October 28, 2022

Assol Kubeisinova
Technical Advisor, NWB
P.O. Box 119
Gjoa Haven, NU X0B 1J0

RE: Issued for Construction Drawings Submission – 2022/2023 Tote Road Culvert Upgrades Mary River Project - Type 'A' Water Licence 2AM-MRY1325 - Amend. No. 1 – Expedited NWB Review

Baffinland Iron Mines Corporation (Baffinland) is pleased to submit final design and for-construction drawings for planned culvert upgrade construction work at the Mary River Project (the Project) in accordance with Part E, Item 23 of Type 'A' Water Licence 2AM-MRY1325 - Amendment No. 1 (Type A Water Licence).

The purpose of these measures is to improve fish passage and surface water drainage, and to reduce potential erosion and sedimentation. The proposed measures are consistent with the scope of Baffinland's Type 'A' Water Licence and with Baffinland's commitments. The planned construction work to be completed during 2022-2023 includes upgrades to culverts at twenty (20) locations on the Milne Inlet Tote Road.

This letter is to provide written notification to the Nunavut Water Board (NWB) that Baffinland would like to proceed with construction in the first 3 locations by November 18, 2022, in order to maximize the overall culvert upgrade work that can be completed during frozen site conditions. These three locations are:

- **Crossing BG-04 (Km 94)**
- **Crossing CV-216 (Km 80.5)**
- **Crossing BG-50 (km 63)**

This construction timeframe is critical to ensure that the planned upgrades can be completed before freshet in 2023. Accordingly, this letter requests an **expedited review** by NWB for the three culvert crossings listed above, as discussed with the NWB. For the remaining 17 crossings, a customary 30-day review period as specified in Part E, Item 23 of the Licence is requested.

The following documents which includes relevant drawings and figures has been attached. For context, the enclosed drawings and documents are similar to the original approved culvert designs and are a standard accepted approach:

- Permanent Crossing Plan – 20 Tote Road Crossings

Baffinland will prepare a Construction Summary Report within ninety (90) days following completion of this work, in accordance with Part D, Item 17 of the Licence.

We trust that this information meets the requirements under Part E of the Licence.

Regards,

Steve Borcsok
Approvals Manager

Attachments:
Attachment 1: Design Brief & For-Construction Drawings

Cc:
Karén Kharatyan (Nunavut Water Board)
Chris Spencer (Qikiqtani Inuit Association)
Lauren Perrin, Omer Pasalic (Crown-Indigenous Relations and Northern Affairs Canada)
Alasdair Beattie, Daniel Coombs, Edyta Ratajczyk (Fisheries and Oceans Canada)
Megan-Lord Hoyle, Lou Kamermans, Timothy Ray Sewell, Connor Devereaux, Todd Swenson (Baffinland)

Attachment 1

Design Brief & For Construction-Drawings

Prepared for
Baffinland Iron Mines Corporation
#300-2275 Upper Middle Road East
Oakville, Ontario
Canada, L6H 0C3

Prepared by
Knight Piésold Ltd.
200 - 1164 Devonshire Avenue
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NB102-181/77-3

MARY RIVER PROJECT
PERMANENT CROSSING PLAN - 20 TOTE ROAD CROSSINGS

Rev	Description	Date
0	Issued in Final	October 28, 2022

EXECUTIVE SUMMARY

Baffinland Iron Mines Corporation (Baffinland) is proposing to carry out remedial works on culverts installed in 20 fish-bearing streams along the Milne Inlet Tote Road. These crossings were identified by Baffinland and Fisheries and Oceans Canada (DFO) as high priority for remediation because of one or more issues, including perched culverts that impede fish passage, undersized culverts that do not adequately pass flows, or erosion and sedimentation issues.

Knight Piésold Ltd. (KP) developed this Permanent Crossing Plan to address the above-mentioned issues at each of the 20 crossings. Development of this Plan included the following:

- Review of each water crossing to confirm:
  - Compliance with the Project's design criteria applicable to water crossings (Hatch, 2018)
  - Fish passage issues (i.e., perched culvert, modelled high velocities, etc.)
  - Erosion and sediment control concerns
- Prepare a remediation plan for each crossing to achieve compliance with the design criteria, improve conditions for fish passage, and address erosion and sedimentation issues.

The following summarizes the findings of our review:

- Culvert replacements are required at all 20 crossings to meet current design flows and/or to meet Baffinland's minimum diameter culvert in fish-bearing streams (Hatch, 2018). Culvert replacements include one to seven barrels of culvert sizes ranging from 1.0 m to 2.0 m diameter.
- The slope of the culvert replacements should be consistent with the existing ground, which in most cases will match the slope of the existing culverts.
- Existing embankment side slopes do not meet the design criterion of 2H:1V. Thus, side slopes will need to be flattened, and culverts will need to be lengthened to accommodate the flatter slopes.
- All crossings require additional permanent erosion and sediment control (ESC) measures, including riprap armouring of side slopes and ditching approaching the crossings with riprap.

The work should be carried out in accordance with the culvert typical drawing provided and other measures described in this report; in accordance with the Erosion and Sediment Control Plan - Culvert Replacements During Winter (KP, 2022); relevant Baffinland management plans (i.e., the Roads Management Plan, Surface Water and Aquatic Ecosystem Management Plan, and the Environmental Protection Plan); and applicable legislation.

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Abbreviations

Baffinland	Baffinland Iron Mines Corporation
CSP	corrugated steel pipe
DFO	Fisheries and Oceans Canada
ESC	erosion and sediment control
EPP	Environmental Protection Plan
HADD	harmful alteration, disruption, or destruction
KP	Knight Piésold Ltd.
NSC	North/South Consultants Inc.
Tote Road	Milne Inlet Tote Road

1.0 INTRODUCTION

1.1 OVERVIEW

Baffinland Iron Mines Corporation (Baffinland) is proposing to carry out remedial works on culverts previously installed in 20 fish-bearing streams along the Milne Inlet Tote Road (Figure 1.1). These crossings were identified by Baffinland and Fisheries and Oceans Canada (DFO) as high priority for remediation because of one or more issues, including perched culverts that impede fish passage, undersized culverts that do not adequately pass flows, or erosion and sedimentation issues (Baffinland, 2022a and 2022b).

Knight Piésold Ltd. (KP) developed this Permanent Crossing Plan to address the above-mentioned issues (as applicable) at each of the 20 crossings. Development of this Plan included the following:

- Review of each water crossing to confirm:
  - Compliance with the Project's design criteria applicable to water crossings (Hatch, 2018).
  - Fish passage issues (i.e., perched culvert, modelled high velocities, etc.).
  - Erosion and sediment control (ESC) concerns.
- Incorporation of input from the fisheries consultant (North/South Consultants Inc.) on fish use of the stream and surrounding area including the identification of overwintering fish habitat.
- Verification of crossing catchment areas.
- A hydrologic and hydraulic assessment to determine the culvert numbers and sizes required to pass the design flows.
- A fish passage assessment to determine the risk of the existing and proposed culverts being a barrier to fish passage, with adjustments to the number and sizes of proposed culverts as required to reduce flow velocities to acceptable levels.
- Development of a typical culvert design that will improve fish passage at low and high flows (i.e., one culvert embedded 40% of its diameter).
- Development of crossing-specific permanent ESC measures to achieve compliance with the design criteria and address erosion and sedimentation issues.

1.2 AQUATIC SETTING

The Milne Inlet Tote Road (Tote Road) crosses a number of watercourses in two major watersheds: Phillips Creek and the Ravn River system. Two species of fish are present in the Tote Road area: Arctic Char and Ninespine Stickleback, the latter being relatively uncommon in watercourses along the Tote Road. None of the 20 Tote Road crossings support any aquatic species at risk. The Arctic Char present in watercourses crossed by the Tote Road are considered landlocked, as permanent, natural fish barriers prevent anadromous char from accessing the reaches of both the Phillips Creek and Ravn River where all the fish-bearing crossings are situated.

Fish use of these streams is limited to the open-water season (typically from early to mid-June to early September); all these streams freeze solid in winter in the vicinity of the crossings Potential overwintering habitat is present in several lakes downstream and/or upstream from each of the fish-bearing crossings in both major watersheds. Arctic Char use of stream habitat in the vicinity of the Tote Road is exclusively as juvenile rearing habitat.

Ninespine Stickleback, where present, use stream habitat for rearing / adult feeding with potential spawning[1] in some locations. No other species of fish are present in freshwater habitat within the study area.

Localized habitat information for each of the 20 crossings is shown on maps and described in Appendix B.

[1]Spawning for all life history types occurs in shallow brackish or fresh water, typically from May to late July, usually over soft substrate in areas with sufficient nest-building material (e.g., aquatic vegetation), but it can also occur later during the open water season and as deep as 40 m (North/South Consultants Inc., 2012).

520,000
560,000
7,960,000
7,960,000
480,000
MILNE INLET
MILNE PORT
PHILLIPS CREEK
5 KM
10 KM
15 KM
20 KM
25 KM
30 KM
CV-114
CV-111
CV-112
CV-106
35 KM
CV-102
40 KM
45 KM
50 KM
KATIKTOK LAKE
55 KM
CV-059
60 KM
BG-50
65 KM
70 KM
75 KM
80 KM
CV-216
BG-30
85 KM
90 KM
BG-17
95 KM
BG-04
CV-001
MURIEL LAKE
DAVID LAKE
TOM RIVER
MINE SITE
CV-225
BG-01
SHEARDOWN LAKE
CAMP LAKE
MARY RIVER
MARY LAKE
RAVN RIVER
SCALE 2 1 0 2 4 6 8 10 km

LEGEND:

- TOTE ROAD PRIORITY WATER CROSSINGS
- FLOW DIRECTION
- RIVER/STREAM
- MILNE INLET TOTE ROAD
- WATER
- TOTE ROAD PRIORITY WATER CROSSING CATCHMENTS
- EXISTING BORROW AREA (FROM TETRATECH, 2019)

NOTES:

1. BASE MAP: HER MAJESTY THE QUEEN IN RIGHTS OF CANADA, DEPARTMENT OF NATURAL RESOURCES (2004).
2. COORDINATE GRID IS UTM (NAD83) ZONE 17 AND IS IN METRES.
3. FIGURE CREATED BY KNIGHT PIESOLD LTD.
4. CATCHMENT BASED ON JULY 2006 INSPECTIONS.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	RAC	AS	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

PRIORITY TOTE ROAD WATER CROSSING CATCHMENTS

Knight Piésold CONSULTING

P/A NO. NB102-181/77

REF NO. 3

FIGURE 1.1

REV 0

SAVED: I:\1\02\DD\181\77A\GIS\Figs\BG5 RD.mxd; Oct 14, 2022 8:58 AM; asimpson

2.0 DESIGN CRITERIA

2.1 CROSSING DESIGN CRITERIA

The Project's design criteria for culvert water crossings are summarized as follows (Hatch, 2018):

