019

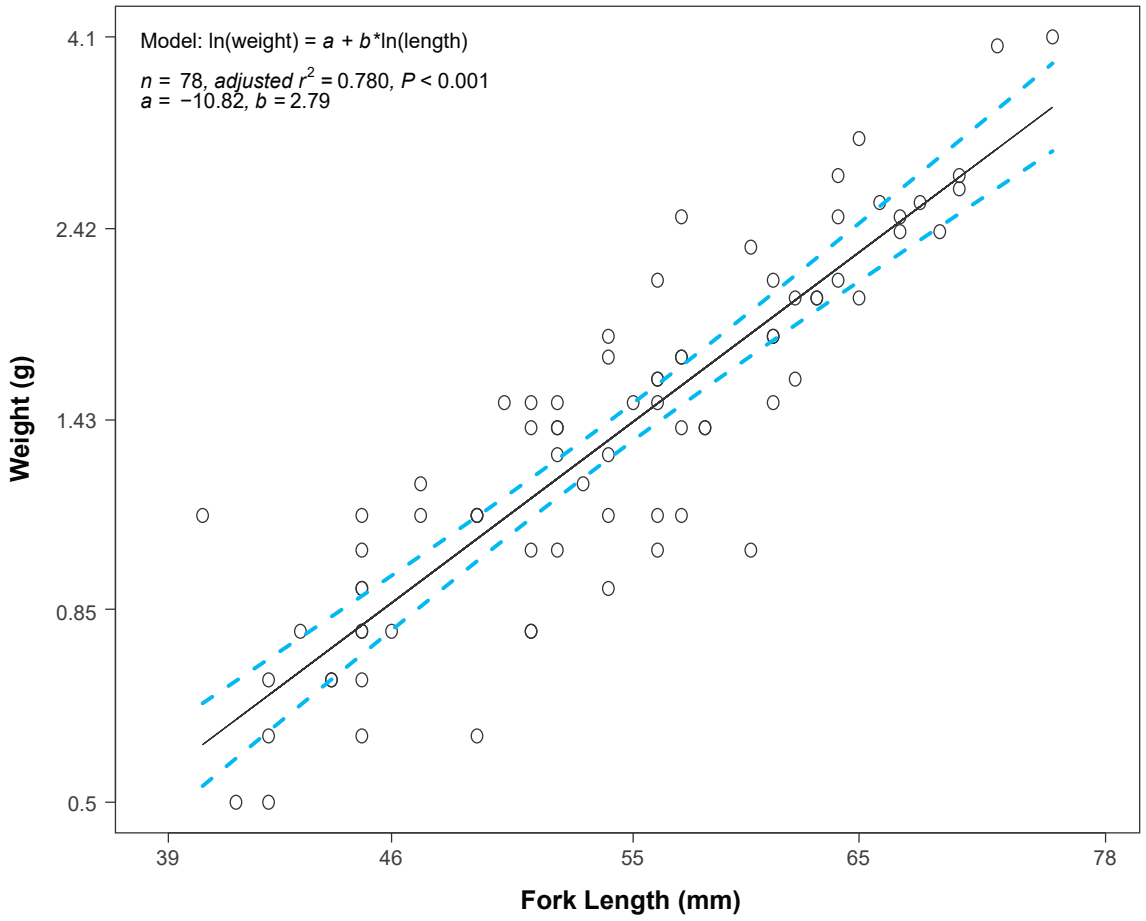
Site	Species	Gillnets (n)	Standard CPUE (# fish caught per net × 100 m^2 / total net area (m^2) / Set time (h))							Bootstrap CPUE (# fish caught per net × 100 m^2 / total net area (m^2) / Set time (h))			
			Mean	SD	SE	Min	Max	Lower CI	Upper CI	Mean	SD	Lower CI	Upper CI
Pond 3	ARCH	3	0	0	0	0	0	0	0	0	0	0	0
Pond 4	ARCH	38	0.111	0.329	0.053	0	1.682	0	1.037	0.112	0.053	0.025	0.23
Pond 5	ARCH	5	0.107	0.175	0.078	0	0.402	0	0.375	0.107	0.07	0	0.268

Notes:
CI = 95% confidence interval
n = gillnet sample size
SD = standard deviation of the mean
NSSB = Ninespine Stickleback
SE = standard error of the mean
CPUE = Catch-Per-Unit-Effort

Table 3.3-7: Fork Length and Weight Summary Statistics of Arctic Char Captured in Grenier Lake East Outflow, 2019

Site	Species	Fork Length (mm)								Weight (g)							
		n	Mean	SD	SE	Min	Max	Lower CI	Upper CI	n	Mean	SD	SE	Min	Max	Lower CI	Upper CI
Pond 4	ARCH	18	377.278	82.13	19.358	284	576	285.275	572.175	18	690.5	586.321	138.197	204	2250	228.65	2232.15
Pond 5*	ARCH	2	393.052	18.481	-	367	419	367	419	2	587.423	64.756	-	495	679	495	679

Notes:
n = sample size
SD = standard deviation of the mean
SE = standard error of the mean
CI = 95% confidence interval
** Bootstrapped data due to low sample size.*
Dashes indicates data not available.



Note: Axis values have been backtransformed from the natural log (Ln).
Open circles represent individual observations,
solid line represents the weight-length regression,
dotted lines represent 95% confidence intervals.

Figure 3.3-7: Weight-Length Regression for Ninespine Stickleback from Grenier Lake East Outflow, 2019

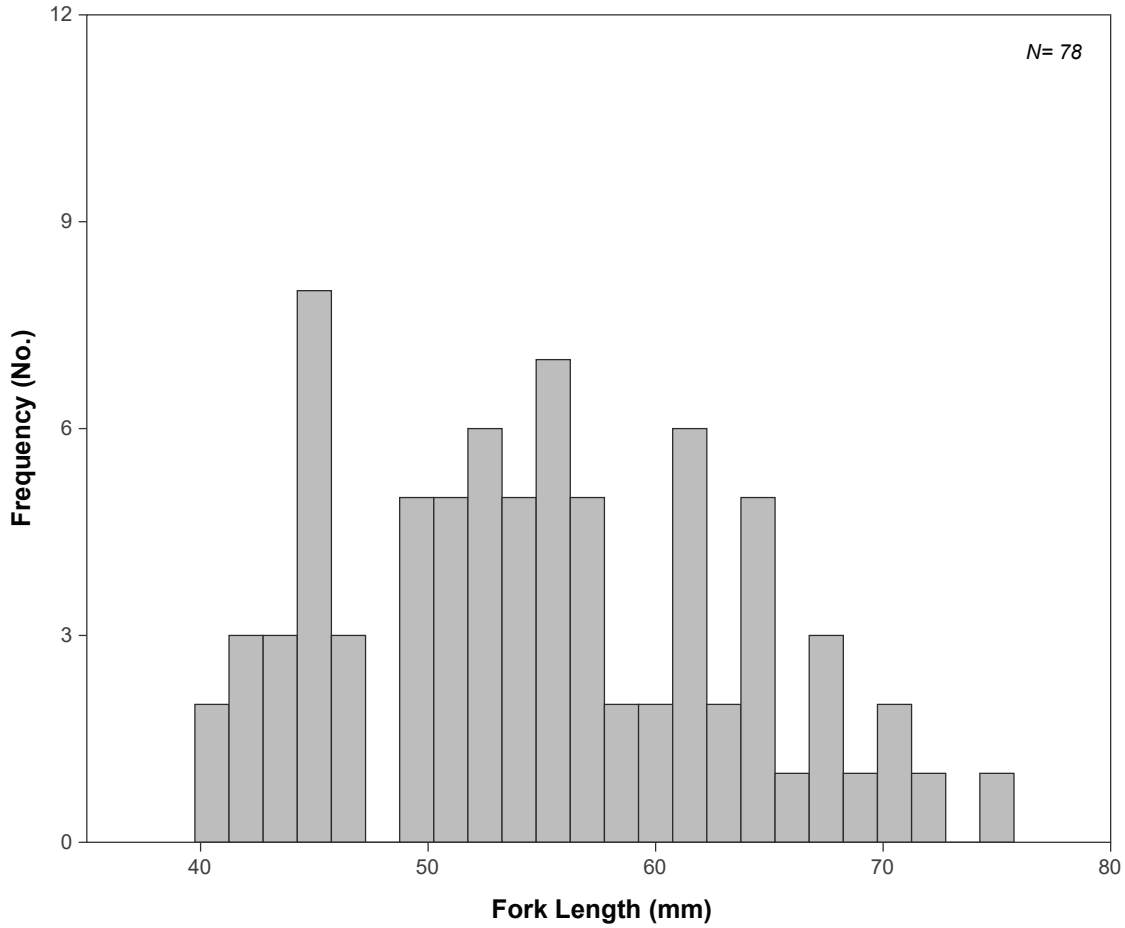


Figure 3.3-8: Length-Frequency Distribution of Ninespine Stickleback from Grenier Lake East Outflow, 2019

Weight-Length regressions were used to analyse condition in Arctic Char. The regression was statistically significant (p-value <0.05; Figure 3.3-9), indicating a positive relationship between weight and length. Condition, expressed as the slope of the weight-length relationship (b) was 3.06. Length-frequency was also plotted using a histogram to visualize the size structure of the population. The lengths of captured Arctic Char ranged from 284 to 576 mm, and the majority of fish fell into size classes ranging from 300 to 400 mm (Figure 3.3-10). The size distribution suggests that both adult and juvenile Arctic Char use Ponds 4 and 5 within Grenier Lake East Outflow. Additional biological information collected from mortalities showed that the majority of fish were immature or had undeveloped gonads, though one ripe female was collected in Pond 4.

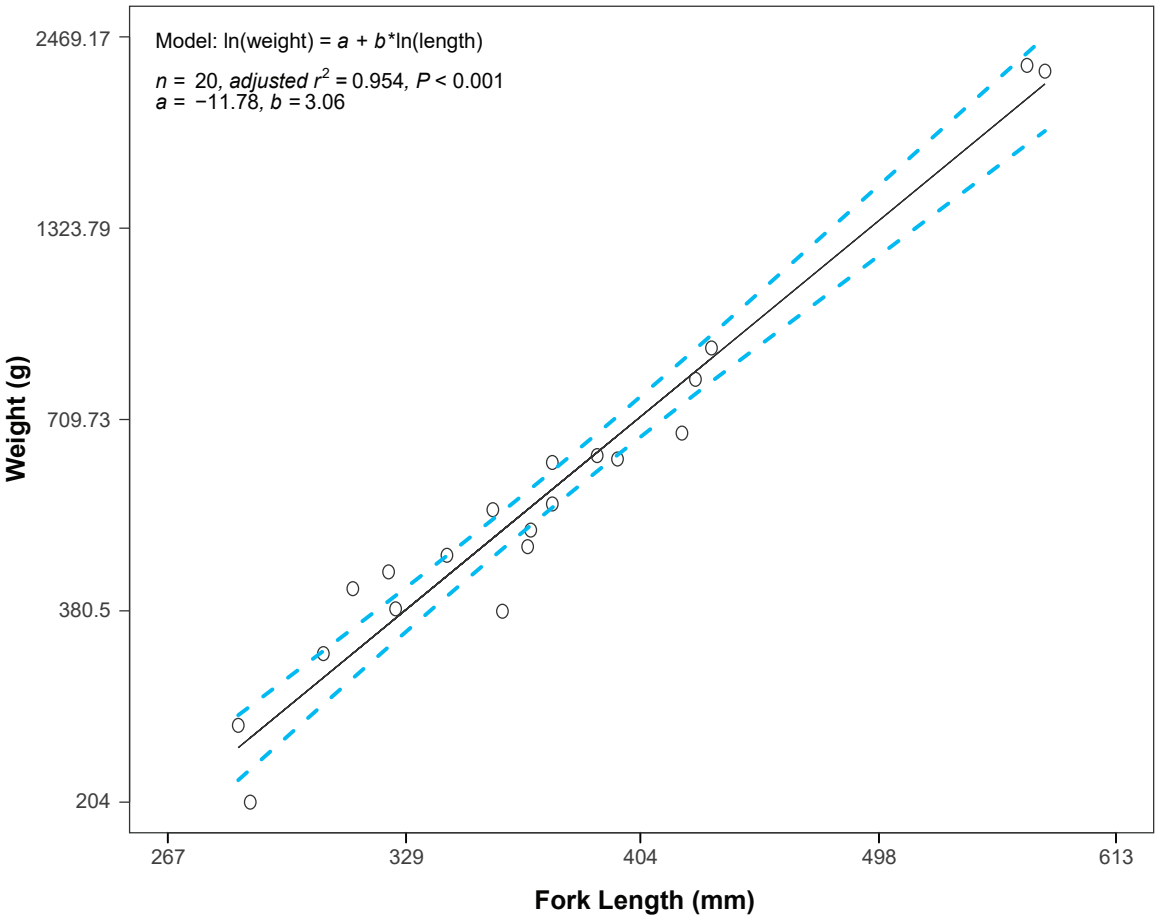
3.3.2 Tahilugyuak Outflow

3.3.2.1 Hydrology

Water Level and Streamflow

A hydrometric monitoring station was installed in Tahilugyuak Outflow on June 25, 2019 (Table 3.2-2). Freshet occurred in mid-July, 2019 in the Tahilugyuak Outflow, with peak flows between July 14 and 19 (Figure 3.3-11). Water levels receded uniformly until the station was removed September 20, 2019 prior to freeze-up. In 2019, there was significant ice covering and adjacent to the channel as late as the end of August (Photo 3.3-7). The ice was located downstream of the hydrometric station and the melting of this ice would have influenced streamflow in the channel downstream of the hydrometric station. The annual frequency that ice cover persists in Tahilugyuak Outflow for the majority of the typical open-water season is unknown and therefore the typical influence of summer ice melt on streamflow is also unknown.

Photo 3.3-7: Tahilugyuak Outflow, facing NE (downstream) toward Elu Inlet, August 8, 2019. Hydrometric station was located near the left edge of the photo, upstream of ice cover.



Note: Axis values have been backtransformed from the natural log (Ln).
Open circles represent individual observations,
solid line represents the weight-length regression,
dotted lines represent 95% confidence intervals.

Figure 3.3-9: Weight-Length Regression for Arctic Char from Grenier Lake East Outflow, 2019

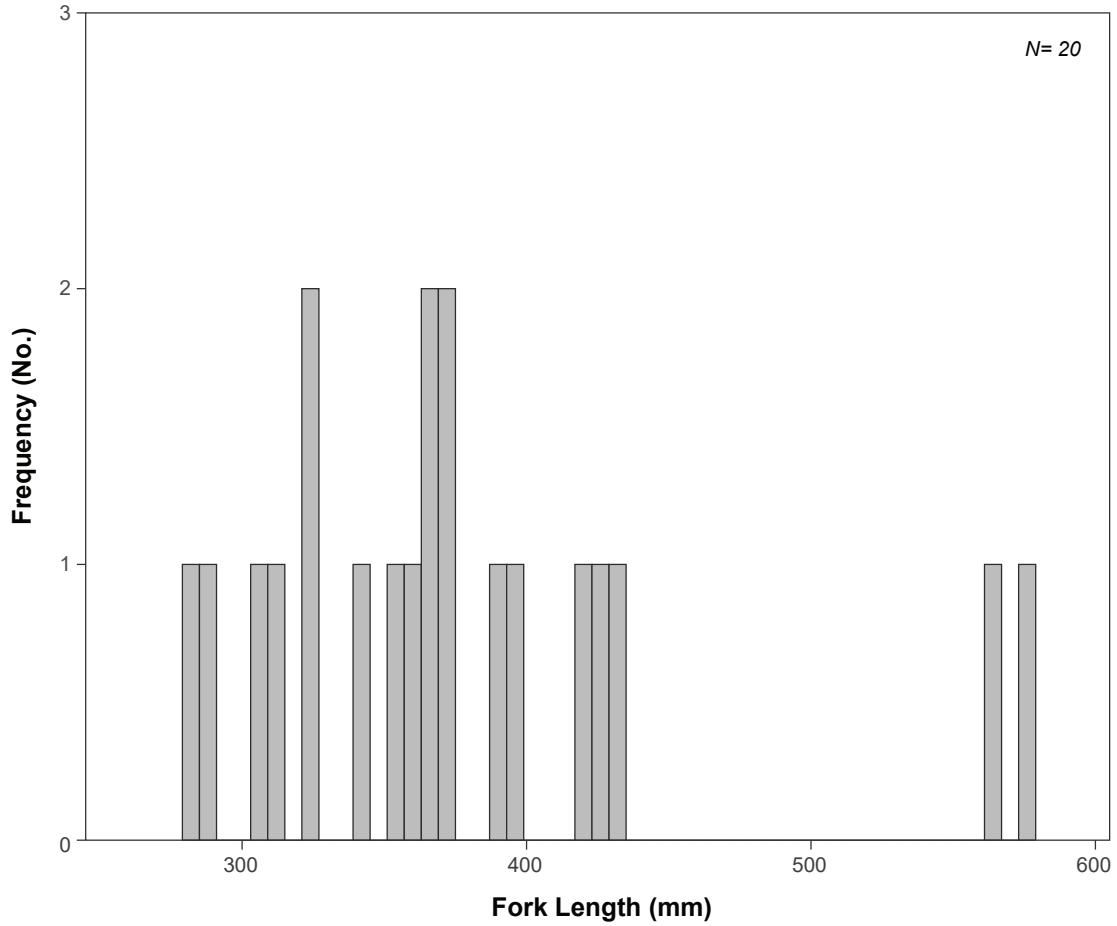
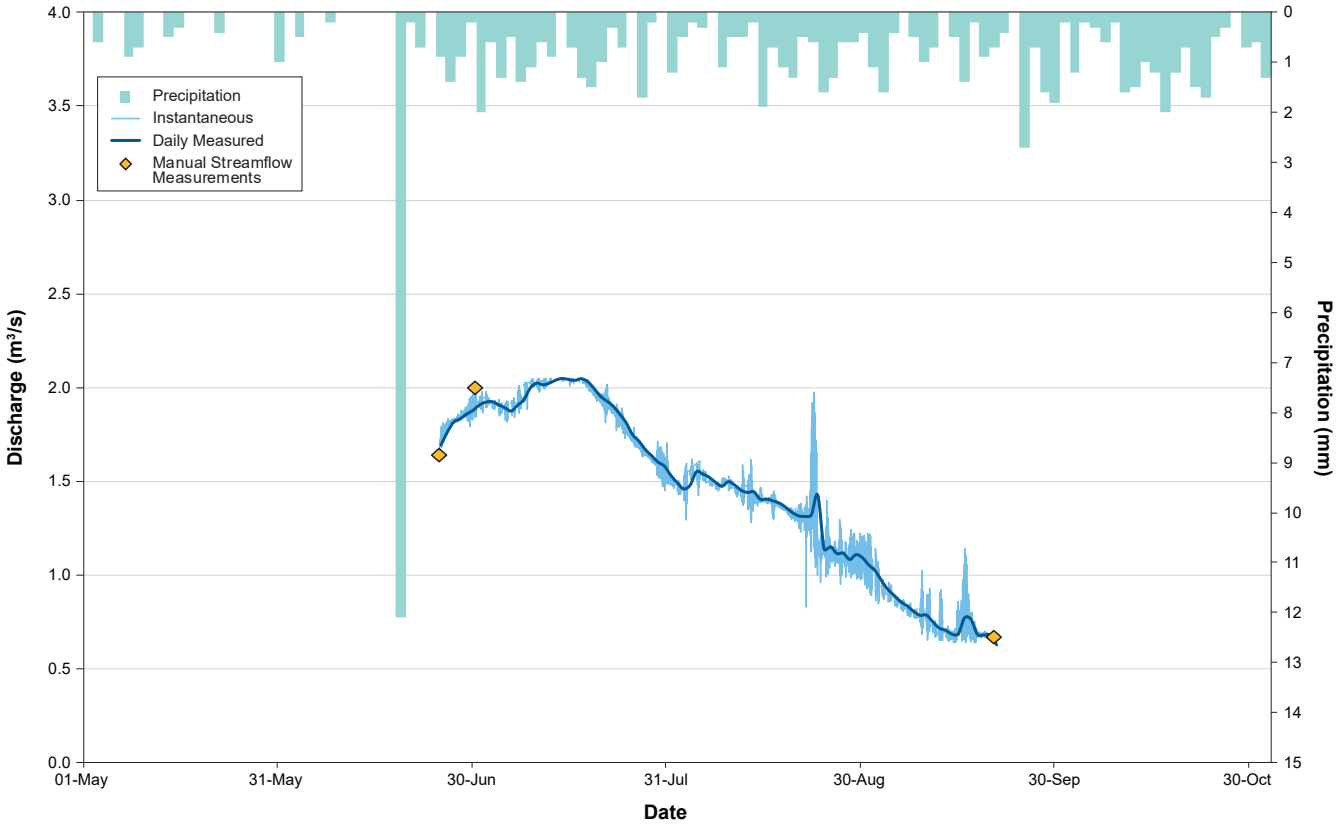


Figure 3.3-10: Length-Frequency Distribution of Arctic Char from Grenier Lake East Outflow, 2019



Note: Precipitation data are from Cambridge Bay A Nunavut Station - Climate ID 2400600 (Environment and Climate Change Canada, 2020).

Figure 3.3-11: Tahilugyuak Outflow Station Discharge and Regional Precipitation Data

3.3.2.2 Fish Habitat

Bathymetry and Sublittoral Habitat

The water depths measured in the hydroacoustic bathymetric survey ranged from 0.7 to 7 m. The bathymetric contours derived from hydroacoustic data are shown in Figure 3.3-12.

Boulder substrate comprised the largest percentage of the surveyed area at water depths of 1 to 2 m (22.9% of the hydroacoustic survey area; Table 3.3-8; Photo 3.3-8). Fines were the subdominant substrate type at this depth range, representing 0.3% of the overall bottom type of the hydroacoustic survey (Photo 3.3-8). Fines made up the largest percentage of the surveyed area at water depths between 2 and 4 m (19.7% of the hydroacoustic survey area; Table 3.3-8). Boulder was the subdominant substrate type at this depth range, representing 4.1% of the overall bottom area of the hydroacoustic survey. At water depths greater than 4 m, fines were the dominant substrate type, representing 52.9% of the overall bottom area of the hydroacoustic survey (Table 3.3-8).

Photo 3.3-8: Boulder (top) and fine (bottom) substrates observed at approximately 2 and 5 m water depth respectively, during underwater video surveys in T-Pond, August 27, 2019.

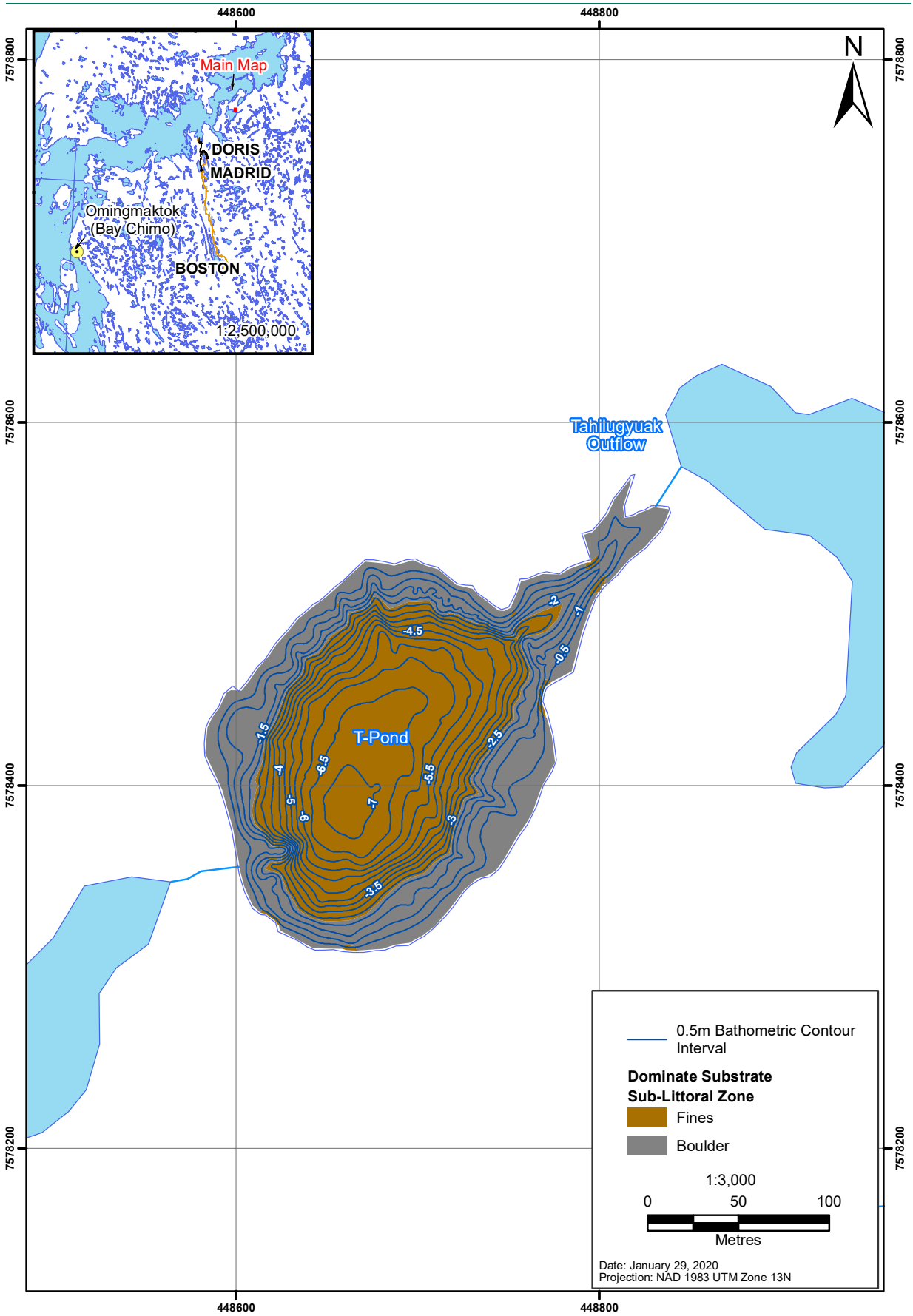


Figure 3.3-12: Bathymetry and Sub-Littoral Substrate Composition in T-Pond, Tahilugyuak Outflow, 2019

Table 3.3-8: Substrate Types Identified by Hydroacoustic Survey in T-Pond, Tahilugyuak Outflow, 2019

Bottom Type	Water Depth (m)	Area (m^2)	Relative Composition (%)
Fines	1-2	73.8	0.3
	2-4	4,865.3	19.7
	>4	13,067.8	52.9
Boulder	1-2	5,664.6	22.9
	2-4	1,016.3	4.1
	>4	0.0	0.0
Total		**24,688**	**100.0**

Notes:
Substrate: F = Fines (< 2 mm), B = Boulders (256 – 4000 mm)

Bathymetric and habitat surveys suggest that T-Pond has habitat characteristics that would provide good rearing habitat for Arctic Char and Lake Trout due to the availability of cover amongst the rocky substrate. Based on the maximum depth of T-Pond (7 m), overwintering habitat quality is expected to be present. Potential spawning habitat was identified around the periphery of the Pond, comprised of boulders reaching down into the 2-4 m depth range where ice wouldn't scour the area if eggs were deposited over winter. Migratory potential out of the lake is known to become limited as flows recede (boulder gardens and other low flow barriers and frozen conditions). For descriptions of barriers upstream and downstream see ERM 2019a.

3.3.2.3 Fish Community

Two Arctic Char were captured by angling in Tahilugyuak Outflow and Elu Inlet over a total of 4.13 rod-hours. Angling effort data are presented in Table 3.3-9.

A total of 21 sinking gillnets were set in Tahilugyuak Outflow and Elu Inlet (Appendix A-7). The majority of nets were deployed in Elu Inlet (n = 14) and T-Pond (n = 5). Two nets were set across Tahilugyuak Outflow by wading. Fishing effort totalled 11.9, 2.6, and 2.1 hours for Elu Inlet, T-Pond, and Tahilugyuak Outflow, respectively. Arctic Char was the only species captured at all sites (n = 15). Lake Trout were only captured in T-Pond (n = 9). The majority of fish were captured in T-Pond (n = 11). Mean CPUE for Arctic Char ranged from 0.03 fish/100 m^2 of net/h (Elu Inlet) to 1.9 fish/100 m^2 of net/h (T-Pond; Table 3.3-10). Mean CPUE for Lake Trout captured in T-Pond was 1.6 fish/100 m^2 of net/h (Table 3.3-10).

Mean fork length (mm) and weight (g), were calculated for Arctic Char and Lake Trout captured at the Tahilugyuak Outflow site (Table 3.3-11). Arctic Char and Lake Trout captured in T-Pond ranged in fork length from 300 – 430 mm, and 320 – 740 mm, respectively. Detailed biological information for each fish caught is presented in Appendix A-6.

Table 3.3-9: Angling Effort and Catch Data, Tahilugyuak Outflow and Elu Inlet, 2019

Site	Set ID	No. of Rods	Set Date	Location (UTM Zone 13W)		Time		Effort (decimal h)	Fish	
				Easting	Northing	Start	End		Arctic Char	CPUE (fish/rod/hour)
Elu Inlet	1	3	16-Jul	-	-	11:18	11:25	0.12	0	0
Elu Inlet	2	3	17-Jul	450036	450036	11:51	12:30	0.65	0	0
Elu Inlet	3	3	17-Jul	450182	7580824	14:55	15:22	0.45	0	0
T-Lake Outflow	4	3	18-Jul	447873; 448100	7578169; 7578102	10:50	12:20	1.50	0	0
T-River	5	3	18-Jul	448392	7578233	13:55	14:20	0.42	0	0
T-Lake Outflow	6	1	18-Jul	448100	7578102	14:30	15:30	1.00	2	2
Total								**4.13**	**2**	

Notes:
CPUE = No. of fish caught per rod × (1/total no. of rods) × [1 h/(set time, h)]

Table 3.3-10: Gillnet CPUE Summary Statistics for Arctic Char and Lake Trout, Tahilugyuak Outflow, 2019

Site	Species	Gillnets (n)	Standard CPUE (# fish caught per net × 100 m^2 / total net area (m^2) / Set time (h))							Bootstrap CPUE (# fish caught per net × 100 m^2 / total net area (m^2) / Set time (h))			
			Mean	SD	SE	Min	Max	Lower CI	Upper CI	Mean	SD	Lower CI	Upper CI
Elu Inlet	ARCH	14	0.027	0.101	0.027	0	0.379	0	0.256	0.027	0.026	0	0.081
	LKTR	14	0	0	0	0	0	0	0	0	0	0	0
T-Lake Outflow	ARCH	2	0.505	0.714	0.505	0	1.009	0.025	0.984	0.496	0.358	0	1.009
	LKTR	2	0	0	0	0	0	0	0	0	0	0	0
T-Pond	ARCH	5	1.936	1.51	0.675	0	3.588	0.071	3.498	1.928	0.609	0.68	3.05
	LKTR	5	1.604	1.614	0.722	0.708	4.485	0.727	4.14	1.602	0.652	0.811	3.05

Notes:
CI = 95% confidence interval
n = gillnet sample size
SD = standard deviation of the mean
NSSB = Ninespine Stickleback
SE = standard error of the mean
CPUE = Catch-Per-Unit-Effort

Table 3.3-11: Fork Length and Weight Summary Statistics of Arctic Char and Lake Trout Captured in Tahilugyuak Outflow and Elu Inlet, 2019

Site	Species	Fork Length (mm)								Weight (g)							
		n	Mean	SD	SE	Min	Max	Lower CI	Upper CI	n	Mean	SD	SE	Min	Max	Lower CI	Upper CI
Elu Inlet	ARCH	1	766	-	-	766	766	766	766	1	4200	-	-	4200	4200	4200	4200
T-Lake Outflow	ARCH	1	440	-	-	440	440	440	440	1	990	-	-	990	990	990	990
T-Pond	ARCH	11	372.727	42.152	12.709	300	430	300	427.5	8	491.625	169.797	60.032	273	800	275.975	760.625
	LKTR	8	430.375	131.088	46.346	320	740	324.375	684.875	7	1731.286	2769.458	1046.757	450	8000	459	6932.75

Notes:

n = sample size

SD = standard deviation of the mean

SE = standard error of the mean

CI = 95% confidence interval

** Bootstrapped data due to low sample size.*

Dashes indicates data not available.

4. OFFSETTING POTENTIAL AND RECOMMENDATIONS

4.1 Grenier Lake East Outflow

Based on data from 2018 (ERM 2019a) and measured water levels and streamflows and stream fish habitat assessments in 2019, fish migration potential at multiple stream channel locations in the Grenier Lake East Outflow system becomes compromised in mid- to late-July and remains that way until freshet of the following year. Flow and water level conditions at the culverts that cross Grenier Lake East Outflow at the Ovayok Road in 2019 indicated that upstream fish passage potential is compromised even earlier in the open-water season, and that the culverts may even act as a permanent barrier to upstream fish passage. Without passable wetted stream channel connections and with the culverts acting as a barrier to fish passage, pond habitats along the East Outflow become disconnected from each other, from upstream Grenier Lake, and from the downstream marine environment and fish may become stranded in pond habitats.

Fish community surveys in the Grenier Lake East Outflow in 2019 captured Ninespine Stickleback in stream and pond habitats and Arctic Char in ponds. The biological characteristics of the fish captured and the depth and habitat characteristics of the streams (when wetted) and ponds suggest that they may be used by Ninespine Stickleback for migration, spawning, and rearing and by Arctic Char for migration and rearing. Although some maturing or mature Arctic Char were captured, no spawning habitats were identified in the ponds assessed in 2019. Water depths in Ponds 4 and 5 suggested overwintering potential for both fish species captured in 2019, though overwintering success may depend on the duration and thickness of ice cover in a given year. Ponds 1, 2, and 3 were considered likely too shallow for overwintering. In general, fish that are stranded in ponds along the Grenier Lake East Outflow when stream channel connections dry up may not survive over winter or may have limited overwintering success.

Overall, 2019 assessments of fish habitat and the fish community in Grenier Lake East Outflow suggest that enhancements of migratory and overwintering habitats in the system could be effective options for increasing fish habitat and fisheries productivity. Improved habitat connectivity could extend the period over which fish can access suitable overwintering habitat and improve their survival. Enhancement to overwintering habitat could also improve survival.

Based on the results of the 2019 field program, methods for the implementation of offsetting through fish habitat enhancements in the Grenier Lake East Outflow have been further considered and the following methods have been identified:

- Raise water levels using a weir: increase water levels in stream habitats to maintain habitat connectivity, increase perimeter habitat in ponds, and increase depth in ponds to improve overwintering conditions;
- Culvert rehabilitation: increase habitat connectivity; and
- Flow supplementation from Freshwater Creek: increase flow through East Outflow to maintain habitat connectivity, increase perimeter habitat in ponds, and increase depth in ponds to improve overwintering conditions.

Predicted habitat improvements and estimates for potential fish habitat gains associated with fisheries offsetting based on these methods are subject to additional data being collected to evaluate them.

Conceptually, if found to be technically feasible, raising the water levels in Grenier Lake East Outflow could increase the area/volume of habitat in ponds and streams during the open-water season and increase quality of habitat for overwintering in the ponds. In ponds, a 0.3 m water level increase could provide up to 3,000 m^3 of new habitat per hectare of existing pond surface area, depending on the bathymetric contours of the pond. The 2019 hydroacoustic surveys covered approximately 364,000 m^2 of pond surface area.

Therefore, if the water level was raised in all surveyed ponds by 0.3 m it could result in approximately 109,200 m^3 of additional habitat by volume. On a surface area basis, an increase in pond water level of 0.3 m could result in approximately 300 m^2 of additional habitat per kilometre by area (based on 0.3 m^2 increase per 1 m of pond shoreline length). In the case of Ponds 3 and 4, littoral habitat increase could be approximately 1,800 m^2 and 400 m^2, respectively. The concurrent increase in overwintering habitat would be based on the increase in pond habitat greater than approximately 2.5 to 3 m in depth and would depend on the bathymetric contours (i.e., the bottom slope of the pond) in the 2.5 to 3 m water depth range. Additionally, raising water levels in ponds by approximately 0.3 m would be expected to maintain connection to the streams at levels similar to or greater than those surveyed in July 2019, providing an increase in the area of stream habitat during the open-water season. In order to accurately estimate the amount of fish habitat that may be created/enhanced by increasing water levels, digital elevation data for the Grenier Lake East Outflow system are required and would be used in combination with the stream and pond fish habitat information collected in 2019 (including pond bathymetry and substrate information).

Two methods for raising water levels in Grenier Lake East Outflow may be considered. As previously identified and described in Section 2.1, a weir may be constructed at the outlet of one or more of the ponds to modify upstream water levels.

Based on the 2019 hydrology monitoring results, a potential alternative method of flow supplementation from Grenier Lake has been identified. The potential for fish habitat enhancement by flow supplementation in the East Outflow by diversion of flow from Freshwater Creek can be conceptually described as follows. On July 11, 2019, streamflow in Freshwater Creek was approximately 32 m^3/s (Environment and Climate Change Canada 2019) and streamflow in the East Outflow was measured as 1.35 m^3/s, which is slightly less than 5% of the Freshwater Creek flow at this time. When Grenier Lake East Outflow stopped flowing and became discontinuous in 2019, Freshwater Creek streamflow was between approximately 20 and 25 m^3/s (Environment and Climate Change Canada 2019) through the balance of the open water season. If the East Outflow control was modified to divert 5% of the flow of Freshwater Creek flows throughout the open water season, this would amount to approximately 1 m^3/s of streamflow added to the Grenier Lake East Outflow and would likely result in the ability of fish to migrate through the East Outflow system unimpeded. The Grenier Lake levels should not be altered due to any modifications in outflow control as the total outflow from the lake would remain the same as currently experienced. Increased flows in the East Outflow, should also result in higher water levels in ponds throughout the open water season, extending to freeze-up. This would provide both an increase in perimeter habitat in ponds during the open water season and an increase in depth that would likely improve overwintering habitat conditions.

To provide increased flow from Grenier Lake through the East Outflow, the outlet conditions from Grenier Lake would need to be modified. Specifically, the control elevation at the inlet to the East Outflow would need to be reshaped and lowered. The reshaping would consist of the creation of a small channel in conjunction with narrowing the upland slightly to control freshet flows.

Flow requirements for both Grenier Lake East Outflow and Freshwater Creek need to be further assessed to determine the complete potential for flow supplementation as a method for raising water levels and improving habitat continuity. Flow modification, to be effective in maintaining habitat continuity, would also require improvements to the culverts at the Ovayok Road crossing for fish passage improvements and removal as a control to the Pond 1 water level.

Finally, rehabilitation of the culverts at the Ovayok Road crossing along Grenier Lake East Outflow would provide fish habitat benefits by removing the current barrier to fish passage thereby improving access to overwintering habitats and increasing survival. The rehabilitation of the culverts would be particularly important if other enhancements are undertaken in Grenier Lake East Outflow (i.e., water levels are increased by one of the methods described above) as the culverts would then become the main impediment to fish passage in the system.