- Return period for culvert sizing = 1 in 100-year, 24-hour storm event (64.2 mm; KP, 2012).
- Minimum Culvert Slope = 0.3%.
- Minimum culvert diameters:
  - Non-fish-bearing streams = 500 mm.
  - Fish-bearing streams = 1,000 mm.
- For fish-bearing streams, one culvert is to be embedded by 40% of the culvert diameter.
- Manning's n values for corrugated steel pipe (CSP) culverts = 0.024.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm in accordance with AASHTO HS20-44, except for areas of special equipment operation, which shall consider vehicle loading.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- The footprint of stream crossing will be minimized.
- Ditch side slopes in soil = 2H:1V.
- Riprap shall be provided at locations susceptible to erosion, including ditch sections subject to high velocities (greater than 1.5 m/s), sections of super critical flow, ditch outlets, and culvert inlets and outlets. If the ditch is in rock, no riprap is required. Energy dissipaters shall be used where the flow velocities may reach values high enough to cause severe erosion or hydraulic jumps.
- Streambanks will not be cut, and material will not be removed from below the ordinary highwater mark of any waterbody unless authorized.
- Culverts and bridges for stream and river crossings will be designed to limit barriers to fish movement and where possible, minimum flows will be maintained in streams important for fish habitat.
- Use of explosives in or near streams/water bodies will be done as per Fisheries and Oceans Canada (DFO) Guidelines.
- Limit barrier to fish movement with site specific design of rocky ramps at culvert crossing (where required).
- For creek crossings and construction activities that will likely result in a Harmful Alteration, Disruption, or Destruction (HADD) of fish habitat as defined under the *Fisheries Act,* a Fish Habitat and Compensation Monitoring Plan (No Net Loss Plan) will be developed to mitigate impacts on associated fish habitat (requirement under the terms of the Section 35(2) Fisheries Authorization issued by Fisheries and Oceans Canada [DFO] for these installations).

2.2 PEAK DESIGN FLOWS

The scaling equation to estimate the 1 in 100-year return period peak instantaneous flow was used to size the culverts (KP, 2012 and 2016). The equation is shown below:

$$Q_{100} = 2.27\ x\ A^{0.80}$$

Where Q is the peak instantaneous flow and A is the culvert catchment area in km^2.

3.0 WATER CROSSING REVIEW

3.1 OVERVIEW

The following summarizes the findings of our review:

- Culvert replacements are required at all 20 crossings to meet current design flows.
- Culvert replacements include one to four culvert barrels of sizes ranging from the minimum 1.0 m diameter required for fish-bearing crossings, to 2.0 m diameter.
- The slope of the new culverts should be consistent with the existing ground, which in most cases will be the slope of the existing culverts.
- The existing road embankment side slopes will undergo earthworks to meet the design criterion of 2H:1V.
- All crossings require additional armouring around the culvert inlet and outlets, on the side slopes of the road embankments, and in the ditches approaching the crossings.

Table 3.1 summarizes the recommended remediation measures for each of the 20 crossings. The detailed results are presented in Appendix B, including photographs, identification of issues, and the proposed remediation plan for each crossing.

A discussion of the fish passage assessment on both the existing crossings and proposed culvert replacements is provided in Section 3.2.

3.2 FISH PASSAGE ASSESSMENT

The fish passage assessment was completed on both the existing culverts and proposed installations as part of the remediation plan, using an assessment methodology previously employed by KP for the proposed North Railway (KP, 2019). The fish passage assessment considers fish presence, water velocities and depth within the culvert, culvert length, culvert embeddedness and outlet drop to assign a corresponding fish barrier risk rating. The methodology and results are presented in Appendix C.

The following summarizes the modelling results:

- **Existing Crossings -** All crossings were rated high risk of being a barrier to fish passage.
- **Culvert Replacements -** All rated as moderate or low risk of being a fish passage barrier.

Mitigation measures employed to reduce the risk to fish passage included embedding one culvert (or the only culvert) by 40% of its diameter consistent with best practices (Government of British Columbia, 2010). This level of embeddedness will increase the amount of rough substrate within the culvert (reducing velocity) and will reduce the potential for the culverts to become perched in the future. An additional culvert was added as a further mitigation measure at several crossings to help reduce the fish passage barrier risk from high to moderate.

Table 3.1 Proposed Crossing Remediation Plan

Water Crossing	UTM Coordinates		No. Barrels	Culvert Diameter (mm)	Culvert Embeddedness	Culvert Length (m)	Slope (%)	Other Remedial Measures
	Easting	Northing						
BG-01	557,992	7,914,921	2	1800	1 culvert 40% of diameter	38	1.66	2H:1V armoured embankments
CV-224	556,226	7,915,057	2	1200	1 culvert 40% of diameter	31	1.50	2H:1V armoured embankments
CV-225	557,430	7,915,203	2	1800	1 culvert 40% of diameter	45	3.69	2H:1V armoured embankments
BG-04	553,248	7,915,111	2	1800	1 culvert 40% of diameter	28	1.28	2H:1V armoured embankments
BG-17	550,697	7,917,651	3	1800	1 culvert 40% of diameter	52	0.54	2H:1V armoured embankments
BG-24	548,789	7,918,886	4	1200	1 culvert 40% of diameter	22	3.54	2H:1V armoured embankments
BG-27	557,993	7,914,920	2	1000	1 culvert 40% of diameter	24 (1)	6.03	2H:1V armoured embankments
BG-30	546,206	7,919,886	2	1200	1 culvert 40% of diameter	36	0.88	2H:1V armoured embankments
CV-216	542,777	7,921,733	4	1800	1 culvert 40% of diameter	29	1.46	2H:1V armoured embankments
BG-50	529,331	7,926,817	4	1800	1 culvert 40% of diameter	29	0.24	2H:1V armoured embankments
CV-001	553,546	7,914,906	3	1000	1 culvert 40% of diameter	24	0.54	2H:1V armoured embankments
CV-057	528,369	7,928,658	2	1000	1 culvert 40% of diameter	22	1.29	2H:1V armoured embankments
CV-059	528,099	7,929,358	3	1200	1 culvert 40% of diameter	22	4.80	2H:1V armoured embankments
CV-078	525,860	7,936,794	3	2000	1 culvert 40% of diameter	33	3.50	2H:1V armoured embankments
CV-079	525,543	7,937,318	4	1800	1 culvert 40% of diameter	27 (1)	1.26	2H:1V armoured embankments
CV-102	521,942	7,950,572	2	1200	1 culvert 40% of diameter	23	2.04	2H:1V armoured embankments
CV-106	521,659	7,953,394	2	1000	1 culvert 40% of diameter	24	2.54	2H:1V armoured embankments
CV-111	521,374	7,954,521	2	1800	1 culvert 40% of diameter	34	2.69	2H:1V armoured embankments
CV-112	521,042	7,954,943	2	1200	1 culvert 40% of diameter	25	1.47	2H:1V armoured embankments
CV-114	520,290	7,956,540	3	1200	1 culvert 40% of diameter	26	5.08	2H:1V armoured embankments

Note(s):

1. The road at this location is narrow and should be widened for safety reasons. As such, the proposed culvert length is based on widening the road surface to achieve the nominal 15 m road width.

3.3 CULVERT DESIGN AND CONSTRUCTION

A drawing showing a culvert typical section and detail is included in Appendix D. This design should be applied considering the remediation measures identified in Table 3.1, with field fitting, as necessary.

All culvert pipes shall be installed as shown on the drawing according to the supplier's recommendations and technical specifications and in compliance with all applicable regulatory requirements. Foundation preparation for the culvert installations will generally involve grading, levelling, and preparation of a compacted pad, consisting of well graded sand and gravel, onto which the culverts will be installed. Some areas may require excavation and removal of poor-quality materials as required by the Engineer.

The culverts are assumed to be 6 m lengths, and therefore, installation will require couplers to connect multiple culverts to provide sufficient length to accommodate the road design width and cross-section. Culvert backfill material will be placed and compacted in accordance with the technical specifications. Backfill around pipes (i.e., haunching, crown, etc.) shall be carefully placed in thin lifts and compacted using hand compaction equipment to prevent damage to the pipes. All other fill material will be General Fill and shall be compacted using standard vibratory roller equipment.

Erosion protection measures may be required to protect the abutment fill at the major crossings. Non-woven geotextile may also be used for the overflow swales to provide additional support and erosion protection during periods of the high flows. A site assessment by the contractor and site Engineer is recommended, prior to each installation, to identify the stabilization requirements.

Given the work involved to remove the existing culvert crossings, and to install the replacement culverts (i.e., excavate below the base of the current culverts to embed a barrel at each crossing), it is recommended to complete the work under low/no flow conditions.

Construction vehicle access shall be limited to existing roadways and construction access routes, away from existing natural areas and watercourses to the extent practical. All access to the work site shall be from either side of the watercourse. No equipment or construction vehicles are permitted to cross through the watercourse at any time, unless approved by DFO. The contractor shall carry out the proposed works in a manner that minimizes disturbance to the existing stream bed. Where extension of a culvert is required, stream bed material may be salvaged and reused on site for erosion protection if possible.

Culverts and surrounding fill will be removed through excavation where ground is unfrozen or by using drilling and blasting methods where the ground is frozen. Use of explosives in or near streams/water bodies will be undertaken as per Fisheries and Oceans Canada (DFO) Guidelines, as committed to in Baffinland's Surface Water and Aquatic Ecosystem Management Plan. If required, blasting mats will be put in place to diminish the effects of detonation such as flying debris to limit runoff of loose sediments. Blasted soil will be removed and will be hauled to former borrow pits or low-lying areas for containment.

All activities including maintenance procedures, shall be controlled to prevent the entry of petroleum products, debris, rubble, blasting spoils, or other deleterious substances into nearby waters, including drainage ditches that outlet to these waters.

Other recommended environmental protection measures are described in Section 4.18 of Baffinland's Environmental Protection Plan (EPP; Baffinland, 2021).

The Tote Road access procedures to be used to maintain road access during construction are listed in Table 3.2 below.