Continued investigation of the Grenier Lake East Outflow candidate offsetting option near Cambridge Bay is recommended. The next step for development of a Fisheries Offsetting Plan at Grenier Lake East Outflow is to build on fish habitat and community data that were collected in 2019. Water level and digital elevation data of Grenier Lake East Outflow and Freshwater Creek/Grenier Lake are required for modelling of water level enhancements and culvert rehabilitation design. Fish migration data are required to quantify fisheries productivity gains associated with enhancement and rehabilitation. Given these requirements, a follow up baseline field data collection program is recommended to consist of:

- continuous water level monitoring (i.e., installation of hydrometric monitoring stations) in up to four locations along the Grenier Lake East Outflow and at one location in Freshwater Creek/Grenier Lake;
- acquisition of digital elevation data for the Grenier Lake East Outflow and potentially the Freshwater Creek watershed (e.g., aerial or terrestrial LiDAR or satellite imagery); and
- fish migration monitoring in Grenier Lake East Outflow using fish fence and PIT tag antenna systems.

4.2 Tahilugyuak Outflow

The amount and type of fish habitat and fish community data collected during the 2019 field program at Tahilugyuak Outflow was significantly influenced by ice cover in the system that persisted at least until the time of the final field visit in late August. Planned assessments of stream fish habitat and monitoring of the migratory timing and distribution of fish in Tahilugyuak Outflow could not be carried out as the ice cover logistically prevented surveys and the installation of fish capture and monitoring equipment (i.e., fish fence and PIT tag antenna systems).

The collection of fish and fish habitat data at Tahilugyuak Outflow in 2019 were thus mostly limited to T-Pond. Arctic Char and Lake Trout were captured in T-Pond in late August, when migration out of the pond would likely have been limited by up- and downstream fish passage barriers in stream habitats (identified in 2018; ERM 2019a). However, results of the 2019 bathymetric and sublittoral substrate survey of T-Pond found that it has a maximum depth of 7 m and therefore provides migratory, rearing, overwintering, and potentially spawning habitat for Arctic Char and Lake Trout.

The proposed method for implementing a fisheries offsetting project at Tahilugyuak Outflow is to enhance the migratory potential of anadromous Arctic Char and Lake Trout between the marine environment (Elu Inlet) and spawning and overwintering habitats in Tahilugyuak upstream. This would be implemented through construction of migration channel(s). Data collected in 2019 suggest that a fisheries offsetting project involving enhancement of migratory habitats using migration channels is still potentially a feasible option. However, sufficient baseline data have not been collected at this time to quantify potential fisheries benefits that would result from the implementation of these enhancements. The most prominent barrier to fish passage in Tahilugyuak Outflow identified in 2018 was a boulder garden directly upstream of T-Pond. Although this barrier was also present in 2019 and may prevent fish from migrating upstream to Tahilugyuak to spawn and overwinter, habitat conditions in T-Pond in 2019 suggested that fish would be able to survive overwinter in the pond, before continuing their upstream migration to Tahilugyuak the following spring. The influence of this delay in upstream migration on fisheries productivity in the system cannot be quantified using data collected to date.

The annual frequency that ice cover persists in Tahilugyuak Outflow for the majority of the typical open-water season (as happened in 2019) is unknown but could present difficulties for the implementation and subsequent monitoring of a fisheries offset if one were developed at this location. Based on the limited results of baseline studies at Tahilugyuak Outflow in 2019, it is recommended that it continue to be considered as a contingency candidate fisheries offsetting option for Madrid and Boston (as an alternative to Grenier Lake East Outflow) but that additional field studies not be pursued at this time.

5. SUMMARY

The 2019 Freshwater Fisheries Offsetting Baseline Program continued to build on TMAC's efforts towards the development of a freshwater Fisheries Offsetting Plan for the Madrid and Boston developments by collecting baseline data at two candidate offsetting sites: Grenier Lake East Outflow and Tahilugyuak Outflow.

Field work at Grenier Lake East Outflow assessed the quantity and quality of stream and pond fish habitats and sampled the fish communities utilizing those habitats. The results of 2019 baseline studies at Grenier Lake East Outflow allowed for further refinement of offsetting opportunities and potential methods for implementing offsetting projects. Continued field investigations to contribute to the development of Grenier Lake East Outflow as a candidate offsetting option have been recommended.

Baseline studies at Tahilugyuak Outflow in 2019 were limited by ice cover in the system that persisted for the majority of the typical open-water season. Although certain objectives of the baseline program at Tahilugyuak Outflow could not be met, fish habitat and fish community data collected in T-Pond provided some information on fish migration and overwintering potential in Tahilugyuak Outflow. The potential for implementing and monitoring an offsetting project in Tahilugyuak Outflow depends on the frequency at which persistent ice cover may extend over a large portion of the typical open-water season. Because this is unknown, continued field investigations at Tahilugyuak Outflow have not been recommended at this time. Instead, it is recommended that Tahilugyuak Outflow continue to be considered as a contingency candidate offsetting option for inclusion in a Fisheries Offsetting Plan as an alternative to Grenier Lake East Outflow.

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APPENDIX A FISH HABITAT AND COMMUNITY SAMPLING DATA

Table A-1: Detailed Habitat Assessment Data in Grenier Lake East Outflow, 2019

Date	Stream Name	Site Name	Crew	Start Location (UTM Zone 13 W)		End Location (UTM Zone 13W)		Fish Form (Y/N)	Temperature (°C)	pH	Conductivity (µS)	Turbidity
				Easting	Northing	Easting	Northing					
24-Jul	EO	EO2	KK	503664	7672352	503738	7672450	Y	6.9	-	250	-
				503664	7672352	503738	7672450	Y	-	-	-	-
		EO1	KK	503738	7672450	503774	7672555	Y	-	-	-	-
		EO3	KK, TE	503933	7671668	503861	7671822	Y	9.9	-	275	-
				503933	7671668	503861	7671822	Y	-	-	-	-
				503933	7671668	503861	7671822	Y	-	-	-	-
		EO4	KK, TE	504187	7671491	504144	7671476	Y	10.2	-	283	-

Date	Stream Name	Site Name	Discharge	No Vis Channel	Dry/ Intermittent	Tributary	Habitat Unit	Habitat Type	Unit Length (m)	Gradient (%)	Width (m)	
											Wetted	Bankfull
24-Jul	EO	EO2	M	N	Y	N	1	Flat	39	0.5	10.6	74.5
			-	-	-	-	2	Flat	102	1	6.9	67
		EO1	-	-	-	-	3	Glide	110	0	34	75
		EO3	M	N	Y	N	1	Riffle	27	1	10	99
			-	-	-	-	2	Flat	67	0	39	66
			-	-	-	-	3	Glide	84	0	6	50
		EO4	M	N	N	N	1	Glide	45	0	10.5	25

Notes:

Dashes (-) = data not collected

Residual pool depth = (max depth - crest height)

Substrate: F = Fines (< 2 mm), G = Gravel (2 - 64 mm), C = Cobble (64 - 256 mm), B = Boulders (256 - 4000 mm), R = Bedrock (>4000 mm), O = Other

Bank Shape: U = undercut, V = vertical, S = sloping, O = overhanging

Bank Texture: dominant substrate type

Barriers: F = impassable falls, BG = impassable boulder garden, D = dry channel, OF = overland flow, SF = subsurface flow, WQ = water quality barrier, G = gradient, O = other (list in Comments column)

Classification: list barriers as either T = temporary, P = permanent

Table A-1: Detailed Habitat Assessment Data in Grenier Lake East Outflow, 2019

Date	Stream Name	Site Name	Depth (m)			Substrate Composition (%)						Bank Height (m)		Bank	
			Wetted	Bankfull	Residual Pool	O	F	G	C	B	R	Left	Right	Shape	Texture
24-Jul	EO	EO2	0.1	-	-	60	30	-	10	-	-	-	-	Sloping	Fines
			0.1	-	-	30	20	-	50	-	-	-	-	Sloping	Fines
		EO1	0.8	-	-	-	10	10	80	-	-	-	-	Sloping	Cobble
		EO3	0.1	-	-	10	10	30	40	10	-	-	-	Sloping	Fines
			0.17	-	-	-	10	20	40	30	-	-	-	Sloping	Fines
			0.34	-	-	-	-	10	40	50	-	-	-	Sloping	Fines
		EO4	0.3	-	-	-	10	10	70	10	-	-	-	Sloping	Fines

Date	Stream Name	Site Name	Barriers								Photos	Comments
			F	BG	D	OF	SF	WQ	G	O		
24-Jul	EO	EO2	-	-	-						7424-7425	No barrier at time of survey for juvenile salmonids or NNSB
			-	-	-						7426-7428	-
		EO1	-	-	-						-	-
		EO3	-	-	-						36-38	-
			-	-							39-41	-
			-	-							42-49	-
		EO4	-	-	-						-	Wetted width, bankfull width, and depth are estimated

Notes:

Dashes (-) = data not collected

Residual pool depth = (max depth - crest height)

Substrate: F = Fines (< 2 mm), G = Gravel (2 - 64 mm), C = Cobble (64 - 256 mm), B = Boulders (256 - 4000 mm), R = Bedrock (>4000 mm), O = Other

Bank Shape: U = undercut, V = vertical, S = sloping, O = overhanging

Bank Texture: dominant substrate type

Barriers: F = impassable falls, BG = impassable boulder garden, D = dry channel, OF = overland flow, SF = subsurface flow, WQ = water quality barrier, G = gradient, O = other (list in Comments column)

Classification: list barriers as either T = temporary, P = permanent

Table A-2: Littoral Substrate Data Collected from Grenier Lake East Outflow, 2019

Date	Site	Habitat Unit	WP Start	UTM (Zone 13W)		Shoreline Length (m)	Area (m^2)	Substrate Type	
				Easting	Northing			Dominant	Subdominant
27-Jul	Pond 4	1	567	504257	7671535	137	2,460	Bo	Co
		2	568	504251	7671482	527	16,496	Co	Bo
		3	569	504543	7671440	25	1,424	Bo	Co
		4	570	504556	7671460	60	2,557	Co	Bo
		5	571	504582	7671508	35	1,161	Co	Fi
		6	572	504598	7671536	72	2,203	Bo	Co
		7	573	504647	7671594	29	812	Co	Bo
		8	574	504667	7671612	84	1,458	Br	Co
		9	575	504716	7671668	105	3,657	Co	Bo
		10	576	504754	7671772	44	1,326	Co	Bo
		11	577	504801	7671795	64	2,474	Co	Fi
		12	578	504825	7671828	48	2,454	Co	Gr
		13	579	504836	7671862	55	2,140	Co	Fi
		14	580	504856	7671903	1,280	48,484	Co	Bo
		15	581	504843	7671937	48	1,226	Co	Bo
		16	582	504822	7671901	41	941	Bo	Fi
		17	583	504795	7671873	22	570	Bo	Co
		18	584	504784	7671855	68	1,158	Bo	Fi
		19	585	504738	7671807	26	225	Br	Co
		20	586	504729	7671785	38	368	Co	Bo
		21	587	504712	7671747	95	954	Bo	Co
		22	588	504625	7671703	38	369	Co	Bo
		23	589	504596	7671680	50	274	Bo	Co
		24	590	504558	7671648	51	283	Co	Gr
		25	591	504522	7671611	30	268	Co	Bo
		26	592	504496	7671595	51	525	Co	Gr
		27	593	504455	7671565	17	220	Gr	Co
		28	594	504442	7671554	14	214	Bo	Gr
		29	595	504427	7671547	30	348	Bo	Co
		30	596	504399	7671531	17	317	Co	Bo
		31	597	504380	7671529	15	359	Co	Gr
		32	598	504362	7671533	71	821	Co	Bo
		33	599	504296	7671534	15	181	Co	Gr
		34	600	504281	7671531	23	389	Co	Bo
		End	601	504270	7671528	n/a			
29-Jul	Pond 4	1	605	503942	7670763	90	1,038	Co	Bo
		2	606	503922	7670677	92	950	Co	Bo
		3	607	503863	7670610	84	1,603	Bo	Co
		4	608	503876	7670578	23	354	Co	Gr
		5	609	503889	7670573	213	2,508	Co	Bo
		6	610	504020	7670685	56	719	Co	Gr
		7	611	504014	7670736	15	164	Co	Bo
		8	612	504022	7670753	12	181	Co	Gr
		9	613	504025	7670767	142	2,537	Co	Bo

Notes:
Substrate Type: Fi = Fines, Gr = Gravel, Co = Cobble, Bo = Boulder, Br = Bedrock

Table A-2: Littoral Substrate Data Collected from Grenier Lake East Outflow, 2019

Date	Site	Habitat Unit	WP Start	UTM (Zone 13W)		Shoreline Length (m)	Area (m^2)	Substrate Type	
				Easting	Northing			Dominant	Subdominant
29-Jul	Pond 4	10	614	504113	7670871	81	1,673	Co	Gr
(cont'd)		11	615	504155	7670936	79	2,016	Co	Bo
		12	616	504195	7671004	62	1,307	Co	Fi
		13	617	504222	7671057	46	915	Co	Bo
		14	618	504236	7671098	19	302	Bo	Fi
		15	619	504243	7671110	32	585	Co	Fi
		16	620	504253	7671136	120	1,895	Co	Bo
		17	621	504267	7671186	44	1,056	Bo	Fi
		18	622	504301	7671215	165	3,903	Co	Bo
		19	623	504411	7671322	19	511	Bo	Co
		20	624	504430	7671338	49	773	Co	Fi
		21	625	504461	7671361	62	2,129	Fi	Co
		22	626	504432	7671391	7	160	Co	Bo
		23	627	504426	7671393	96	826	Bo	Fi
		24	628	504363	7671325	29	321	Co	Fi
		25	629	504344	7671302	135	2,377	Co	Bo
		26	630	504240	7671140	17	285	Co	Fi
		27	631	504232	7671125	22	277	Co	Bo
		28	632	504227	7671104	19	347	Co	Fi
		29	633	504217	7671087	20	455	Co	Bo
		30	634	504209	7671067	19	423	Co	Fi
		31	635	504193	7671054	31	643	Bo	Fi
		32	636	504179	7671023	86	6,393	Co	Bo
		33	637	504156	7671091	19	402	Co	Fi
		34	638	504159	7671101	175	4,119	Co	Bo
		35	639	504135	7671143	44	1,429	Co	Fi
		36	640	504111	7671164	25	1,012	Co	Bo
		37	641	504090	7671161	10	365	Co	Fi
		38	642	504085	7671158	29	945	Co	Bo
		39	643	504068	7671140	28	774	Fi	Bo
		40	644	504055	7671125	16	475	Bo	Fi
		41	645	504056	7671113	21	800	Co	Bo
		42	646	504062	7671097	13	535	Bo	Co
		43	647	504063	7671084	388	5,686	Co	Bo
		End	648	503946	7670778	n/a			
	Pond 1	1	649	503764	7672051	192	2,014	Co	bo
		2	650	503632	7672162	21	152	Bo	Co
		3	651	503624	7672178	203	2,255	Co	Bo
		4	652	503695	7672186	19	172	Bo	Fi
		5	653	503714	7672203	27	237	Co	Fi
		6	654	503729	7672207	22	282	Co	Bo
		7	655	503746	7672203	68	934	Co	Fi
		8	656	503746	7672165	292	3,633	Co	Bo
		9 (end)	657	503678	7672129	n/a			

Notes:
Substrate Type: Fi = Fines, Gr = Gravel, Co = Cobble, Bo = Boulder, Br = Bedrock

Table A-2: Littoral Substrate Data Collected from Grenier Lake East Outflow, 2019

Date	Site	Habitat Unit	WP Start	UTM (Zone 13W)		Shoreline Length (m)	Area (m^2)	Substrate Type	
				Easting	Northing			Dominant	Subdominant
29-Jul	Pond 2	1		503846	7672028	163	2,749	Co	Gr
(cont'd)		2		503737	7671945	392	11,794	Co	Bo
		End		503846	7672028	n/a			
30-Jul	Pond 3	1	691	503995	7671423	111	2,176	Co	Fi
		2	692	504021	7671407	168	4,546	Co	Bo
		3	693	503949	7671413	13	81	Bo	Co
		4	694	503937	7671413	129	2,448	Co	Bo
		5	695	503914	7671484	20	326	Co	Fi
		6	696	503925	7671498	28	892	Co	Bo
		7	697	503911	7671534	58	653	Bo	Co
		8	698	503864	7671543	256	3,868	Co	Bo
		9	699	503988	7671699	34	311	Bo	Fi
		10	700	504000	7671721	452	18,260	Co	Bo
		11	701	503978	7671459	11	276	Fi	Co
		12	702	503987	7671456	42	803	Co	Bo
		End	703	503997	7671441	n/a			
31-Jul	Pond 5	1	733	502130	7669930	48	1,216	Co	Bo
		2	734	502116	7669943	37	624	Fi	Co
		3	735	502096	7669942	382	9,046	Co	Bo
		End	736	502119	7669875	n/a			
		4	737	502011	7669505	293	6,602	Co	Bo
		5	738	502093	7669412	315	6,302	Bo	Co
		6	739	502153	7669429	525	12,232	Co	Bo
		7	740	502514	7669755	232	4,130	Bo	Co
		End	741	502553	7669950	n/a			
		8	742	502350	7670133	192	3,000	Co	Bo
		9	743	502232	7670012	56	510	Bo	Co
		10	744	502205	7669963	111	25,413	Co	Bo
		11	745	502146	7669824	121	7,384	Co	Gr
		12	746	502079	7669731	269	5,696	Co	Bo
		13	747	502070	7669672	28	701	Co	Gr
		14	748	502090	7669647	162	3,504	Co	Bo
		End	737	502011	7669505	n/a			
		15	799	504005	7670851	830	18,141	Co	Bo
		16	750	502557	7670003	19	239	Bo	Fi
		17	751	502550	7669988	22	330	Co	Bo
		End	741	502553	7669950	n/a			
1-Aug	Pond 5	18	754	502206	7669994	38	1,255	Co	Bo
		19	755	502380	7670156	46	1,392	Co	Gr
		20	756	502409	7670196	153	3,362	Co	Bo
		21	757	502527	7670271	116	1,468	Bo	Co
		22	758	502632	7670297	354	5,557	Co	Bo
		End	759	502869	7670532	n/a			

Notes:
Substrate Type: Fi = Fines, Gr = Gravel, Co = Cobble, Bo = Boulder, Br = Bedrock

Table A-3: Minnow Trap Effort and Catch Data from Grenier Lake East Outflow, 2019

Site	Trap No.	Location (UTM)		Depth (m)	Set		Pulled		Effort (decimal h)	Fish	
		Easting	Northing		Date	Time	Date	Time		NSSB	CPUE
Pond 4	1	504598	7671687	0.4	26-Jul	16:00	27-Jul	11:49	19.8	0	0.0
	2	504582	7671672	0.5	26-Jul	16:00	27-Jul	11:49	19.8	0	0.0
	3	504582	7671672	0.7	26-Jul	16:01	27-Jul	11:41	19.7	13	15.9
	4	504574	7671666	0.6	26-Jul	16:02	27-Jul	11:40	19.6	0	0.0
	5	504570	7671661	0.7	26-Jul	16:02	27-Jul	11:40	19.6	0	0.0
	6	504569	7671659	0.7	26-Jul	16:03	27-Jul	11:37	19.6	1	1.2
	7	504559	7671655	0.8	26-Jul	16:04	27-Jul	11:36	19.5	0	0.0
	8	504556	7671651	0.8	26-Jul	16:05	27-Jul	11:34	19.5	0	0.0
	9	504551	7671648	0.7	26-Jul	16:06	27-Jul	11:34	19.5	0	0.0
	10	504543	7671641	0.6	26-Jul	16:06	27-Jul	11:31	19.4	1	1.2
	11	504535	7671632	1	26-Jul	16:07	27-Jul	11:30	19.4	0	0.0
	12	504528	7671625	0.7	26-Jul	16:08	27-Jul	11:28	19.3	1	1.2
	13	504518	7671612	0.7	26-Jul	16:09	27-Jul	11:26	19.3	1	1.2
	14	504507	7671608	0.7	26-Jul	16:09	27-Jul	11:23	19.2	0	0.0
	15	504507	7671613	0.4	26-Jul	15:36	27-Jul	11:00	19.4	0	0.0
	16	504309	7671535	0.5	26-Jul	15:36	27-Jul	11:00	19.4	0	0.0
	17	504301	7671533	0.3	26-Jul	15:36	27-Jul	11:00	19.4	0	0.0
	18	504298	7671537	0.3	26-Jul	15:36	27-Jul	11:00	19.4	5	6.2
	19	504294	7671537	0.5	26-Jul	15:36	27-Jul	11:00	19.4	0	0.0
	20	504289	7671534	0.5	26-Jul	15:37	27-Jul	11:00	19.4	2	2.5
	21	504282	7671534	0.3	26-Jul	15:37	27-Jul	10:58	19.4	0	0.0
	22	504273	7671533	0.6	26-Jul	15:37	27-Jul	10:56	19.3	2	2.5
	23	504272	7671530	0.5	26-Jul	15:37	27-Jul	10:56	19.3	1	1.2
	24	504267	7671530	0.4	26-Jul	15:38	27-Jul	10:56	19.3	0	0.0
	25	504264	7671528	0.7	26-Jul	15:38	27-Jul	10:44	19.1	0	0.0
	26	504252	7671521	0.7	26-Jul	15:38	27-Jul	10:43	19.1	0	0.0
	27	504229	7671510	0.5	26-Jul	15:39	27-Jul	10:40	19.0	0	0.0
	1	503922	7670734	0.3	29-Jul	11:15	30-Jul	11:10	23.9	0	0.0
	2	503924	7670746	0.2	29-Jul	11:15	30-Jul	11:11	23.9	0	0.0
	3	503929	7670755	0.4	29-Jul	11:15	30-Jul	11:12	24.0	0	0.0
	4	503932	7670762	0.5	29-Jul	11:16	30-Jul	11:13	24.0	0	0.0
	5	503934	7670764	0.6	29-Jul	11:16	30-Jul	11:14	24.0	0	0.0
	6	503939	7670770	0.8	29-Jul	11:17	30-Jul	11:15	24.0	0	0.0
	7	503942	7670776	0.7	29-Jul	11:17	30-Jul	11:16	24.0	0	0.0
	8	503949	7670783	1	29-Jul	11:18	30-Jul	11:17	24.0	0	0.0
	9	503953	7670790	0.6	29-Jul	11:18	30-Jul	11:19	24.0	0	0.0
	10	503956	7670796	0.8	29-Jul	11:19	30-Jul	11:20	24.0	0	0.0
	11	503959	7670800	0.7	29-Jul	11:19	30-Jul	11:20	24.0	0	0.0
	12	503960	7670803	0.5	29-Jul	11:20	30-Jul	11:21	24.0	0	0.0
	13	503966	7670808	0.5	29-Jul	11:21	30-Jul	11:22	24.0	0	0.0
	14	503970	7670815	0.4	29-Jul	11:22	30-Jul	11:25	24.1	0	0.0

Notes:

CPUE = Catch-Per-Unit-Effort (fish/trap/24 h)

NSSB = Ninespine Stickleback

All UTM coordinates in Zone 13W

Table A-3: Minnow Trap Effort and Catch Data from Grenier Lake East Outflow, 2019

Site	Trap No.	Location (UTM)		Depth (m)	Set		Pulled		Effort (decimal h)	Fish	
		Easting	Northing		Date	Time	Date	Time		NSSB	CPUE
Pond 4	15	504001	7671005	0.6	29-Jul	11:50	30-Jul	11:48	24.0	2	2.0
(cont'd)	16	504004	7671008	0.5	29-Jul	11:50	30-Jul	11:48	24.0	0	0.0
	17	504010	7671012	0.6	29-Jul	11:51	30-Jul	11:49	24.0	5	5.0
	18	504016	7671014	0.5	29-Jul	11:51	30-Jul	11:49	24.0	0	0.0
	19	504021	7671017	0.5	29-Jul	11:52	30-Jul	11:50	24.0	0	0.0
	20	504025	7671021	0.7	29-Jul	11:52	30-Jul	11:50	24.0	2	2.0
	21	504029	7671025	0.6	29-Jul	11:53	30-Jul	11:51	24.0	0	0.0
	22	504033	7671034	1	29-Jul	11:53	30-Jul	11:51	24.0	1	1.0
	23	504033	7671038	0.5	29-Jul	11:54	30-Jul	11:52	24.0	1	1.0
	24	504035	7671043	0.6	29-Jul	11:54	30-Jul	11:52	24.0	0	0.0
	25	504035	7671050	0.6	29-Jul	11:55	30-Jul	11:53	24.0	1	1.0
	26	504034	7671054	0.5	29-Jul	11:55	30-Jul	11:54	24.0	0	1.0
	27	503994	7671002	0.4	29-Jul	11:56	30-Jul	11:54	24.0	1	0.0
Pond 5	1	502288	7670081	0.5	30-Jul	16:00	31-Jul	9:36	17.6	0	0.0
	2	502282	7670078	0.5	30-Jul	16:00	31-Jul	9:37	17.6	0	0.0
	3	502280	7670077	0.4	30-Jul	16:01	31-Jul	9:38	17.6	1	1.4
	4	502277	7670073	0.4	30-Jul	16:01	31-Jul	9:39	17.6	0	0.0
	5	502273	7670069	0.3	30-Jul	16:02	31-Jul	9:40	17.6	0	0.0
	6	502269	7670065	0.4	30-Jul	16:02	31-Jul	9:43	17.7	0	0.0
	7	502262	7670058	0.2	30-Jul	16:03	31-Jul	9:45	17.7	0	0.0
	8	502260	7670053	0.4	30-Jul	16:03	31-Jul	9:47	17.7	2	2.7
	9	502256	7670052	0.6	30-Jul	16:04	31-Jul	9:47	17.7	0	0.0
	10	502250	7670049	0.4	30-Jul	16:05	31-Jul	9:48	17.7	0	0.0
	11	502248	7670043	0.4	30-Jul	16:06	31-Jul	9:49	17.7	1	1.4
	12	502244	7670041	0.3	30-Jul	16:07	31-Jul	9:50	17.7	0	0.0
	13	502239	7670032	0.4	30-Jul	16:08	31-Jul	9:50	17.7	0	0.0
	14	502544	7669828	0.4	30-Jul	16:45	31-Jul	10:00	17.3	0	0.0
	15	502545	7669835	0.5	30-Jul	16:45	31-Jul	10:01	17.3	1	1.4
	16	502546	7669840	0.5	30-Jul	16:46	31-Jul	10:02	17.3	0	0.0
	17	502553	7669847	0.4	30-Jul	16:46	31-Jul	10:03	17.3	0	0.0
	18	502555	7669853	0.5	30-Jul	16:47	31-Jul	10:04	17.3	0	0.0
	19	502558	7669855	0.4	30-Jul	16:47	31-Jul	10:05	17.3	0	0.0
	20	502561	7669859	0.3	30-Jul	16:48	31-Jul	10:06	17.3	0	0.0
	21	502563	7669860	0.3	30-Jul	16:48	31-Jul	10:07	17.3	0	0.0
	22	502564	7669868	0.4	30-Jul	16:49	31-Jul	10:08	17.3	1	1.4
	23	502564	7669875	0.4	30-Jul	16:50	31-Jul	10:12	17.4	0	0.0
	24	502563	7669880	0.3	30-Jul	16:51	31-Jul	10:14	17.4	0	0.0
	25	502563	7669885	0.5	30-Jul	16:51	31-Jul	10:15	17.4	0	0.0
	26	502565	7669891	0.3	30-Jul	16:52	31-Jul	10:16	17.4	0	0.0
	27	502568	7669896	0.4	30-Jul	16:52	31-Jul	10:17	17.4	0	0.0
Total									**1643.8**	**46**	

Notes:

CPUE = Catch-Per-Unit-Effort (fish/trap/24 h)

NSSB = Ninespine Stickleback

All UTM coordinates in Zone 13W

Table A-4: Biological Characteristics of Fish Sampled in Minnow Trapping and Electrofishing Surveys in Grenier Lake East Outflow, 2019

Date	Site	Method	Gear ID	Fish Number	Species	Length (mm)	Weight (g)	Parasite	Comments
24-Jul	EO1	EF	-	-	NSSB	57	1.1	N	
		EF	-	-	NSSB	67	2.4	Y	
		EF	-	-	NSSB	58	1.4	Y	
		EF	-	-	NSSB	52	1.3	Y	
		EF	-	-	NSSB	51	0.8	N	
		EF	-	-	NSSB	75	4.1	Y	
		EF	-	-	NSSB	42	0.5	N	
		EF	-	-	NSSB	54	1.1	N	
		EF	-	-	NSSB	54	1.8	Y	
		EF	-	-	NSSB	42	0.6	N	
		EF	-	-	NSSB	45	0.9	N	
		EF	-	-	NSSB	45	1.1	N	
		EF	-	-	NSSB	52	1.5	Y	
		EF	-	-	NSSB	42	0.7	N	
		EF	-	-	NSSB	49	1.1	N	
		EF	-	-	NSSB	45	0.8	N	
		EF	-	-	NSSB	49	1.1	N	
		EF	-	-	NSSB	44	0.7	N	
25-Jul	EO2	EF	-	-	NSSB	51	1.4	Y	
		EF	-	-	NSSB	51	1	N	
		EF	-	-	NSSB	64	2.1	N	
		EF	-	-	NSSB	45	0.7	N	
		EF	-	-	NSSB	45	0.8	N	
		EF	-	-	NSSB	45	1	N	
		EF	-	-	NSSB	62	1.6	Y	
		EF	-	-	NSSB	49	1.1	N	
		EF	-	-	NSSB	56	1.6	N	
		EF	-	-	NSSB	61	1.8	Y	
		EF	-	-	NSSB	47	1.1	N	
		EF	-	-	NSSB	47	1.2	N	
		EF	-	-	NSSB	52	1.4	Y	
		EF	-	-	NSSB	41	0.5	N	
		EF	-	-	NSSB	54	1.7	N	
		EF	-	-	NSSB	44	0.7	N	
		EF	-	-	NSSB	51	0.8	N	
		EF	-	-	NSSB	56	1.1	N	
		EF	-	-	NSSB	60	1	N	Mortality
		EF	-	-	NSSB	40	1.1	N	

Notes:
NSSB = Ninespine Stickleback
Method: EF = Electrofishing, MT = Minnow Trapping
Dashes (-) indicate data not collected

Table A-4: Biological Characteristics of Fish Sampled in Minnow Trapping and Electrofishing Surveys in Grenier Lake East Outflow, 2019

Date	Site	Method	Gear ID	Fish Number	Species	Length (mm)	Weight (g)	Parasite	Comments
25-Jul	EO3	EF	-	-	NSSB	62	2	Y	
(cont'd)		EF	-	-	NSSB	70	2.7	N	
		EF	-	-	NSSB	65	3.1	Y	
		EF	-	-	NSSB	49	0.6	N	
		EF	-	-	NSSB	57	1.7	Y	
		EF	-	-	NSSB	61	2.1	N	
		EF	-	-	NSSB	63	2	Y	
		EF	-	-	NSSB	60	2.3	Y	
		EF	-	-	NSSB	51	1.5	Y	
		EF	-	-	NSSB	50	1.5	N	
		EF	-	-	NSSB	55	1.5	N	
24-Jul	EO4	EF	-	-	NSSB	56	1.5	Y	
		EF	-	-	NSSB	52	1.4	Y	
		EF	-	-	NSSB	43	0.8	N	
27-Jul	Pond4	MT	22	1	NSSB	52	1	N	
		MT	22	2	NSSB	56	1	N	
		MT	23	3	NSSB	66	2.6	N	
		MT	18	4	NSSB	64	2.8	Y	
		MT	18	5	NSSB	61	1.8	N	
		MT	18	6	NSSB	67	2.5	N	
		MT	18	7	NSSB	72	4	N	
		MT	18	8	NSSB	57	1.7	N	
		MT	20	9	NSSB	69	2.4	N	
		MT	20	10	NSSB	61	1.5	N	
		MT	13	11	NSSB	68	2.6	Y	
		MT	12	12	NSSB	57	2.5	Y	
		MT	10	13	NSSB	54	1.3	N	
		MT	6	14	NSSB	63	2	N	
		MT	3	15	NSSB	56	1.6	N	
		MT	3	16	NSSB	64	2.5	N	
		MT	3	17	NSSB	56	2.1	N	
		MT	3	18	NSSB	53	1.2	N	
		MT	3	19	NSSB	70	2.8	N	
		MT	3	20	NSSB	45	0.9	N	
31-Jul	Pond5	MT	3	1	NSSB	57	1.4	N	
		MT	8	2	NSSB	45	0.6	N	
		MT	8	3	NSSB	46	0.8	N	
		MT	11	4	NSSB	65	2	N	
		MT	16	5	NSSB	58	1.4	N	
		MT	22	6	NSSB	54	0.9	N	

Notes:
NSSB = Ninespine Stickleback
Method: EF = Electrofishing, MT = Minnow Trapping
Dashes (-) indicate data not collected

Table A-5: Gillnet Catch Data, Grenier Lake East Outflow, 2019

Site	Net Size ID	Gillnet Number	Start Location (UTM)		End Location (UTM)		Set		Pulled		Effort (decimal h)	Fish	
			Easting	Northing	Easting	Northing	Date	Time in	Date	Time Out		Arctic	CPUE
Pond 4	A	1	504412	7671536	504407	7671519	26-Jul	11:13	26-Jul	11:55	0.7	0	0.00
	A	2	504411	7671487	504410	7671473	26-Jul	11:18	26-Jul	11:58	0.7	0	0.00
	B	3	504350	7671519	504352	7671499	26-Jul	11:22	26-Jul	12:02	0.7	0	0.00
	A	4	504590	7671536	504571	7671533	26-Jul	12:16	26-Jul	13:32	1.3	0	0.00
	B	5	504550	7671636	504557	7671627	26-Jul	12:11	26-Jul	13:24	1.2	0	0.00
	A	6	504614	7671604	504596	7671612	26-Jul	12:14	26-Jul	13:27	1.2	0	0.00
	A	7	504726	7671754	504735	7671742	26-Jul	13:35	26-Jul	14:59	1.4	0	0.00
	A	8	504772	7671848	504780	7671836	26-Jul	13:38	26-Jul	14:56	1.3	0	0.00
	B	9	504808	7671901	504824	7671893	26-Jul	13:42	26-Jul	14:52	1.2	0	0.00
	A	10	504709	7671658	504686	7671654	26-Jul	15:02	26-Jul	16:47	1.8	0	0.00
	A	11	504656	7671643	504643	7671643	26-Jul	15:05	26-Jul	16:43	1.6	0	0.00
	B	12	504603	7671644	504604	7671634	26-Jul	15:09	26-Jul	16:41	1.5	0	0.00
	A	1	503923	7671449	503932	7671463	30-Jul	13:01	30-Jul	14:11	1.2	0	0.00
	A	2	503932	7671614	503951	7671619	30-Jul	13:05	30-Jul	14:05	1.0	0	0.00
	B	3	504002	7671657	503996	7671676	30-Jul	13:08	30-Jul	14:03	0.9	0	0.00
	C	1	502245	7669539	502176	7669598	31-Jul	11:35	31-Jul	12:42	1.1	1	0.40
	C	1	504587	7671519	504493	7671532	20-Aug	14:56	20-Aug	16:41	1.8	0	0.00
	D	2	504728	7671706	504679	7671695	20-Aug	15:02	20-Aug	16:47	1.8	0	0.00
	C	3	504316	7671461	504396	7671463	20-Aug	15:13	20-Aug	17:01	1.8	0	0.00
	D	4	504388	7671411	504417	7671445	21-Aug	9:26	21-Aug	12:06	2.7	5	1.68
	C	5	504428	7671544	504453	7671460	21-Aug	9:33	21-Aug	12:17	2.7	6	0.98
	C	6	504453	7671460	504244	7671492	21-Aug	9:42	21-Aug	12:25	2.7	2	0.33
	C	7	504332	7671495	504526	7671477	21-Aug	10:14	21-Aug	12:53	2.7	1	0.17
	E	8	504578	7671550	504340	7671285	21-Aug	10:53	21-Aug	13:05	2.2	0	0.00
	C	9	504460	7671570	504470	7671476	21-Aug	13:55	21-Aug	14:55	1.0	0	0.00
	C	10	504356	7671397	504430	7671466	21-Aug	14:10	21-Aug	15:35	1.4	0	0.00
	D	11	504243	7671491	504285	7671498	21-Aug	14:28	21-Aug	15:50	1.4	1	0.66
	C	12	503842	7670983	503696	7670913	22-Aug	9:20	22-Aug	10:30	1.2	0	0.00

Notes:
CPUE = Catch-Per-Unit-Effort (fish/100 m²/h)
All UTM coordinates in Zone 13W
Net Size ID described in Table 3.2-7

Table A-5: Gillnet Catch Data, Grenier Lake East Outflow, 2019

Site	Net Size ID	Gillnet Number	Start Location (UTM)		End Location (UTM)		Set		Pulled		Effort (decimal h)	Fish	
			Easting	Northing	Easting	Northing	Date	Time in	Date	Time Out		Arctic	CPUE
Pond 4	D	13	504062	7670816	504043	7670858	22-Aug	9:24	22-Aug	10:45	1.4	0	0.00
(cont'd)	C	14	503984	7670848	503992	7670939	22-Aug	9:53	22-Aug	13:30	3.6	0	0.00
	C	15	503921	7670591	503939	7670678	22-Aug	10:40	22-Aug	13:47	3.1	0	0.00
	D	16	504134	7670935	504115	7670978	22-Aug	10:50	22-Aug	14:03	3.2	0	0.00
	D	17	503909	7670659	503955	7670678	25-Aug	11:30	25-Aug	13:40	2.2	0	0.00
	C	18	504027	7670761	504005	7670851	25-Aug	11:40	25-Aug	13:50	2.2	0	0.00
	C	19	503978	7670874	504016	7670951	25-Aug	11:50	25-Aug	14:10	2.3	0	0.00
	C	20	504072	7671054	504112	7670980	25-Aug	11:59	25-Aug	14:18	2.3	0	0.00
	D	21	503880	7670585	503931	7670626	25-Aug	13:45	25-Aug	16:32	2.8	1	0.32
	C	22	504016	7670787	504016	7670787	25-Aug	14:00	25-Aug	16:44	2.7	0	0.00
	C	23	503967	7670916	504058	7670900	25-Aug	14:13	25-Aug	16:56	2.7	0	0.00
	C	24	504072	7671054	504147	7671099	25-Aug	14:20	25-Aug	17:08	2.8	0	0.00
	C	25	504114	7671043	503992	7670807	25-Aug	17:13	26-Aug	9:30	16.3	1	0.03
	C	26	503872	7670605	503954	7670644	25-Aug	17:07	26-Aug	9:45	16.6	2	0.05
Pond 5	C	27	503965	7670722	502476	7670061	26-Aug	12:00	27-Aug	16:40	4.7	0	0.00
	D	28	502511	7669761	502456	7669795	26-Aug	12:11	27-Aug	16:33	4.4	0	0.00
	C	29	502075	7669405	502060	7669494	26-Aug	12:26	27-Aug	15:45	3.3	1	0.14
	C	30	502150	7669758	502233	7669807	26-Aug	12:33	27-Aug	15:35	3.0	0	0.00