Table 3.2 Tote Road Access Procedures During Construction

Location	Procedures
BG-01	Road Closure
CV-225	Single Traffic Staging
BG-24	Ice Road
BG-04	Ice Road
BG-17	Single Traffic Staging
BG-27	Road Closure
BG-30	Ice Road
CV-216	Single Traffic Staging
BG-50	Single Traffic Staging
CV-057	Single Traffic Staging
CV-059	Ice Road
CV-078	Ice Road
CV-079	Ice Road
CV-106	Ice Road
CV-111	Ice Road
CV-114	Ice Road
CV-112	Ice Road
CV-224	Ice Road
CV-001	Ice Road
CV-102	Ice Road

4.0 CONCLUSIONS AND RECOMMENDATIONS

Remedial measures are required at all 20 high priority crossings on the Tote Road. This includes the following:

- Replace the existing culverts with culverts of larger diameter and longer length (Table 3.1 and Appendix B)
- Embed one of the new culverts at each crossing by 40% of the culvert diameter (previous embedding was only 10%)
- Flatten road embankment side slopes at the crossings to 2H:1V (the longer length culverts are required for this reason)
- Armour the embankments and line ditches adjacent to the crossings with riprap

The work should be carried out in accordance with the culvert typical drawing and other measures described in this report, in accordance with the ESC Plan, other Baffinland management plans, and applicable legislation.

5.0 REFERENCES

Baffinland Iron Mines Corporation (Baffinland), 2021. *Environmental Protection Plan (EPP)*. April 30. Ref. No. BAF-PH1-830-P16-0008, Rev 2.

Baffinland Iron Mines Corporation (Baffinland), 2022a. Letter to: Alasdair Beattie, Fisheries and Ocean Canada. Letter from: Steve Borcsok of Baffinland. Re: *Milne Inlet Tote Road Remediation Plans*. March 1.

Baffinland Iron Mines Corporation (Baffinland), 2022b. Letter to: Fisheries Protection Program, Fisheries and Oceans Canada. Letter from: Steve Borcsok of Baffinland. Re: *DFO Request for Review - 2022 Tote Road Culvert Remediation*. June 1.

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Government of British Columbia, 2010. *Design and Installation of Embedded Culverts - Part 2: Design*. Kamloops, March 12, 2002. Retrieved from: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/resource-roads/fishstreamcrossingtrainingpart_2_design_march12_2010.pdf.

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Knight Piésold Ltd. (KP), 2012. *Baseline Hydrology Report*. January 4. North Bay, Ontario. Ref. No. NB102-181/30-7, Rev 1.

Knight Piésold Ltd. (KP), 2016. Letter to: Matt Weaver, Baffinland Iron Mines Corporation. Re: *Updated Design Peak Flow Assessment*. December 13. Vancouver, BC. Ref. No. VA16-01950 (NB102-181/39).

Knight Piésold Ltd. (KP), 2019. Letter to: Lou Kamermans, Baffinland Iron Mines Corporation. Re: *Fish Passage Risk Assessment of Water Crossings and Stream Diversions - Proposed North Railway - Mary River Project - Phase 2 Proposal*. June 18. Vancouver, BC. Ref. No. VA19-00838 (NB102-181/53).

Knight Piésold Ltd. (KP), 2022. *Erosion and Sediment Control Plan - Culvert Replacements During Winter*. October 14. North Bay, Ontario. Ref. No. NB102-181/77-2, Rev 0.

North/South Consultants Inc. (NSC), 2012. *Baffinland Iron Mines Corporation - Mary River Project - Freshwater Aquatic Biota and Habitat Baseline Synthesis Report 2005-2011*. January.

North/South Consultants Inc. (NSC), 2021. *Attachment 2 - Description of the Aquatic Environment*.

North/South Consultants Inc. (NSC), 2022. Email from: Michael Johnson. To: Greg Johnstone, Knight Piésold Ltd and Megan Cooley North/South Consultants. *Re: Mary River Water Crossings*. October 18.

6.0 CERTIFICATION

This report was prepared and reviewed by the undersigned.

Prepared:

Greg Johnstone, EIT
Geological Engineering

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
2022-10-28
NWT/NU

Reviewed:

C. A. (Andy) Phillips, P.Eng.
Senior Engineer

Reviewed:

Matthew Pickett, B.A., CAN-CISEC, CPESC
Designated Inspector of Erosion and Sediment Control
Groundwater Environmental Management Services (GEMS)

PERMIT TO PRACTICE
KNIGHT PIESOLD LTD.
Signature
Date 2022-10-28
PERMIT NUMBER: P 547
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

Reviewed:

Richard Cook, P.Geo. (Ltd.)
Specialist Environmental Scientist | Associate

Approval that this document adheres to the Knight Piésold Quality System:

APPENDIX A

Tote Road Fish Habitat Locations

Page (A-1)

MILNE PORT

Phillips Creek

CV-129

CV-128

CV-115

CV-114

CV-112

CV-111

KM 32 Lake

CV-106

CV-104

CV-102

CV-099

Phillips Ck.

CV-079

CV-078

CV-076

CV-072

Katiktok Lake

CV-060

CV-059

CV-058

CV-057

BG-50

CV-049

BG-32

CV-030

Muriel Lake

CV-217

CV-216

BG-29

BG-30

David Lake

BG-27

BG-24

BG-17

CV-223

CV-224

BG-04

CV-225

CV-001

BG-01

MINE SITE

CV-186

CV-187

0 5 10 Kilometres

FISH HABITAT

Yes

Overwintering Lake

Tote Road

BARRIER

Permanent

Semi-Permanent

NOTES:

1. BASE DATA SOURCE: CANVEC 1:250 000
2. COORDINATE GRID IS SHOWN IN UTM (NAD83) ZONE 17 AND IS IN METRES.

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

TOTE ROAD FISH HABITAT LOCATIONS OVERVIEW

North/South Consultants Inc.
Aquatic Environment Specialists

DATE CREATED: 11/10/2021

Document Path: W:\PROJECTS\BIM Baffinland Iron Mine\BIM - Tote Road Monitoring_short_2022_MC\GIS\MXDs\FishBearingToteRdSitesOWLs_OverviewNoMapExtents_cp_20221024_.mxd

APPENDIX B

Crossing Remediation Plans

APPENDIX B1

Crossing CV-114

(Pages B1-1 to B1-5)

APPENDIX B1
CROSSING CV-114

1.0 CURRENT CONDITIONS

The water crossing CV-114 is located at KM29.2 of the Milne Inlet Tote Road and contains two culvert barrels each approximately 1.0 m in diameter with an estimated contributing catchment area of approximately 3.27 km^2. Baffinland identified that the culvert barrels are perched, and remediation is required in its initial remediation plan provided to the DFO (Baffinland, 2022a, b).

According to the 2021 survey by North/South Consultants Inc. (NSC) the stream flowing through the culvert is a 3rd order stream that drains 60 m west to Phillip Creek (NSC, 2021). A permanent barrier consisting of two large vertical drops 1.5-2.0 m in height, 20 m apart, over a high gradient is located approximately 810 m upstream from the road crossing (Figure B1.1). There are no downstream barriers to fish movement. There are a number of nearby overwintering lakes in the Phillips Creek system. The two most likely to provide adequate overwintering habitat are KM 26 and KM 32 lakes, each approximately 2.1 km from the crossing (Figure B1.1). Potential Overwintering Lake 3 (POWL-3) and POWL-4 may provide small quantities of overwintering habitat, though accessibility to POWL-3 may be restricted to periods of high flow.

The stream provides open water rearing habitat for juvenile land-locked Arctic Char ranging in size from 70-140 mm (NSC, 2021). Water depths are typically insufficient for larger size classes. Ninespine Stickleback have not been captured or observed in the stream during any surveys and are thought to be absent from the watershed (NSC, 2021). Habitat is primarily run/riffle/pool over a mixture of coarse and fine substrate.

The culverts are perched sufficiently that upstream access is likely limited. No fish were captured upstream in 2021, however fish have been caught upstream as recent as 2020 (Baffinland, 2020 and 2021).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B1.1 (culvert inlet) and Photo B1.2 (culvert outlet):

- Damaged Culverts - The culvert barrels appear to be damaged (Photo B1.1).
- Erosion of Slopes - The embankment slopes are steep, lack armouring and contain fines leading to erosion of the embankment slopes (Photos B1.1 and B1.2).
- Adequate Cover - Loading over culvert pipes should be in accordance with the design criteria with the minimum cover for culverts being 600 mm, or as required by the differing specific design vehicle (Hatch, 2018) (Photo B1.1).
- Perched Culverts - The culvert barrels are perched above the stream (Photo B1.2).

The existing water crossing at CV-114 was rated high risk and was identified as a barrier for 88 mm Arctic Char fish passage (Appendix C).

Photo B1.1 CV-114 Culvert Inlet

Photo B1.2 CV-114 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B1.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
- For structural loading, the minimum cover is to be 600 mm.
- For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the embankments and adjacent slope with riprap to reduce the potential for erosion.
- Line the ditches to the north and south of the road with riprap to reduce erosion and sediment production.

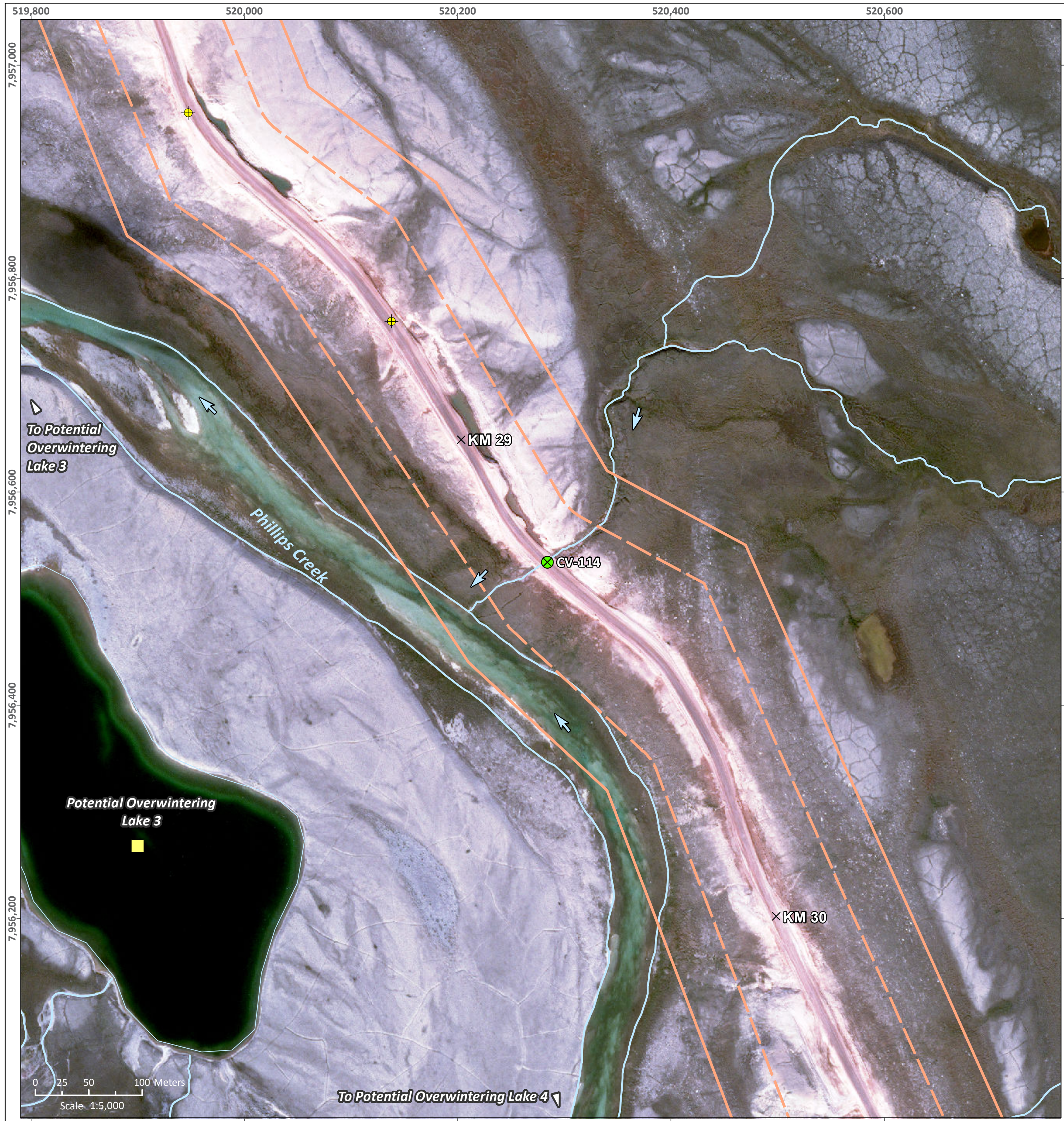
The above remediation measures will ensure the CV-114 water crossing meets the project design criteria.