Notes:
CPUE = Catch-Per-Unit-Effort (fish/100 m²/h)
All UTM coordinates in Zone 13W
Net Size ID described in Table 3.2-7

Table A-6: Biological Characteristics of Fish Sampled in Gillnetting Surveys in the Grenier Lake East Outflow, Tahilugyuak Lake Outflow and Elu Inlet, 2019

Site	Crew	Date	Fish No.	Species Code	Net No. (set)	Fork Length (mm)	Weight (g)	Mort (S/I/N)	Aging	Sex	Reproductive Status	Recapture (Y/N)	PIT Tag ID	DELT (Y/N)	Photos	Comments
Pond 4	KK,RK	21-Aug	1	ARCH	4-6	355	529	N	-	-	-	N	-	-		
	KK,RK	21-Aug	2	ARCH	4-7	396	624	N	-	-	-	N	-	-		
	KK,RK	21-Aug	3	ARCH	4-8	306	331	N	FR	-	-	N	-	-		
	KK,RK	21-Aug	4	ARCH	4-9	284	262	N	FR	-	-	N	-	-		
	KK,RK	21-Aug	5	ARCH	4-10	366	469	N	FR	-	-	N	-	-		
	KK,RK	21-Aug	6	ARCH	4-11	324	432	N	FR	-	-	N	-	-		
	KK,RK	21-Aug	7	ARCH	4-12	374	617	Y	FR,O	U	1	N	-	-		Stomach full of NSSB fry
	KK,RK	21-Aug	8	ARCH	4-13	374	539	Y	FR,O	U	1	N	-	-		
	KK,RK	21-Aug	9	ARCH	4-14	430	896	Y	FR,O	F	1	N	-	-		
	KK,RK	21-Aug	10	ARCH	4-15	314	409	Y	FR,O	M	1	N	-	-		
	KK,RK	21-Aug	11	ARCH	4-16	389	631	Y	FR,O	F	1	N	-	-		
	KK,RK	21-Aug	12	ARCH	4-17	341	456	Y	FR,O	F	1	N	-	-		
	KK,RK	21-Aug	13	ARCH	4-18	326	383	Y	FR,O	F	1	N	-	-		
	KK,RK	21-Aug	14	ARCH	7	358	380	N	FR	-	-	N	-	-		
	KK,RK	21-Aug	15	ARCH	11	287	204	N	-	-	-	Y	-	-		Recap fish 4
	KK,IE	25-Aug	16	ARCH	21	567	2250	N	FR	U	0	N	900236000218763	-		Gash on dorsal fin
	KK,IE	26-Aug	17	ARCH	25	576	2208	Y	O	F	2-3	Y	900236000219763	-		Stomach empty
	KK,IE	26-Aug	18	ARCH	26	424	809	Y	FR,O	M	1	N	-	-		Stomach empty
Pond 5	KK,IE	26-Aug	19	ARCH	26	419	679	Y	FR,O	F	1	N	-	-		Stomach empty, 1 cyst on liver
	KK,IE	26-Aug	20	ARCH	29	367	495	N	FR	U	0	N	-	-		
Elu Inlet	VT,NZ, LI	17-Jul	1	ARCH	7	766	4200	N	S	F?	0	-	900 2360 002 19168	N		Photos P71710034-0036
T-Lake OF	VT,NZ, LB	18-Jul	2	ARCH	1	440	990	N	S	U	0	-	900 2360 002 19152	N		
T-Pond	NZ, AT	26-Aug	1	ARCH	1	395	-	N	-	U	0	-	-	N	P8260507	
	NZ, AT	26-Aug	2	ARCH	1	420	-	N	-	U	0	-	-	N	P8260509	
	NZ, AT	26-Aug	3	ARCH	1	395	-	N	-	U	0	-	-	N	P8260511	
	NZ, AT	26-Aug	4	LKTR	1	420	-	N	-	U	0	-	-	N	P8260508	
	NZ, AT	27-Aug	5	LKTR	2	345	450	N	-	U	0	-	900 2360 002 18640	N		
	NZ, AT	27-Aug	6	ARCH	3	370	520	N	-	U	0	-	900 2360 002 18649	N	P8270544-45	Jaw damaged in net
	NZ, AT	27-Aug	7	ARCH	4	300	273	N	-	U	0	-	900 2360 002 18665	N		
	NZ, AT	27-Aug	8	LKTR	4	425	764	N	-	U	0	-	900 2360 002 18639	N	P8270548	
	NZ, AT	27-Aug	9	ARCH	4	390	565	N	-	U	0	-	900 2360 002 18667	N	P8270550-51	
	NZ, AT	27-Aug	10	ARCH	4	360	490	N	-	U	0	-	900 2360 002 18664	Y	P8270553- 556	Abrasion on back
	NZ, AT	27-Aug	11	LKTR	5	740	8000	N	-	U	0	-	900 2360 002 18610	N	P8270557- 559	
	NZ, AT	27-Aug	12	LKTR	5	365	510	N	-	U	0	-	900 2360 002 18584	N	P8270560	
	NZ, AT	27-Aug	13	LKTR	5	413	880	N	-	U	0	-	900 2360 002 18654	N		
	NZ, AT	27-Aug	14	ARCH	5	380	575	N	-	U	0	Y*	900 2360 002 18600	N		* Realised had puncture mark after put in new tag, no reading for old tag.
	NZ, AT	27-Aug	15	ARCH	5	300	290	N	-	U	0	Y	900 2360 002 18665	N		
	NZ, AT	27-Aug	16	ARCH	5	430	800	N	-	U	0	-	900 2360 002 18583	N		
	NZ, AT	27-Aug	17	LKTR	5	415	885	N	-	U	0	-	900 2360 002 18666	N		
	NZ, AT	27-Aug	18	ARCH	5	360	420	N	-	U	0	-	900 2360 002 18668	N		
	NZ, AT	27-Aug	19	LKTR	5	320	630	N	-	U	0	-	900 2360 002 18609	N		

Notes:

Species: ARCH = Arctic Char, LKTR = Lake Trout

DELT = Deformities, erosions, lesions, and tumors

Aging: FR = Fin Ray, O = Otolith, S = Scales

Sex: M = Male, F = Female, U = Unknown

Reproductive Status: 0 = Unknown, 1 = Undeveloped, 2 = Green, 3 = Ripe

Dashes (-) indicate data not collected

Table A-7: Gillnet Effort and Catch Data, Tahilugyuak Outflow and Elu Inlet, 2019

Site	Gillnet Number	Start Location (UTM)		End Location (UTM)		Set		Pulled		Effort (decimal h)	No. of Fish Captured								CPUE							
		Easting	Northing	Easting	Northing	Date	Time in	Date	Time Out		ARCH	LKTR	FSP	SSP	SF	CP	PH	Total	ARCH	LKTR	FSP	SSP	SF	CP	PH	Total
Elu Inlet	1	449781	7580215	449790	7580313	15-Jul	16:39	15-Jul	17:03	0.4	0	0	0	0	1	0	0	**1**	0.0	0.0	0.0	0.0	1.1	0.0	0.0	**1.1**
	2	449784	7580212	449863	7580156	15-Jul	17:12	15-Jul	17:30	0.3	0	0	0	0	0	0	0	**0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	3	449849	7580610	449762	7580580	16-Jul	10:20	16-Jul	10:43	0.4	0	0	0	0	0	0	0	**0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	4	449759	7580624	449849	7580610	16-Jul	10:23	16-Jul	11:00	0.6	0	0	0	0	0	1	0	**1**	0.0	0.0	0.0	0.0	0.0	0.7	0.0	**0.7**
	5	449722	7580550	449821	7580530	16-Jul	10:50	16-Jul	11:50	1.0	0	0	0	0	2	0	1	**3**	0.0	0.0	0.0	0.0	0.9	0.0	0.4	**1.3**
	6	449989	7580654	449945	7580735	16-Jul	11:05	16-Jul	11:40	0.6	0	0	0	0	0	0	2	**2**	0.0	0.0	0.0	0.0	0.0	0.0	1.5	**1.5**
	7	449785	7580906	449869	7580860	17-Jul	11:32	17-Jul	12:43	1.2	1	0	0	0	0	0	1	**2**	0.4	0.0	0.0	0.0	0.0	0.0	0.4	**0.8**
	8	450375	7580907	450288	7580937	17-Jul	11:40	17-Jul	12:57	1.3	0	0	0	0	0	0	0	**0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	9	449809	7580933	449902	7580922	17-Jul	12:52	17-Jul	14:18	1.4	0	0	0	0	0	0	10	**10**	0.0	0.0	0.0	0.0	0.0	0.0	3.1	**3.1**
	10	449911	7581038	450011	7581029	17-Jul	13:06	17-Jul	14:33	1.5	0	0	2	0	0	0	1	**3**	0.0	0.0	0.6	0.0	0.0	0.0	0.3	**0.9**
	11	449822	7580924	449917	7580915	17-Jul	14:30	17-Jul	15:38	1.1	0	0	0	1	0	0	0	**1**	0.0	0.0	0.0	0.4	0.0	0.0	0.0	**0.4**
	12	449947	7581415	450037	7581400	17-Jul	14:44	17-Jul	15:54	1.2	0	0	0	0	0	0	0	**0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	13	449959	7580753	449864	7580793	17-Jul	15:49	17-Jul	16:24	0.6	0	0	0	0	0	0	0	**0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	14	450037	7580846	450011	7580943	17-Jul	16:05	17-Jul	16:32	0.5	0	0	0	0	0	0	0	**0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
T-Lake Outflow	1	448094	7578150	448117	7578112	18-Jul	13:30	18-Jul	14:50	1.3	3	0	0	0	0	0	0	**3**	1.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.0**
	2	448094	7578150	448117	7578112	19-Jul	15:30	19-Jul	16:15	0.8	0	0	0	0	0	0	0	**0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
T-Pond	1	448695	7578377	448756	7578478	26-Aug	14:28	26-Aug	14:58	0.5	3	1	0	0	0	0	0	**4**	2.7	0.9	0.0	0.0	0.0	0.0	0.0	**3.6**
	2	448658	7578337	448676	7578438	27-Aug	12:24	27-Aug	12:50	0.4	0	1	0	0	0	0	0	**1**	0.0	1.0	0.0	0.0	0.0	0.0	0.0	**1.0**
	3	448621	7578375	448710	7578426	27-Aug	13:00	27-Aug	13:38	0.6	1	1	0	0	0	0	0	**2**	0.7	0.7	0.0	0.0	0.0	0.0	0.0	**1.4**
	4	448705	7578376	448710	7578478	27-Aug	13:38	27-Aug	14:08	0.5	3	1	0	0	0	0	0	**4**	2.7	0.9	0.0	0.0	0.0	0.0	0.0	**3.6**
	5	448652	7578479	448768	7578480	27-Aug	14:21	27-Aug	14:51	0.5	4	5	0	0	0	0	0	**9**	3.6	4.5	0.0	0.0	0.0	0.0	0.0	8.1

Notes:
CPUE = Catch-Per-Unit-Effort (fish/100 m²/h)
All UTM coordinates in Zone 13W
Species: ARCH = Arctic Char, LKTR = Lake Trout, FSP = Fourhorn Sculpin, SSP = Shorthorn Sculpin, SF = Starry Flounder, CP = Capelin, PH = Pacific Herring

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Iqaluktuuttiaq East Outflow System Fish and Fish Habitat Baseline Study 2022 and 2023

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September 2024

Iqaluktuuttiaq East Outflow System Fish and Fish Habitat Baseline Study 2022 and 2023

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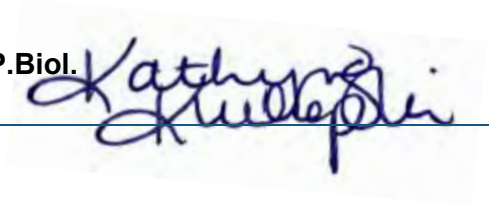

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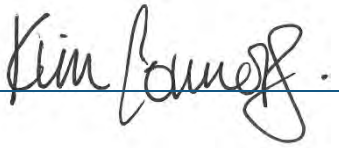

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ACRONYMS AND ABBREVIATIONS

AGNICO EAGLE – Agnico Eagle Mines Ltd.

CPUE – Catch-per-unit-effort

DELT – Deformities, Erosions, Lesions, and Tumours

DO – Dissolved Oxygen

EOS – Iqaluktuuttiaq East Outflow System

ERM – ERM Consultants Canada Ltd.

FOP – Fisheries Offsetting Plan

GPS – Global Positioning System

MINNOW – Minnow Environmental Inc.

NAD83 – North American Datum 83

NIRB – Nunavut Impact Review Board

NU – Nunavut

NWB – Nunavut Water Board

THE PROJECT – the Madrid-Boston Project

1 INTRODUCTION

The Hope Bay Project, a gold mine development owned by Agnico Eagle Mines Ltd. (Agnico Eagle), is located in the Hope Bay Greenstone Belt area of the Queen Maud Gulf Lowlands in the West Kitikmeot region of mainland Nunavut (NU; Figure 1.1). Cambridge Bay is the nearest community to the Hope Bay Project, located approximately 150 kilometers (km) northeast, on Victoria Island, NU. The Hope Bay Project area has been actively explored and developed since the late 1980s and is comprised of three main gold deposits at Doris, Madrid (North and South), and Boston (Figure 1.1).

Agnico Eagle is in the process of developing the Madrid area for mining as part of the Hope Bay Project (the Project) having received a Project Certificate (No. 009; the Project Certificate) from the Nunavut Impact Review Board (NIRB) in November 2018 and amended Type A Water Licence (2AM-DOH1335) from the Nunavut Water Board (NWB) in December 2018. Agnico Eagle has been developing a Fisheries Offsetting Plan (FOP) for the Project at the Hope Bay Mine since 2018, as the Project is predicted to impact freshwater and marine fish habitat via changes to water quantity in lakes and streams as well as infrastructure footprints. Since 2021, Minnow Environmental Inc. (Minnow) has supported Agnico Eagle in the development of fisheries offsetting measures to address anticipated effects on fish and fish habitat and to achieve compliance with the terms and conditions of the Project Certificate. The most recent draft of the Hope Bay Project Conceptual FOP (Minnow 2022), focused on two potential offsetting measures:

1) The opportunity to improve habitat and connectivity in the freshwater environment in the Iqaluktuuttiaq East Outflow System (the EOS) near Cambridge Bay.
2) Habitat enhancement through the development of marine shoals in Roberts Bay, adjacent to the Hope Bay Project.

This report presents baseline information supporting the development of the potential freshwater offsetting measure in the EOS only. Ongoing development of the marine offsetting measure in Roberts Bay is addressed elsewhere.

The EOS is an outflow from Iqaluktuuttiaq, a lake with a surface area of 3,400 ha (hectares), which flows south to the Freshwater Creek Estuary located in the Dease Strait, near Cambridge Bay, NU (Figure 1.2). The EOS is approximately 8 km in length and is comprised of multiple small waterbodies connected by intermittent stream habitat. The known fish community in Iqaluktuuttiaq includes Arctic charr (*Salvelinus alpinus*), lake trout (*Salvelinus namaycush*), lake whitefish (*Coregonus clupeaformis*), broad whitefish (*Coregonus nasus*), least cisco (*Coregonus sardinella*), cisco (*Coregonus artedi*), and ninespine stickleback (*Pungitius pungitius*; Grosbois et al. 2022). These species have access to the EOS from

LEGEND

- Community
- Permitted Infrastructure
- Proposed Madrid-Boston Infrastructure and Facilities
- Phase 2 Project Development Area

0 10 20 40 km

N W E S

Projection: North American Datum 1983 UTM Zone 13N

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Location of the Agnico Eagle Mines Ltd. Hope Bay Project

Date: September 2024
Project 237202.0071

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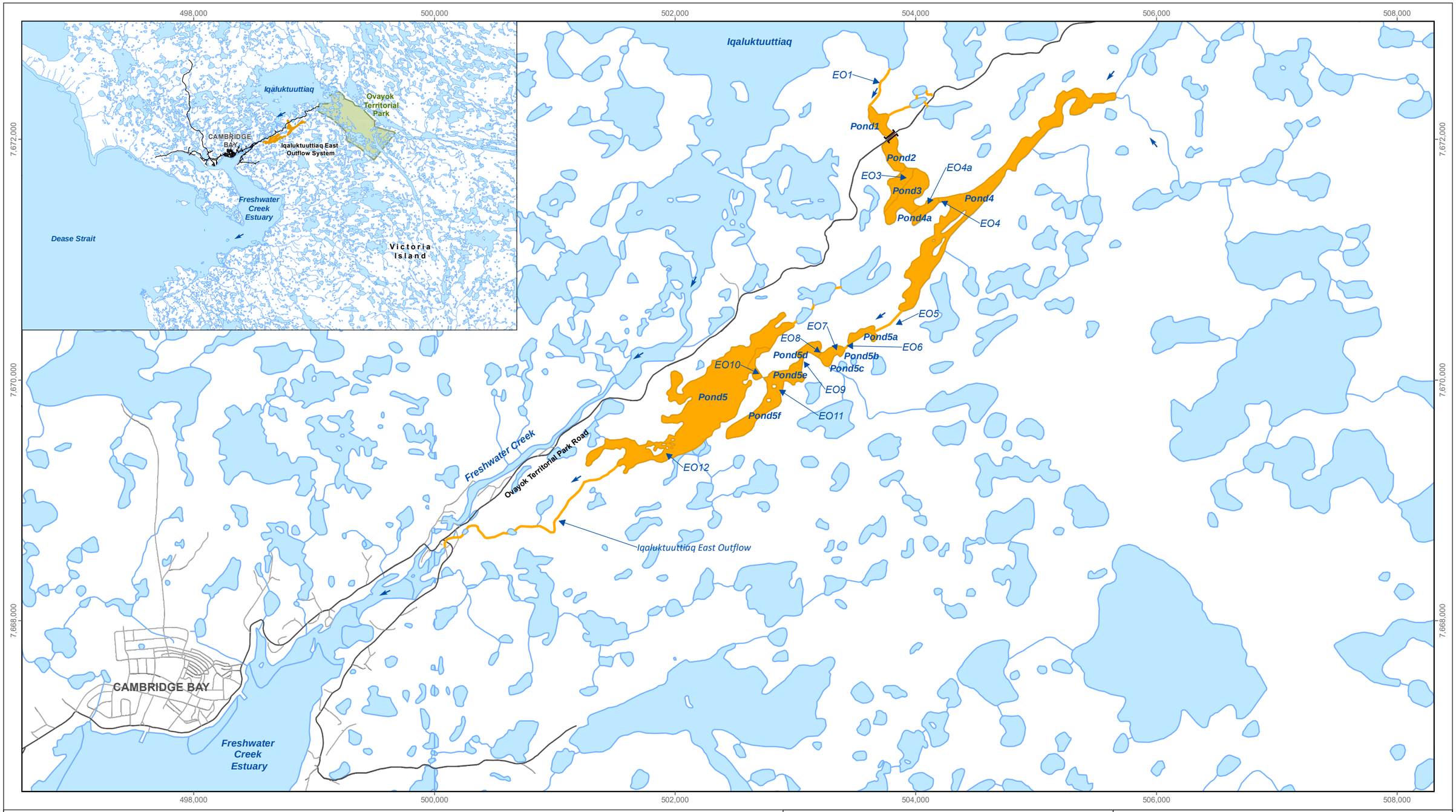
Figure 1.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure 1.1 Hope Bay Project Location.mxd



LEGEND

- Ovayok Road Culverts
- Iqaluktuuttiaq East Outflow System

Note: The map shows the East Outflow System at high flows and does not represent the intermittent nature of some connecting stream channel sections (e.g., EO3) during seasonal low flows.

0 0.5 1 2
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 13N

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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada.

Iqaluktuuttiaq East Outflow System

Date: September 2024
Project 237202.0071

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Figure 1.2

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure 1.2 Iqaluktuuttiaq East Outflow System.mxd

Iqaluktuuttiaq annually during the open-water season, mostly under high flow conditions, and some fish may overwinter in the small waterbodies along the EOS (ERM 2019, 2020; Minnow 2022).

A road from Cambridge Bay to Ovayok Territorial Park (i.e., the Ovayok Road) runs parallel to the EOS (Figure 1.2), then crosses the EOS near its outflow from Iqaluktuuttiaq. At the crossing location, there are eight culverts that are perched under certain flow conditions (ERM 2019, 2020; Appendix Photo A.1). These culverts create an impediment to both upstream and downstream fish passage during most of the open water season each year (ERM 2020). Additionally, fish migration at multiple stream channel locations in the EOS has been observed to become compromised in mid- to late-July (e.g., EO1 and EO3) due to low flow conditions resulting in dry channel and depth barriers to fish passage, and remain that way until freshet of the following year (ERM 2019, 2020). Without passable stream channel connections and with the culverts acting as a barrier to fish migration, fish habitats in small waterbodies along the EOS become disconnected from each other, from Iqaluktuuttiaq upstream, and from the downstream marine environment over the course of the open-water season. The potential to improve fish passage and waterbody connectivity were the reasons the EOS was identified as a candidate offsetting option by participants at a Fisheries Offsetting Workshop in Cambridge Bay in June 2018 (ERM 2018).

One component of Minnow's contribution to the development of the Project FOP was the collection of baseline fish and fish habitat data in the EOS in 2022, 2023, and 2024 to support on-going confirmation of feasibility, detailed design of the proposed offsetting measures, and future post-construction effectiveness monitoring. One earlier year of baseline fish and fish habitat data collection was completed in the EOS in 2019 (ERM 2020). Specifically, fish habitat was characterized in five ponds and three connecting stream channels, and the fish community was characterized in three ponds and three stream channels in the EOS under moderate flow conditions in July 2019 (Figure 1.2; Table 1.1). Additional fish habitat and fish community characterization was undertaken in 2022, 2023, and 2024 to supplement the existing baseline information through additional sampling in areas that were included in the 2019 survey and to characterize the fish habitat and community in areas that were not sampled in 2019 (Table 1.1).[1] The methods and results of baseline fish habitat and fish community studies completed in the EOS in 2022, 2023, and 2024 are presented in this report along with a summary of baseline information to date and conclusions to support development of the FOP.

[1] Hydrometric data were collected throughout the open-water seasons in 2022 and 2023. Methods and results are presented separately in GeoProcess (2024).

Table 1.1: Summary of Completed Fish Habitat and Community Baseline Data Collection, Iqaluktuuttiaq East Outflow System, 2019, 2022, 2023, and 2024

Habitat Type	Area	UTM (NAD 83)		2019 Baseline		2022 Baseline[a]		2023 Baseline		2024 Baseline
		Easting	Northing	Fish Community	Habitat	Fish Community	Fish Habitat	Fish Community	Fish Habitat	Under-Ice Water Quality Profile
Pond	Pond 1	503669	7672172	-	Bathy, Sub	GN, MT	-	-	-	DO, Temp, Cond
	Pond 2	503798	7671900	-	Bathy, Sub	MT	-	GN, MT	-	DO, Temp, Cond
	Pond 3	503932	7671614	GN	Bathy, Sub	-	-	GN, MT	-	DO, Temp, Cond
	Pond 4a	504125	7671448	-	-	-	-	MT	Lit, Sub	-
	Pond 4	504558	7671557	GN, MT	Bathy, Sub	-	-	GN, MT	-	DO, Temp, Cond
	Pond 5a	503542	7670381	-	-	-	Lit	MT	Lit, Sub, DO, Temp	-
	Pond 5b	503360	7670272	-	-	-	Lit	MT	Lit, Sub, DO, Temp	-
	Pond 5c	503270	7670206	-	-	-	Lit	MT	Lit, Sub, DO, Temp	-
	Pond 5d	503514	7670275	-	-	-	-	MT	Lit, Sub	-
	Pond 5e	502912	7670027	-	-	-	-	GN, MT	Lit, Sub	-
	Pond 5f	502609	7669658	-	-	-	-	MT	Lit, Sub	-
	Pond 5	502413	7669929	GN, MT	Bathy, Sub	-	-	-	-	DO, Temp, Cond
Stream	EO1	503738	7672450	EF	FHAP	-	FHAP	-	-	-
	EO3	503933	7671668	EF	FHAP	-	FHAP	-	-	-
	EO4a	504079	7671425	-	-	-	FHAP	-	-	-
	EO4	504187	7671491	EF	FHAP	-	FHAP	-	-	-
	EO5	503775	7670459	-	-	-	FHAP	-	-	-
	EO6	503425	7670296	-	-	-	FHAP	-	-	-
	EO7	503312	7670266	-	-	-	FHAP	-	-	-
	EO8	503213	7670229	-	-	-	FHAP	-	-	-
	EO9	503059	7670156	-	-	-	FHAP	-	-	-
	EO10	502713	7670032	-	-	-	FHAP	-	-	-
	EO11	502868	7669915	-	-	-	FHAP	-	-	-
	EO12	501931	7669397	-	-	-	FHAP	-	-	-

Notes: "-" = not sampled; "Bathy" = bathymetry ;"Lit" = littoral habitat characterization; "Sub" = sublittoral substrate characterization; "GN" = gill nets; "MT" = minnow traps; "EF" = electrofishing; "DO" = dissolved oxygen profile; "Temp" = temperature profile; "Cond" = conductivity profile; "FHAP" = modified Fish Habitat Assessment Procedure (ERM 2020).

[a] Freezing temperatures and subsequent ice formation on ponds and stream channels prevented the completion of all planned components of the 2022 baseline survey.

2 METHODS

2.1 Overview

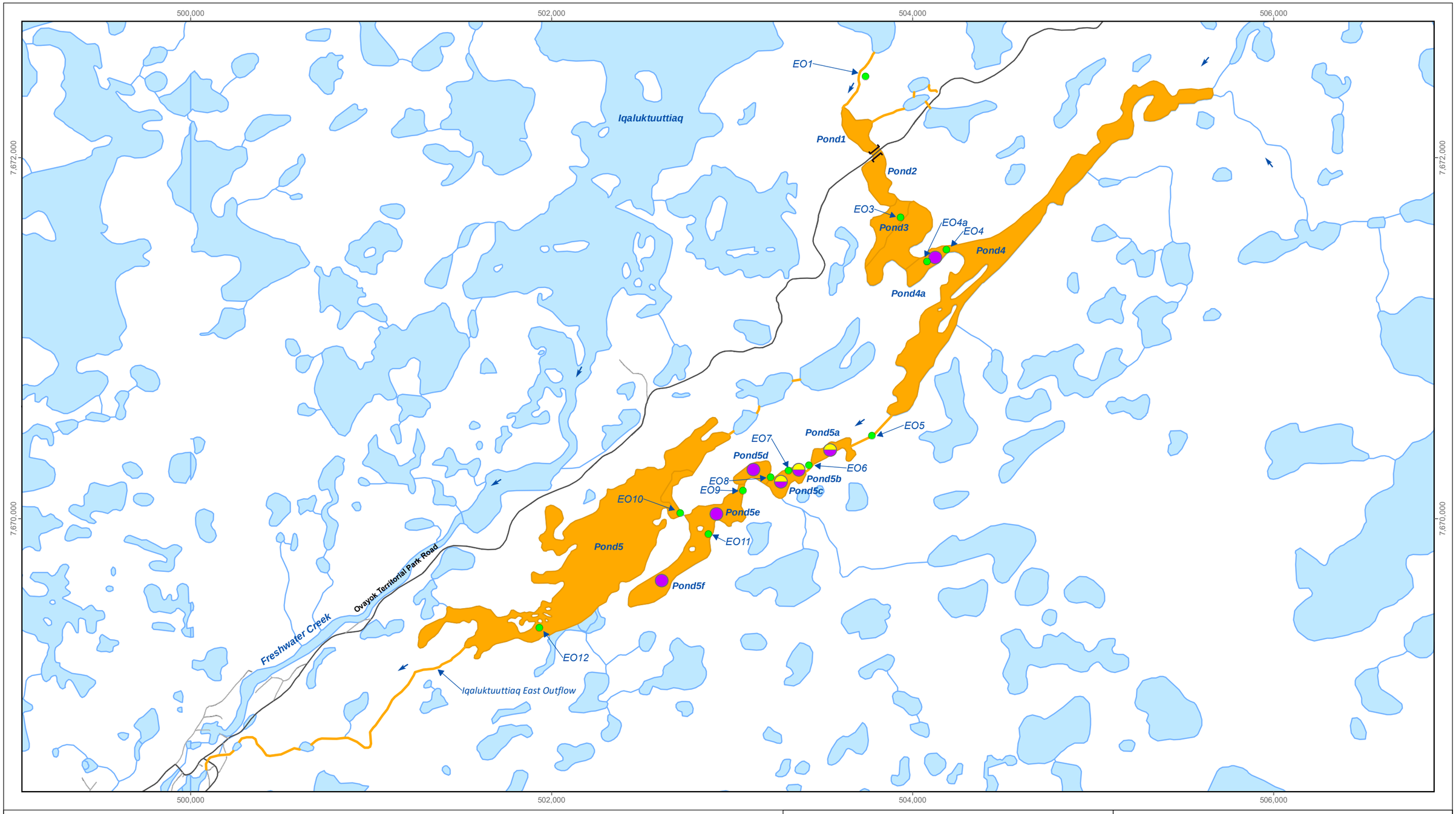
Baseline fish habitat and fish community data collection was carried out in ponds and stream channels in the EOS from September 20 to 22, 2022 during low flow conditions. In general, characterization of fish habitat in ponds and streams, particularly in areas that were not sampled during the 2019 baseline survey, was identified as a priority during baseline survey planning in 2022, in addition to fish community sampling in ponds that were not assessed in 2019 (Table 1.1). The original study design for the 2022 baseline work included fish community and habitat characterization in twelve ponds and twelve stream channels within the EOS (Figure 1.2; Table 1.1), however, due to weather conditions (i.e., a winter storm on September 23, 2022, and subsequent freezing temperatures that resulted in ice formation on the ponds and stream channels) data collection could only be completed for some components of the baseline survey at a subset of the proposed study areas (Table 1.1).[2] For this reason, a second field survey was conducted in the EOS from August 7 to 16, 2023, to characterize fish habitats and communities in ponds that were not assessed (i.e., because field data collection ended prematurely due to freezing temperatures) or could not be adequately assessed (i.e., because of ice formation on the surface of the ponds) in 2022 (Table 1.1). Finally, an under-ice water quality assessment was completed from April 6 to 8, 2024 to support assessment of the availability and quality of overwintering habitat in a subset of ponds that were considered to have the potential to support overwintering fish based on their size, depth, and location within the watershed (Table 1.1).

2.2 Fish Habitat Characterization

2.2.1 Stream Habitat

Fish habitat was characterized at 12 stream channel sections in the EOS on September 20, 2022 (Figure 2.1; Table 1.1). Consistent with the 2019 baseline survey (ERM 2020), stream habitat was assessed using methods based on a Level 1 Fish Habitat Assessment Procedure survey (Johnston and Slaney 1996) for representative sections of stream channel (transects; one or more transects were sampled within each connecting channel depending on the channel length). Habitat units were identified within each connecting channel and were classified based on the following criteria:

[2] Weather conditions (i.e., ice formation and freezing temperatures) at the time of the baseline survey were deemed to be a health and safety risk for crews completing the field program and ice formation on ponds and streams also restricted the effectiveness of fishing gear and use of boats, and reduced visibility for visual characterization of fish habitat.



LEGEND

- Pond Fish Habitat Characterization Location (2022)
- Pond Fish Habitat Characterization Location (2023)
- Stream Fish Habitat Characterization Location (2022)
- Ovayok Road Culverts
- Iqaluktuuttiaq East Outflow System

Note: The map shows the East Outflow System at high flows and does not represent the intermittent nature of some connecting stream channel sections (e.g., EO3) during seasonal low flows.

0 0.325 0.65 1.3
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 13N

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Baseline Fish Habitat Characterization Locations, Iqaluktuuttiaq East Outflow System, 2022 and 2023

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Figure 2.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure 2.1 Baseline Fish Habitat Characterization Locations.mxd

- Cascade: high energy, steep (i.e., gradient greater than 4%) sections of stream typically dominated by bedrock, boulders, and cobble.
- Riffle: shallower gradient than cascades with relatively shallow, turbulent, fast flowing water dominated by cobble and gravel.
- Glide: relatively flat-bottomed sections of stream with flowing, non-turbulent water.
- Flat: relatively shallow areas of still or stagnant water.
- Pool: relatively deep, slow flowing sections of stream with a concave longitudinal streambed profile and a surface gradient near 0%.

For each transect, the stream channel was measured for bankfull and wetted channel width, water depth, substrate composition, and bank shape and texture. Water depth was calculated as the mean of 3 to 11 water depth measurements (m) across the wetted channel (i.e., depending on wetted width) using a metre stick and measured to the nearest 0.01 m and bankfull and wetted width (m) was measured to the nearest 0.1 m using a survey tape at each of the established transects. Substrate composition was visually estimated as the proportion of bedrock (particle diameter greater than 4,000 mm), boulders (256 to 4,000 mm), cobble (64 to 256 mm), gravel (2 to 64 mm), and fines (less than 2 mm) within the transect and bank shape and texture were also assessed visually (Johnston and Slaney 1996). Barriers or seasonal restrictions to fish passage/migration were noted. Representative photographs were taken to further support habitat descriptions.

2.2.2 Pond Habitat

Fish habitat was characterized at three ponds in the EOS on September 22, 2022, and at seven ponds in the EOS between August 8 and 15, 2023 (Figure 2.1; Table 1.1). Pond habitat assessments were conducted by visually assessing the entire wetted area/perimeter of each pond on foot and recording the dominant shoreline, littoral, and/or sublittoral substrate types (i.e., bedrock, boulder, cobble, gravel, fines, and organic debris) where visible. Visual assessment of sublittoral habitats was dependent on water clarity and surface water conditions (i.e., still or turbulent) at the time of data collection, therefore, some sections could not be characterized. The presence and percent areal coverage of aquatic vegetation and the type of riparian vegetation was also recorded, when visible. During the 2022 survey, shoreline and littoral habitat characterization were partially assessed at three ponds (Pond 5a, 5b, and 5c; Figure 2.1; Table 1.1) but were limited by weather conditions and ice cover. Furthermore, sublittoral habitat could not be assessed given the presence of ice and slush at the time of the survey which prevented the use of a boat to characterize habitat in the deeper areas of the ponds and reduced visibility. During the 2023 survey, seven ponds were assessed for

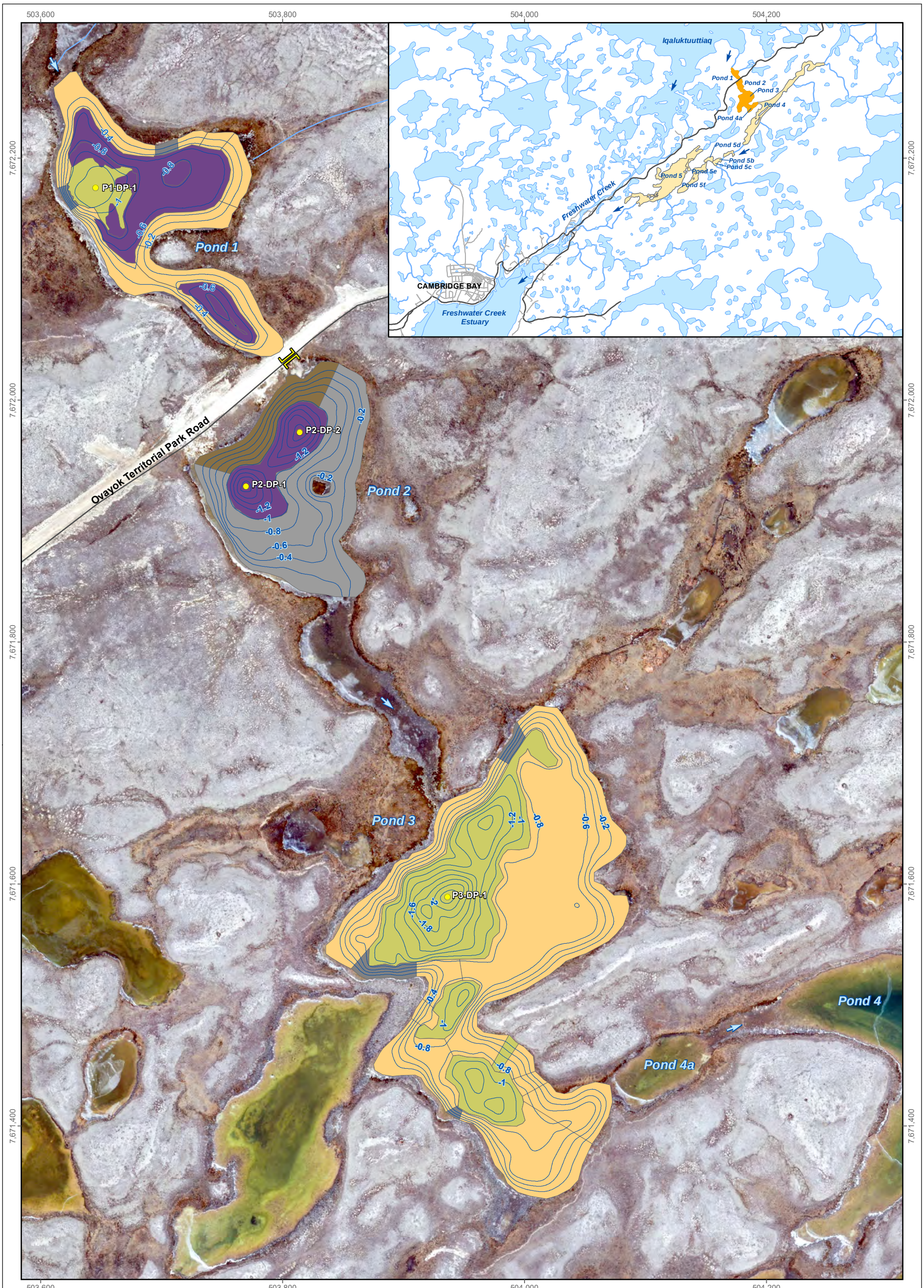
substrate characterization throughout the littoral zone and where possible in the sublittoral zone based on visibility (Figure 2.1; Table 1.1).

During the 2023 survey, *in situ* profiles for temperature and DO were collected in Ponds 5a, 5b, and 5c using a calibrated YSI handheld field meter with a YSI Sonde (YSI Inc., Yellow Springs, OH). No *In situ* water quality were collected in the ponds in 2022.

From April 6 to 8, 2024, under-ice *in situ* water quality profiles were completed by Agnico Eagle personnel, with remote support from Minnow, at the deepest areas of five ponds in the EOS (Ponds 1, 2, 3, 4, and 5). These ponds were considered to have the potential to support overwintering fish based on their size, depth, and locations within the watershed. Under-ice *in situ* water quality profiles were thus completed to support characterization of the potential availability and quality of overwintering habitat for fish. Within each pond, bathymetric maps were used to select between one and ten sampling station locations at the deepest points in each basin (Figures 2.2 to 2.4). Under-ice water quality profiles were completed using a calibrated YSI handheld field meter and sonde. After navigating to each sampling location by snowmobile using a handheld GPS (Global Positioning System) unit, a hole was augured into the ice using a gas-powered ice auger and floating ice and slush were cleared from the hole. Ice thickness was measured (m) using a rigid folding ruler modified to hook onto the bottom edge of the ice surface. Water depth under the ice (m) was determined by subtracting ice thickness from total depth, measured from the top of the ice surface to the pond substrates. Water quality parameters including temperature, DO, and conductivity were recorded just below the bottom of the ice surface and descending every half meter until reaching the bottom. At some of the selected sampling locations, the ponds were frozen to the bottom substrate, preventing measurement of an under-ice water quality profile and only the ice thickness was recorded. The date, time, and GPS coordinates (NAD83) were recorded at each sampling station.

2.3 Fish Community

Fish community sampling was conducted to provide information on species presence and relative abundance in the EOS. Sampling was completed in Pond 1 and Pond 2 (Figure 2.5; Table 1.1; Appendix Figure B.1) on September 21 and 22, 2022, after which freezing temperatures and ice formation on ponds and stream channels prevented fish community sampling at the remaining study areas. In Pond 1 and Pond 2, standard galvanized mesh cylindrical minnow traps (42 cm length, 0.6 cm mesh, 2.5 cm diameter opening) were baited with dry cat food and deployed overnight in groups of three at three locations in Pond 1 and two locations in Pond 2 (Figure 2.5, Appendix Figure B.1). Gill nets were also deployed in Pond 1 (Figure 2.5, Appendix Figure B.1). Specifically, one three panel gill net with mesh sizes



LEGEND

- Under-Ice Water Quality Profile Location
- Bathymetry (.2 m interval)
- Ovayok Territorial Park Road Crossing Culvert

Subittoral Substrate

- Fines
- Large Rock

Littoral Substrate

- Boulder
- Cobble
- Fines

Baseline Under-Ice Water Quality Profile Stations, Ponds 1, 2, and 3, Iqaluktuuttiaq East Outflow System, April 2024

0 50 100 200
Meters

Projection: North American Datum 1983 UTM Zone 13N

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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada. Base imagery on main map collected in September 2021.

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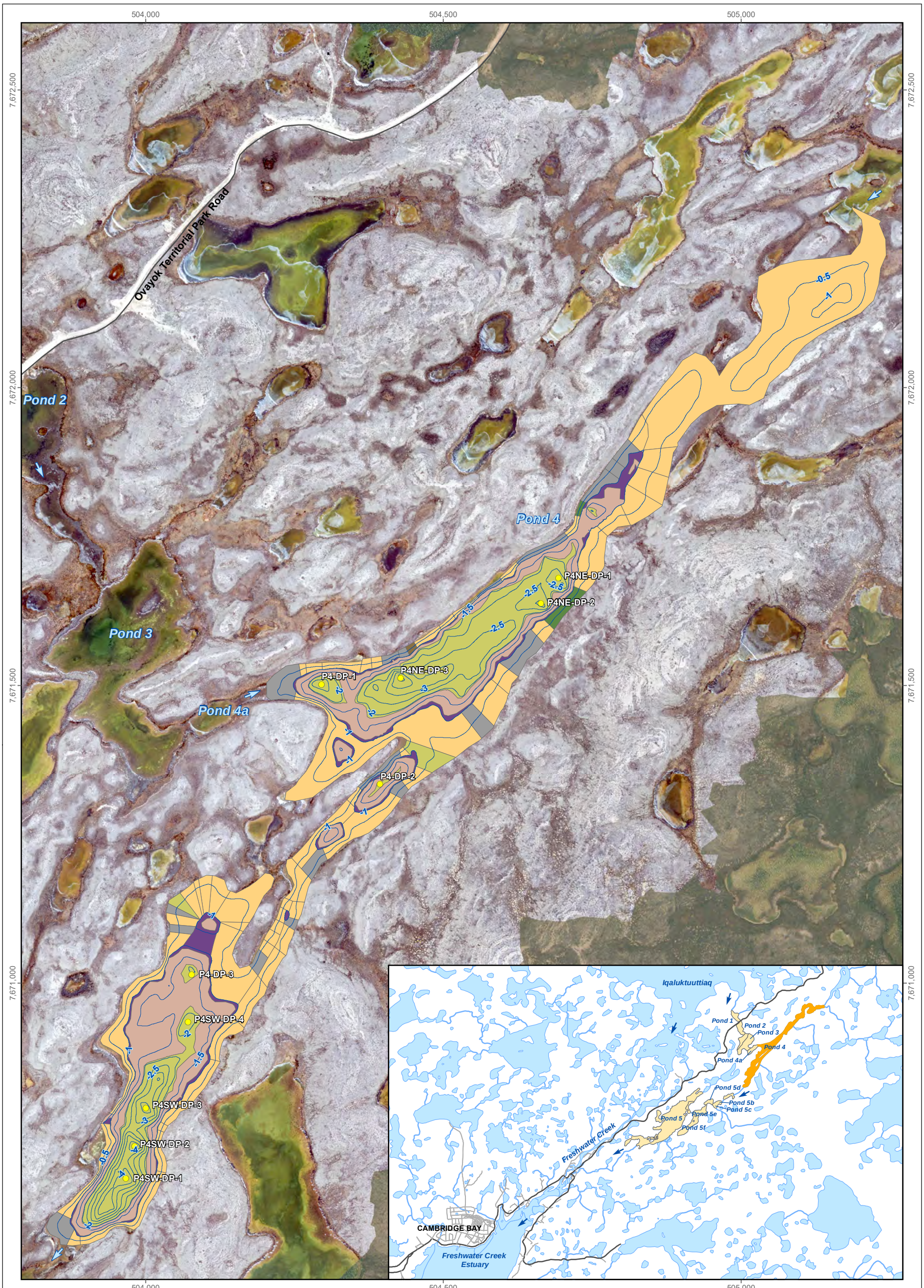
Figure 2.2

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure 2.2 Baseline Under-Ice Water Quality Profile Sampling, Ponds 1, 2, and 3.mxd



LEGEND

- Under-Ice Water Quality Profile Location
- Pond 4 Bathymetry (.5 m interval)

Littoral Substrate

- Bedrock
- Boulder
- Cobble
- Fines
- Gravel

Sublittoral Substrate

- Fines
- Large Rock
- Mixed

Baseline Under-Ice Water Quality Profile Stations, Pond 4, Iqaluktuuttiaq East Outflow System, April 2024

0 100 200 400
Meters

N W E S

Projection: North American Datum 1983 UTM Zone 13N

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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada. Base imagery on main map for East Outflow System collected in September 2021.

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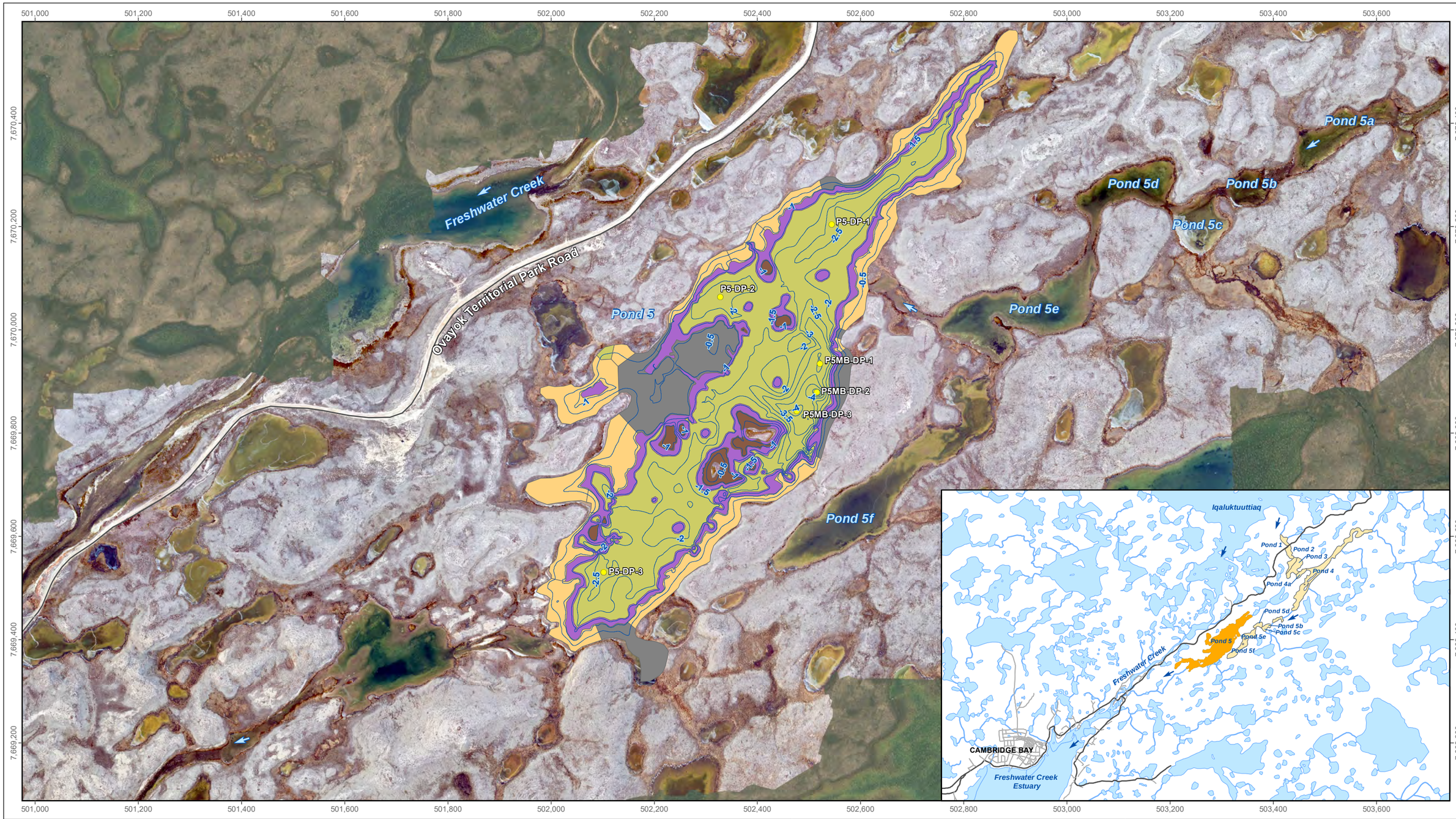
Figure 2.3

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure 2.3 Baseline Under-Ice Water Quality Profile Sampling, Pond 4.mxd



LEGEND

- Under-Ice Water Quality Profile Location
- Bathymetry (.5 m interval)

Littoral Substrate	Sublittoral Substrate
Boulder	Fines
Cobble	Large Rock
Fines	Mixed

0 125 250 500
Meters

N W E S

Projection: North American Datum 1983 UTM Zone 13N

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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada. Base imagery on main map for East Outflow System collected in September 2021.

Baseline Under-Ice Water Quality Profile Stations, Pond 5, Iqaluktuuttiaq East Outflow System, April 2024

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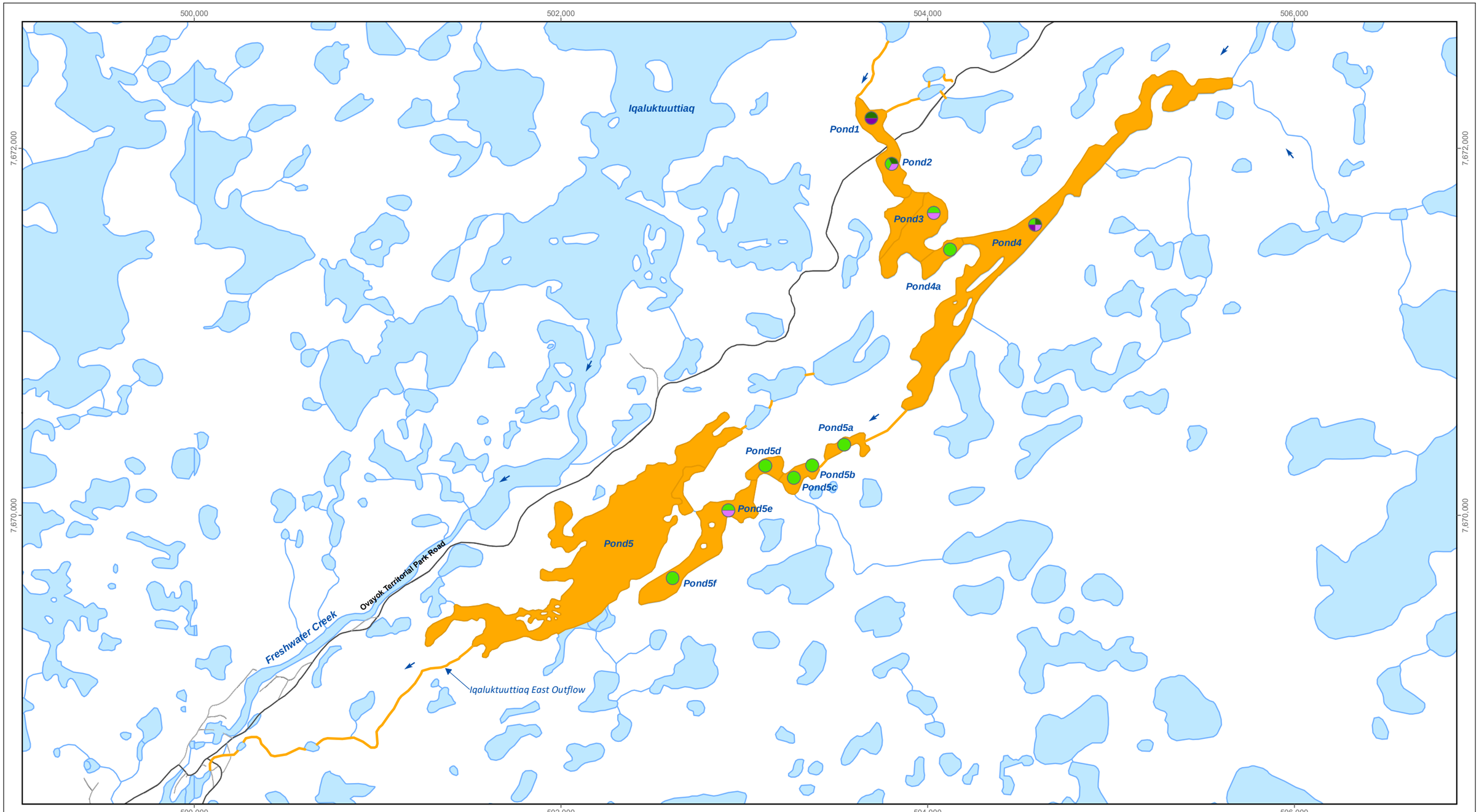
Figure 2.4

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure 2.4 Baseline Under-Ice Water Quality Profile Sampling, Pond 5.mxd



LEGEND

- Fish Community Sampling Location
- Minnow Trap Location (2022)
- Minnow Trap Location (2023)
- Gill Net Location (2022)
- Gill Net Location (2023)
- Iqaluktuuttiaq East Outflow System

0 0.25 0.5 1 km

N W E S

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Baseline Fish Community Sampling Locations, Iqaluktuuttiaq East Outflow System, 2022 and 2023

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Figure 2.5

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure 2.5 Baseline Fish Community Sampling Locations.mxd

ranging from 2.5 to 3.8 cm (45.7 m length, 1.2 m depth) and one six panel gill net with mesh sizes ranging from 2.5 to 6.4 cm (91.2 m length, 2.4 m depth) were deployed in Pond 1 on September 21, 2022, for approximately two to three hours. Due to the low number of fish caught during the initial deployment (one fish; see Section 3.3) and based on information from the 2019 baseline study which indicated that fish were generally not captured in shorter sets, the duration of deployment was increased to overnight (approximately 17 to 18 hours) with nets subsequently lifted on September 22, 2022. Supporting information recorded during fish community sampling included GPS coordinates of each fishing location (i.e., net set), amount of effort (net area and net deployment and retrieval times), and water depth.

Given restrictions on fish community sampling imposed by weather in 2022, fish sampling at the EOS was included in the 2023 baseline survey and was conducted from August 7 to 16 using minnow traps (ten ponds) and gill nets (four ponds; Figure 2.5, Table 1.1, Appendix Figures B.1 to B.4). Minnow traps were placed individually, or in groups of two traps per sampling station for overnight sets.[3] Gill net sets were deployed in Ponds 2, 3, 4 and 5e with soak times ranging from 1.5 hours to overnight sets. Gill nets were deployed either in a single panel (mesh size 3.8 cm, length 15.2 m, and height 1.2 m), three-panel (45.7 m length, 2.4 m depth), or six-panel (91.2 m length, 2.4 m depth) sets with mesh sizes ranging from 2.5 to 8.9 cm. Supporting information was recorded for each fishing gear type as described for the 2022 fishing efforts.

All fish caught during the fish community surveys were identified to the lowest possible taxonomic level (i.e., genus or species). Throughout this report, the term “cisco” represents a species complex of fish from the genus *Coregonus*, of which at least four species have been documented in the EOS (i.e., cisco, least cisco, lake whitefish, and broad whitefish; Grosbois et al. 2022). Field identification to the species level for *Coregonus spp.* is extremely difficult and unreliable in non-lethal surveys and thus was not attempted in the EOS baseline sampling program. Other species encountered included Arctic charr and ninespine stickleback which were identified as such. A subsample of individuals of each taxon caught were measured for length and body weight (target of 30 and 40 individuals in 2022 and 2023, respectively) and the remaining individuals were enumerated only. The subsample of individuals that was weighed and measured was selected to be representative of the range of size classes captured. A measuring board was used to measure fork and/or total length to the nearest millimeter. Fresh body weight was measured using a set of Pesola spring scales (size of scale selected based on fish weight).

[3] In Ponds 3 and 4a, minnow trap sets were deployed for between approximately 60 and 70 hours due to logistical constraints that prevented crews from returning to lift them. The longer duration sets did not result in an increased incidental mortality rate of fish captured (see Section 3.3).

The Pesola scales were demarcated at intervals of 1 to 2% of the total scale range, providing an accuracy of ± 0.3% of the fish mass. The Pesola spring scale for individual weight measurement was selected so that the fish weight was near the top of the scale's range to ensure that measurements achieved a resolution near 1%. Any abnormalities (i.e., deformities, erosions, lesions, and tumours [DELTs]) or parasites were also noted during the assessment and recorded on field sheets. For incidental mortalities of larger fish (i.e., Arctic charr and cisco), aging structures (pelvic fin rays or otoliths, with scales for use as back up) were removed, wrapped in waxed paper, placed in labelled coin envelopes, and then stored frozen until they could be shipped to the laboratory for aging analyses. Aging structures were shipped to AAE Tech Services Inc. in LaSalle, Manitoba for determination of fish ages. All other fish were released live at the location of capture.

The fish community in the EOS ponds was summarized based on total species richness, total catch, and catch-per-unit-effort (CPUE). Minnow trapping CPUE was calculated as the number of fish caught per trap per day (24 hours) and gill netting CPUE was calculated as the number of fish caught per 100 m^2 of net area per hour.

3 RESULTS

3.1 Stream Habitat Characterization

Stream habitat in the 12 EOS connecting channel sections assessed in September 2022 generally consisted of either shallow flat habitat, which was the only habitat type observed in the channels closest to Iqaluktuuttiaq (i.e., EO1 to EO4; Appendix Photo A.2), or shallow, slow, riffle habitat which was the dominant habitat type in most connecting channels further downstream (EO5 to EO12; Appendix Photo A.2, Table 3.1). Wetted and bankfull widths ranged from approximately 2 m to 34 m and 22 m to greater than 140 m, respectively, at the time of the survey (Table 3.1). Relatively large differences between the wetted and bankfull widths of the channels reflected the generally flat elevation of the terrain in the EOS watershed (GeoProcess 2022) which results in unconfined channels that are wide, but still relatively shallow, even under high flow conditions (ERM 2020). Stream bed substrate was dominated by large gravel at most transects across the connecting channels followed by cobble, with the proportion of boulders and fines each typically comprising less than 5% of substrate (Appendix Photos A.3 and A.4; Table 3.1). At all transects, channel banks were sloping and consisted of fines and vegetation (e.g., moss, lichen, short grasses, and shrubs). Aquatic vegetation in the form of moss and green filamentous algae was observed at transects sampled in EO5 to EO9 but was absent from the remaining channels (Appendix Photo A.5, Table 3.1). Results of physical habitat assessments in the EOS connecting channels in 2022 were consistent with results of the 2019 survey except that substrates in EO1 to EO4 were characterized as cobble dominant in 2019 (ERM 2020) but gravel dominant in 2022 (Table 3.1). This is likely due to variability by individual field scientists in visually classifying substrates at the higher and lower size ranges of gravel and cobble, respectively, rather than a change in dominant substrates over time.

Water level and flow in the EOS connecting stream channels was low at the time of the survey in September 2022. Mean wetted depths ranged from 6 cm to 38 cm but were less than 15 cm at most transects (Table 3.1). Some sections of EO1 (immediately downstream from Iqaluktuuttiaq) and in EO3 were completely dry while water levels at EO5, EO11, and EO12 were sufficiently low that they represented potential barriers to passage for large-bodied fish (Appendix Photos A.6 and A.7, Table 3.1). At the Ovayok Road crossing between Pond 1 and Pond 2, water was observed flowing through only two of the culverts on the 2022 survey dates (Appendix Photo A.1). Based on water depth and culvert position, fish passage was likely only possible for small-bodied fish through one of the culverts. Of the two culverts with flow, one was perched at the upstream end at the time of the survey (preventing fish passage in either direction) and the water depth through the other was insufficient for passage by large-bodied fish (Appendix Photo A.8).

Table 3.1: Summary of Stream Habitat Characteristics, Iqaluktuuttiaq East Outflow System, September 2022

Area	UTM (NAD 83, 13W)		Habitat			Channel Width (m)		Mean Wetted Depth (cm)	Substrate Composition (%)					Bank		Barriers [e]	Comments
	Easting	Northing	Unit	Transect	Type [a]	Wetted	Bankfull		Fines	Gravel	Cobble	Boulder	Bedrock	Shape [c]	Texture [d]		
EO1	503754	7672499	1	1	F	8.8	66.2	6	< 5	70	20	5	0	S	F/V	D/T	-
	503904	7672447	1	2	F	17.4	69.0	11	< 5	85	10	< 5	0	S	F/V	D/T	Main channel and smaller secondary channel separated by 6.8 m gravel/cobble bar
	-	-	1	2	-	4.5		7	-	-	-	-	-	-	-	-	
	503716	7672408	2	1	Dry	-	86.8	-	65 [b]	10	20	5	0	S	F/V	D/T	-
	503693	7672374	3	1	F	8.9	55.3	7	70 [b]	< 5	20	5	0	S	F/V	D/T	-
	503684	7672334	3	2	F	4.8	61.5	6	10	85	5	0	0	S	F/V	D/T	-
EO3	503877	7671768	1	1	F	27.3	102	17	< 5	60	30	< 5	0	S	F/V	N	Ice on outflow
	503904	7671747	1	2	F	25.8	47.3	38	< 5	60	35	< 5	0	S	F/V	N	-
	503919	7671681	1	3	F	22.5	> 143	7	< 5	75	20	< 5	0	S	F/V	D/T	-
EO4a	504079	7671425	1	1	F	17.1	46.5	16	< 5	20	75	5	0	S	F/V	N	Ice at channel margins
EO4	504283	7671499	1	1	F	13.9	59.5	8	< 5	90	5	5	0	S	F/V	N	Ice at channel margins
	504218	7671489	1	2	F	20.1	48.9	8	< 5	95	5	< 5	0	S	F/V	N	
EO5	503770	7670465	1	1	G	10.3	34.0	9	< 5	90	10	< 5	0	S	F/V	N	Small gravel present; more aquatic vegetation (moss, algae, etc.) on substrate than noted for previous channels
	503744	7670450	2	1	R	16.4	37.2	11	< 5	90	10	< 5	0	S	F/V	T [f]	
	503722	7670434	2	2	R	16.8	30.4	8	< 5	80	20	< 5	0	S	F/V	T [f]	
	503695	7670419	2	3	R	33.6	64.3	8	< 5	60	35	< 5	0	S	F/V	T [f]	
EO6	503423	7670306	1	1	R	22.1	42.0	9	< 5	80	15	< 5	0	S	F/V	N	green filamentous algae present
EO7	503312	7670266	1	1	R	14.1	48.9	10	< 5	70	25	< 5	0	S	F/V	N	green filamentous algae present
EO8	503208	7670234	1	1	R	8.5	21.7	15	< 5	75	20	< 5	0	S	F/V	N	green filamentous algae present
EO9	503064	7670197	1	1	R	11.8	35.7	10	< 5	75	20	< 5	0	S	F/V	N	green filamentous algae present
EO10	502747	7670020	1	1	G	15.2	31.8	14	< 5	70	25	0	0	S	F/V	N	-
	502727	7670027	1	2	G	15.4	> 85	17	0	80	15	< 5	0	S	F/V	N	-
EO11	502858	7669920	1	1	F	2.3	46.8	9	95	0	< 5	0	0	S	F/V	T	Main channel = 2.3 m wetted width but pooled water to 15.5 m width; some flowing water where main channel is constricted to about 20 to 30 cm wetted width
EO12	501885	7669400	1	1	R	7.3	22.3	10	0	85	10	5	0	S	F/V	N	Main channel and smaller secondary channel separated by 12.8 m bar
	-	-	1	1	-	2.7		8	-	-	-	-	-	S	F/V	-	
	501856	7669391	1	2	R	15.0	50.4	13	0	85	10	< 5	0	S	F/V	T	Water level is very low but flowing

Note: "-" = data not available or no comment.
[a] "F" = flat; "G" = glide; "R" = riffle.
[b] Substrate embedded in fines and vegetation (e.g., moss and lichens).
[c] "S" = sloping.
[d] "F" = fines; "V" = vegetation.
[e] "D" = dry channel; "T" = temporary; "N" = none.
[f] Water is flowing but very shallow.

Aside from low water levels or dry channel conditions, no other physical barriers to fish passage were observed. Low water levels and dry channel conditions observed in September 2022 were consistent with conditions documented in the 2019 baseline survey wherein water levels were low enough in the surveyed channels (EO1 to EO4) to be deemed an impediment to passage for larger fish by July and were subsequently observed to be dry in August (ERM 2020).

3.2 Pond Habitat Characterization

Habitat characterization in EOS ponds in September 2022 was limited by weather conditions. For the ponds where a habitat survey was initiated (Ponds 5a, 5b, and 5c), ice cover and slush in the ponds prevented the use of boats and/or reduced visibility in some littoral/sublittoral areas (Appendix Photos A.9, A.10, and A.11). Therefore, ponds that were partially characterized in 2022 were reassessed in August 2023 along with characterization of Ponds 4a, 5d, 5e, and 5f (Table 3.2).

In Pond 4a, the shoreline was dominated by cobble followed by equal ratios of gravel and sand, with littoral and sublittoral substrates also dominated by cobble (Figure 3.1, Table 3.2, Appendix Photo A.12). In Ponds 5a to 5f, sand/fines dominated the shoreline areas (Figures 3.2 and 3.3, Table 3.2), whereas littoral substrate was generally dominated by cobble with some smaller areas dominated by gravel, boulder, or fines (Figure 3.2 and 3.3, Table 3.2, Appendix Photos A.10, A.11, A.13, A.14, A.15, and A.16). Silt was the dominant sublittoral substrate type recorded in Ponds 5c to 5f in 2023, whereas cobble dominated sublittoral substrate in Ponds 5a and 5b (Figures 3.2 and 3.3; Table 3.2). Riparian vegetation at all ponds consisted of short grasses, moss, lichen, and Arctic willow (Table 3.2). Aquatic vegetation was sparse across all assessed ponds with water horsetail, moss, and algae ranging from less than 1% to less than 5% areal coverage (Table 3.2). Water temperatures throughout the water columns of Ponds 5a, 5b, and 5c in August 2023 ranged from 8.2 to 8.9 °C while DO concentrations ranged from 12.95 and 13.90 mg/L (i.e., concentrations that are protective of all life stages of cold water biota[4]; Table 3.3). In general, fish habitat features in the ponds of the EOS that were measured in multiple baseline surveys were consistent across study years (i.e., 2019, 2022, and 2023)

Under-ice *in situ* water quality profiles measured in April 2024 suggested overwintering habitat for fish is available in Ponds 4 and 5, but not in Ponds 1, 2, or 3. Within the EOS, Pond 4 and Pond 5 have the largest surface areas and greatest maximum depths (i.e., maximum depths of 4.7 and 4.8 m, respectively [ERM 2020]; Figures 1.2, 2.3, and 2.4), whereas Ponds 1, 2, and 3

[4] The CCME guideline is 9.5 mg/L for the protection of early life stages of cold water biota while 6.5 mg/L is protective of all other life stages of cold water biota (CCME 2024).

Table 3.2: Summary of Pond Habitat Characteristics, Iqaluktuuttiaq East Outflow System, September 2022 and August 2023

Year		2022			2023						
Area		Pond 5a	Pond 5b	Pond 5c	Pond 4a	Pond 5a	Pond 5b	Pond 5c	Pond 5d	Pond 5e	Pond 5f
Date Sampled		22-Sep-22	22-Sep-22	22-Sep-22	8-Aug-23	14-Aug-23	14-Aug-23	14-Aug-23	14-Aug-23	14-Aug-23	15-Aug-23
UTM	Easting	503542	503360	503270	504120	503542	503360	503270	503124	502912	502609
	Northing	7670380	7670272	7670206	7671431	7670380	7670272	7670206	7670255	7670027	7669658
Habitat Characteristics											
Size of Area Assessed (m)		Entire Waterbody Perimeter	Entire Waterbody Perimeter	Entire Waterbody Perimeter	Entire Waterbody	Entire Waterbody	Entire Waterbody	Entire Waterbody	Entire Waterbody	Entire Waterbody	Entire Waterbody
Riparian Vegetation[a]		Moss, lichen, short grasses, shrubs	Moss, lichen, short grasses, shrubs	Moss, lichen, short grasses, shrubs	Grasses, moss, arctic willow, lichen	Grasses, moss, arctic willow, lichen	N/A	Moss, lichen, short grasses, and shrubs	Grasses, moss, arctic willow, lichen	Grasses, moss, arctic willow, lichen	Grasses, moss arctic willow, lichen
Aquatic Vegetation	% Emergent	0	0	0	0	1 (Water Horsetail)	1 (Horsetail)	<1 (Horsetail)	<1 (Water Horsetail)	<1 (Water Horsetail)	1 (Water Horsetail)
	% Submergent	0	0	0	<1 (Moss)	0	0	0	0	0	0
	% Floating	0	0	0	0	0	0	0	0	0	0
	% Attached Algae	1	1	1	0	1	1	1	0	0	<5
Shoreline (% areal coverage)	% Bedrock	0	0	0	0	0	0	0	0	0	0
	% Boulder	0	0	0	1	0	0	0	5	5	2
	% Cobble	15	15	15	40	15	5	15	10	10	13
	% Gravel	0	0	0	30	0	0	0	0	0	0
	% Sand/Fines	85[a]	85[a]	85[a]	30	85	95	85	85	85	85
	% Organic Debris	0	0	0	0	0	0	0	0	0	0
	Comments	Shoreline vegetated (moss, etc.) to waters edge	Vegetated to waters edge	Vegetated to waters edge	-	-	-	-	-	-	-
Littoral Substrate (% areal coverage)	% Bedrock	0	0	0	0	0	0	0	0	0	0
	% Boulder	10	5	5	10	10	15	5	5	10	10
	% Cobble	70	65	70	75	70	65	70	70	80	60
	% Gravel	15	15	15	10	15	5	15	<5	5	0
	% Sand/Finer	5	15	10	5	5	15	10	20	5	20
	% Organic Debris	0	0	0	0	0	0	0	0	0	10
Sublittoral Substrate (% areal coverage)	% Bedrock	N/A	N/A	N/A	0	0	0	0	0	0	0
	% Boulder	N/A	N/A	N/A	10	10	5	2	10	10	10
	% Cobble	N/A	N/A	N/A	60	70	75	3	30	10	20
	% Gravel	N/A	N/A	N/A	10	0	0	0	0	0	0
	% Sand/Fines	N/A	N/A	N/A	30	20	20	95	60	80	70
	% Organic Debris	N/A	N/A	N/A	0	0	0	0	0	0	0
Comments		Ice cover reduced visibility in some areas of the littoral zone and prevented the use of a boat to assess habitat	Ice cover and slush reduced visibility and prevented the use of a boat to assess habitat	Ice cover reduced visibility in some areas of the littoral zone and prevented the use of a boat to assess habitat	Littoral and sublittoral substrate assessed	Littoral and sublittoral substrate assessed	Littoral and sublittoral substrate assessed	Littoral and sublittoral substrate assessed	Littoral and sublittoral substrate assessed	Littoral and sublittoral substrate assessed	Littoral and sublittoral substrate assessed

Note: "N/A" = data not available, "-" = none or not applicable.

[a] Shoreline was predominantly fines and vegetation

504,040 504,060 504,080 504,100 504,120 504,140 504,160 504,180 504,200 504,220

7,671,480 7,671,460 7,671,440 7,671,420 7,671,400

Pond 4a

LEGEND
Dominant Substrate Type
Littoral/Sublittoral
- Cobble
- Silt
- Silt/Fines

0 5 10 20
Meters

N W E S

Projection: North American Datum 1983 UTM Zone 13W
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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada. Base imagery on main map for East Outflow System collected in September 2021.

Substrate Composition in Pond 4a, Iqaluktuuttiaq East Outflow System, 2023

Date: July 2024
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minnow environmental inc.

Figure 3.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure 3.1 Substrate Composition in Pond 4a.mxd

503,000 503,200 503,400 503,600

7,670,400

7,670,200

Pond 5a

Pond 5c

Pond 5d

Pond 5b

Iqaluktuuttiaq

Pond 1
Pond 2
Pond 3
Pond 4
Pond 4a
Pond 5d
Pond 5a
Pond 5b
Pond 5c
Pond 5e
Pond 5
Pond 5f

Freshwater Creek

CAMBRIDGE BAY

Freshwater Creek Estuary

LEGEND

Dominant Substrate Type

Shoreline	Littoral/Sublittoral	
Boulder	Boulder	Not Surveyed
Cobble	Cobble	
Sand and Finer	Gravel	
	Silt	

Note: Not surveyed based on limited visibility to characterize substrates.

0 30 60 120
Meters

N W E S

Projection: North American Datum 1983 UTM Zone 13W

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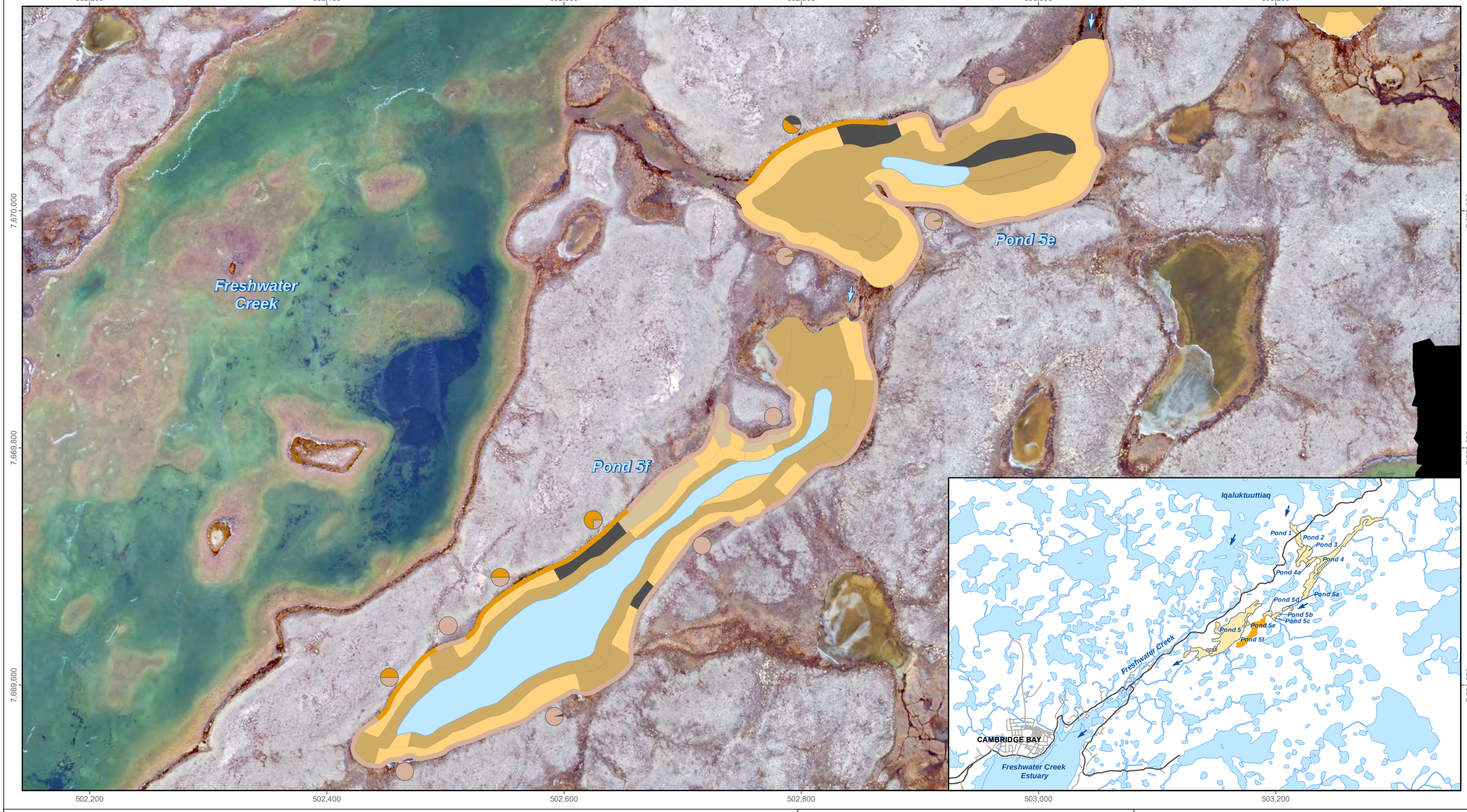
Substrate Composition in Ponds 5a, 5b, 5c, and 5d, Iqaluktuuttiaq East Outflow System, 2023

Date: July 2024
Project 237202.0071

minnow environmental inc.

Figure 3.2

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure 3.2 Substrate Composition in Ponds 5a, 5b, 5c, 5d.mxd



LEGEND

Dominant Substrate Type

Shoreline
- Boulder
- Cobble
- Sand and Finer

Littoral/Sublittoral
- Boulder
- Cobble
- Organics
- Silt

- Not Surveyed

Note: Not surveyed based on limited visibility to characterize substrates.