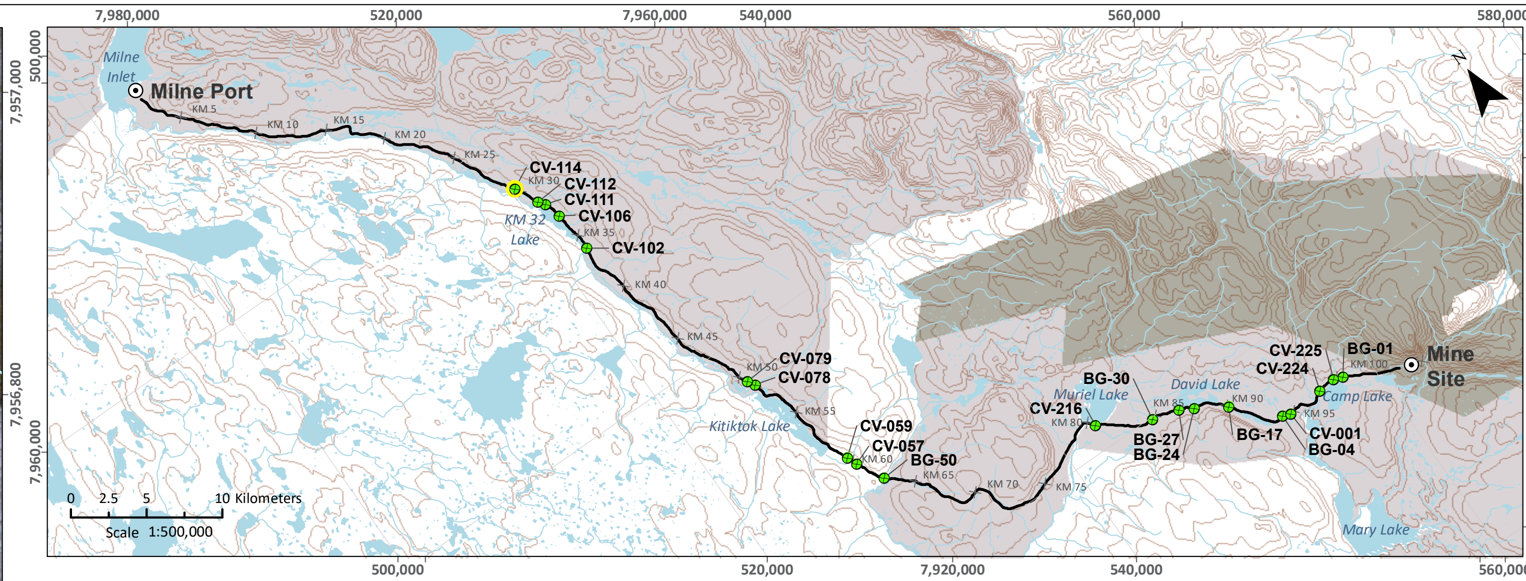
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B1.1. The plan and section of CV-114 is shown on Figure B1.2.

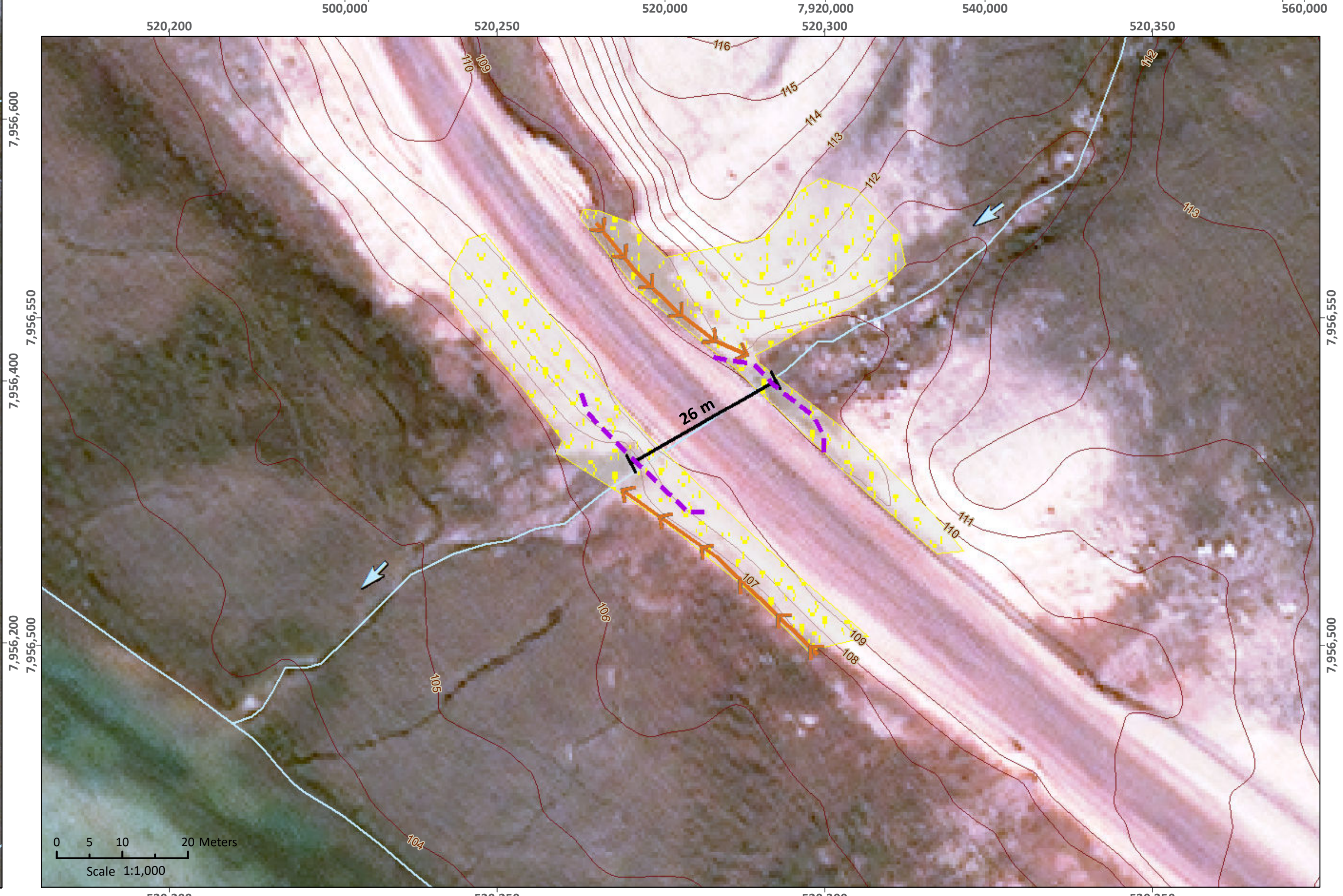
Table B1.1 Culvert Sizing Details

Peak Flow (m^3/s)	5.86
Culvert diameter (mm)	1,200
Number of culvert barrels	3
Embeddedness	One-barrel embedded 40%
Culvert length (m)	26
Slope	5.08%
Minimum cover over barrels (mm)	600

The fish passage risk assessment fish barrier risk rating of high decreases to moderate after implementation of the above remediation measures.







LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat

Riprap Armoured Slope
- Existing
- Proposed

Riprap Lined Ditch
- Existing
- Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