0 55 110 220
Meters

N W E S

Projection: North American Datum 1983 UTM Zone 13W

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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada. Base imagery on main map for East Outflow System collected in September 2021.

Substrate Composition in Ponds 5e and 5f, Iqaluktuuttiaq East Outflow System, 2023

Date: July 2024
Project 237202.0071

minnow environmental inc.

Figure 3.3

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure 3.3 Substrate Composition in Ponds 5e and 5f.mxd

Table 3.3: Water Quality Depth Profile Measurements, Iqaluktuuttiaq East Outflow System, August 2023 and April 2024

Area	Station	Date	UTM (11U, NAD83)		Depth from top of ice	Ice Thickness	Depth under ice	Water Depth Reading	Temperature	Dissolved Oxygen		Conductivity	Specific Conductivity
		dd-mmm-yy	Easting	Northing	(m)	(m)	(m)	(m)	(°C)	(mg/L)	(%)	(µS/cm)	(µS/cm)
Open Water (August 2023)													
Pond 5a	P5a-1	14-Aug-23	503564	7670408	-	-	-	0.0	8.2	13.90	120.7	-	-
					-	-	-	0.5	8.2	13.57	118.5	-	-
					-	-	-	1.0	8.3	13.50	115.0	-	-
Pond 5b	P5b-1	14-Aug-23	503327	7670266	-	-	-	0.0	8.8	12.95	114.2	-	-
					-	-	-	0.5	8.8	12.97	114.6	-	-
					-	-	-	1.0	8.8	12.96	114.2	-	-
Pond 5c	P5c-1	14-Aug-23	-	-	-	-	-	0.0	8.9	13.82	121.3	-	-
					-	-	-	0.5	8.8	13.74	120.8	-	-
Under-Ice (April 2024)													
Pond 1	P1-DP-1	8-Apr-24	503645	7672175	1.19	1.19	-	-	-	-	-	-	-
Pond 2	P2-DP-1	08-Apr-24	503770	7671929	2.46	1.97	0.49	2.0	-0.8	2.10	14.9	9,345	18,434
	P2-DP-2	08-Apr-24	503814	7671973	2.41	1.97	0.44	2.2	-1.0	2.76	19.6	11,622	23,143
Pond 3	P3-DP-1	8-Apr-24	503937	7671589	2.28	1.92	0.36	2.0	0.3	1.13	8.0	6,535	12,374
Pond 4	P4-DP-1	7-Apr-24	504296	7671589	3.79	1.94	1.85	2.0	-0.2	1.95	12.8	1,204	2,318
								2.5	-0.1	1.38	9.1	1,164	2,238
								3.0	0.0	1.65	11.2	1,190	2,278
								3.5	0.1	1.46	9.7	1,219	2,327
	P4-DP-2	7-Apr-24	504394	7671334	1.95	1.95	-	-	-	-	-	-	-
	P4-DP-3	7-Apr-24	504077	7671014	2.50	1.93	0.57	2.0	-0.2	1.95	12.9	1,751	3,379
								2.4	-0.2	1.09	7.2	1,689	3,266
	P4NE-DP-1	6-Apr-24	504694	7671680	3.90	1.89	2.01	2.0	-0.8	5.57	35.6	33.0	65.1
								2.5	-0.7	5.15	33.2	34.8	68.9
								3.0	-0.7	4.79	31.0	37.9	47.8
								3.5	-0.6	4.50	29.2	41.8	82.2
	P4NE-DP-2	6-Apr-24	504664	7671638	4.28	2.34	1.94	2.5	0.3	1.70	11.5	1,601	3,027
								3.0	0.4	1.53	10.3	1,606	3,032
								3.5	0.6	1.13	7.6	1,618	3,038
								4.0	0.5	0.92	8.3	1,486	2,792
	P4NE-DP-3	7-Apr-24	504429	7671512	3.91	1.99	1.92	2.0	-0.2	6.93	46.5	1,357	2,614
								2.5	0.0	5.21	34.6	1,373	2,632
								3.0	0.2	5.14	34.9	1,399	2,658
								3.5	0.4	5.45	37.3	1,441	2,724
	P4SW-DP-1	6-Apr-24	503967	7670672	2.81	1.97	0.84	2.0	-0.2	6.02	40.5	260.2	501.2
								2.5	-0.2	4.16	27.2	305.7	592.8
	P4SW-DP-2	6-Apr-24	503982	7670726	0.55	0.55	-	-	-	-	-	-	-
	P4SW-DP-3	6-Apr-24	504000	7670790	4.15	1.85	2.30	2.5	-0.5	7.89	50.5	44.6	86.7
								3.0	-0.4	7.10	46.3	44.0	85.2
								3.5	-0.4	6.37	41.4	46.5	90.6
								4.0	-0.4	6.00	39.3	50.8	98.7
	P4SW-DP-4	7-Apr-24	504072	7670935	2.72	1.95	0.77	2.0	-0.2	1.11	7.0	1,578	3,040
								2.5	-0.1	0.75	5.0	1,514	2,912
Pond 5	P5MB-DP-1	6-Apr-24	502521	7669534	3.55	1.93	1.62	2.5	-0.2	1.62	10.8	1,405	2,709
								3.0	-0.1	1.09	7.2	1,418	2,727
								3.5	0.1	0.92	6.0	1,295	2,448
	P5MB-DP-2	6-Apr-24	502515	7669879	3.62	1.93	1.69	2.0	-0.1	6.44	43.1	1,422	2,737
								2.5	-0.2	5.10	34.0	1,431	2,752
								3.0	-0.2	4.28	29.1	1,444	2,779
								3.5	-0.2	3.96	26.9	1,423	2,734
	P5MB-DP-3	6-Apr-24	502477	7669842	3.60	1.90	1.70	2.0	-0.2	6.61	43.7	1,454	2,797
								2.5	-0.1	5.25	35.2	1,460	2,809
								3.0	-0.1	5.00	33.5	1,428	2,747
								3.5	-0.1	4.58	30.8	1,561	2,996
	P5-DP-1	7-Apr-24	502544	7670205	2.57	1.94	0.63	2.0	0.0	11.3	74.6	1,396	2,672
	P5-DP-2	7-Apr-24	502328	7670064	2.46	2.02	0.44	2.0	-0.2	2.98	19.8	1,157	2,231
								2.5	-0.1	2.55	16.8	1,170	2,244
	P5-DP-3	7-Apr-24	502102	7669530	2.93	1.94	0.99	2.0	-0.2	1.36	8.9	1,547	2,980
								2.5	-0.2	0.88	5.5	1,549	2,984

Notes: "-" indicates data not available.

are comparatively smaller and shallower (i.e., less than 2.4 m maximum depths [ERM 2020]; Figures 1.2 and 2.2). Ice thickness across all ponds assessed ranged from approximately 1.9 m to 2.3 m, suggesting that only pond areas with open water depths greater than approximately 2 m were not frozen to the substrate at the time of the survey (Table 3.3).

During the under-ice water quality assessment, Pond 1 was frozen to the substrate at the single *in situ* water quality profile station (P1-DP-1; Table 3.3) located at the deepest area of the pond (maximum depth = 1.4 m; ERM 2020). This result suggests that Pond 1 was likely frozen to the substates over its entire area in April 2024. There was water under the ice at both of the *in situ* water quality profile stations in Pond 2 (under-ice water depths of 0.49 and 0.44 m; Table 3.3). Based on contours from a bathymetric survey of Pond 2 (ERM 2020; Figure 2.2), the profile stations were located in small areas in the deepest part of the pond that would have been isolated from each other by adjacent shallower areas that were likely frozen to the substrate. Under-ice water quality in Pond 2 indicated high specific conductivity (18,434 µS/cm and 23,143 µS/cm) and near hypoxic[5] DO concentrations (2.10 mg/L and 2.76 mg/L; Table 3.3, Figure 3.4). There was also water under the ice at the only *in situ* water quality profile station in Pond 3 (under-ice water depth of 0.36 m; Table 3.3). Specific conductivity was also high under the ice in Pond 3 (12,374 µS/cm) while the DO concentration was low enough to indicate hypoxic conditions (1.13 mg/L; Table 3.3, Figure 3.4). High specific conductivity in small, isolated areas under the ice in Pond 2 and Pond 3 likely resulted from ion exclusion during freeze up and ice thickening periods, causing concentration of ions in the remaining water. Dissolved oxygen is generally negatively related to conductivity but low DO concentrations in Pond 2 and Pond 3 likely also reflected depletion by biological processes under the ice (i.e., primary producer and sediment consumption). Overall, Ponds 1, 2, and 3 had no or negligible amounts of overwintering habitat given limited areas that were not frozen to the bottom and water quality conditions that are generally not suitable for fish.

Water depth and quality under the ice in Pond 4 and Pond 5 in April 2024 suggested overwintering habitat for fish was present in limited areas of each pond. In Pond 4, the under-ice water depth was between 1.8 and 2.3 m at five of the ten *in situ* water quality profile stations (Table 3.3). Of those stations, three were in the northeast basin (i.e., P4NE-DP-1 to 3), one was in the southwest basin (P4SW-DP-3), and one was near the inflow from Pond 4a (P4-DP-1; Figure 2.3). Relative to the CCME guidelines for the protection of cold water biota (CCME 2024), DO only met

[5] Water is generally considered hypoxic when DO concentrations are less than approximately 2.0 mg/L.

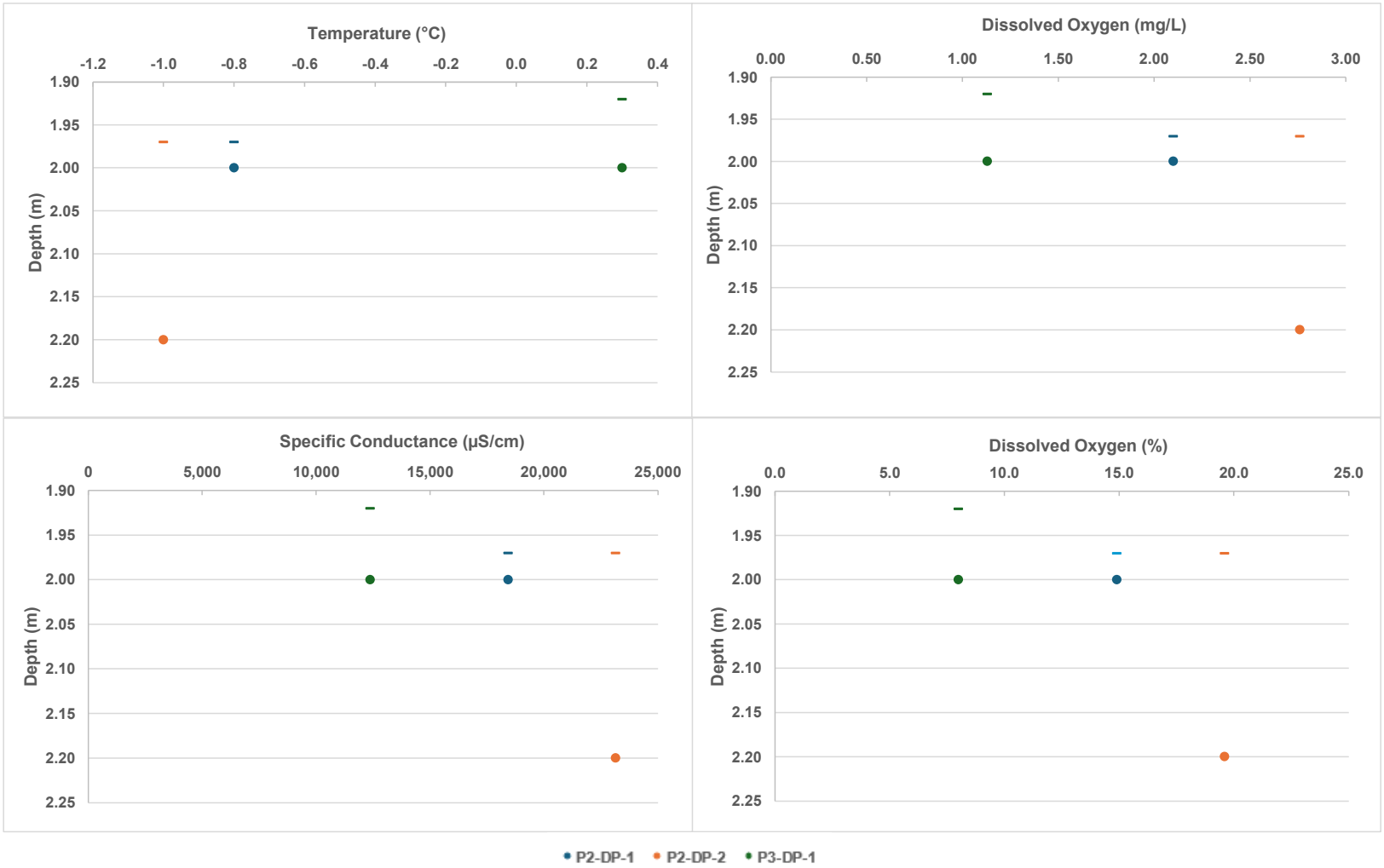

Figure 3.4: Ice Thickness and Under-Ice Water Temperature, Dissolved Oxygen, and Specific Conductance in Pond 2 and Pond 3, Iqaluktuuttiaq East Outflow System, April 2024

Notes: Depth is measured from top of ice surface (0 m). Dashed lines indicate ice thickness (i.e., bottom of the ice surface).

the 6.5 mg/L guideline[6] over the majority of the water column at P4SW-DP-3, which was the Pond 4 station with the greatest under-ice water depth (Table 3.3, Figure 3.5). Other profile stations in the southwest basin were frozen to the substrates or had under-ice water depths less than 1 m with DO concentrations of ≤ 6.0 mg/L (Table 3.3, Figure 3.5). Bathymetric data collected in 2019 suggests other portions of the southwest basin may have greater depth under-ice than reflected by 2024 profile sampling (ERM 2020; Figure 2.3). These habitats may not have been captured in the 2024 surveys given their relatively small areas and the difficultly of precisely augering holes at exact locations given ice thickness near 2 m. All three *in situ* water profile locations in the northeast basin of Pond 4, had under-ice water depths greater than 1.9 m and two of the stations had DO concentrations between 4.50 and 6.93 mg/L (Table 3.3, Figure 3.5) which were close to or exceeded the CCME 6.5 mg/L guideline (CCME 2024). Conductivity ranged from very low (approximately 30 to 50 µS/cm) at the deepest two stations to moderate (approximately 1,200 to 1,750 µS/cm) across the remaining stations (Table 3.3, Figure 3.5).

Under-ice water depth in the deepest basin of Pond 5, along the southeast shoreline (Figure 2.4), was between 1.6 and 1.7 m (Table 3.3). At two of the three *in situ* water quality profile stations in this area, DO concentrations were close to or above the CCME 6.5 mg/L criteria for the protection of cold water biota (stations P5MB-DP-2 and P5-DP-3; DO range of 3.96 to 6.61 mg/L; Table 3.3, Figure 3.6). At these stations, DO was only ≥ 6.5 mg/L at the ice-water interface and decreased with increasing depth (Table 3.3, Figure 3.6). All other stations in Pond 5 had hypoxic or near-hypoxic under-ice DO concentrations (Table 3.3, Figure 3.6). Under-ice conductivity was moderate throughout Pond 5 (approximately 1,150 to 1,550 µS/cm; Table 3.3, Figure 3.6). Overall, habitats potentially suitable for supporting overwintering fish were present in Pond 4 and Pond 5 of the EOS, though they were limited in area and, in some cases, had marginal water quality. All water quality profile stations where potential overwintering fish habitat was identified were within relatively large and interconnected areas of the ponds with open water depths greater than 2 m (Figures 2.3 and 2.4).

3.3 Fish Community

The fish community present in the EOS based on minnow trapping and gillnetting efforts completed in September 2022 and August 2023 included Arctic charr, cisco, and ninespine stickleback (Tables 3.4 and 3.5). This is similar to the fish community documented during sampling completed in the EOS in July 2019, except cisco were not captured during fishing in 2019 (ERM 2020).

[6] Protective of all but the early life stages of biota.

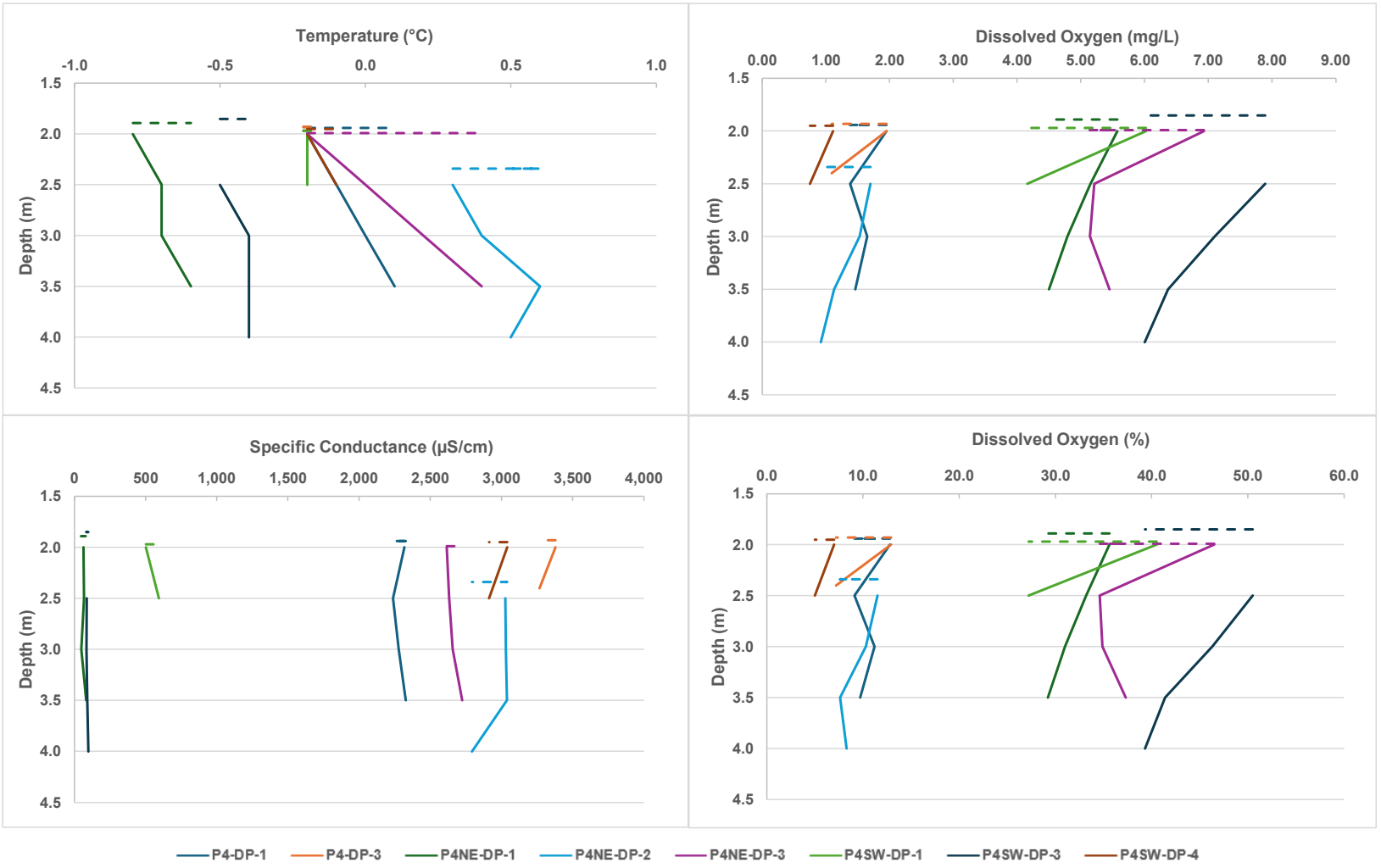

Figure 3.5: Ice Thickness and Under-Ice Water Temperature, Dissolved Oxygen, and Specific Conductance in Pond 4, Iqaluktuuttiaq East Outflow System, April 2024

Notes: Depth is measured from top of ice surface (0 m). Dashed lines indicate ice thickness (i.e., bottom of the ice surface).

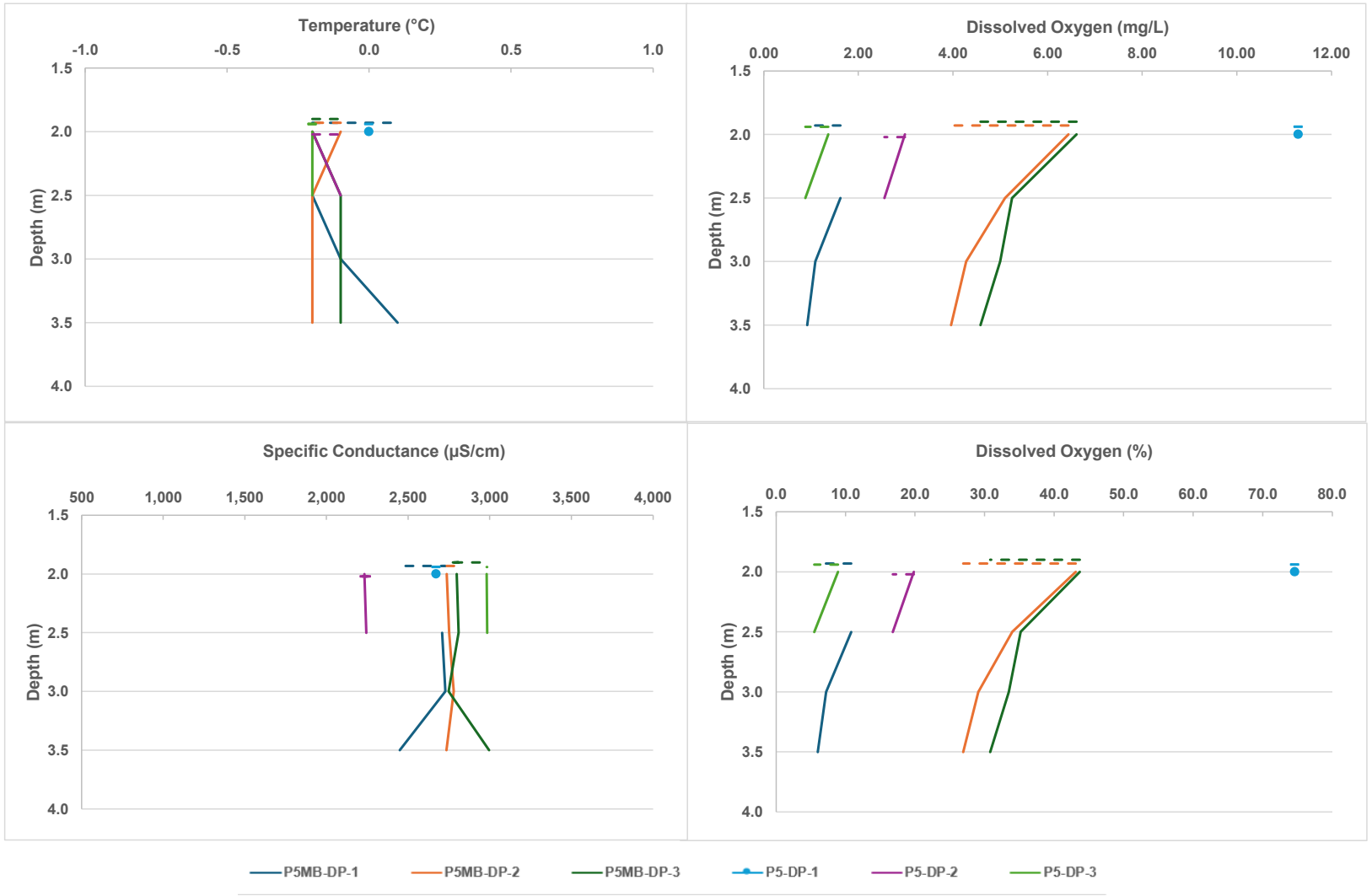

Figure 3.6: Ice Thickness and Under-Ice Water Temperature, Dissolved Oxygen, and Specific Conductance in Pond 5, Iqaluktuuttiaq East Outflow System, April 2024

Notes: Depth is measured from top of ice surface (0 m). Dashed lines indicate ice thickness (i.e., bottom of the ice surface).

Table 3.4: Summary of Minnow Trap Catch and Catch-per-Unit-Effort, Iqaluktuuttiaq East Outflow System, September 2022 and August 2023

Area	Year	Ninespine Stickleback			Cisco (*Coregonus* spp.)[a]		
		Catch	Mortalities/ Sacrificed	CPUE[b]	Catch	Mortalities/ Sacrificed	CPUE[b]
Pond 1	2022	25	0	1.08	0	0	0.00
Pond 2	2022	145	0	8.48	6	1	0.35
	2023	1,093	24	20.68	0	0	0.00
Pond 3	2023	123	1	1.22	0	0	0.00
Pond 4	2023	649	15	15.51	0	0	0.00
Pond 4a	2023	101	4	1.72	0	0	0.00
Pond 5a	2023	10	1	1.08	0	0	0.00
Pond 5b	2023	1	1	0.13	0	0	0.00
Pond 5c	2023	13	0	1.31	0	0	0.00
Pond 5d	2023	12	0	0.63	0	0	0.00
Pond 5e	2023	56	0	3.04	0	0	0.00
Pond 5f	2023	42	0	3.04	0	0	0.00
	Total	**2,270**	**46**	**6.08**	**6**	**1**	**0.02**

Notes: "CPUE" = catch-per-unit-effort.

[a] "Cisco" refers to a species complex of at least 4 co-occurring *Coregonus* species in the study area (cisco, least cisco, lake whitefish and broad whitefish)

[b] CPUE = total number of fish caught per trap day.

Table 3.5: Summary of Gill Net Catch and Catch-per-Unit-Effort, Iqaluktuuttiaq East Outflow System, September 2022 and August 2023

Waterbody	Year	Cisco[a]			Arctic Charr		
		Catch	Mortalities	CPUE[b]	Catch	Mortalities	CPUE[b]
Pond 1	2022	1	1	0.018	2	2	0.036
Pond 2	2023	24	15	0.911	4	2	0.152
Pond 3		3	2	0.029	5	3	0.049
Pond 4		15	6	0.169	35	14	0.393
Pond 5e		1	1	0.097	1	0	0.097
Total		**43**	**24**	**0.158**	**45**	**19**	**0.165**

Note: "CPUE" = catch-per-unit-effort.

[a] "Cisco" refers to a species complex of at least 4 co-occurring *Coregonus* species in the study area (cisco, least cisco, lake whitefish and broad whitefish).

[b] CPUE calculated as the number of fish caught per 100 m^2 of net area per hour.

In September 2022, minnow trapping in Ponds 1 and 2 captured a total of 25 and 145 ninespine stickleback, respectively (CPUE = 1.08 and 8.48 fish/trap day, respectively; Table 3.4, Appendix Table B.1). Additionally, six young-of-the-year cisco (fork lengths of 5 cm or less) were caught by minnow trapping in Pond 2 (CPUE = 0.35 fish/trap day; Table 3.4, Appendix Table B.1 and B.3). During the initial, short duration gill net set in Pond 1, a single adult cisco (age 6) was caught. Two adult Arctic charr were subsequently caught in the overnight gill net sets in Pond 1 (ages 4 and 6; Table 3.5, Appendix Tables B.2 and B.3, Appendix Photo A.17). In addition to fish caught from minnow trapping and gill netting in Ponds 1 and 2, one adult Arctic charr was observed in channel EO7, between Ponds 5b and 5c (Figure 1.2, Appendix Photo A.18) during the stream channel habitat assessment surveys. This fish was likely restricted from migrating/accessing habitat further upstream due to low water levels observed at channel EO6 (Appendix Photo A.19).

During fish community sampling in August 2023, a total of 2,100 ninespine stickleback were captured in minnow traps across the ten sampled ponds (Table 3.4). Pond 2 and 4 had the highest relative abundance of ninespine stickleback (CPUE = 20.68 and 15.51 fish/ trap day, respectively; Table 3.4, Appendix Table B.1) whereas relative abundance of ninespine stickleback was lowest at Pond 5b and 5d (CPUE = 0.13 and 0.63 fish/trap day, respectively; Table 3.4, Appendix Table B.1). Gill netting in Pond 1, 2, 3, 4 and 5e resulted in a total catch of 43 cisco and 45 Arctic charr (Table 3.5, Appendix Table B.2). Total fish catch and CPUE from gill netting was higher in Pond 2 and Pond 4 than in Ponds 1, 3, and 5e with highest relative abundance of cisco and Arctic charr documented in Pond 2 and Pond 4, respectively (CPUE = 0.911 and 0.393 fish/100 m^2 net per hour, respectively; Table 3.5, Appendix Table B.2).

Fish morphometric data summarized by sampling year (i.e. 2022 and 2023) is provided in Appendix Tables B.3 and B.4. Total lengths of ninespine stickleback were similar across all sampled ponds in both sampling years, generally ranging from approximately 4 to 8 cm (Appendix Table B.4). Incidental mortalities of cisco and Arctic charr (i.e., individuals from which aging structures were collected) ranged from age 1 to 12 (mean = 4 years) and age 3 to 9 (mean = 5 years), respectively (Appendix Table B.4). On average, Arctic charr and cisco from Pond 4 were both the largest (based on mean length) and oldest (based on the age of incidental mortalities; Appendix Table B.4). In both the 2022 and 2023 sampling, abnormalities in fish appearance and condition (DELTs) were rare. No DELTs were recorded for cisco and Arctic charr while only a small proportion of ninespine stickleback had DELTs (< 0.01%) in the form of parasites or deformities (Appendix Table B.4).

4 SUMMARY AND CONCLUSIONS

Baseline fish habitat and community data were collected in ponds and connecting stream channels in the EOS in September 2022 and August 2023 to supplement baseline data collection completed in 2019 (ERM 2020). In September 2022, planned data collections were limited by weather conditions on the survey dates and therefore additional baseline data collection was completed in August 2023.

Overall, stream and pond habitat characterizations in 2022 and 2023 were consistent with EOS habitat assessments conducted in 2019. Streams consisted primarily of gravel/small cobble dominated, shallow, flat or slow flowing riffle habitats with relatively undefined banks and riparian vegetation consisting of moss, lichen, short grasses and shrubs. Water levels were low at the time of the 2022 stream habitat survey and some sections of the surveyed channels were completely dry (e.g., EO1 and EO3). Only one culvert at the Ovayok Road was not perched at the time of the 2022 survey and the low water level in the culvert suggested it was only suitable for passage by small-bodied fish. The habitat assessments completed in the EOS to date indicate that there is a period during high flows where stream habitats in the EOS provide fair quality habitat for cisco, Arctic charr, and ninespine stickleback migration, nursery, and foraging but that habitat quality declines rapidly with declining flows, particularly for large-bodied species (Evans et al. 2002, ERM 2020, Minnow 2022). At the time of the baseline surveys in 2022 and 2023, habitat for larger Arctic charr and cisco was mostly limited to ponds in the EOS as water levels were too low in many of the stream channels for migration and foraging by large-bodied fish. However, stream habitats (except those that dried up completely) generally remained suitable for ninespine stickleback migration, nursery, and foraging throughout the open water season. In general, when the depths of stream channel connections in the EOS decrease and/or the channels dry up with receding flows, the potential for migration between waterbodies in the EOS (i.e., access to deeper waterbodies with overwintering habitat), to Iqaluktuuttiaq, and/or to the estuarine/marine environment becomes extremely limited.

Ponds in the EOS in which physical fish habitat characteristics were quantified in 2022 and 2023 (Ponds 4a, and 5a to 5f) had littoral substrates that were dominated by cobble, with sublittoral substrates consisting of a mix of cobble, sand, and fines. Sublittoral habitats in Ponds 4a, and 5a to 5f, had suitable habitat for Arctic charr and cisco nursery and foraging (Hancock 2020, Richardson et al. 2002). In particular, preferred nursery habitat for cisco is in water less than 1 m in depth over hard, mixed, or coarse substrates (Hancock 2020) which is consistent with the habitat in Pond 2 where young-of-the year cisco were caught during the 2022 survey.

Under-ice *in situ* water quality profiles measured in April 2024 showed that Ponds 1, 2, and 3 provide no or marginal overwintering habitat. This is based on ice extending to the substrate in most cases, or, in the very limited areas with shallow water under the ice, concentrations of DO indicating hypoxic or near hypoxic conditions. Because barriers to migration have been documented both upstream and downstream of these ponds under certain flow conditions, including the low flow period immediately prior to freeze-up, there is potential for fish to become stranded. Based on results of the under-ice water quality assessment, fish stranded in these ponds would not be expected to survive the winter. Under-ice conditions in Pond 4 and Pond 5 in April 2024 suggested these ponds were more suitable for supporting overwintering fish. Water quality profile sampling identified potential overwintering fish habitat within relatively large and interconnected areas of the ponds with open water depths between 2 m and 5 m. These locations had under-ice water depths of up to 2 m. While DO concentrations in the upper part of the water column were often suitable for all but the earliest life stages of cold water biota, they decreased with increasing depth, frequently resulting in only marginal water quality in the majority of the available overwintering area.

Cisco (genus *Coregonus*; i.e., cisco, least cisco, lake whitefish, and broad whitefish), Arctic charr, and ninespine stickleback were captured in multiple ponds in the EOS using minnow traps and gill nets, with the highest relative abundance of all species recorded in Ponds 2 and 4 in 2022 and 2023. Higher relative abundance of fish in Pond 2 potentially reflects its location in the EOS watershed, including its proximity to Iqaluktuuttiaq (i.e., it is the second waterbody downstream of Iqaluktuuttiaq in the EOS) and position relative to potential fish migration barriers (e.g., culverts on the Ovayok Road). The proximity of Pond 2 to Iqaluktuuttiaq represents the potential for fish to reach Pond 2 from Iqaluktuuttiaq during the high flow period, before low flow and dry channel barriers begin to impede fish movement throughout the EOS (i.e., noted as early as July in 2019; ERM 2020). Pond 2 is also located directly downstream of the culverts on the Ovayok Road that have been documented to be impediments to upstream fish passage under high flow conditions due to the velocity of flows through the culverts as well as to upstream and downstream fish passage under low flow conditions when they are perched and/or have limited depth or no flow (ERM 2020). Therefore, baseline study results to date suggest that fish reach Pond 2 from Iqaluktuuttiaq early in the open water season but are then prevented from returning upstream to the lake through the culverts under most flow conditions, stranding them in the EOS and potentially in Pond 2 itself (depending on seasonal fish passage potential to the ponds further downstream in the EOS).

The greater relative abundance of Arctic charr and cisco in Pond 4 in the 2023 surveys, in addition to the fact that fish caught in this pond were both the largest (based on mean length) and oldest (based on the age of incidental mortalities) may reflect its relatively greater size

and depth. Foraging Arctic charr and cisco prefer habitats with depths greater than 2 m with mixed or coarse substrates over shallower areas with similar substrates (Hancock 2020, Richardson et al. 2002). Therefore, larger fish that access the EOS from Iqaluktuuttiaq may migrate as far downstream as Pond 4 to reach these preferred habitats, given that the upstream ponds are smaller and shallower. While under-ice water quality surveys in April 2024 suggest conditions in Pond 4 (and Pond 5 further downstream) that may support overwintering fish, it is still unconfirmed whether any fish use these habitats under-ice, and if so, if they are able to survive over winter under baseline conditions.

Overall, results of baseline fish habitat and fish community surveys in the EOS in 2022 and 2023 confirm initial results from 2019 (ERM 2020) and continue to support the viability of improvements to habitat and connectivity in the EOS as a potential offsetting measure for the Project. In particular, seasonal barriers to fish migration observed in connecting stream channels suggest that habitat enhancements to improve migration potential (including access to overwintering habitats that are required for survival) would be effective. Further, under-ice conditions indicating no (Ponds 1, 2, and 3) or limited amounts of overwintering habitat with marginal water quality (Pond 4 and Pond 5) suggest that there is capacity for habitat enhancements to improve overwintering habitat availability and quality throughout the EOS.

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APPENDIX A
PHOTOS

Photo A.1: Culvert Outlets at the Ovayok Road Crossing of the Iqaluktuuttiaq East Outflow System, September 2022 (top) and August 2023 (bottom)

Photo A.2: Representative Flat (EO4, Top) and Riffle (EO5, Bottom) Stream Habitat Types in the Iqaluktuuttiaq East Outflow System, September 2022

Photo A.3: Typical Substrate in Stream Habitat of the Iqaluktuuttiaq East Outflow System Represented by EO4 (Top) and EO5 (Bottom), September 2022

Photo A.4: Typical Substrate in the Stream Habitat of Iqaluktuuttiaq East Outflow System Represented by EO6, September 2022

Photo A.5: **Aquatic Vegetation in EO5 (Top) and EO9 (Bottom) in the Iqaluktuuttiaq East Outflow System, September 2022**

Photo A.6: Dry Sections of Stream Channel in EO1 in the Iqaluktuuttiaq East Outflow System, September 2022

Photo A.7: Dry Section of Stream Channel in EO3 (Top) and Low Water Level in Stream Channel EO5 (Bottom) in the Iqaluktuuttiaq East Outflow System, September 2022

Photo A.8: Limited Water Depth and Flow through the Only Culvert that was Wetted and not Perched on the Survey Date (Facing Upstream), September 2022

Photo A.9: Ice and Slush in the Littoral Area of Pond 5a in the Iqaluktuuttiaq East Outflow System, September 2022

Photo A.10: Littoral Substrates Through Ice Cover (top), September 2022 and Turbulent Water Surface (bottom), August 2023 at Pond 5b, Iqaluktuuttiaq East Outflow System, September 2022

Photo A.11: Limited Visibility Through Ice Cover (top), September 2022 and Littoral Substrates (bottom), August 2023 at Pond 5c, Iqaluktuuttiaq East Outflow System

Photo A.12: Shoreline and Littoral Substrates in Pond 4a, Iqaluktuuttiaq East Outflow System, August 2023

Photo A.13: Littoral Substrates Through Ice Cover (top), September 2022 and Wave Action (bottom), August 2023 at Pond 5a, Iqaluktuuttiaq East Outflow System, September 2022

Photo A.14: Shoreline Substrates in Pond 5d, Iqaluktuuttiaq East Outflow System, August 2023

Photo A.15: Shoreline Substrates and Vegetation in Pond 5e, Iqaluktuuttiaq East Outflow System, August 2023

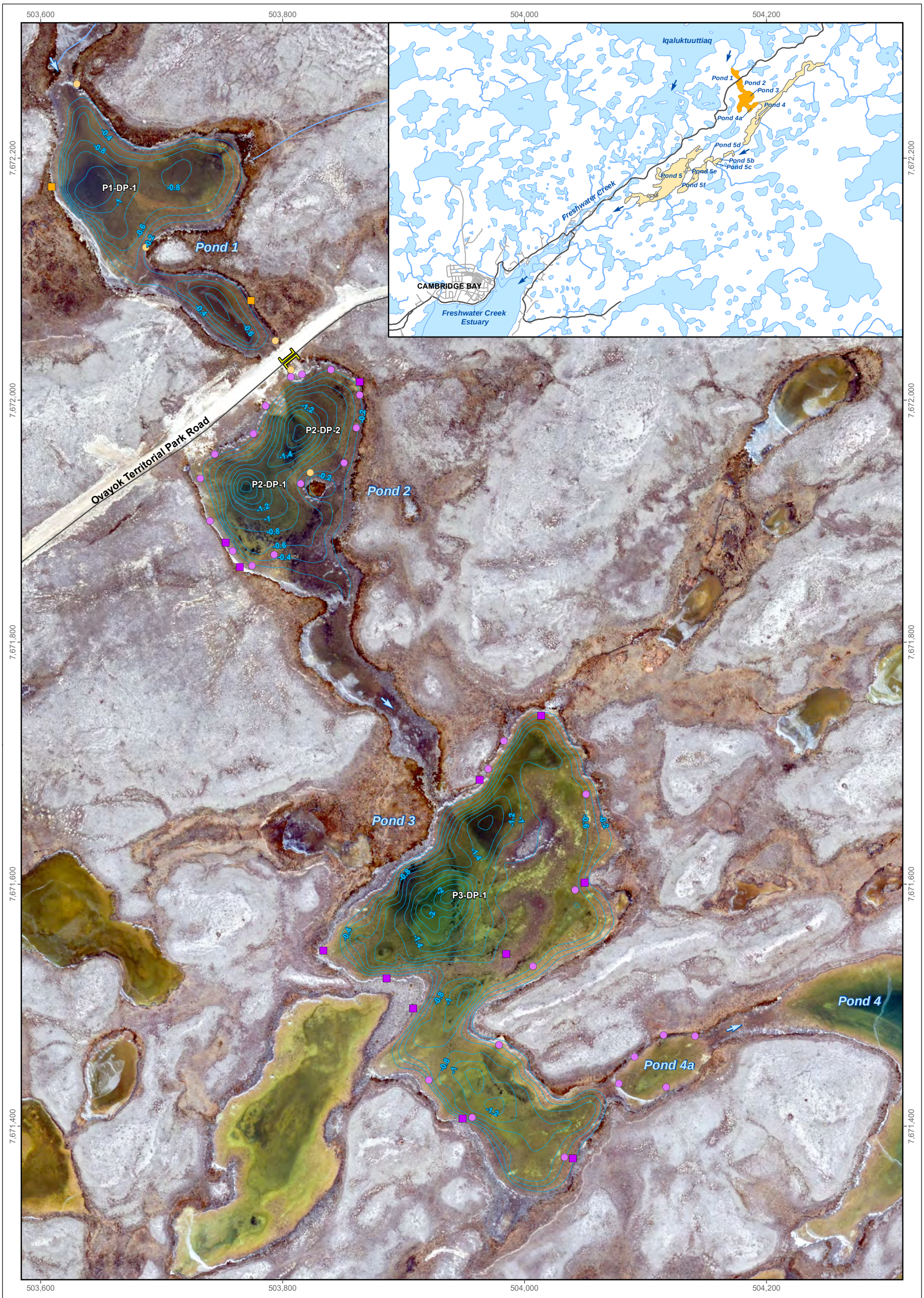
Photo A.16: Shoreline Substrates and Vegetation in Pond 5f, Iqaluktuuttiaq East Outflow System, August 2023

Photo A.17: Adult Arctic Char Caught by Gill Netting in Pond 1, Iqaluktuuttiaq East Outflow System, September 2022

Photo A.17: Adult Arctic Char Observed in EO7, Iqaluktuuttiaq East Outflow System, September 2022

Photo A.19: Looking Upstream at the EO6 Channel, Iqaluktuuttiaq East Outflow System, September 2022

APPENDIX B
FISH COMMUNITY SAMPLING DATA



LEGEND

- Gillnet Location (2022)
- Gillnet Location (2023)
- Minnow Trap Location (2022)
- Minnow Trap Location (2023)
- Bathymetry (.2 m interval)
- Ovayok Territorial Park Road Crossing Culvert

Minnow Trap and Gillnet Fish Community Sampling Locations Ponds 1, 2, 3, and 4a, Iqaluktuuttiaq East Outflow, 2022 and 2023

0 50 100 200
Meters

Projection: North American Datum 1983 UTM Zone 13N

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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada. Base imagery on main map collected in September 2021.

Date: July 2024
Project 237202.0071

minnow environmental inc.

Figure B.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure B.1 Minnow Trap and Gillnet Fish Community Sampling Locations Ponds 1, 2, 3, and 4a .mxd

504,000 504,500 505,000

7,672,500 7,672,000 7,671,500 7,671,000

Ovayok Territorial Park Road

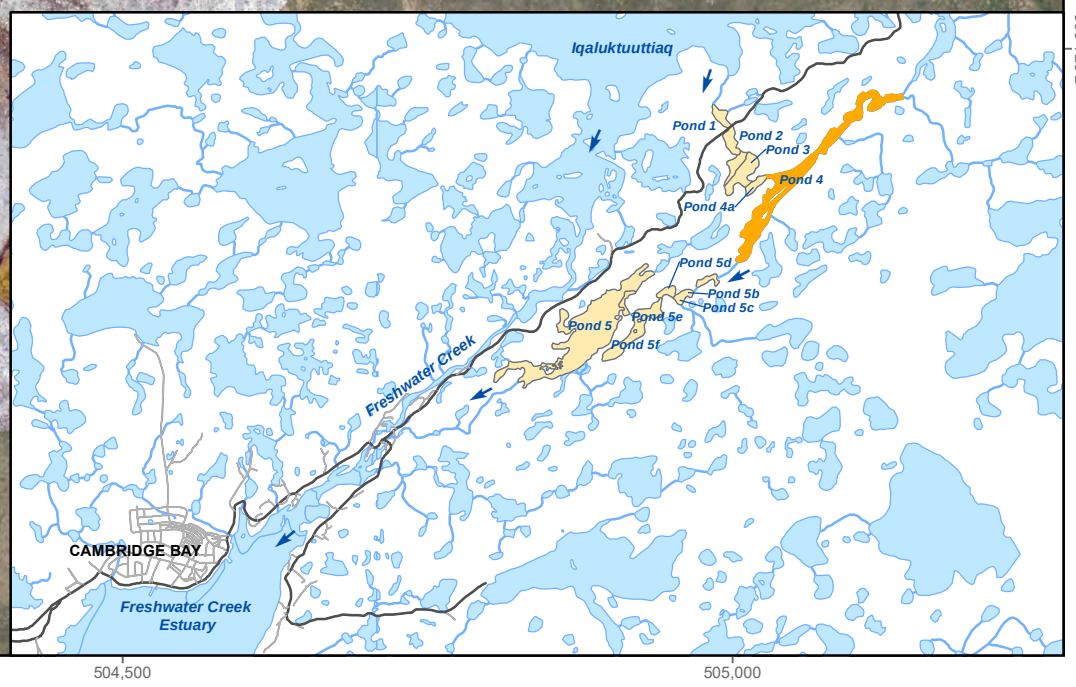
Pond 2

Pond 3

Pond 4

Pond 4a

-0.5 -1 -1.5 -2 -2.5 -3 -3.5



504,000 504,500 505,000

LEGEND

- Gillnet Location (2023)
- Minnow Trap Location (2023)
- Pond 4 Bathymetry (.5 m interval)

Minnow Trap and Gillnet Fish Community Sampling Locations Pond 4, Iqaluktuuttiaq East Outflow, 2022 and 2023

0 100 200 400
Meters

Projection: North American Datum 1983 UTM Zone 13N

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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada. Base imagery on main map for East Outflow System collected in September 2021.

N W E S

Date: July 2024
Project 237202.0071

minnow environmental inc.

Figure B.2

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure B.2 Minnow Trap and Gillnet Fish Community Sampling Locations Pond 4.mxd

503,000 503,200 503,400 503,600

7,670,400

7,670,200

Pond 5a

Pond 5c

Pond 5d

Pond 5b

Iqaluktuuttiaq

Pond 1
Pond 2
Pond 3
Pond 4
Pond 4a
Pond 5d
Pond 5a
Pond 5b
Pond 5c
Pond 5
Pond 5e
Pond 5f

Freshwater Creek

CAMBRIDGE BAY

Freshwater Creek Estuary

LEGEND

- Minnow Trap Location (2023)

0 30 60 120

Meters

N W E S

Projection: North American Datum 1983 UTM Zone 13W

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Minnow Trap and Gillnet Fish Community Sampling Locations Ponds 5a, 5b, 5c, and 5d, Iqaluktuuttiaq East Outflow, 2022 and 2023

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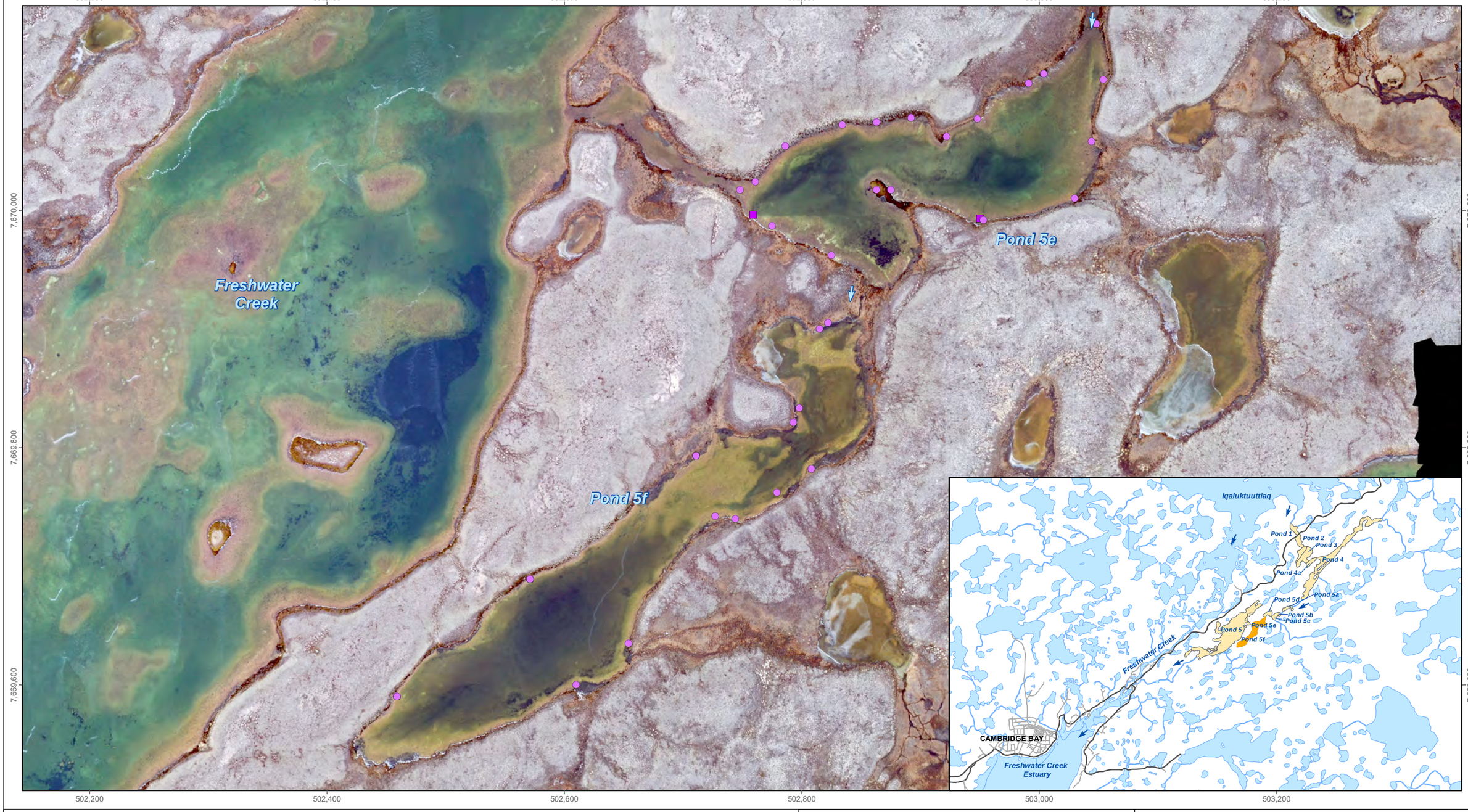
Figure B.3

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure B.3 Minnow Trap and Gillnet Fish Community Sampling Locations Ponds 5a, 5b, 5c, and 5d .mxd



LEGEND

- Minnow Trap Location (2023)
- Gillnet Location (2023)

0 55 110 220
Meters

N
W E
S

Projection: North American Datum 1983 UTM Zone 13W

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Note: Waterbody extent and location data sourced from National Hydro Network (NHN) 1:50,000 - GeoBase Series, Government of Canada. Base imagery on main map for East Outflow System collected in September 2021.

Minnow Trap and Gillnet Fish Community Sampling Locations Ponds 5e and 5f, Iqaluktuuttiaq East Outflow, 2022 and 2023

Date: July 2024
Project 237202.0071

minnow environmental Inc.

Figure B.4

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Agnico Eagle - 237202.0071 - 2023 Madrid-Boston FAA\D - GIS\Baseline Memo\23-71 Figure B.4 Minnow Trap and Gillnet Fish Community Sampling Locations Ponds 5e and 5f.mxd

Table B.1: **Minnow Trap Catch and Catch-per-Unit-Effort, Iqaluktuuttiaq East Outflow System, September 2022 and August 2023**

Area	Year	Trap ID	UTM (NAD83, 13W)		Set Date	Lift Date	Set Time	Lift Time	Trap Hours (hrs)	# of Traps	Effort (trap days)[a]	Depth Range (m)		Ninespine Stickleback			Cisco (*Coregonus* spp.)[c]		
			Easting	Northing										Catch	Mortalities/ Sacrificed	CPUE[b]	Catch	Mortalities/ Sacrificed	CPUE[b]
Pond 1	2022	MT-P1-01	503794	7672049	21-Sep-22	22-Sep-22	14:00	10:50	62.5	3	7.81	0.20	0.40	25	0	3.20	0	0	0.00
		MT-PT-02	503687	7672126	21-Sep-22	22-Sep-22	14:15	10:36	61.05	3	7.63	0.40	0.60	0	0	0.00	0	0	0.00
		MT-PT-03	503630	7672261	21-Sep-22	22-Sep-22	14:30	11:14	62.2	3	7.78	0.20	0.35	0	0	0.00	0	0	0.00
										Total	**23.22**	**-**	**-**	**25**	**0**	**1.08**	**0**	**0**	**0.00**
Pond 2	2022	MT-P2-01	503807	7672025	21-Sep-22	22-Sep-22	13:30	12:19	68.45	3	8.56	0.2	0.4	144	0	16.83	6	1	0.70
		MT-P2-02	503823	7671940	21-Sep-22	22-Sep-22	13:45	12:31	68.3	3	8.54	0.4	0.6	1	0	0.12	0	0	0.00
										Total	**17.09**	**-**	**-**	**145**	**0**	**8.48**	**6**	**1**	**0.35**
	2023	MT-P2-01	503840	7672025	07-Aug-23	08-Aug-23	11:59	8:08	40.30	2	3.36	0.35	0.4	73	0	21.74	0	0	0.00
		MT-P2-02	503864	7672004	07-Aug-23	08-Aug-23	12:03	8:49	41.53	2	3.46	0.3	-	67	0	19.36	0	0	0.00
		MT-P2-03	503861	7671977	07-Aug-23	08-Aug-23	12:04	8:53	41.63	2	3.47	0.3	-	44	1	12.68	0	0	0.00
		MT-P2-04	503851	7671948	07-Aug-23	08-Aug-23	12:07	8:58	41.70	2	3.48	0.3	-	44	0	12.66	0	0	0.00
		MT-P2-05	503815	7671931	07-Aug-23	08-Aug-23	12:09	9:07	41.93	2	3.49	0.3	-	40	0	11.45	0	0	0.00
		MT-P2-06	503816	7672021	07-Aug-23	08-Aug-23	12:13	9:11	41.93	2	3.49	0.45	-	32	0	9.16	0	0	0.00
		MT-P2-07	503807	7672019	07-Aug-23	08-Aug-23	12:15	9:15	42.00	2	3.50	0.45	-	407	11	116.29	0	0	0.00
		MT-P2-08	503786	7671995	07-Aug-23	08-Aug-23	12:17	9:40	42.77	2	3.56	0.4	-	95	7	26.66	0	0	0.00
		MT-P2-09	503776	7671972	07-Aug-23	08-Aug-23	12:19	9:45	42.87	2	3.57	0.35	-	30	0	8.40	0	0	0.00
		MT-P2-10	503744	7671955	07-Aug-23	08-Aug-23	12:21	9:48	42.90	2	3.58	0.35	-	16	0	4.48	0	0	0.00
		MT-P2-11	503732	7671935	07-Aug-23	08-Aug-23	12:23	9:51	42.93	2	3.58	0.3	0.45	29	0	8.11	0	0	0.00
		MT-P2-12	503740	7671900	07-Aug-23	08-Aug-23	12:25	9:53	42.93	2	3.58	0.4	-	81	3	22.64	0	0	0.00
		MT-P2-13	503759	7671875	07-Aug-23	08-Aug-23	12:28	9:57	42.97	2	3.58	0.35	-	53	1	14.80	0	0	0.00
		MT-P2-14	503775	7671863	07-Aug-23	08-Aug-23	12:30	10:00	43.00	2	3.58	0.35	-	31	1	8.65	0	0	0.00
		MT-P2-15	503793	7671872	07-Aug-23	08-Aug-23	12:32	9:59	42.90	2	3.58	0.35	-	51	0	14.27	0	0	0.00
										Total	**52.86**	**-**	**-**	**1,093**	**24**	**20.68**	**0**	**0**	**0.00**
Pond 3	2023	MT-P3-01	503983	7671718	08-Aug-23	11-Aug-23	14:02	8:54	133.73	2	11.14	0.3	-	1	0	0.09	0	0	0.00
		MT-P3-02	503970	7671695	08-Aug-23	11-Aug-23	14:02	9:02	134.00	2	11.17	0.3	-	57	1	5.10	0	0	0.00
		MT-P3-03	504051	7671674	08-Aug-23	11-Aug-23	14:08	9:50	135.40	2	11.28	0.45	-	9	0	0.80	0	0	0.00
		MT-P3-04	504007	7671532	08-Aug-23	11-Aug-23	14:20	9:56	135.20	2	11.27	0.4	-	1	0	0.09	0	0	0.00
		MT-P3-05	504042	7671595	08-Aug-23	11-Aug-23	14:22	9:58	135.20	2	11.27	0.45	-	1	0	0.09	0	0	0.00
		MT-P3-06	503921	7671438	08-Aug-23	11-Aug-23	14:26	10:02	135.20	2	11.27	0.3	-	0	0	0.00	0	0	0.00
		MT-P3-07	503957	7671407	08-Aug-23	11-Aug-23	14:28	10:04	135.20	2	11.27	0.45	-	0	0	0.00	0	0	0.00
		MT-P3-08	504033	7671374	08-Aug-23	11-Aug-23	14:30	10:06	135.20	2	11.27	0.4	-	4	0	0.36	0	0	0.00
		MT-P3-09	503979	7671467	08-Aug-23	11-Aug-23	14:32	10:08	135.20	2	11.27	0.35	-	50	0	4.44	0	0	0.00
										Total	**101.19**	**-**	**-**	**123**	**1**	**1.22**	**0**	**0**	**0.00**

Table B.1: **Minnow Trap Catch and Catch-per-Unit-Effort, Iqaluktuuttiaq East Outflow System, September 2022 and August 2023**

Area	Year	Trap ID	UTM (NAD83, 13W)		Set Date	Lift Date	Set Time	Lift Time	Trap Hours (hrs)	# of Traps	Effort (trap days)[a]	Depth Range (m)		Ninespine Stickleback			Cisco (*Coregonus* spp.)[c]		
			Easting	Northing										Catch	Mortalities/ Sacrificed	CPUE[b]	Catch	Mortalities/ Sacrificed	CPUE[b]
Pond 4	2023	MT-P4-01	504175	7671160	11-Aug-23	12-Aug-23	15:28	11:56	40.93	2	3.41	0.35	-	100	1	29.32	0	0	0.00
		MT-P4-02	504138	7671144	11-Aug-23	12-Aug-23	15:35	11:51	40.53	2	3.38	0.35	-	54	2	15.99	0	0	0.00
		MT-P4-03	504048	7671077	11-Aug-23	12-Aug-23	15:40	11:46	40.20	2	3.35	0.3	-	117	4	34.93	0	0	0.00
		MT-P4-04	503955	7670948	11-Aug-23	12-Aug-23	15:47	11:37	39.67	2	3.31	0.35	-	1	0	0.30	0	0	0.00
		MT-P4-05	503946	7670792	11-Aug-23	12-Aug-23	15:53	11:34	39.37	2	3.28	0.4	0.45	0	0	0.00	0	0	0.00
		MT-P4-06	503896	7670656	11-Aug-23	12-Aug-23	15:58	11:31	39.10	2	3.26	0.75	-	32	0	9.82	0	0	0.00
		MT-P4-07	503852	7670571	11-Aug-23	12-Aug-23	16:04	11:30	38.87	2	3.24	0.35	-	15	0	4.63	0	0	0.00
		MT-P4-08	503925	7670756	11-Aug-23	12-Aug-23	16:20	11:26	38.20	2	3.18	0.4	-	32	0	10.05	0	0	0.00
		MT-P4-09	503959	7670863	11-Aug-23	12-Aug-23	16:33	11:24	37.70	2	3.14	0.35	-	15	0	4.77	0	0	0.00
		MT-P4-10	503985	7670999	11-Aug-23	12-Aug-23	16:41	11:21	37.33	2	3.11	0.4	0.45	52	2	16.71	0	0	0.00
		MT-P4-11	504282	7671369	11-Aug-23	12-Aug-23	16:52	11:21	36.97	2	3.08	0.4	-	40	1	12.98	0	0	0.00
		MT-P4-12	504298	7671402	11-Aug-23	12-Aug-23	16:54	11:13	36.63	2	3.05	0.35	-	153	5	50.12	0	0	0.00
		MT-P4-13	504317	7671436	11-Aug-23	12-Aug-23	16:56	11:17	36.70	2	3.06	0.35	-	38	0	12.43	0	0	0.00
										Total	**41.85**	**-**	**-**	**649**	**15**	**15.51**	**0**	**0**	**0.00**
Pond 4a	2023	MT-P4a-01	504141	7671474	08-Aug-23	11-Aug-23	11:47	10:32	141.50	2	11.79	0.3	-	41	1	3.48	0	0	0.00
		MT-P4a-02	504115	7671475	08-Aug-23	11-Aug-23	11:49	10:27	141.27	2	11.77	0.45	-	15	0	1.27	0	0	0.00
		MT-P4a-03	504091	7671457	08-Aug-23	11-Aug-23	11:51	10:24	141.10	2	11.76	0.45	0.6	12	0	1.02	0	0	0.00
		MT-P4a-04	504078	7671435	08-Aug-23	11-Aug-23	11:54	10:35	141.37	2	11.78	0.35	-	4	1	0.34	0	0	0.00
		MT-P4a-05	504117	7671432	08-Aug-23	11-Aug-23	11:55	10:40	141.50	2	11.79	0.6	0.7	29	2	2.46	0	0	0.00
										Total	**58.89**	**-**	**-**	**101**	**4**	**1.71**	**0**	**0**	**0.00**
Pond 5a	2023	MT-P5a-01	503634	7670430	13-Aug-23	14-Aug-23	10:13	8:36	22.38	1	0.93	0.3	-	7	1	7.51	0	0	0.00
		MT-P5a-02	503578	7670388	13-Aug-23	14-Aug-23	10:16	8:37	22.35	1	0.93	0.35	-	0	0	0.00	0	0	0.00
		MT-P5a-03	503537	7670372	13-Aug-23	14-Aug-23	10:18	8:40	22.37	1	0.93	0.45	-	1	0	1.07	0	0	0.00
		MT-P5a-04	503503	7670342	13-Aug-23	14-Aug-23	10:21	8:41	22.33	1	0.93	0.45	-	0	0	0.00	0	0	0.00
		MT-P5a-05	503462	7676313	13-Aug-23	14-Aug-23	10:23	8:43	22.33	1	0.93	0.35	-	1	0	1.07	0	0	0.00
		MT-P5a-06	503442	7670320	13-Aug-23	14-Aug-23	10:25	8:45	22.33	1	0.93	0.35	-	0	0	0.00	0	0	0.00
		MT-P5a-07	503476	7670386	13-Aug-23	14-Aug-23	10:27	8:43	22.27	1	0.93	0.3	-	0	0	0.00	0	0	0.00
		MT-P5a-08	503522	7670421	13-Aug-23	14-Aug-23	10:34	8:51	22.28	1	0.93	0.4	-	0	0	0.00	0	0	0.00
		MT-P5a-09	503571	7670420	13-Aug-23	14-Aug-23	10:36	8:53	22.28	1	0.93	0.25	-	0	0	0.00	0	0	0.00
		MT-P5a-10	503615	7670445	13-Aug-23	14-Aug-23	10:38	8:54	22.27	1	0.93	0.30	-	1	0	1.08	0	0	0.00
										Total	**9.30**	**-**	**-**	**10**	**1**	**1.08**	**0**	**0**	**0.00**
Pond 5b	2023	MT-P5b-01	503371	7670305	13-Aug-23	14-Aug-23	10:48	10:13	23.42	1	0.98	0.3	-	0	0	0.00	0	0	0.00
		MT-P5b-02	503350	7670309	13-Aug-23	14-Aug-23	10:50	10:12	23.37	1	0.97	0.3	-	0	0	0.00	0	0	0.00
		MT-P5b-03	503325	7670295	13-Aug-23	14-Aug-23	10:51	10:10	23.32	1	0.97	0.35	-	1	1	1.03	0	0	0.00
		MT-P5b-04	503313	7670271	13-Aug-23	14-Aug-23	10:52	10:22	23.50	1	0.98	0.35	-	0	0	0.00	0	0	0.00
		MT-P5b-05	503326	7670239	13-Aug-23	14-Aug-23	10:54	10:20	23.43	1	0.98	0.35	-	0	0	0.00	0	0	0.00
		MT-P5b-06	503371	7670244	13-Aug-23	14-Aug-23	10:57	10:18	23.35	1	0.97	0.35	-	0	0	0.00	0	0	0.00
		MT-P5b-07	503389	7670261	13-Aug-23	14-Aug-23	11:00	10:17	23.28	1	0.97	0.30	-	0	0	0.00	0	0	0.00
		MT-P5b-08	503386	7670286	13-Aug-23	14-Aug-23	11:01	10:15	23.23	1	0.97	0.35	-	0	0	0.00	0	0	0.00
										Total	**7.79**	**-**	**-**	**1**	**1**	**0.13**	**0**	**0**	**0.00**

Table B.1: **Minnow Trap Catch and Catch-per-Unit-Effort, Iqaluktuuttiaq East Outflow System, September 2022 and August 2023**

Area	Year	Trap ID	UTM (NAD83, 13W)		Set Date	Lift Date	Set Time	Lift Time	Trap Hours (hrs)	# of Traps	Effort (trap days)[a]	Depth Range (m)			Ninespine Stickleback			Cisco (*Coregonus* spp.)[c]		
			Easting	Northing											Catch	Mortalities/ Sacrificed	CPUE[b]	Catch	Mortalities/ Sacrificed	CPUE[b]
Pond 5c	2023	MT-P5c-01	503264	7670260	13-Aug-23	14-Aug-23	11:14	11:28	24.23	1	1.01	0.25	-		1	0	0.99	0	0	0.00
		MT-P5c-02	503247	7670248	13-Aug-23	14-Aug-23	11:16	11:27	24.18	1	1.01	0.3	-		0	0	0.00	0	0	0.00
		MT-P5c-03	503228	7670241	13-Aug-23	14-Aug-23	11:18	11:26	24.13	1	1.01	0.45	-		0	0	0.00	0	0	0.00
		MT-P5c-04	503213	7670237	13-Aug-23	14-Aug-23	11:20	11:23	24.05	1	1.00	0.25	-		1	0	1.00	0	0	0.00
		MT-P5c-05	503211	7670218	13-Aug-23	14-Aug-23	11:23	11:17	23.90	1	1.00	0.35	-		0	0	0.00	0	0	0.00
		MT-P5c-06	503219	7670193	13-Aug-23	14-Aug-23	11:24	11:12	23.80	1	0.99	0.25	-		0	0	0.00	0	0	0.00
		MT-P5c-07	503247	7670157	13-Aug-23	14-Aug-23	11:27	11:09	23.70	1	0.99	0.3	-		0	0	0.00	0	0	0.00
		MT-P5c-08	503289	7670181	13-Aug-23	14-Aug-23	11:29	11:07	23.63	1	0.98	0.3	-		0	0	0.00	0	0	0.00
		MT-P5c-09	503296	7670221	13-Aug-23	14-Aug-23	11:31	11:05	23.57	1	0.98	0.35	-		0	0	0.00	0	0	0.00
		MT-P5c-10	503290	7670266	13-Aug-23	14-Aug-23	11:33	11:04	23.52	1	0.98	0.35	-		11	0	11.23	0	0	0.00
										Total	**9.95**	**-**	**-**		**13**	**0**	**1.31**	**0**	**0**	**0.00**
Pond 5d	2023	MT-P5d-01	503190	7670256	14-Aug-23	15-Aug-23	12:42	11:01	22.32	1	0.93	0.35	-		0	0	0.00	0	0	0.00
		MT-P5d-02	503149	7670251	14-Aug-23	15-Aug-23	12:44	10:59	22.25	1	0.93	0.3	-		0	0	0.00	0	0	0.00
		MT-P5d-03	503123	7670261	14-Aug-23	15-Aug-23	12:46	10:55	22.15	1	0.92	0.35	-		0	0	0.00	0	0	0.00
		MT-P5d-04	503100	7670251	14-Aug-23	15-Aug-23	12:47	10:53	22.10	1	0.92	0.35	-		1	0	1.09	0	0	0.00
		MT-P5d-05	503065	7670219	14-Aug-23	15-Aug-23	12:50	10:48	21.97	1	0.92	0.3	-		0	0	0.00	0	0	0.00
		MT-P5d-06	503033	7670230	14-Aug-23	15-Aug-23	12:52	10:45	21.88	1	0.91	0.35	-		0	0	0.00	0	0	0.00
		MT-P5d-07	503036	7670269	14-Aug-23	15-Aug-23	12:55	11:17	22.37	1	0.93	0.3	-		0	0	0.00	0	0	0.00
		MT-P5d-08	503114	7670317	14-Aug-23	15-Aug-23	12:57	11:13	22.27	1	0.93	0.3	-		5	0	5.39	0	0	0.00
		MT-P5d-09	503191	7670329	14-Aug-23	15-Aug-23	13:00	11:08	22.13	1	0.92	0.35	-		1	0	1.08	0	0	0.00
		MT-P5d-10	503207	7670288	14-Aug-23	15-Aug-23	13:02	11:05	22.05	1	0.92	0.35	-		2	0	2.18	0	0	0.00
		MT-P5d-11	503208	7670312	15-Aug-23	16-Aug-23	11:02	10:45	23.72	1	0.99	0.35	-		0	0	0.00	0	0	0.00
		MT-P5d-12	503149	7670251	15-Aug-23	16-Aug-23	11:02	10:44	23.70	1	0.99	0.3	-		0	0	0.00	0	0	0.00
		MT-P5d-13	503183	7670240	15-Aug-23	16-Aug-23	10:57	10:57	24.00	1	1.00	0.35	-		0	0	0.00	0	0	0.00
		MT-P5d-14	503137	7670256	15-Aug-23	16-Aug-23	10:54	10:43	23.82	1	0.99	0.35	-		0	0	0.00	0	0	0.00
		MT-P5d-15	503088	7670246	15-Aug-23	16-Aug-23	10:50	10:41	23.85	1	0.99	0.35	-		0	0	0.00	0	0	0.00
		MT-P5d-16	503027	7670230	15-Aug-23	16-Aug-23	10:46	10:57	24.18	1	1.01	0.35	-		1	0	0.99	0	0	0.00
		MT-P5d-17	503036	7670269	15-Aug-23	16-Aug-23	11:18	10:55	23.62	1	0.98	0.3	-		1	0	1.02	0	0	0.00
		MT-P5d-18	503016	7670256	15-Aug-23	16-Aug-23	11:15	10:51	23.60	1	0.98	0.35	-		1	0	1.02	0	0	0.00
		MT-P5d-19	503067	7670295	15-Aug-23	16-Aug-23	11:10	10:49	23.65	1	0.99	0.35	-		0	0	0.00	0	0	0.00
		MT-P5d-20	503157	7670324	15-Aug-23	16-Aug-23	11:06	10:47	23.68	1	0.99	0.35	-		0	0	0.00	0	0	0.00
										Total	**19.14**	**-**	**-**		**12**	**0**	**0.63**	**0**	**0**	**0.00**

Table B.1: **Minnow Trap Catch and Catch-per-Unit-Effort, Iqaluktuuttiaq East Outflow System, September 2022 and August 2023**

Area	Year	Trap ID	UTM (NAD83, 13W)		Set Date	Lift Date	Set Time	Lift Time	Trap Hours (hrs)	# of Traps	Effort (trap days)[a]	Depth Range (m)			Ninespine Stickleback			Cisco (*Coregonus* spp.)[c]		
			Easting	Northing											Catch	Mortalities/ Sacrificed	CPUE[b]	Catch	Mortalities/ Sacrificed	CPUE[b]
Pond 5e	2023	MT-P5e-01	503048	7670157	14-Aug-23	15-Aug-23	13:21	8:46	19.42	1	0.81	0.35	-		6	0	7.42	0	0	0.00
		MT-P5e-02	503044	7670058	14-Aug-23	15-Aug-23	13:25	8:42	19.28	1	0.80	0.35	-		0	0	0.00	0	0	0.00
		MT-P5e-03	502953	7669992	14-Aug-23	15-Aug-23	13:29	8:36	19.12	1	0.80	0.4	-		1	0	1.26	0	0	0.00
		MT-P5e-04	502863	7670017	14-Aug-23	15-Aug-23	13:33	8:32	18.98	1	0.79	0.25	-		1	0	1.26	0	0	0.00
		MT-P5e-05	502775	7669987	14-Aug-23	15-Aug-23	13:37	8:25	18.80	1	0.78	0.25	-		0	0	0.00	0	0	0.00
		MT-P5e-06	502761	7670024	14-Aug-23	15-Aug-23	13:41	8:18	18.62	1	0.78	0.3	-		0	0	0.00	0	0	0.00
		MT-P5e-07	502834	7670072	14-Aug-23	15-Aug-23	13:46	8:13	18.45	1	0.77	0.35	-		0	0	0.00	0	0	0.00
		MT-P5e-08	502892	7670078	14-Aug-23	15-Aug-23	13:49	8:11	18.37	1	0.77	0.3	-		1	0	1.31	0	0	0.00
		MT-P5e-09	502948	7670077	14-Aug-23	15-Aug-23	13:49	8:05	18.27	1	0.76	0.25	-		4	0	5.26	0	0	0.00
		MT-P5e-10	502991	7670107	14-Aug-23	15-Aug-23	13:51	8:49	18.97	1	0.79	0.25	-		2	0	2.53	0	0	0.00
		MT-P5e-11	503048	7670157	15-Aug-23	16-Aug-23	8:47	9:33	24.77	1	1.03	0.35	-		1	0	0.97	0	0	0.00
		MT-P5e-12	503054	7670110	15-Aug-23	16-Aug-23	8:44	9:40	24.93	1	1.04	0.35	-		4	0	3.85	0	0	0.00
		MT-P5e-13	503030	7670010	15-Aug-23	16-Aug-23	8:39	9:44	25.08	1	1.05	0.35	-		0	0	0.00	0	0	0.00
		MT-P5e-14	502875	7670017	15-Aug-23	16-Aug-23	8:33	9:48	25.25	1	1.05	0.35	-		0	0	0.00	0	0	0.00
		MT-P5e-15	502825	7669962	15-Aug-23	16-Aug-23	8:28	9:52	25.40	1	1.06	0.35	-		0	0	0.00	0	0	0.00
		MT-P5e-16	502748	7670017	15-Aug-23	16-Aug-23	8:21	9:55	25.57	1	1.07	0.35	-		0	0	0.00	0	0	0.00
		MT-P5e-17	502786	7670054	15-Aug-23	16-Aug-23	8:16	9:57	25.68	1	1.07	0.35	-		2	0	1.87	0	0	0.00
		MT-P5e-18	502863	7670074	15-Aug-23	16-Aug-23	8:12	10:00	25.80	1	1.07	0.35	-		30	0	27.91	0	0	0.00
		MT-P5e-19	502922	7670062	15-Aug-23	16-Aug-23	8:08	10:04	25.93	1	1.08	0.35	-		3	0	2.78	0	0	0.00
		MT-P5e-20	503004	7670115	15-Aug-23	16-Aug-23	8:52	10:08	25.27	1	1.05	0.35	-		1	0	0.95	0	0	0.00
										Total	**18.41**	**-**	**-**		**56**	**0**	**3.04**	**0**	**0**	**0.00**
Pond 5f	2023	MT-P5f-01	502808	7669782	14-Aug-23	15-Aug-23	15:03	13:32	22.48	1	0.94	0.3	-		2	0	2.13	0	0	0.00
		MT-P5f-02	502744	7669740	14-Aug-23	15-Aug-23	15:06	13:42	22.60	1	0.94	0.3	-		5	0	5.31	0	0	0.00
		MT-P5f-03	502654	7669635	14-Aug-23	15-Aug-23	15:11	13:55	22.73	1	0.95	0.4	-		0	0	0.00	0	0	0.00
		MT-P5f-04	502459	7669590	14-Aug-23	15-Aug-23	15:19	14:10	22.85	1	0.95	0.35	-		7	0	7.35	0	0	0.00
		MT-P5f-05	502571	7669689	14-Aug-23	15-Aug-23	15:25	14:27	23.03	1	0.96	0.3	-		8	0	8.34	0	0	0.00
		MT-P5f-06	502711	7669793	14-Aug-23	15-Aug-23	15:29	14:39	23.17	1	0.97	0.35	-		0	0	0.00	0	0	0.00
		MT-P5f-07	502798	7669833	14-Aug-23	15-Aug-23	15:33	14:40	23.12	1	0.96	0.35	-		1	0	1.04	0	0	0.00
		MT-P5f-08	502822	7669905	14-Aug-23	15-Aug-23	15:36	14:57	23.35	1	0.97	0.35	-		1	0	1.03	0	0	0.00
		MT-P5f-09	502779	7669762	15-Aug-23	16-Aug-23	13:36	8:39	19.05	1	0.79	0.35	-		4	0	5.04	0	0	0.00
		MT-P5f-10	502727	7669742	15-Aug-23	16-Aug-23	13:44	8:41	18.95	1	0.79	-	-		1	0	1.27	0	0	0.00
		MT-P5f-11	502610	7669600	15-Aug-23	16-Aug-23	13:59	8:45	18.77	1	0.78	0.35	-		2	0	2.56	0	0	0.00
		MT-P5f-12	502459	7669590	15-Aug-23	16-Aug-23	14:11	8:53	18.70	1	0.78	0.35	-		0	0	0.00	0	0	0.00
		MT-P5f-13	502571	7669689	15-Aug-23	16-Aug-23	14:30	8:56	18.43	1	0.77	0.35	-		1	0	1.30	0	0	0.00
		MT-P5f-14	502711	7669793	15-Aug-23	16-Aug-23	14:40	9:01	18.35	1	0.76	0.35	-		3	0	3.92	0	0	0.00
		MT-P5f-15	502793	7669821	15-Aug-23	16-Aug-23	14:41	9:05	18.40	1	0.77	0.35	-		6	0	7.83	0	0	0.00
		MT-P5f-16	502815	7669900	15-Aug-23	16-Aug-23	15:00	9:11	18.18	1	0.76	0.35	-		1	0	1.32	0	0	0.00
										Total	**13.84**	**-**	**-**		**42**	**0**	**3.03**	**0**	**0**	**0.00**
										Overall Total	**373.54**	**-**	**-**		**2,270**	**46**	**6.08**	**6**	**1**	**0.02**

Notes: "CPUE" = catch-per-unit-effort; "-" indicates no available data.