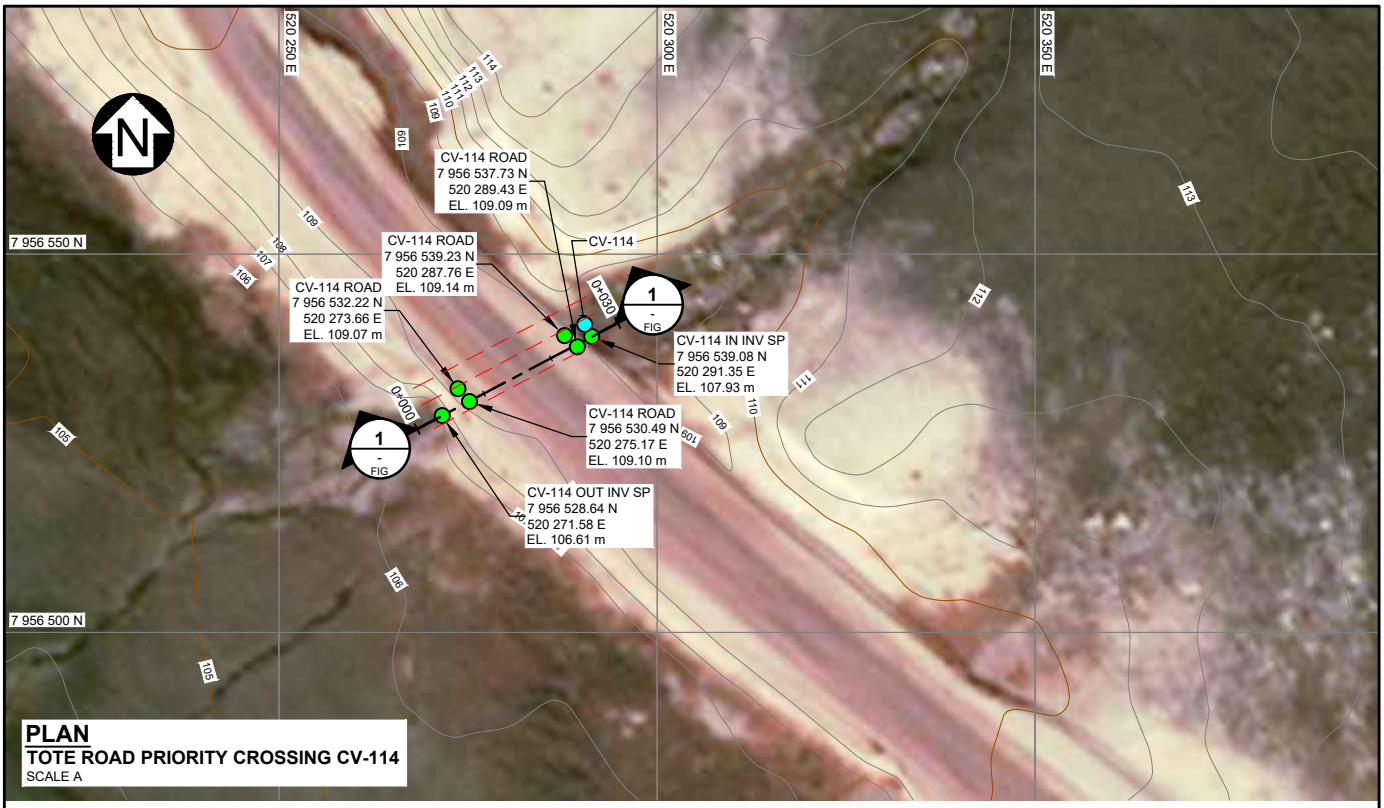
MARY RIVER PROJECT

Erosion and Sediment Control Plan
Site Specific Drawing - CV-114

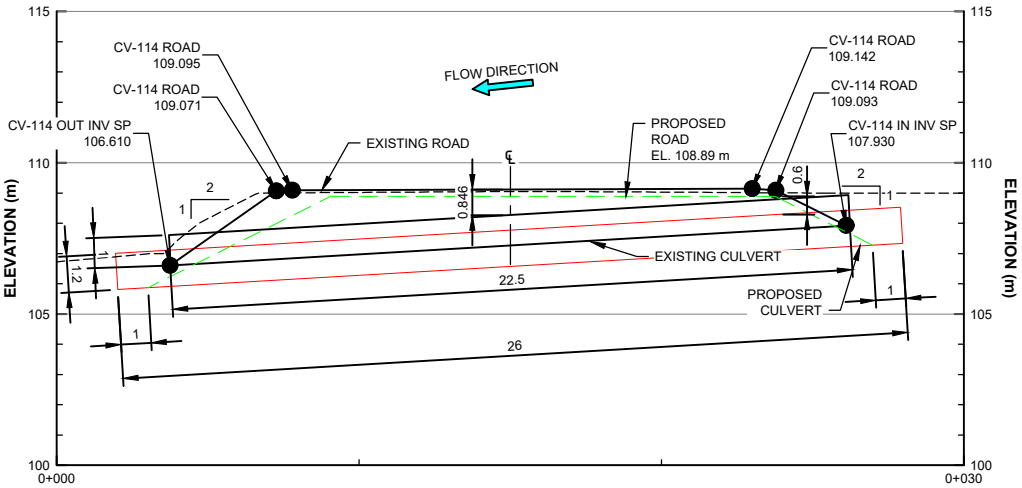
Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.
 Imagery and Infrastructure are representative as of July 2022.

Baffinland

FIGURE B1.1



PLAN
TOTE ROAD PRIORITY CROSSING CV-114
SCALE A



SECTION
TOTE ROAD PRIORITY CROSSING CV-114
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 2.5 1.25 0 2.5 5 7.5 10 12.5 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CV-114
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/77	3

FIGURE B1.2 REV 0

APPENDIX B2

Crossing CV-112

(Pages B2-1 to B2-6)

APPENDIX B2
CROSSING CV-112

1.0 CURRENT CONDITIONS

The water crossing CV-112 is located at KM31.5 of the Milne Inlet Tote Road and contains three culvert barrels approximately 1.2 m in diameter with an estimated contributing catchment area of approximately 2.70 km^2. DFO identified that the culverts are damaged, perched downstream and not embedded and will likely become perched upstream as well (DFO, 2022). Erosion of the upstream bank was also identified.

Based on information provided by North/South Consultants (NSC), the stream flowing through the culvert at CV-112 is a 3rd order stream that drains west to Phillips Creek 130 m downstream (NSC, 2021). There are two nearby potential overwintering lakes on Phillips Creek; an unnamed lake approximately 400 m upstream and KM32 Lake approximately 600 m downstream from the confluence with CV-112 (Figure B1.1; NSC, 2021).

The CV-112 stream provides abundant open-water season rearing habitat for juvenile Arctic Char (40-120 mm) from the confluence with Phillips Creek upstream to permanent barriers (NSC, 2021). This stream is split into two branches from ~1.4 km upstream of the crossing to these barriers (NSC, 2021). On the north branch, the barrier consists of multiple vertical drops 0.5 m in height, over boulders on a steep (15°) gradient (NSC, 2021). The south branch barrier is subsurface flow at the top of a plateau; the source of this branch is drainage from surrounding hills (NSC, 2021).

Ninespine Stickleback have not been observed in this stream since monitoring began in 2009 (NSC, 2021). Water velocities and substrates are not within the preferred ranges/sizes for stickleback in the Mary River study area.

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B2.1 (culvert inlet) and Photo B2.2 (culvert outlet):

- Damaged Culverts - The culvert barrels appear to be damaged (Photos B2.1 and B2.2).
- Erosion of Slopes - The embankment slope is steep and contains fines leading to erosion of the embankment slope (Photos B2.1 and B2.2).
- Perched Culvert - The culvert barrel is slightly perched above the stream (Photo B2.2).

The existing water crossing at CV-112 was rated high risk for fish passage (Appendix C).

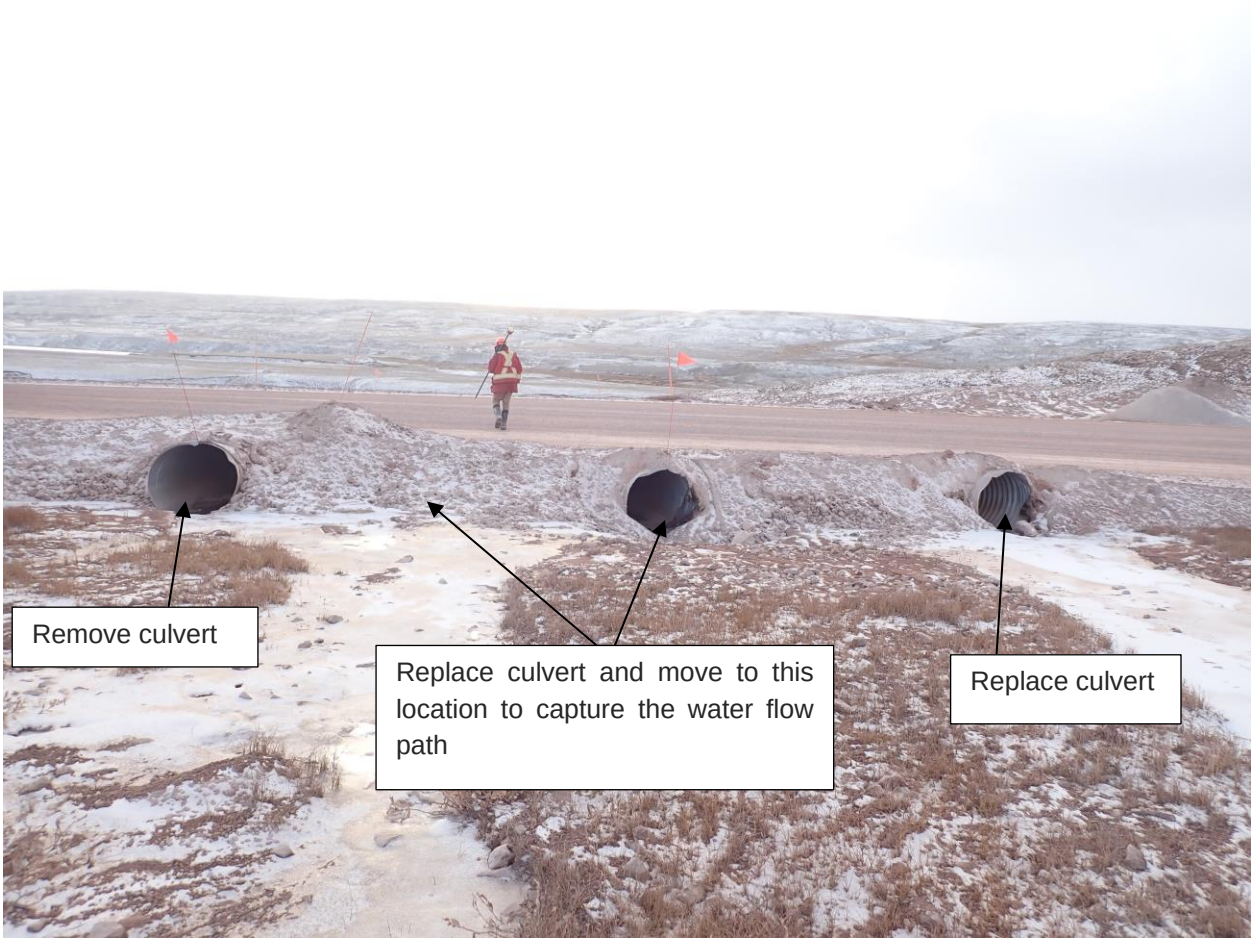


Photo B2.1 CV-112 Culvert Inlet

Photo B2.2 CV-112 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B2.1.
- Lengthen the culvert to allow for a 2H:1V downstream embankment side slope to reduce the potential for downstream embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.

- Armour the downstream embankment with riprap to reduce the potential for embankment erosion.
- Line the ditches on the north and south of the Tote Road to reduce the potential for erosion and sediment production.

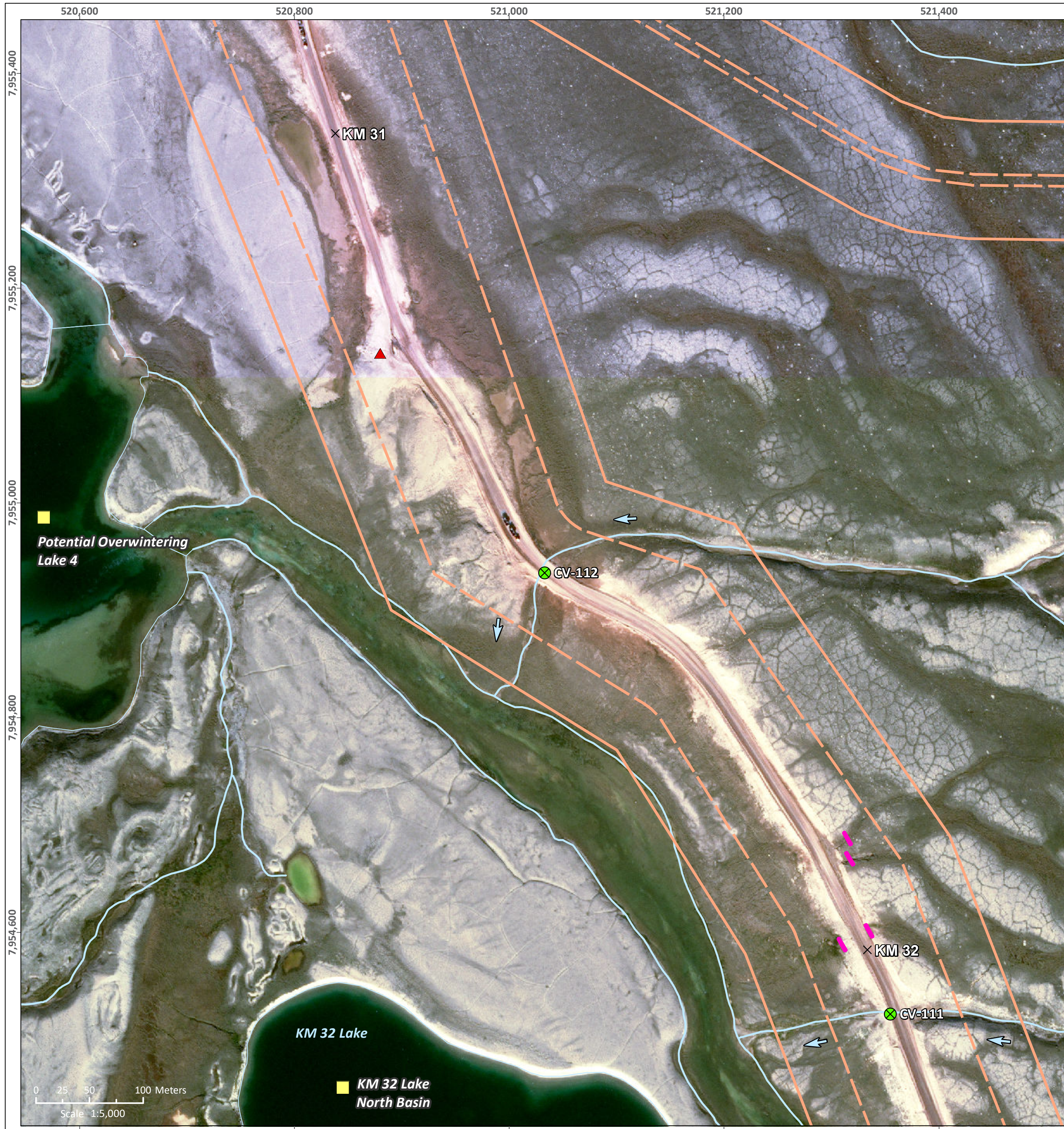
The above remediation measures will ensure the CV-112 water crossing meets the project design criteria.

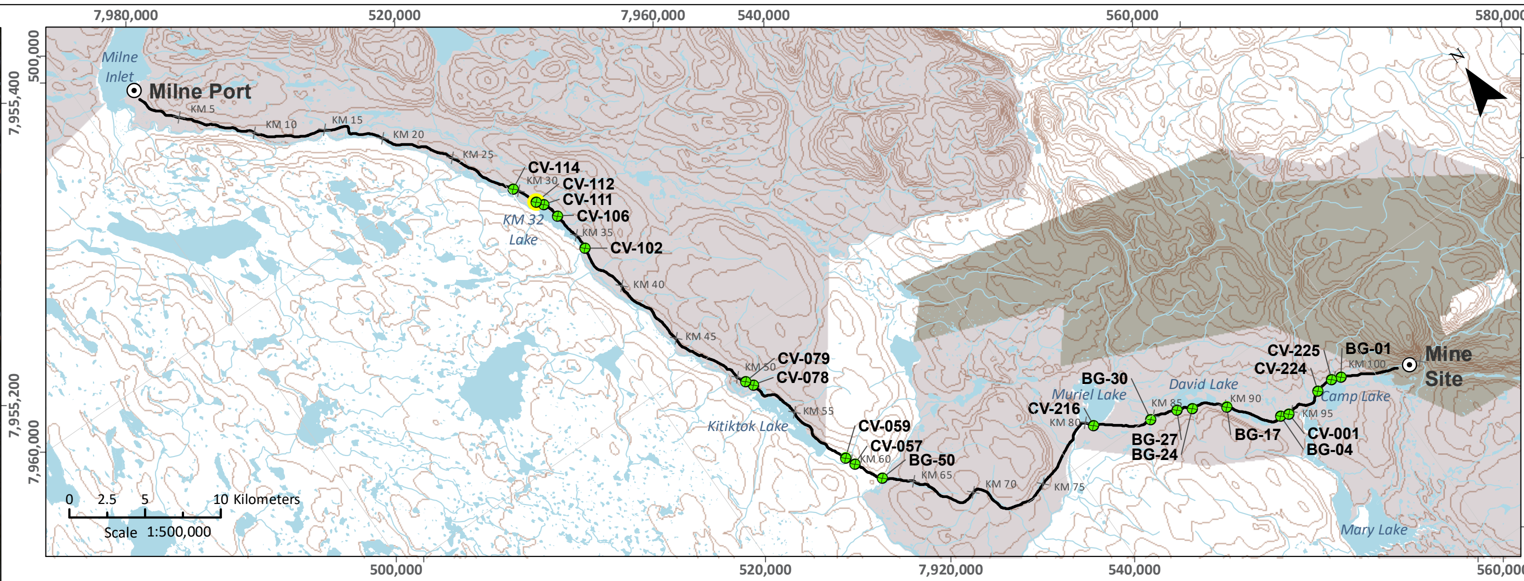
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B2.1. The plan and section of CV-112 is shown in Figure B2.2.

Table B2.1 Culvert Sizing Details

Peak Flow (m^3/s)	5.03
Culvert diameter (mm)	1,200
Number of culvert barrels	3
Embeddedness	One-barrel embedded 40%
Culvert length (m)	25
Slope	1.47%
Minimum cover over barrels (mm)	600

The fish passage risk assessment fish barrier risk rating of high decreases to moderate after implementation of the above remediation measures.





LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary
- Commercial Lease Boundary - 50 m Buffer
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat

Riprap Armoured Slope

- Existing
- Proposed

Riprap Lined Ditch

- Existing
- Proposed

Note

1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

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MARY RIVER PROJECT

Erosion and Sediment Control Plan
Site Specific Drawing - CV-112

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.

Baffinland

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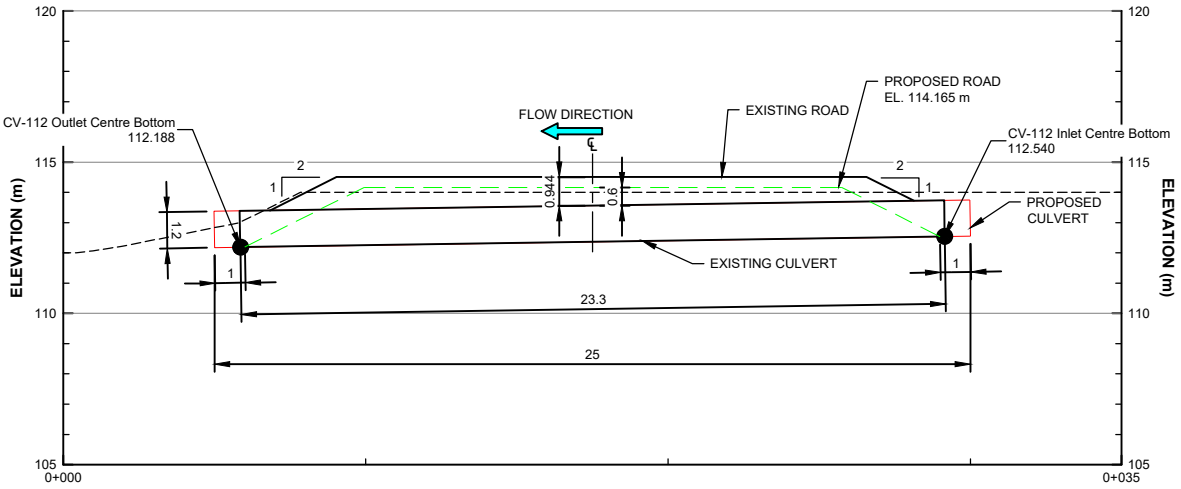
FIGURE **B2.1**

PLAN
TOTE ROAD PRIORITY CROSSING CV-112
SCALE A



1 - FIG SECTION
TOTE ROAD PRIORITY CROSSING CV-112
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 2.5 1.25 0 2.5 5 7.5 10 12.5 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CV-112
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/77	3

FIGURE B2.2 REV 0

APPENDIX B3

Crossing CV-111

(Pages B3-1 to B3-5)

APPENDIX B3
CROSSING CV-111

1.0 CURRENT CONDITIONS

The water crossing CV-111 is located at KM32.1 of the Milne Inlet Tote Road and contains one culvert barrel approximately 1.0 m in diameter with an estimated contributing catchment area of approximately 2.66 km^2. Baffinland identified that the culvert is perched, and remediation is required in its initial remediation plan provided to DFO (Baffinland, 2022a, b).

According to the 2021 survey by North/South Consultants Inc. (NSC) the stream flowing through the culvert is a 3rd order stream that drains 130 m west to Phillip Creek (Figure B3.1; NSC, 2021). The stream provides rearing habitat for juvenile land-locked Arctic Char from 50-130 mm during the open water period (NSC, 2021). Depths are typically insufficient to support larger juveniles. Only one Ninespine Stickleback has been captured (in 2019) since monitoring of this stream began in 2009. Habitat is generally cascade/riffle over cobble/gravel/boulder substrate, which is not habitat typically preferred by stickleback.