[a] Effort was measured as the total number of trap days.

[b] CPUE = total number of fish caught per trap day.

[c] "Cisco" refers to a species complex of at least 4 co-occurring *Coregonus* species in the study area (cisco, least cisco, lake whitefish and broad whitefish)

Table B.2: Gill Net Catch and Catch-per-Unit-Effort, Iqaluktuuttiaq East Outflow System, September 2022 and August 2023

Waterbody	Year	Net ID	UTM (NAD83, 13W)		Depth Range (m)		Set Date	Lift Date	Set Time	Lift Time	Time (Hours)	Set				Effort (hours per 100 m^2 net area)[a]	Cisco (*Coregonus* spp.)[c]			Arctic Charr		
			Easting	Northing								Net Area (m^2)	Height (m)	Length (m)	Mesh (mm)		Catch	Mortalities/ sacrificed	CPUE[b]	Catch	Mortalities/ sacrificed	CPUE[b]
Pond 1	2022	GN-P1-01	503609	7672176	0	1.0	21-Sep-22	21-Sep-22	13:55	16:44	2.82	223	2.4	91.4	25, 76, 51, 89, 38, 64	6.28	1	1	0.159	0	0	0.000
		GN-P1-02	503774	7672082	0	0.6	21-Sep-22	21-Sep-22	14:26	16:30	2.07	55.7	1.2	45.7	38, 38, 25	1.15	0	0	0.000	0	0	0.000
		GN-P1-03	503609	7672176	0	1.0	21-Sep-22	22-Sep-22	16:50	9:50	17.0	223	2.4	91.4	25, 76, 51, 89, 38, 64	37.90	0	0	0.000	2	2	0.053
		GN-P1-04	503774	7672082	0	0.6	21-Sep-22	22-Sep-22	16:40	10:31	17.9	55.7	1.2	45.7	38, 38, 25	9.95	0	0	0.000	0	0	0.000
															Total	**55.29**	**1**	**1**	**0.018**	**2**	**2**	**0.036**
Pond 2	2023	GN-P2-01	503864	7672015	0	1.2	07-Aug-23	07-Aug-23	10:36	14:05	3.48	219	2.4	91.2	25, 76, 51, 89, 38, 64	7.62	15	9	1.967	0	0	0.000
		GN-P2-02	503753	7671882	0	1.2	07-Aug-23	07-Aug-23	10:59	14:25	3.43	219	2.4	91.2	25, 76, 51, 89, 38, 64	7.51	3	2	0.399	4	2	0.532
		GN-P2-03	503765	7671862	0	1.0	07-Aug-23	07-Aug-23	11:09	17:00	5.85	18	1.2	15.2	38	1.07	0	0	0.000	0	0	0.000
		GN-P2-04	503864	7672015	0	1.2	07-Aug-23	07-Aug-23	14:06	16:20	2.23	219	2.4	91.2	25, 76, 51, 89, 38, 64	4.89	4	2	0.818	0	0	0.000
		GN-P2-05	503753	7671882	0	1.2	07-Aug-23	07-Aug-23	14:31	16:55	2.40	219	2.4	91.2	25, 76, 51, 89, 38, 64	5.25	2	2	0.381	0	0	0.000
															Total	**26.35**	**24**	**15**	**0.911**	**4**	**2**	**0.152**
Pond 3	2023	GN-P3-01	503963	7671686	0	2.0	08-Aug-23	08-Aug-23	13:03	14:45	1.70	219	2.4	91.2	64, 38, 89, 51, 76, 25	3.72	0	0	0.000	1	1	0.269
		GN-P3-02	503886	7671522	0	2.0	08-Aug-23	08-Aug-23	13:20	15:05	1.75	219	2.4	91.2	25, 76, 51, 89, 38, 64	3.83	1	1	0.261	1	1	0.261
		GN-P3-03	503908	7671497	0	1.2	08-Aug-23	08-Aug-23	13:32	15:10	1.63	18	1.2	15.2	38	0.30	1	0	3.357	1	0	3.357
		GN-P3-04	503963	7671686	0	2.0	08-Aug-23	08-Aug-23	14:45	16:35	1.83	219	2.4	91.2	64, 38, 89, 51, 76, 25	4.01	1	1	0.249	0	0	0.000
		GN-P3-05	503886	7671522	0	2.0	08-Aug-23	08-Aug-23	15:05	16:42	1.62	219	2.4	91.2	25, 76, 51, 89, 38, 64	3.54	0	0	0.000	1	0	0.283
		GN-P3-06	503908	7671497	0	1.2	08-Aug-23	08-Aug-23	15:21	16:44	1.38	18	1.2	15.2	38	0.25	0	0	0.000	0	0	0.000
		GN-P3-07	504040	7671373	0	1.5	11-Aug-23	11-Aug-23	11:10	13:38	2.47	219	2.4	91.2	64, 38, 89, 51, 76, 25	5.40	0	0	0.000	0	0	0.000
		GN-P3-08	503949	7671406	0	1.5	11-Aug-23	11-Aug-23	11:17	13:44	2.45	1097	24	45.7	64, 38, 89, 51, 76, 25	26.87	0	0	0.000	0	0	0.000
		GN-P3-09	503985	7671542	0	2.0	11-Aug-23	11-Aug-23	11:25	13:51	2.43	219	2.4	91.2	25, 76, 51, 89, 38, 64	5.33	0	0	0.000	0	0	0.000
		GN-P3-10	504014	7671739	0	2.0	11-Aug-23	11-Aug-23	11:31	14:03	2.53	219	2.4	91.2	25, 76, 51, 89, 38, 64	5.54	0	0	0.000	0	0	0.000
		GN-P3-11	504050	7671601	0	1.0	11-Aug-23	11-Aug-23	11:45	13:56	2.18	18	1.2	15.1	38	0.40	0	0	0.000	0	0	0.000
		GN-P3-12	503834	7671545	0	2.0	11-Aug-23	11-Aug-23	11:53	14:39	2.77	219	2.4	91.2	25, 76, 51, 89, 38, 64	6.06	0	0	0.000	1	1	0.165
		GN-P3-13	504040	7671373	0	1.5	11-Aug-23	11-Aug-23	13:50	17:19	3.48	219	2.4	91.2	25, 76, 51, 89, 38, 64	7.62	0	0	0.000	0	0	0.000
		GN-P3-14	503949	7671406	0	1.5	11-Aug-23	11-Aug-23	13:46	17:24	3.63	110	2.4	45.7	51, 64, 76	3.99	0	0	0.000	0	0	0.000
		GN-P3-15	503985	7671542	0	2.0	11-Aug-23	11-Aug-23	13:52	17:39	3.78	219	2.4	91.2	25, 76, 51, 89, 38, 64	8.28	0	0	0.000	0	0	0.000
		GN-P3-16	504014	7671739	0	2.0	11-Aug-23	11-Aug-23	14:05	18:10	4.08	219	2.4	91.2	25, 76, 51, 89, 38, 64	8.94	0	0	0.000	0	0	0.000
		GN-P3-17	503834	7671545	0	2.0	11-Aug-23	11-Aug-23	14:40	17:54	3.23	219	2.4	91.2	25, 76, 51, 89, 38, 64	7.08	0	0	0.000	0	0	0.000
		GN-P3-18	504050	7671601	0	1.0	11-Aug-23	11-Aug-23	13:58	17:44	3.77	18	1.2	15.1	38	0.68	0	0	0.000	0	0	0.000
															Total	**101.83**	**3**	**2**	**0.0295**	**5**	**3**	**0.0491**
Pond 4	2023	GN-P4-01	504695	7671746	0	1.5	12-Aug-23	12-Aug-23	9:35	13:47	4.20	18	1.2	15.2	38	0.77	0	0	0.000	0	0	0.000
		GN-P4-02	504619	7671705	0	2.0	12-Aug-23	12-Aug-23	9:47	14:05	4.30	219	2.4	91.2	25, 76, 51, 89, 38, 64	9.41	2	1	0.002	4	3	0.004
		GN-P4-03	504654	7671586	0	2.0	12-Aug-23	12-Aug-23	10:05	14:15	4.17	219	2.4	91.2	25, 76, 51, 89, 38, 64	9.12	0	0	0.000	3	3	0.003
		GN-P4-04	504312	7671450	0	1.5	12-Aug-23	12-Aug-23	10:15	14:24	4.15	110	2.4	45.7	51, 64, 76	4.55	3	3	0.007	0	0	0.000
		GN-P4-05	503986	7671000	0	2.0	12-Aug-23	12-Aug-23	10:50	15:27	4.62	219	2.4	91.2	64, 191, 89, 51, 76, 25	10.10	1	1	0.001	12	0	0.012
		GN-P4-06	503954	7670596	0	3.0	12-Aug-23	12-Aug-23	11:01	15:43	4.70	219	2.4	91.2	25, 76, 51, 89, 38, 64	10.29	6	0	0.006	2	0	0.002
		GN-P4-07	504047	7670782	0	3.0	12-Aug-23	12-Aug-23	11:07	15:52	4.75	219	2.4	91.2	25, 76, 51, 89, 38, 64	10.40	0	0	0.000	2	0	0.002
		GN-P4-08	504695	7671746	1	1.5	12-Aug-23	12-Aug-23	13:48	17:16	3.47	18	1.2	15.2	38	0.63	0	0	0.000	0	0	0.000
		GN-P4-09	504619	7671705	0	2.0	12-Aug-23	12-Aug-23	14:07	17:19	3.20	219	2.4	91.2	25, 76, 51, 89, 38, 64	7.00	0	0	0.000	2	2	0.003
		GN-P4-10	504654	7671586	0	2.0	12-Aug-23	12-Aug-23	14:16	17:35	3.32	219	2.4	91.2	25, 76, 51, 89, 38, 64	7.26	0	0	0.000	1	1	0.001
		GN-P4-11	504312	7671450	0	1.5	12-Aug-23	12-Aug-23	14:26	17:44	3.30	110	2.4	45.7	51, 64, 76	3.62	1	0	0.003	1	1	0.003
		GN-P4-12	503986	7671000	0	2.0	12-Aug-23	12-Aug-23	15:30	17:56	2.43	219	2.4	91.2	64, 38, 89, 51, 76, 25	5.33	2	1	0.004	3	3	0.006
		GN-P4-13	503954	7670596	0	3.0	12-Aug-23	12-Aug-23	15:45	18:08	2.38	219	2.4	91.2	25, 76, 51, 89, 38, 64	5.22	0	0	0.000	4	1	0.008
		GN-P4-14	504047	7670782	0	3.0	12-Aug-23	12-Aug-23	15:55	18:20	2.42	219	2.4	91.2	25, 76, 51, 89, 38, 64	5.29	0	0	0.000	1	0	0.002
															Total	**88.99**	**15**	**6**	**0.169**	**35**	**14**	**0.393**
Pond 5e	2023	GN-P5e-01	502950	7669993	0	2.0	14-Aug-23	14-Aug-23	14:25	16:06	1.68	219	2.4	91.2	25, 76, 51, 89, 38, 64	3.68	0	0	0.000	0	0	0.000
		GN-P5e-02	502759	7669996	0	3.0	14-Aug-23	14-Aug-23	14:34	16:28	1.90	110	2.4	45.7	51, 64, 76	2.08	1	1	0.005	1	0	0.005
		GN-P5e-03	502950	7669993	0	2.0	14-Aug-23	14-Aug-23	16:08	17:36	1.47	219	2.4	91.2	25, 76, 51, 89, 38, 64	3.21	0	0	0.000	0	0	0.000
		GN-P5e-04	502759	7669996	0	3.0	14-Aug-23	14-Aug-23	16:30	17:45	1.25	110	2.4	45.7	51, 64, 76	1.37	0	0	0.000	0	0	0.000
															Total	**10.35**	**1**	**1**	**0.097**	**1**	**0**	**0.097**
															Overall Total	**272.45**	**43**	**24**	**0.158**	**45**	**19**	**0.165**

Note: "CPUE" = catch-per-unit-effort.

[a] Effort was measured as the total number of hors per 100 m^2 of net area.

[b] CPUE = total number of fish caught per 100 m^2 of net area per hour

[c] "Cisco" refers to a species complex of at least 4 co-occurring *Coregonus* species in the study area (cisco, least cisco, lake whitefish and broad whitefish)

Table B.3: Physical Measurements for Fish Caught in Pond 1 and Pond 2, Iqaluktuuttiaq East Outflow System, September 2022

Area	Processing Date	Fish Species[a]	Fish ID	Total Length (cm)	Fork Length (cm)	Body Weight (g)	Age Structure Collected[b]	Age	DELT[c]	Fate[d]	Comment
Pond 1	21-Sep-22	Cisco (*Coregonus* spp.)	P1-LWF-01	42.5	38.6	590	PF, SC	6	N	M	-
	22-Sep-22	Arctic Charr	P1-AC-01	44.4	41.5	780	PF, SC	4	N	M	-
	22-Sep-22	Arctic Charr	P1-AC-02	55.0	51.8	1,360	PF, SC	6	N	M	-
		total sample size		**2**	**2**	**2**	**-**	**2**	-	-	-
		average		**49.7**	**46.7**	**1,070**	**-**	**5**	-	-	-
		median		**49.7**	**46.7**	**1,070**	**-**	**5**	-	-	-
		standard deviation		**7.50**	**7.28**	**410**	**-**	**1**	-	-	-
		standard error		**5.30**	**5.15**	**290**	**-**	**1**	-	-	-
		minimum		**44.4**	**41.5**	**780**	**-**	**4**	-	-	-
		maximum		**55.0**	**51.8**	**1,360**	**-**	**6**	-	-	-
	22-Sep-22	Ninespine Stickleback	P1-SB-01	5.3	-	1.10	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-02	6.1	-	1.80	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-03	7.4	-	3.90	-	-	Y	R	Parasite
	22-Sep-22	Ninespine Stickleback	P1-SB-04	5.9	-	1.60	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-05	5.7	-	1.30	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-06	7.9	-	3.40	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-07	5.8	-	2.00	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-08	7.7	-	3.50	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-09	6.2	-	2.20	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-10	5.8	-	2.60	-	-	Y	R	Deformed Spine
	22-Sep-22	Ninespine Stickleback	P1-SB-11	5.7	-	1.85	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-12	7.2	-	3.65	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-13	6.7	-	2.75	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-14	6.8	-	2.80	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-15	7.4	-	3.90	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-16	6.8	-	3.25	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-17	6.8	-	2.90	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-18	6.3	-	2.70	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-19	6.7	-	2.50	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-20	6.6	-	2.70	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-21	6.5	-	2.30	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-22	7.2	-	2.90	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-23	5.5	-	2.05	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-24	5.6	-	2.10	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P1-SB-25	6.1	-	2.25	-	-	N	R	-
		total sample size		**25**	**-**	**25**	**-**	**-**	-	-	-
		average		**6.47**	**-**	**2.56**	**-**	**-**	-	-	-
		median		**6.50**	**-**	**2.60**	**-**	**-**	-	-	-
		standard deviation		**0.726**	**-**	**0.764**	**-**	**-**	-	-	-
		standard error		**0.145**	**-**	**0.153**	**-**	**-**	-	-	-
		minimum		**5.30**	**-**	**1.10**	**-**	**-**	-	-	-
		maximum		**7.90**	**-**	**3.90**	**-**	**-**	-	-	-
Pond 2	22-Sep-22	Ninespine Stickleback	P2-SB-01	7.3	-	3.60	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-02	6.1	-	2.50	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-03	5.5	-	1.70	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-04	6.0	-	2.70	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-05	5.8	-	2.70	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-06	6.2	-	2.60	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-07	6.5	-	3.20	-	-	N	R	-
Pond 2	22-Sep-22	Ninespine Stickleback	P2-SB-08	5.6	-	2.75	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-09	5.5	-	2.20	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-10	5.4	-	2.25	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-11	5.4	-	2.40	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-12	5.7	-	2.60	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-13	5.2	-	2.10	-	-	Y	R	Parasite
	22-Sep-22	Ninespine Stickleback	P2-SB-14	5.6	-	1.70	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-15	6.3	-	2.90	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-16	7.8	-	4.70	-	-	Y	R	Parasite
	22-Sep-22	Ninespine Stickleback	P2-SB-17	7.3	-	4.10	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-18	5.5	-	1.90	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-19	5.0	-	1.50	-	-	Y	R	Deformed Tail
	22-Sep-22	Ninespine Stickleback	P2-SB-20	7.4	-	4.20	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-21	5.6	-	2.65	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-22	5.7	-	2.40	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-23	7.2	-	3.60	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-24	6.8	-	3.05	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-25	5.7	-	3.10	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-26	5.9	-	2.80	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-27	5.7	-	2.90	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-28	5.8	-	2.40	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-29	5.0	-	2.20	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-30	5.1	-	2.05	-	-	N	R	-
	22-Sep-22	Ninespine Stickleback	P2-SB-31	5.0	-	2.00	-	-	N	R	-
		total sample size		**31**	**-**	**31**	**-**	**-**	-	-	-
		average		**5.95**	**-**	**2.69**	**-**	**-**	-	-	-
		median		**5.70**	**-**	**2.60**	**-**	**-**	-	-	-
		standard deviation		**0.771**	**-**	**0.749**	**-**	**-**	-	-	-
		standard error		**0.138**	**-**	**0.135**	**-**	**-**	-	-	-
		minimum		**5.00**	**-**	**1.50**	**-**	**-**	-	-	-
		maximum		**7.80**	**-**	**4.70**	**-**	**-**	-	-	-
	22-Sep-22	Cisco (*Coregonus* spp.)	P2-LWF-01	5.4	5.0	-	-	-	N	R	Pesola was incorrect, but fish had already been released.
	22-Sep-22	Cisco (*Coregonus* spp.)	P2-LWF-02	5.1	4.8	0.45	-	-	N	R	-
	22-Sep-22	Cisco (*Coregonus* spp.)	P2-LWF-03	5.1	4.7	0.35	-	-	N	R	-
	22-Sep-22	Cisco (*Coregonus* spp.)	P2-LWF-04	5.2	4.7	0.35	-	-	N	R	-
	22-Sep-22	Cisco (*Coregonus* spp.)	P2-LWF-05	5.2	4.8	0.30	-	-	N	R	-
		total sample size		**5**	**5**	**4**	**-**	**-**	-	-	-
		average		**5.20**	**4.80**	**0.363**	**-**	**-**	-	-	-
		median		**5.20**	**4.80**	**0.350**	**-**	**-**	-	-	-
		standard deviation		**0.122**	**0.122**	**0.063**	**-**	**-**	-	-	-
		standard error		**0.055**	**0.055**	**0.031**	**-**	**-**	-	-	-
		minimum		**5.10**	**4.70**	**0.300**	**-**	**-**	-	-	-
		maximum		**5.40**	**5.00**	**0.450**	**-**	**-**	-	-	-

Note: "-" indicates data not available

[a] "Cisco" refers to a species complex of at least 4 co-occurring species in the study area (cisco, least cisco, lake whitefish and broad whitefish)

[b] "PF" = pelvic fin-ray; "SC" = scales

[c] "DELT" = deformities, erosions, lesions, tumours. "N" = no; "Y" = yes. Any observed DELTs were recorded in comments.

[d] "M" = mortality; "R" = released.

Table B.4: Physical Measurements for Fish Caught in Ponds 2, 3, 4, and 5a to 5f, Iqaluktuuttiaq East Outflow System, August 2023

Area	Processing Date	Fish Species[a]	Fish ID	Total Length (cm)	Fork Length (cm)	Body Weight (g)	Age Structure Collected[b]	Age	DELT[c]	Fate[d]	Comment
Pond 2	7-Aug-23	Arctic Charr	P2-AC-01	33.0	30.7	330.0	PF, SC	3	-	M	-
	7-Aug-23	Arctic Charr	P2-AC-02	30.1	28.0	216.0	PF, SC	3	-	M	-
	7-Aug-23	Arctic Charr	P2-AC-03	37.2	34.8	460.0	-	-	-	R	-
	7-Aug-23	Arctic Charr	P2-AC-04	30.2	28.3	237.0	-	-	-	R	-
			total sample size	**4**	**4**	**4**	**-**	**2**	-	-	-
			average	**32.6**	**30.5**	**310.8**	**-**	**3**	-	-	-
			median	**31.6**	**29.5**	**283.5**	**-**	**3**	-	-	-
			standard deviation	**3.33**	**3.14**	**111.1**	**-**	**0**	-	-	-
			standard error	**1.67**	**1.57**	**55.6**	**-**	**0**	-	-	-
			minimum	**30.1**	**28**	**216.0**	**-**	**3**	-	-	-
			maximum	**37.2**	**34.8**	**460.0**	**-**	**3**	-	-	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-01	6.9	-	4.50	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-02	5.5	-	2.75	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-03	6.1	-	3.25	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-04	6.0	-	3.50	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-05	5.2	-	2.75	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-06	5.8	-	3.00	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-07	5.9	-	3.25	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-08	5.9	-	3.25	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-09	6.5	-	4.25	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-10	5.4	-	3.25	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-11	5.2	-	2.75	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-12	4.3	-	2.25	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-13	6.8	-	4.25	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-14	5.4	-	2.75	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-15	5.2	-	2.75	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-16	6.5	-	3.75	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-17	5.2	-	2.75	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-18	5.5	-	3.00	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-19	5.4	-	3.00	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-20	5.4	-	3.00	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-21	6.1	-	3.50	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-22	6.5	-	4.25	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-23	7.3	-	5.00	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-24	5.0	-	2.75	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-25	4.9	-	2.75	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-26	5.7	-	3.25	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-27	7.0	-	4.00	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-28	7.0	-	4.00	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-29	6.1	-	3.50	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-30	4.9	-	2.75	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-31	5.1	-	3.00	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-32	5.1	-	3.00	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-33	6.6	-	4.25	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-34	6.0	-	3.50	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-35	5.7	-	3.50	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-36	5.7	-	3.50	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-37	5.0	-	3.00	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-38	6.0	-	3.50	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-39	6.4	-	4.25	-	-	-	R	-
	08-Aug-23	Ninespine Stickleback	P2-NSSB-40	6.4	-	4.25	-	-	-	R	-
			total sample size	**40**	**-**	**40**	**-**	**-**	-	-	-
			average	**5.82**	**-**	**3.39**	**-**	**-**	-	-	-
			median	**5.75**	**-**	**3.25**	**-**	**-**	-	-	-
			standard deviation	**0.698**	**-**	**0.628**	**-**	**-**	-	-	-
			standard error	**0.110**	**-**	**0.099**	**-**	**-**	-	-	-
			minimum	**4.30**	**-**	**2.25**	**-**	**-**	-	-	-
			maximum	**7.30**	**-**	**5.00**	**-**	**-**	-	-	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-01	12.6	11.9	13.5	-	-	-	R	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-02	13.1	11.8	13.25	-	-	-	R	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-03	12.9	11.8	14.75	OTO, SC	1	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-04	13.1	11.9	14.0	-	-	-	R	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-05	12.0	11.0	11.0	OTO, SC	1	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-06	12.7	12.0	12.25	-	-	-	R	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-07	12.8	11.6	12.75	-	-	-	R	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-08	13.5	12.1	13.50	-	-	-	R	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-09	12.3	11.4	12.75	OTO, SC	1	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-10	16.8	15.5	31.75	OTO, SC	2	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-11	43.8	40.6	700.0	OTO, SC	5	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-12	40.9	37.4	610.0	OTO, SC	5	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-13	39.9	36.3	500.0	PF, SC	5	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-14	43.9	40.0	750.0	PF, SC	9	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-15	29.5	26.5	172.0	OTO, SC	4	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-16	12.1	10.9	11.75	OTO, SC	1	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-17	12.8	11.9	16.75	-	-	-	R	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-18	15.8	14.5	22.50	OTO, SC	2	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-19	16.5	14.6	28.50	-	-	-	R	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-20	12.7	11.6	15.00	OTO, SC	1	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-21	14.1	13.0	18.25	OTO, SC	1	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-22	12.6	11.3	14.25	OTO, SC	1	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-23	37.1	33.8	393.0	OTO, SC	6	-	M	-
	07-Aug-23	Cisco (*Coregonus* spp.)	P2-WF-24	40.2	36.4	580.0	OTO, SC	7	-	M	-
			total sample size	**24**	**24**	**24**	**-**	**16**	-	-	-
			average	**21.0**	**19.2**	**165.9**	**-**	**3.3**	-	-	-
			median	**13.3**	**12.1**	**15.9**	**-**	**2.0**	-	-	-
			standard deviation	**12.3**	**11.3**	**258.7**	**-**	**2.6**	-	-	-
			standard error	**2.52**	**2.3**	**52.8**	**-**	**0.7**	-	-	-
			minimum	**12.0**	**10.9**	**11.0**	**-**	**1.0**	-	-	-
			maximum	**43.9**	**40.6**	**750.0**	**-**	**9.0**	-	-	-

Note: "-" indicates data not available

[a] "Cisco" refers to a species complex of at least 4 co-occurring species in the study area (cisco, least cisco, lake whitefish and broad whitefish)

[b] "PF" = pelvic fin-ray; "SC" = scales; "OTO" = otoliths.

[c] "DELT" = deformities, erosions, lesions, tumours. "N" = no; "Y" = yes. Any observed DELTs were recorded in comments.

[d] "M" = mortality; "R" = released.

Table B.4: Physical Measurements for Fish Caught in Ponds 2, 3, 4, and 5a to 5f, Iqaluktuuttiaq East Outflow System, August 2023

Area	Processing Date	Fish Species[a]	Fish ID	Total Length (cm)	Fork Length (cm)	Body Weight (g)	Age Structure Collected[b]	Age	DELT[c]	Fate[d]	Comment
Pond 3	11-Aug-23	Ninespine Stickleback	P3-NSSB-01	5.8	-	2.75	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-02	6.1	-	4.00	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-03	7.9	-	4.75	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-04	6.7	-	3.5	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-05	6.2	-	3.00	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-06	6.2	-	3.25	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-07	5.9	-	3.00	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-08	6.2	-	3.25	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-09	7.0	-	3.5	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-10	6.2	-	3.75	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-11	6.8	-	3.75	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-12	6.7	-	3.25	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-13	6.6	-	4.25	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-14	5.7	-	2.75	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-15	6.6	-	3.50	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-16	6.2	-	3.50	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-17	5.5	-	3.25	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-18	5.5	-	2.50	-	-	Y	R	Large eye
	11-Aug-23	Ninespine Stickleback	P3-NSSB-19	5.5	-	3.00	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-20	6.4	-	4.50	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-21	7.0	-	4.75	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-22	6.2	-	3.75	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-23	6.0	-	3.25	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-24	5.8	-	3.50	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-25	5.6	-	3.00	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-26	6.5	-	4.00	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-27	6.4	-	3.50	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-28	5.5	-	2.75	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-29	6.4	-	4.00	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-30	5.9	-	3.25	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-31	6.3	-	4.00	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-32	6.6	-	4.00	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-33	7.8	-	5.25	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-34	6.2	-	4.00	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-35	6.0	-	3.50	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-36	5.3	-	3.00	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-37	5.5	-	3.00	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-38	6.1	-	3.75	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-39	5.8	-	3.50	-	-	-	R	-
	11-Aug-23	Ninespine Stickleback	P3-NSSB-40	5.6	-	3.25	-	-	-	R	-
			total sample size	**40**	**-**	**40**	**-**	**-**	-	-	-
			average	**6.21**	**-**	**3.55**	**-**	**-**	-	-	-
			median	**6.20**	**-**	**3.50**	**-**	**-**	-	-	-
			standard deviation	**0.584**	**-**	**0.600**	**-**	**-**	-	-	-
			standard error	**0.092**	**-**	**0.095**	**-**	**-**	-	-	-
			minimum	**5.30**	**-**	**2.50**	**-**	**-**	-	-	-
			maximum	**7.90**	**-**	**5.25**	**-**	**-**	-	-	-
	07-Aug-23	Arctic Charr	P3-AC-01	32.3	30.1	282.0	OTO, SC	5	-	M	-
	07-Aug-23	Arctic Charr	P3-AC-02	31.0	29.0	295.0	OTO, SC	4	-	M	-
	07-Aug-23	Arctic Charr	P3-AC-03	29.0	27.1	234.0	-	-	-	R	-
	07-Aug-23	Arctic Charr	P3-AC-04	33.8	31.5	350.0	-	-	-	R	-
	07-Aug-23	Arctic Charr	P3-AC-05	22.6	21.4	114.0	OTO, SC	3	-	M	-
			total sample size	**5**	**5**	**5**	**-**	**3**	-	-	-
			average	**29.74**	**27.82**	**255.0**	**-**	**4.0**	-	-	-
			median	**31.00**	**29.00**	**282.0**	**-**	**4.0**	-	-	-
			standard deviation	**4.363**	**3.933**	**89.0**	**-**	**1.0**	-	-	-
			standard error	**1.951**	**1.759**	**39.8**	**-**	**0.6**	-	-	-
			minimum	**22.60**	**21.40**	**114.0**	**-**	**3.0**	-	-	-
			maximum	**33.80**	**31.50**	**114.0**	**-**	**3.0**	-	-	-
	8-Aug-23	Cisco (*Coregonus* spp.)	P3-WF-01	13.2	12.0	17.5	OTO, SC	1	-	M	-
	8-Aug-23	Cisco (*Coregonus* spp.)	P3-WF-02	20.4	18.4	60.00	-	-	-	R	-
	8-Aug-23	Cisco (*Coregonus* spp.)	P3-WF-03	22.0	20.0	79.00	OTO, SC	3	-	M	-
			total sample size	**3**	**3**	**3**	**-**	**2**	-	-	-
			average	**18.53**	**16.80**	**52.17**	**-**	**2.0**	-	-	-
			median	**20.40**	**18.40**	**60.00**	**-**	**2.0**	-	-	-
			standard deviation	**4.688**	**4.233**	**31.49**	**-**	**1.4**	-	-	-
			standard error	**2.706**	**2.444**	**18.18**	**-**	**1.0**	-	-	-
			minimum	**13.20**	**12.00**	**17.50**	**-**	**1.0**	-	-	-
			maximum	**22.00**	**20.00**	**79.00**	**-**	**3.0**	-	-	-

Note: "-" indicates data not available

[a] "Cisco" refers to a species complex of at least 4 co-occurring species in the study area (cisco, least cisco, lake whitefish and broad whitefish)

[b] "PF" = pelvic fin-ray; "SC" = scales; "OTO" = otoliths.

[c] "DELT" = deformities, erosions, lesions, tumours. "N" = no; "Y" = yes. Any observed DELTs were recorded in comments.

[d] "M" = mortality; "R" = released.

Table B.4: Physical Measurements for Fish Caught in Ponds 2, 3, 4, and 5a to 5f, Iqaluktuuttiaq East Outflow System, August 2023

Area	Processing Date	Fish Species[a]	Fish ID	Total Length (cm)	Fork Length (cm)	Body Weight (g)	Age Structure Collected[b]	Age	DELT[c]	Fate[d]	Comment
Pond 4	12-Aug-23	Ninespine Stickleback	P4-NSSB-01	5.9	-	3.25	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-02	7.1	-	4.25	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-03	8.0	-	5.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-04	5.3	-	2.50	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-05	4.6	-	2.75	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-06	6.7	-	3.75	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-07	6.3	-	3.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-08	4.8	-	2.75	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-09	6.9	-	4.75	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-10	5.4	-	2.75	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-11	6.3	-	3.75	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-12	5.9	-	3.75	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-13	4.6	-	2.75	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-14	5.4	-	3.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-15	5.6	-	3.75	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-16	7.3	-	5.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-17	7.3	-	4.75	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-18	6.1	-	4.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-19	5.2	-	3.25	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-20	6.5	-	4.25	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-21	6.1	-	3.75	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-22	5.7	-	3.25	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-23	6.0	-	3.75	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-24	5.5	-	3.50	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-25	4.6	-	3.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-26	5.9	-	3.50	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-27	6.6	-	4.25	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-28	5.9	-	4.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-29	4.9	-	3.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-30	5.4	-	3.25	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-31	5.1	-	3.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-32	5.9	-	4.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-33	5.5	-	3.50	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-34	6.2	-	4.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-35	5.5	-	3.25	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-36	6.2	-	3.50	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-37	6.1	-	4.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-38	5.0	-	3.00	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-39	5.8	-	3.25	-	-	-	R	-
	12-Aug-23	Ninespine Stickleback	P4-NSSB-40	7.0	-	4.25	-	-	-	R	-
	total sample size			**40**	**-**	**40**	**-**	**-**	-	-	-
	average			**5.90**	**-**	**3.60**	**-**	**-**	-	-	-
	median			**5.90**	**-**	**3.50**	**-**	**-**	-	-	-
	standard deviation			**0.801**	**-**	**0.645**	**-**	**-**	-	-	-
	standard error			**0.127**	**-**	**0.102**	**-**	**-**	-	-	-
	minimum			**4.60**	**-**	**2.50**	**-**	**-**	-	-	-
	maximum			**8.00**	**-**	**5.00**	**-**	**-**	-	-	-
	12-Aug-23	Arctic Charr	P4-AC-01	36.3	34.1	402.5	OTO, SC	5	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-02	37.1	34.5	532.5	-	-	-	R	-
	12-Aug-23	Arctic Charr	P4-AC-03	42.7	39.4	635.0	OTO, SC	7	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-04	45.6	42.6	835.0	OTO, SC	7	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-05	39.7	37.3	570.0	OTO, SC	5	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-06	27.9	26.0	148.0	OTO, SC	5	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-07	30.7	28.5	244.0	-	-	-	R	-
	12-Aug-23	Arctic Charr	P4-AC-08	41.0	38.1	620.0	-	-	-	R	-
	12-Aug-23	Arctic Charr	P4-AC-09	38.2	35.9	512.0	-	-	-	R	-
	12-Aug-23	Arctic Charr	P4-AC-10	38.5	36.0	560.0	OTO, SC	6	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-11	26.5	25.0	195.0	OTO, SC	4	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-12	37.7	35.5	495.0	OTO, SC	6	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-13	42.0	39.5	822.0	OTO, SC	6	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-14	36.9	34.5	437.0	OTO, SC	5	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-15	37.2	35.0	410.0	OTO, SC	7	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-16	25.8	24.1	-	OTO, SC	4	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-17	37.8	35.0	475.0	OTO, SC	5	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-18	39.0	36.0	520.0	-	-	-	R	-
	12-Aug-23	Arctic Charr	P4-AC-19	25.7	24.1	150.0	OTO, SC	4	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-20	35.0	32.6	375.0	OTO, SC	5	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-21	38.8	35.9	490.0	OTO, SC	5	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-22	30.4	28.4	262.0	OTO, SC	4	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-23	25.0	23.4	152.0	OTO, SC	4	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-24	41.7	38.9	605.0	-	-	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-25	34.6	32.4	415.0	-	-	-	R	-
	12-Aug-23	Arctic Charr	P4-AC-26	40.3	37.5	565.0	-	-	-	R	-
	12-Aug-23	Arctic Charr	P4-AC-27	31.8	29.8	305.0	-	-	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-28	31.5	29.2	295.0	-	-	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-29	33.3	31.2	330.0	-	-	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-30	26.6	24.8	164.0	-	-	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-31	30.9	29.1	262.0	-	-	-	R	-
	12-Aug-23	Arctic Charr	P4-AC-32	36.6	34.4	402.0	-	-	-	R	-
	12-Aug-23	Arctic Charr	P4-AC-33	41.9	39.2	685.0	-	-	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-34	47.4	44.3	910.0	-	-	-	M	-
	12-Aug-23	Arctic Charr	P4-AC-35	49.8	46.4	1,120.0	OTO, SC	9	-	M	-
	total sample size			**35**	**35**	**34**	**-**	**19**	-	-	-
	average			**40.28**	**37.58**	**595.0**	**-**	**6.0**	-	-	-
	median			**39.70**	**37.30**	**570.0**	**-**	**6.0**	-	-	-
	standard deviation			**3.887**	**3.542**	**158.7**	**-**	**1.2**	-	-	-
	standard error			**0.657**	**0.599**	**27.22**	**-**	**0.26**	-	-	-
	minimum			**36.30**	**34.10**	**402.5**	**-**	**5.0**	-	-	-
	maximum			**45.60**	**42.60**	**570.0**	**-**	**5.0**	-	-	-

Note: "-" indicates data not available

[a] "Cisco" refers to a species complex of at least 4 co-occurring species in the study area (cisco, least cisco, lake whitefish and broad whitefish)

[b] "PF" = pelvic fin-ray; "SC" = scales; "OTO" = otoliths.

[c] "DELT" = deformities, erosions, lesions, tumours. "N" = no; "Y" = yes. Any observed DELTs were recorded in comments.

[d] "M" = mortality; "R" = released.