The nearest overwintering lake is KM32 Lake, 600 m downstream from the crossing in the Phillips Creek system (Figure B3.1). There are no downstream barriers. The stream is split into two main branches upstream from the road crossing. There are permanent fish barriers located approximately 1.3 and 2.0 km upstream of the road crossing on the north branch (Figure B3.1). On the south branch. there are no upstream barriers between the road crossing and two small, potential upstream overwintering lakes. The nearest upstream lake is ~3.4 km upstream and it is connected to a smaller lake (CV-29-2-USL1) another 400 m to the north. Juvenile Char have been observed throughout the south branch. Natural habitat for several hundred meters upstream of the road crossing is steeper than downstream with higher velocity flows over cascades limiting potential upstream movements through this reach to larger (>100 mm) juvenile char. Farther upstream near the overwintering lakes, habitat is low velocity pool/run over mostly fine substrate. Currently, the highly perched culvert prevents all upstream access from Phillips Creek (NSC, 2021).

2.0 IDENTIFIED ISSUES

KP Identified the following issues with this crossing, shown on Photo B3.1 (culvert inlet) and Photo B3.2 (culvert outlet):

- Erosion of Slopes - The embankment slopes are steep and contain fines leading to erosion of the embankment slopes (Photos B3.1 and B3.2)
- Damaged and Perched Culvert - The culvert barrel is damaged and perched above the stream (Photo B3.2)

The existing water crossing was rated high risk and was identified as a barrier for 88 mm Arctic Char passage (Appendix C).

Photo B3.1 CV-111 Culvert Inlet

Photo B3.2 CV-111 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B3.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter
- Armour the embankments with riprap to reduce the potential for embankment erosion.
- Line the ditch on the north side of the Tote Road with riprap to reduce the potential for erosion and sediment production.

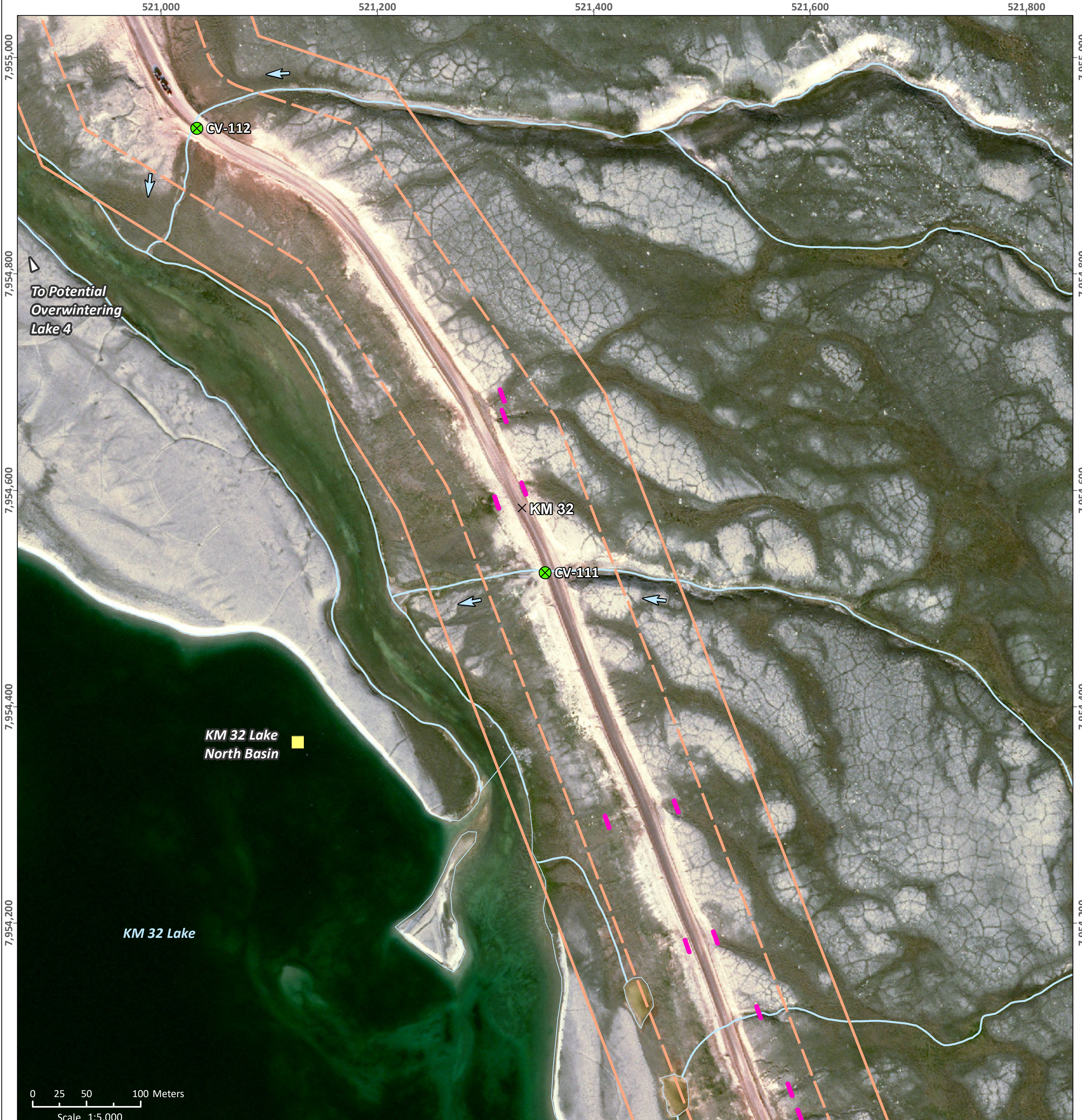
The above remediation measures will ensure the CV-111 water crossing meets the project design criteria.

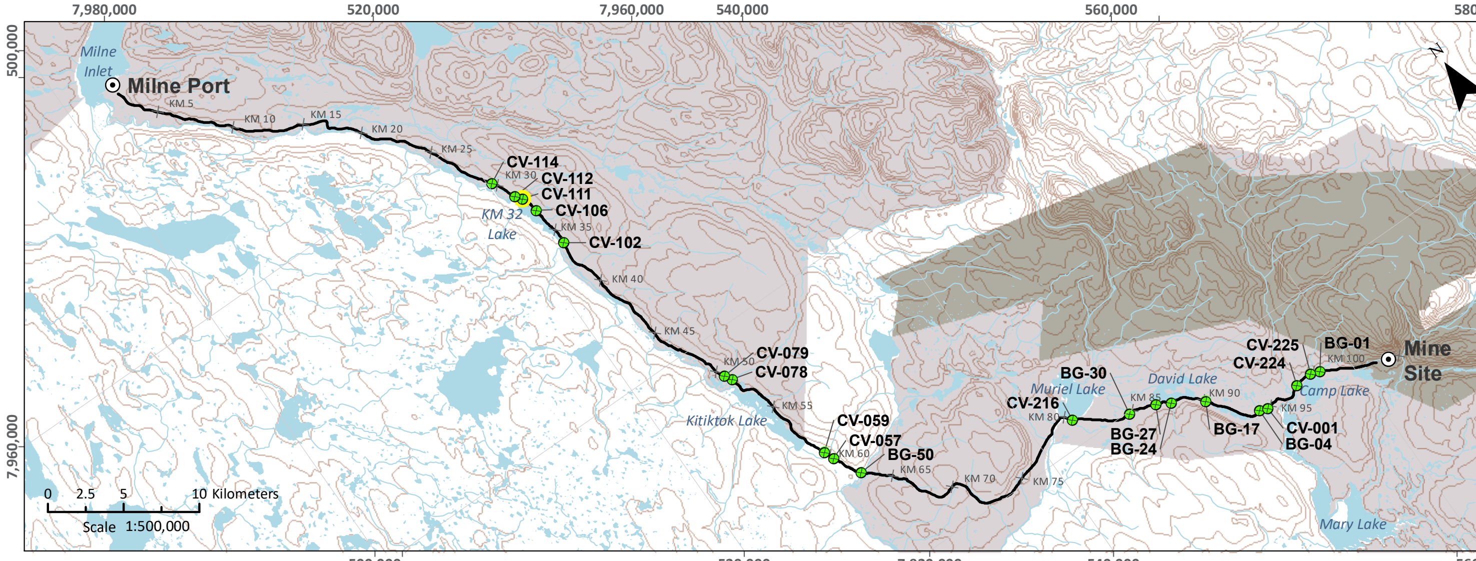
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B3.1. The plan and section of CV-111 Is shown in Figure B3.2.