Table B.4: Physical Measurements for Fish Caught in Ponds 2, 3, 4, and 5a to 5f, Iqaluktuuttiaq East Outflow System, August 2023

Area	Processing Date	Fish Species[a]	Fish ID	Total Length (cm)	Fork Length (cm)	Body Weight (g)	Age Structure Collected[b]	Age	DELT[c]	Fate[d]	Comment
Pond 4	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-01	43.7	39.6	730.0	OTO, SC	7	-	M	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-02	31.1	28.0	212.0	OTO, SC	4	-	M	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-03	24.4	22.2	102.0	OTO, SC	3	-	M	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-04	25.3	22.8	111.0	OTO, SC	3	-	M	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-05	29.0	26.2	162.0	-	-	-	R	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-06	44.5	40.8	822.0	OTO, SC	10	-	M	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-07	39.5	36.0	540.0	OTO, SC	7	-	M	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-08	39.5	35.5	512.0	OTO, SC	7	-	M	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-09	40.0	36.8	532.0	OTO, SC	6	-	M	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-10	47.6	43.0	990.0	PF, SC	12	-	M	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-11	46.8	42.4	1,240.0	OTO, SC	10	-	M	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-12	13.0	11.8	15.75	OTO, SC	1	-	M	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-13	31.8	38.2	650.0	-	-	-	R	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-14	42.8	38.9	690.0	-	-	-	R	-
	12-Aug-23	Cisco (*Coregonus* spp.)	P4-WF-15	29.0	26.2	170.0	-	-	-	M	-
			total sample size	**15**	**15**	**15**	**-**	**11**	-	-	-
			average	**35.20**	**32.56**	**498.6**	**-**	**6.4**	-	-	-
			median	**39.50**	**36.00**	**532.0**	**-**	**7.0**	-	-	-
			standard deviation	**9.920**	**9.138**	**364.1**	**-**	**3.4**	-	-	-
			standard error	**2.561**	**2.359**	**94.01**	**-**	**1.03**	-	-	-
			minimum	**13.00**	**11.80**	**15.75**	**-**	**1.00**	-	-	-
			maximum	**47.60**	**43.00**	**1,240.0**	**-**	**12.0**	-	-	-
Pond 5a	14-Aug-23	Ninespine Stickleback	P5a-NSSB-01	6.0	-	2.75	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5a-NSSB-02	5.8	-	3.25	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5a-NSSB-03	4.9	-	2.25	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5a-NSSB-04	4.9	-	2.25	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5a-NSSB-05	4.5	-	2.25	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5a-NSSB-06	4.8	-	2.25	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5a-NSSB-07	5.0	-	2.50	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5a-NSSB-08	4.7	-	2.25	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5a-NSSB-09	4.9	-	2.25	-	-	-	R	-
Pond 5c	14-Aug-23	Ninespine Stickleback	P5c-NSSB-01	6.1	-	3.25	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5c-NSSB-02	5.9	-	3.25	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5c-NSSB-03	4.5	-	2.50	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5c-NSSB-04	5.8	-	3.25	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5c-NSSB-05	5.0	-	2.25	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5c-NSSB-06	6.8	-	4.00	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5c-NSSB-07	5.1	-	2.75	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5c-NSSB-08	5.0	-	3.00	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5c-NSSB-09	5.1	-	3.25	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5c-NSSB-10	6.5	-	4.00	-	-	-	R	-
	14-Aug-23	Ninespine Stickleback	P5c-NSSB-11	4.7	-	2.50	-	-	-	R	-
Pond 5d	15-Aug-23	Ninespine Stickleback	P5d-NSSB-01	7.4	-	4.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5d-NSSB-02	5.4	-	2.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5d-NSSB-03	4.6	-	2.25	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5d-NSSB-04	4.8	-	2.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5d-NSSB-05	6.1	-	3.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5d-NSSB-06	5.1	-	2.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5d-NSSB-07	5.0	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5d-NSSB-08	5.0	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5d-NSSB-09	4.8	-	2.50	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5d-NSSB-10	4.9	-	2.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5d-NSSB-11	5.3	-	3.00	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5d-NSSB-12	4.8	-	2.75	-	-	-	R	-
Pond 5e	14-Aug-23	Arctic Charr	P5e-AC-01	41.7	38.5	725.0	-	-	-	R	-
	14-Aug-23	Cisco (*Coregonus* spp.)	P5e-WF-01	40.3	37.4	615.0	OTO, SC	1	-	M	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-01	7.8	-	4.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-02	5.0	-	2.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-03	4.9	-	2.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-04	6.1	-	3.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-05	6.6	-	4.00	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-06	7.4	-	4.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-07	5.1	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-08	5.2	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-09	5.1	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-10	4.9	-	2.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-11	4.9	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-12	5.5	-	3.25	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-13	5.0	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-14	4.7	-	2.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5e-NSSB-15	4.8	-	2.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-16	4.8	-	2.50	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-17	6.8	-	5.50	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-18	4.7	-	2.50	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-19	7.1	-	5.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-20	5.7	-	3.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-21	7.8	-	5.50	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-22	5.3	-	3.08	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-23	6.5	-	4.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-24	4.7	-	2.50	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-25	6.2	-	5.00	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-26	6.1	-	5.25	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-27	4.9	-	3.25	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-28	5.1	-	2.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-29	4.9	-	3.25	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-30	4.7	-	2.50	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-31	5.0	-	3.25	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-32	6.0	-	3.25	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-33	5.1	-	3.25	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-34	4.8	-	3.00	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-35	4.9	-	3.25	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-36	5.4	-	3.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-37	5.0	-	3.25	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-38	5.0	-	3.00	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-39	4.8	-	3.00	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5e-NSSB-40	5.6	-	3.75	-	-	-	R	-

Note: "-" indicates data not available

[a] "Cisco" refers to a species complex of at least 4 co-occurring species in the study area (cisco, least cisco, lake whitefish and broad whitefish)

[b] "PF" = pelvic fin-ray; "SC" = scales; "OTO" = otoliths.

[c] "DELT" = deformities, erosions, lesions, tumours. "N" = no; "Y" = yes. Any observed DELTs were recorded in comments.

[d] "M" = mortality; "R" = released.

Table B.4: Physical Measurements for Fish Caught in Ponds 2, 3, 4, and 5a to 5f, Iqaluktuuttiaq East Outflow System, August 2023

Area	Processing Date	Fish Species[a]	Fish ID	Total Length (cm)	Fork Length (cm)	Body Weight (g)	Age Structure Collected[b]	Age	DELT[c]	Fate[d]	Comment
Pond 5f	15-Aug-23	Ninespine Stickleback	P5f-NSSB-01	4.6	-	2.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-02	5.1	-	2.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-03	5.5	-	2.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-04	5.1	-	2.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-05	5.0	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-06	4.8	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-07	4.8	-	2.25	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-08	5.3	-	3.00	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-09	5.0	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-10	5.0	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-11	4.8	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-12	4.8	-	3.00	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-13	5.0	-	3.00	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-14	4.9	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-15	4.5	-	2.00	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-16	5.2	-	3.00	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-17	5.4	-	3.50	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-18	5.1	-	3.00	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-19	5.2	-	3.25	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-20	4.8	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-21	4.9	-	3.00	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-22	4.9	-	2.75	-	-	-	R	-
	15-Aug-23	Ninespine Stickleback	P5f-NSSB-23	5.4	-	3.25	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-24	5.3	-	2.50	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-25	5.0	-	3.25	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-26	5.5	-	2.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-27	5.0	-	2.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-28	5.0	-	2.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-29	4.9	-	2.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-30	5.1	-	2.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-31	4.7	-	2.50	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-32	4.8	-	2.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-33	4.9	-	2.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-34	4.8	-	2.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-35	5.1	-	3.00	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-36	4.8	-	3.00	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-37	5.0	-	3.00	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-38	4.7	-	2.50	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-39	5.1	-	2.75	-	-	-	R	-
	16-Aug-23	Ninespine Stickleback	P5f-NSSB-40	4.9	-	2.75	-	-	-	R	-
			total sample size	**114**	**-**	**114**	**-**	**-**	-	-	-
			average	**5.88**	**-**	**14.73**	**-**	**-**	-	-	-
			median	**5.00**	**-**	**2.75**	**-**	**-**	-	-	-
			standard deviation	**4.764**	**-**	**88.257**	**-**	**-**	-	-	-
			standard error	**0.446**	**-**	**8.266**	**-**	**-**	-	-	-
			minimum	**4.50**	**-**	**2.00**	**-**	**-**	-	-	-
			maximum	**41.70**	**-**	**725.00**	**-**	**-**	-	-	-

Note: "-" indicates data not available

[a] "Cisco" refers to a species complex of at least 4 co-occurring species in the study area (cisco, least cisco, lake whitefish and broad whitefish)

[b] "PF" = pelvic fin-ray; "SC" = scales; "OTO" = otoliths.

[c] "DELT" = deformities, erosions, lesions, tumours. "N" = no; "Y" = yes. Any observed DELTs were recorded in comments.

[d] "M" = mortality; "R" = released.

Iqaluktuuttiaq East Outflow System Hydrometric Baseline Summary Report

Prepared for

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May 26, 2025
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1. Introduction

GeoProcess Research Associates (GeoProcess) was retained by Minnow Environmental Inc. (Minnow) to prepare a summary of the baseline hydrometric work previously completed for the Agnico Eagle Mines Limited (Agnico) project near the Hope Bay Mine, and the nearby community of Cambridge Bay in Nunavut, Canada. This work was completed to support the ongoing planning and design of fisheries offsetting plan (FOP) options in the East Outflow System, an outlet of Iqaluktuuttiaq.

GeoProcess previously completed a conceptual options evaluation for the project, dated August 10, 2022, to support Agnico in the hydrotechnical evaluation of offsetting options for freshwater fish. This report summarized hydrometric work and data analysis completed in 2021, following two field visits in July and September. Subsequent field visits were completed in 2022 and 2023, advancing data collection for the established hydrometric stations. This report summarizes hydrometric activities conducted between 2022 and 2023 and includes up-to-date data analysis.

1.1. Project History

Six hydrometric stations and associated benchmark systems were established in 2021 within the East Outflow System (EOS) which is an outlet for Iqaluktuuttiaq (formerly known as Grenier Lake) that flows through a series of ponds, as shown in Map 1. GeoProcess has numbered the ponds for clarity. The EOS outlets Iqaluktuuttiaq and flows southwest into Pond 1 where it then discharges into Pond 2 through a series of 8 culverts under the main access road to Ovayok Territorial Park. From here it flows southwest for approximately 8 km, through the pond network and into the Freshwater Creek Estuary located in the Dease Strait near Cambridge Bay, NU. The relatively flat terrain results in multiple spill points for each pond, creating complex and dynamic flow patterns governed by water levels and pond shapes.

In July 2021, a field visit was conducted to deploy instrumentation to characterize the system's dynamic "fill and spill" flow regime. Six water level and two barometric sensors were installed. Each water level station was equipped with a HOBO® U20 pressure transducer affixed to a heavy portable weight, steel cable, and float. The sensors were set to record temperatures and stage at 15-minute intervals. Discharge measurements were conducted at four of the sites (G-01, G-03, G-05, G-06) with two high-flow measurements taken at each site during the field visit. The remaining two sites (G-02 and G-04) were not used for measuring discharge due to inadequate hydraulic controls and safety concerns. A network of 3 benchmarks was established for a local assumed datum near each gauging station by tagging and anchoring a concrete screw into nearby boulders. The assumed datum was established using differential levelling for the entire network.

Subsequent fieldwork was undertaken in September 2021 to capture lower flows and retrieve the sensors before ice formation. Additional discharge measurements were made at three stations (G-03, G-05, G-06) under low flow conditions. Benchmarks established in July were surveyed using a base and rover global navigation satellite system (GNSS) with enabled real-time kinematic (RTK) corrections (+/- 0.04 m error) to convert the local datum to a geodetic datum. Data analysis was completed and summarized in GeoProcess' "Conceptual Options Evaluation Report", submitted in March 2022.

2. Field Program

2.1. 2022 Field Program

In July 2022, Minnow and Agnico staff redeployed the six water level sensors, and two barometric pressure sensors in the same locations as the previous year. One additional hydrometric station (G-06b) was also established within Pond 5, in place of G-06 (G-06b is in a more favourable location). The sensors were set to record temperatures and stage at 15-minute intervals. Pins were installed at the water surface elevation for measurement later by GeoProcess staff to perform water level calibrations. Global positioning system (GPS) locations of each pin and sensor were collected for easy relocation. Subsequent fieldwork was undertaken between September 20th and September 22nd, 2022, by GeoProcess, Minnow, and Agnico staff. The assumed datum previously established for the entire network was surveyed again using both differential levelling and a base and rover GNSS for datum integration. The pins installed in July 2022 at the water surface were also surveyed to calibrate the data set. Data was collected and all instrumentation was retrieved during the field visit to prevent damage by ice. No additional flow measurements were collected due to ice formation beginning and the onset of a winter storm.

2.2. 2023 Field Program

GeoProcess coordinated for Agnico staff to redeploy the water level and barometric sensors, which was completed on August 8th, 2023. Six data loggers (G-01, G-02, G-03, G-04, G-05, and G-06B) and one barometric sensor were deployed to collect data at a 15-minute sampling interval, as in previous years. It was determined that G-06 and the second barometric sensor were not required for further analysis and were decommissioned. Pins were again installed at the water surface elevation during installation for subsequent measurement by GeoProcess staff for calibration to outside checks using the established network of benchmarks. A subsequent field visit was completed between August 11th and August 12th, 2023, by GeoProcess staff to assess deployment and survey the benchmark network using a base and rover GNSS. During this visit, a minor deviation was observed within the survey benchmark data, leading to some increased uncertainty in the stage data calibration. The source of this error is not known but is likely due to a subtle shift in the benchmark elevation (e.g. due to freeze/thaw or other ground shift). One flow measurement was conducted at G-05 during the field visit.

Bathymetric surveys were conducted to determine the depth and topography of Ponds 5a and 5b (see Section 4, below). Finally, GPS cross-sectional surveys were also completed for the hydrometric stations and within the associated connecting channels between EOS system ponds. The loggers were removed in late September by Agnico staff and transferred to GeoProcess for analysis. One sensor (G-02) was not located and, as such, data collected in 2023 was not recovered. It is suspected that the sensor may have been accidentally removed by local land users as it was deployed in a fishing area upstream of the culverts. A similar situation occurred previously in 2021.

3. Hydrometric Data Record

3.1. Stage

As the benchmark network was established in 2021, the initial GNSS setup was used as the reference datum. The benchmark network was resurveyed in 2022 and again in 2023 and compared for movement. Several benchmarks could not be located during subsequent field visits, given the dynamic landscape. However, at least two benchmarks associated with each station were surveyed to confirm datum accuracy.

All water level data were compensated for atmospheric pressure and then calibrated to the site visits using direct water level measurements (by survey level) from referenced benchmarks. Sensor values and field observations were imported into Time-Series software for analysis and interpretation. In 2022, stage data was collected from July 8th to September 21st and is of very good quality overall (Figure 1), for all stations except for G01 and G-06, which was deployed on August 2nd. Both stations were subject to wave action, and data exhibited moderate fluctuations as a result. No additional corrections were required. In 2023, stage data was collected between August 4th and September 27th for all stations except G-02, where the logger could not be recovered (Figure 2). Data between August 4th and August 12th for G-06B were removed as the logger exhibited sensor error, resulting in invalid data points. Data collected in 2023 for G-01 also demonstrated moderate fluctuations due to wave action, however, was not severe enough to warrant correction or removal of points. In 2023, a survey error due to a subtle benchmark shift was noted in the water level calibration checks. Although corrections were applied, stage data may exhibit a higher degree of uncertainty than that observed in previous years. This potential error is minor (+/- 2 cm).

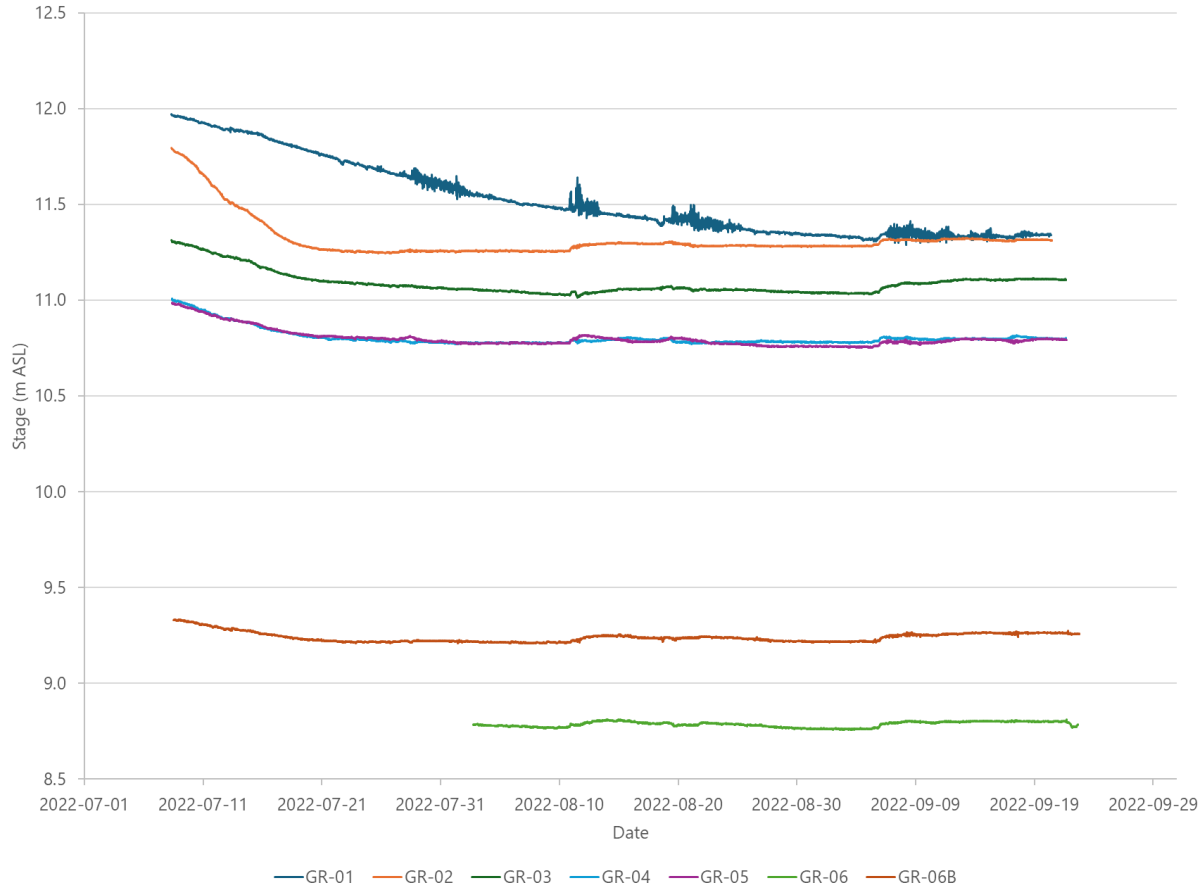

Figure 1: Time-Series of measured stage values at the seven hydrometric stations installed during the 2022 field season.

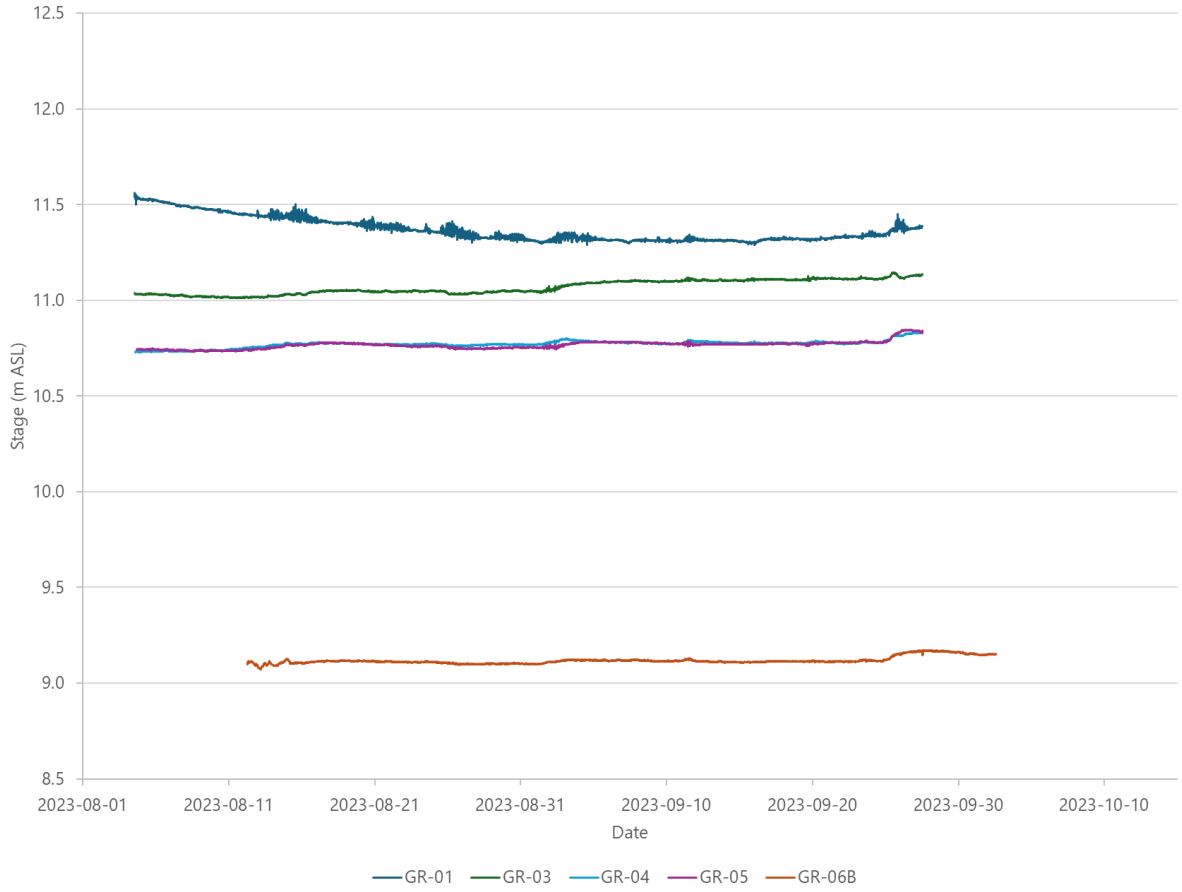

Figure 2: Time-Series of measured stage values at the five hydrometric stations installed during the 2023 field season. Note G-02 was deployed but data could not be recovered for analysis.

Data collected between 2022 and 2023 at all hydrometric stations exhibited similar trends in water level, with minimums observed through August and September of each year before ice formation. In 2022, the receding limb of the hydrograph was captured in early July as water levels receded from recent snow melt before stabilizing, then responding minimally to precipitation. In 2023, loggers were deployed later in the field season and as a result, receding high flows observed in previous years were not captured in the record of data. However, the period of data collected shows that water levels were slightly lower in 2023 than in preceding years.

3.2. Discharge

A stage-discharge curve was developed for the four sites that collected manual discharge measurements by plotting each flow measurement against the corresponding water level for the same time and duration. Curve equations are presented in Table 1, below.

Table 1: Rating curve equations by rating periods for each station.

Station	Period	Rating Curve Equation
G-01	2021-07-02 to 2023-09-27	$x = 9.980(y - 6.917)^{1.666}$
G-03	2021-07-02 to 2023-09-27	$x = 31.421(y - 6.237)^{2.147}$
G-05	2021-07-02 to 2023-09-27	$x = 21.642(y - 5.851)^{2.225}$
G-06	2021-07-02 to 2022-09-22	$x = 45.324(y - 3.872)^{2.242}$
NOTE: "x" refers to discharge in m^3/s and "y" refers to stage in m		

A Time-Series flow record was produced by running the stage collected through the curve model. The curves that were developed in 2021 were not revised as few flow measurements were collected in 2022 and 2023. One additional measurement was collected at G-05 in 2023, which was plotted on the low end of the existing curve without any required adjustments. It should be noted that the curves are considered preliminary because, while they have measurement calibrations at the high and low-end sections, important mid-range flows are required for stronger correlation and confidence in the curve models. However, it is estimated that the developed curves remain valid. It should be noted that the G-01 model is not yet a valid rating curve and still needs a low flow measurement, in addition to a mid-range measurement. Until additional data can be collected and a refined curve plotted, this model was estimated using two high-flow measurements and the zero-flow elevation determined from a cross-sectional field survey at the hydraulic control for the lake. It should also be noted that unobserved control and other local changes over time may directly impact the relationship identified, and regular observations are required to confirm validity.

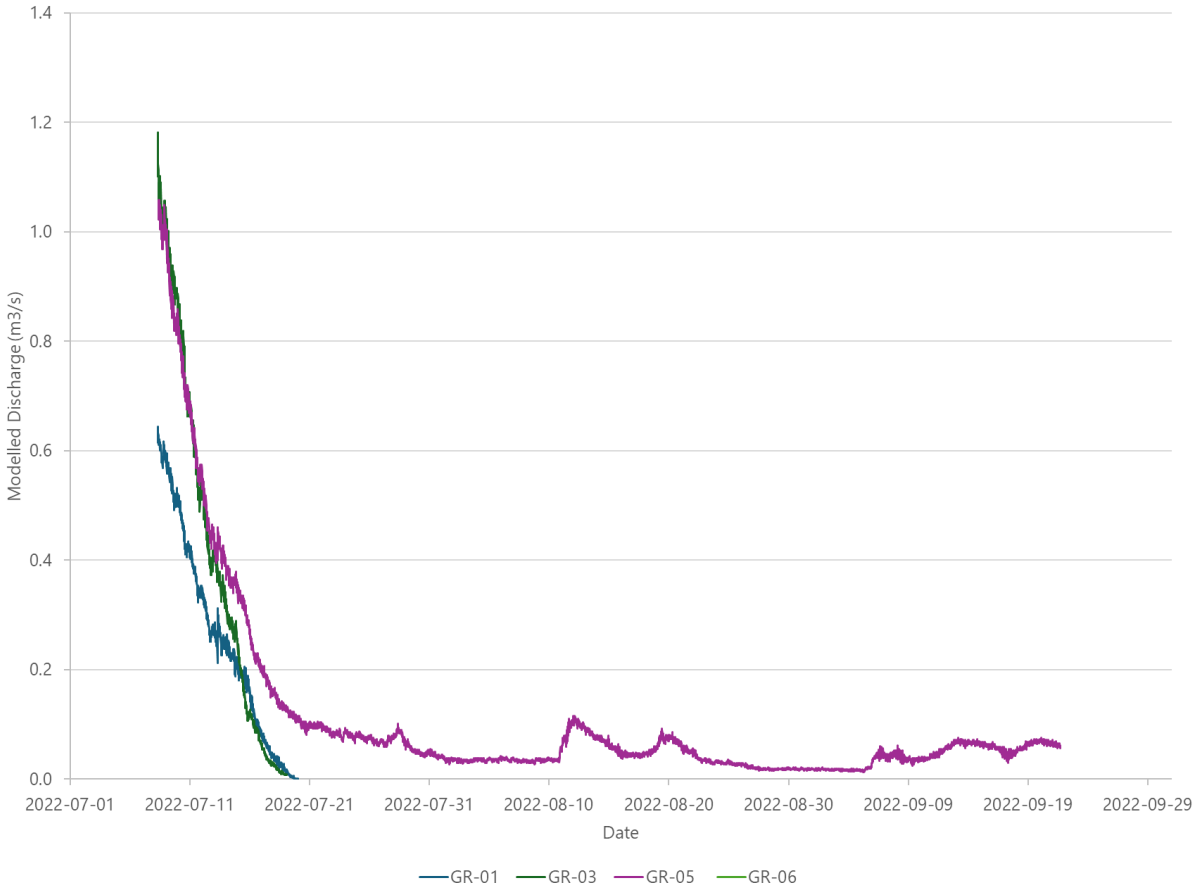

Figure 3: Time-Series of modelled discharge at the four hydrometric stations with established rating curves installed in 2022.

Figure 4: Time-Series of modelled discharge at the three hydrometric stations with established rating curves installed in 2023.

Figure 3 and Figure 4 show the discharge generated for the four hydrometric stations where manual discharge measurements were collected in 2022 and 2023, respectively. In 2022, no discharge was observed for the period of record at G-06 as captured water levels were below the zero-flow point of the curve. Similarly at G-01 and G-03, water levels receded below the zero-flow point in late July and no discharge was modelled. It should be noted that the curves are preliminary, and flows may have been present outside of the modelled values. As the spring freshet was not captured in the 2023 stage data, discharge was only observed at two stations (G-03 and G-05) using the current models. At G-03, flow data was generated in late September as water levels increased following precipitation into the system. Very minimal flow was modelled for G-05 through the period of record, also responding to precipitation additions in late September 2023.

Discharge data was modelled using the developed curves for all three years of data collection for the four discharge stations, where reliable stage data was available. As additional curve development is still required to refine the models across a broader range of flows, it should be noted that data is considered a preliminary estimate. Should more detailed analyses using the discharge data developed be required, additional flow measurements should be conducted during a future open water season to further refine the curves and increase confidence.

4. Bathymetric Survey

Bathymetric surveys were conducted in 2023 for Ponds 5a and 5b using a BathyCat, a portable unmanned survey catamaran that directs a single beam echo sounder that measures the river and lake bathymetry. Raw bathymetry survey points were corrected to a local datum, referencing previously surveyed benchmarks (which form part of the hydrometric network) and the water surface elevation on the day of the survey. The corrected survey points were imported as a .CSV into Civil 3D to develop a tin surface by definition survey points. This surface was exported as a DEM raster with 0.25 m dimension grids, imported to GIS and the DEM was converted to vector contours with smoothing for visualization purposes. A map was created (Map 2). This data supplements previous surveys, filling in data gaps and uncertainty concerning these two ponds. The data is also available for download for use in further analysis and future phases of the project.

5. Conclusion

GeoProcess Research Associates was contracted by Minnow Environmental to support Agnico Eagle Mines Limited in support of the ongoing planning and design of fisheries offsetting plan (FOP) options in the East Outflow System, an outlet of Iqaluktuuttiaq, through the collection of hydrometric data. The hydrometric activities and data summarized in this report are inclusive of the 2022 and 2023 field seasons and capture data collected to date. Two field visits were conducted between 2022 and 2023 by GeoProcess staff in support of the seven established hydrometric stations. Additional fieldwork is recommended to supplement the hydrometric monitoring program should more detailed analyses be required, as stage-discharge relationships and developed rating curves are considered preliminary.

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HOPE BAY HYDROMETRIC BASELINE SUMMARY
FINAL REPORT

Prepared for Agnico Eagle Mines Ltd.

May 26, 2025

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Reviewed by:

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Disclaimer

We certify that the services performed by GeoProcess Research Associates were conducted in a manner consistent with the level of care, skill and diligence to be reasonably exercised by members of the engineering and science professions.

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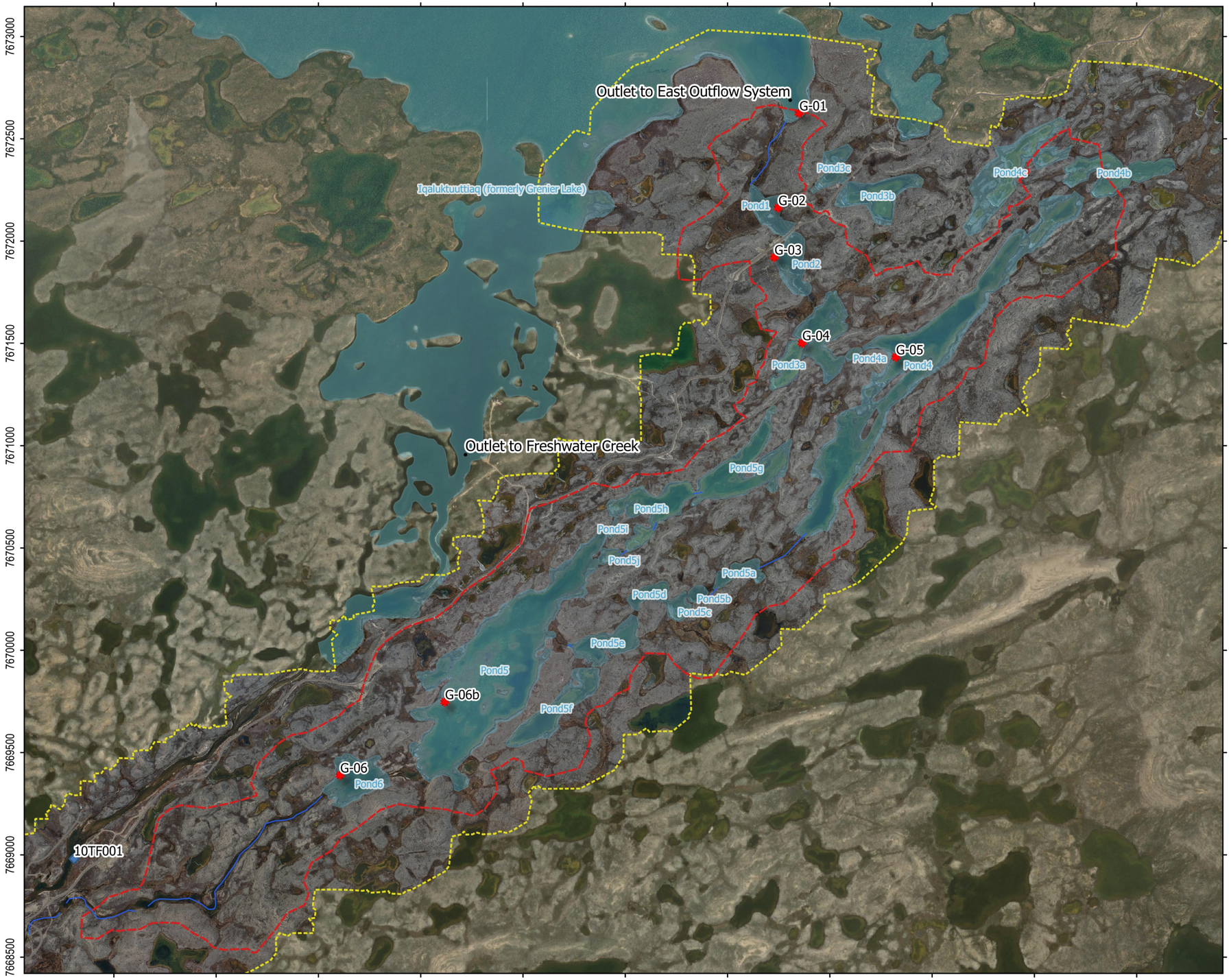
Project Number P2020-427

Maps



Legend

- WSC Gauge
- GRA Hydrometric Stations
- Stream Network
- Study Area Waterbody
- Study Area
- Orthometric Imagery Extents

Notes: Background map provided by ESRI.
Ortho Imagery provided by GeoProcess.

N

0 0.5 1 km

GeoProcess RESEARCH ASSOCIATES

CREATED BY:	SG	PROJECT NO.:	P2020-427
CHECKED BY:	JH	DATE:	Feb 04, 2025

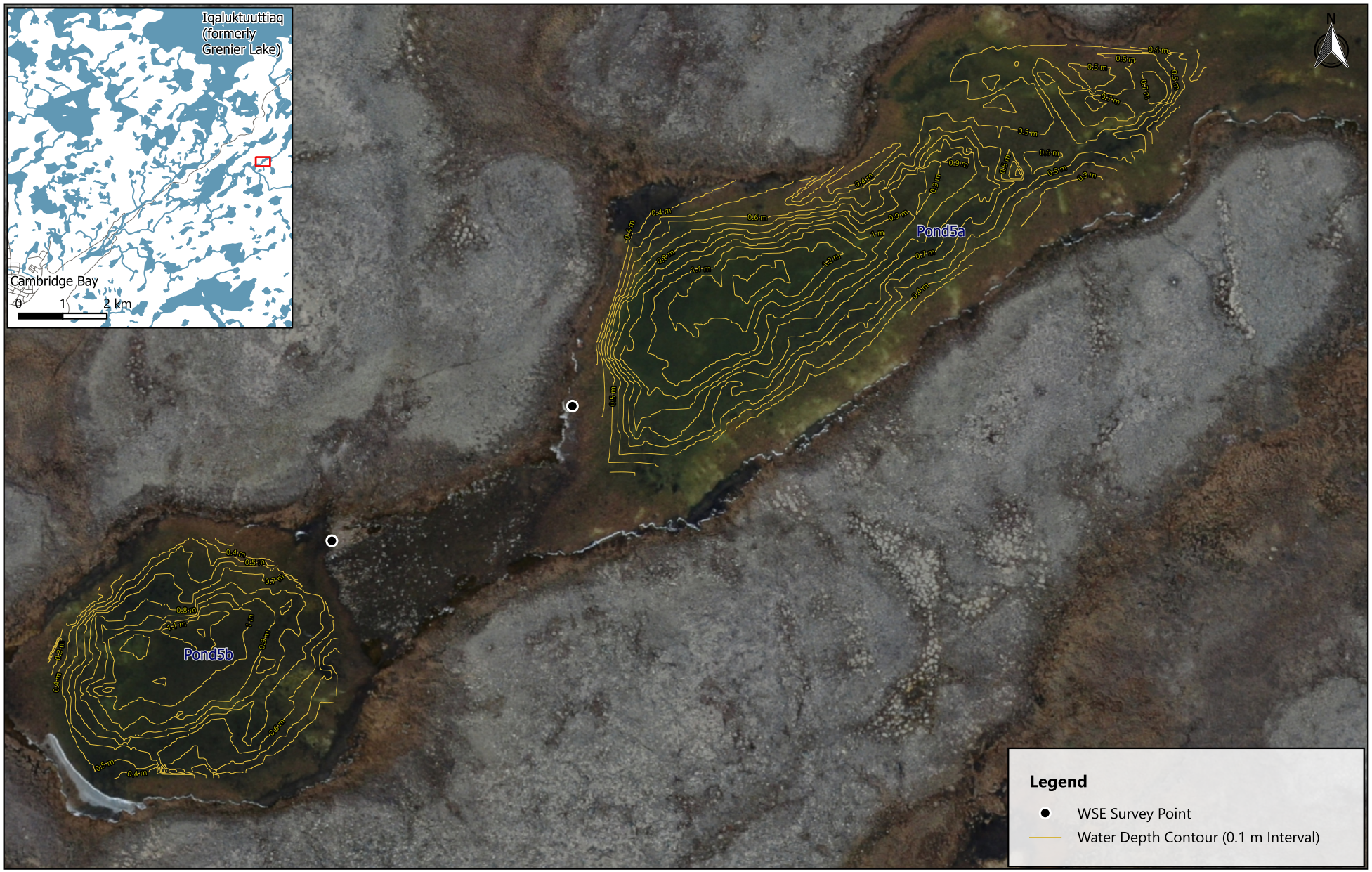
Map 1: Hydrometric Network

Coordinate System: UTM Zone 13 [EPSG:32613]

Hope Bay Fisheries Offsetting Conceptual Options

Minnow Environment Inc. (a Trinity Consultants Company)

G:\Shared drives\Projects-2020\P2020-427 TMAC 2020 Hope Bay Fisheries Program\GIS\Projects\427_Conceptal_Report_Maps_20250204.qgz



GeoProcess
RESEARCH ASSOCIATES

CREATED BY:	FM	PROJECT NO.:	P2020-427
CHECKED BY:	JH	DATE:	Nov 08, 2024

0 25 50 m

WGS 84 / UTM zone 13N (EPSG:32613)

Notes:
[1] Bathy survey date: 2023-08-11
[2] Orthophoto from GeoProcess unmanned aerial vehicle (UAV)
[3] Depths are reletive to water surface elevation (WSE) at time of survey.
[4] Pond5a Corrected WSE: 10.003 m
[5] Pond5a Corrected WSE: 9.491 m

Map 2

Pond 5a and 5b Depth Contours from Bathymetric Survey

2023 Field Program Summary

Minnow Environmental Inc. (a Trinity Consultants Company)

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