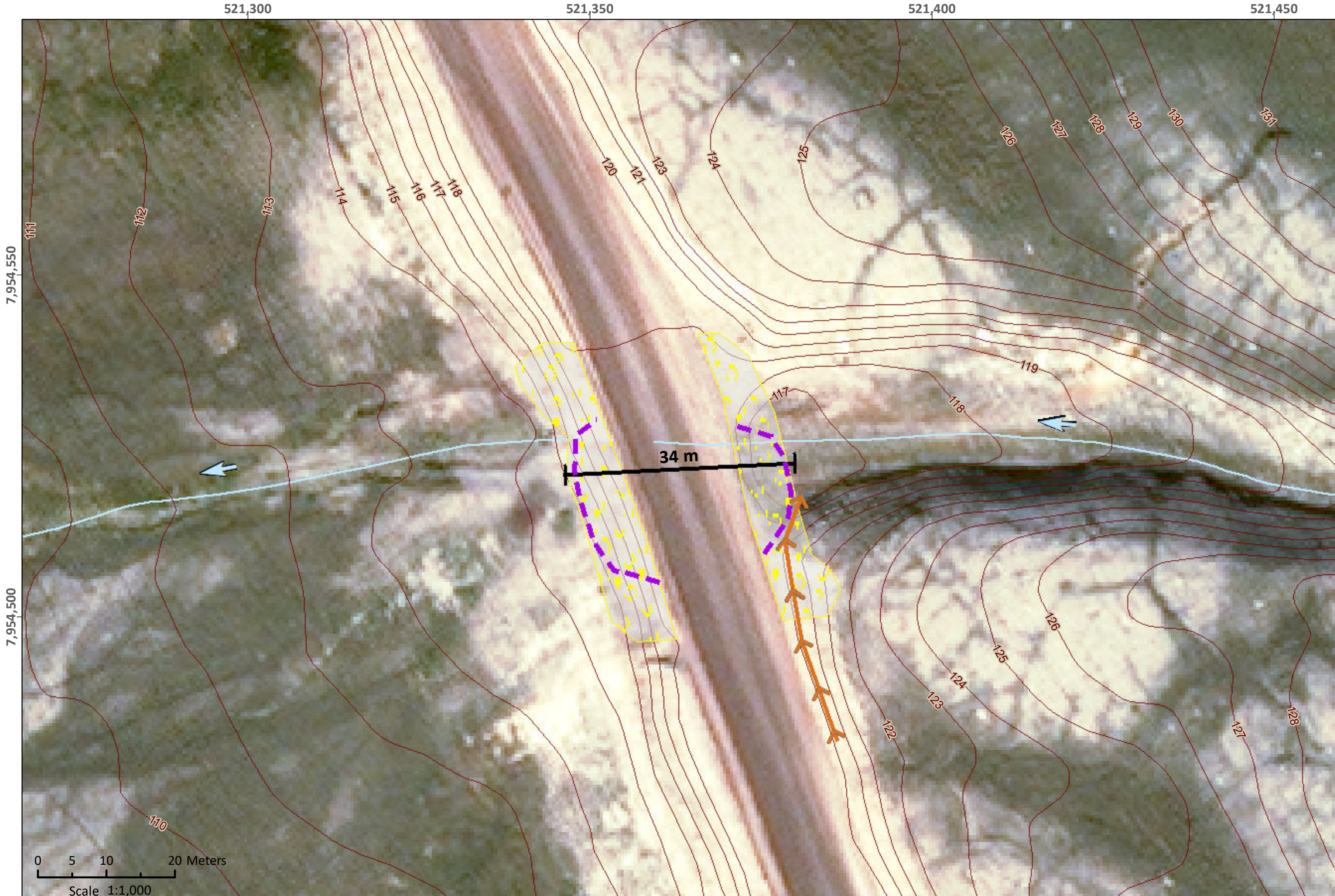
Table B3.1 Culvert Sizing Details

Peak Flow (m^3/s)	4.96
Culvert diameter (mm)	1,800
Number of culvert barrels	2
Embeddedness	One-barrel embedded 40%
Culvert length (m)	34
Slope	2.69%
Minimum cover over barrels (mm)	900

The fish passage risk assessment fish barrier risk rating of high decreases to moderate after implementation of the above remediation measures.







LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat

Riprap Armoured Slope

- Existing
- Proposed

Riprap Lined Ditch

- Existing
- Proposed

Note

1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

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Erosion and Sediment Control Plan
Site Specific Drawing - CV-111

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.

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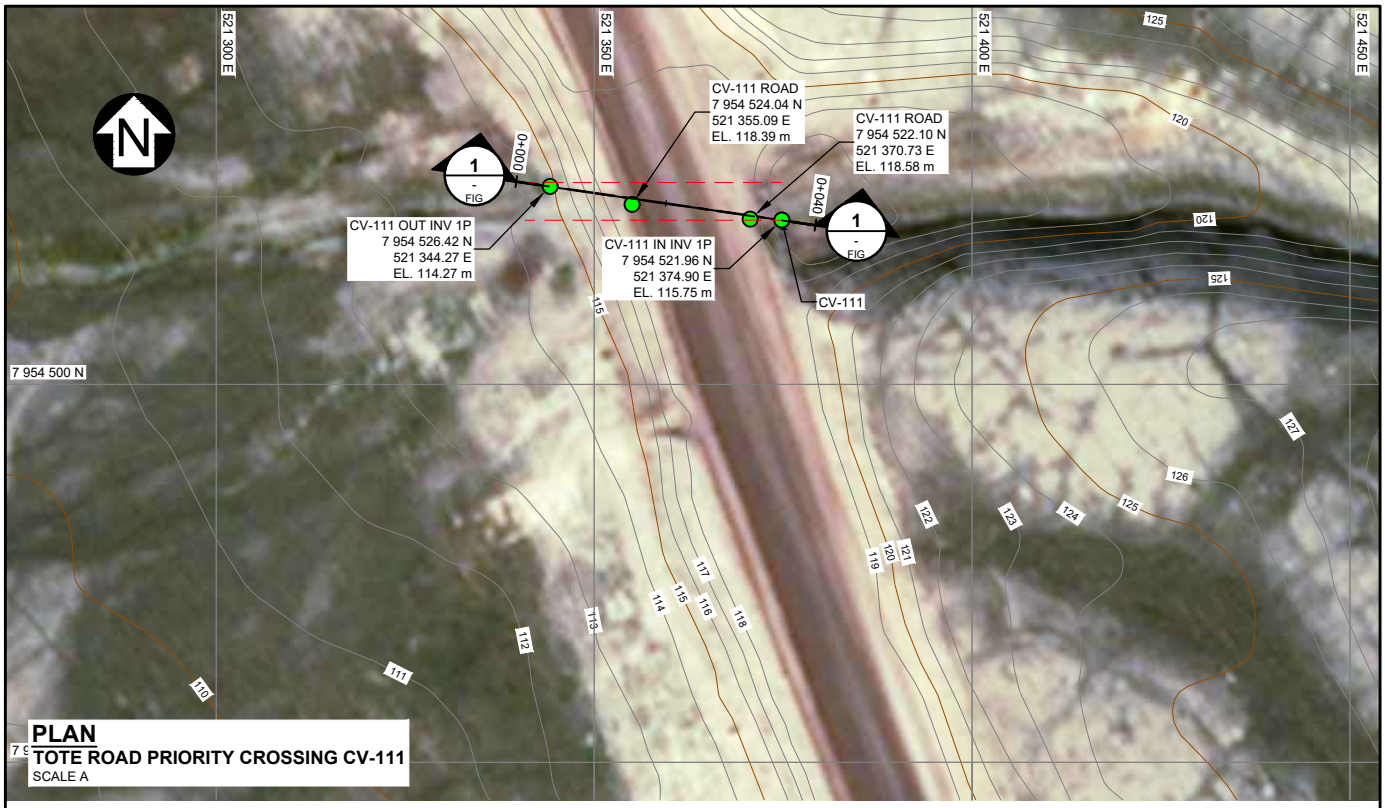
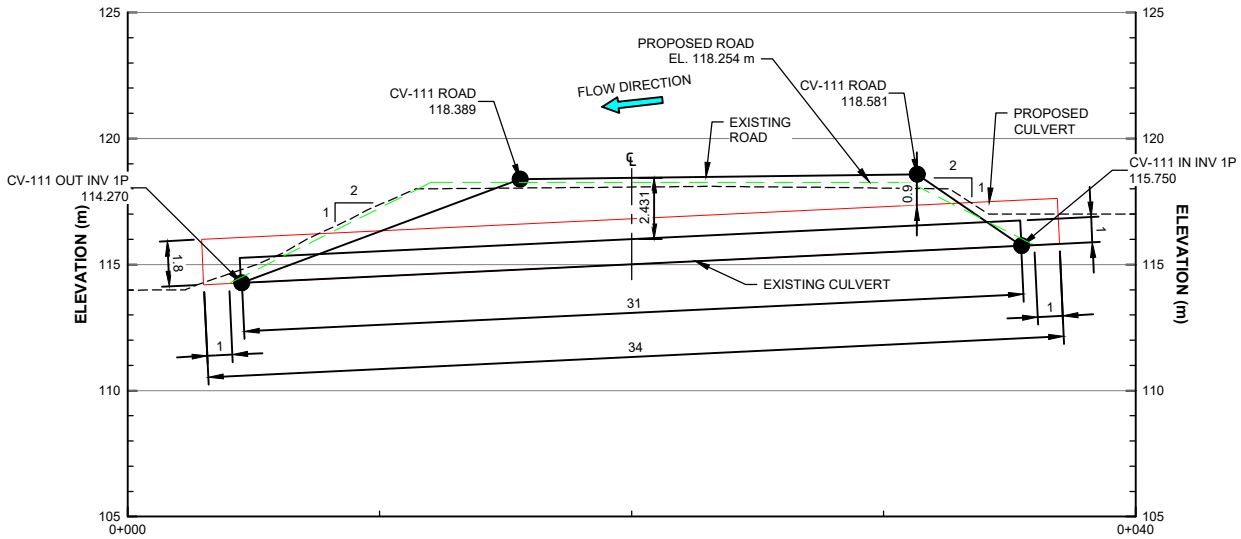
ᑎᑎᕋᐅᓯᐊᖅ FIGURE **B3.1**



PLAN
TOTE ROAD PRIORITY CROSSING CV-111
SCALE A



SECTION
TOTE ROAD PRIORITY CROSSING CV-111
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 3 1.5 0 5 10 15 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CV-111
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO. NB102-181/77 | REF NO. 3

FIGURE B3.2 | REV 0

APPENDIX B4

Crossing CV-106

(Pages B4-1 to B4-5)

APPENDIX B4
CROSSING CV-106

1.0 CURRENT CONDITIONS

The water crossing CV-106 is located at KM33.2 of the Milne Inlet Tote Road and contains one culvert barrel approximately 1.0 m in diameter with an estimated contributing catchment area of approximately 0.98 km^2. Baffinland identified that the culvert is perched resulting in intermittent culvert access for fish in its initial remediation plan provided to DFO (Baffinland, 2022a, b).

According to the 2021 survey by North/South Consultants Inc. (NSC) the stream flowing through the culvert is a 2nd order stream that drains 80 m west to KM 32 Lake (Figure B4.1; NSC, 2021), which is also the nearest potential overwintering lake. The stream provides minimal and temporary (spring only) open water rearing habitat for smaller size classes (<100 mm, but frequently only those <60 mm due to shallow depths) of juvenile Arctic Char in spring (NSC, 2021). Habitat is characterized as riffle/pool downstream to run/pool upstream over fines/gravel substrate. Ninespine Stickleback have not been captured or observed in the stream during any surveys and are thought to be absent from the watershed (NSC, 2021).

A permanent fish barrier is located approximately 340 m upstream from the road crossing (Figure B4.1). There is no accessible upstream overwintering habitat. The stream is noted to frequently have insufficient water for fish use in the late summer and early fall and also during years with little annual precipitation that create intermittent barriers to fish movements (yellow diamonds in Figure B4.2). Fish use of this stream frequently only occurs over short periods of time during spring. It was also noted that the perched culvert may contribute to fish passage issues, particularly for the small size classes that typically use CV-106 habitat (NSC, 2021).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B4.1 (culvert inlet) and Photo B4.2 (culvert outlet):

- Erosion of Slopes - The embankment slopes are steep, lack armouring and contain fines leading to erosion of the embankment slopes (Photo B4.1 and Photo B4.2).
- Adequate Cover - Loading over culvert pipes should be in accordance with the design criteria with the minimum cover for culverts being 600 mm, or as required by the differing specific design vehicle (Hatch, 2018) (Photo B4.1 and Photo B4.2).
- Damaged and Perched Culvert - The culvert barrel is damaged and has collapsed and perched above the stream (Photo B4.2).

The existing water crossing was rated high risk result as a barrier for fish passage (Appendix C).

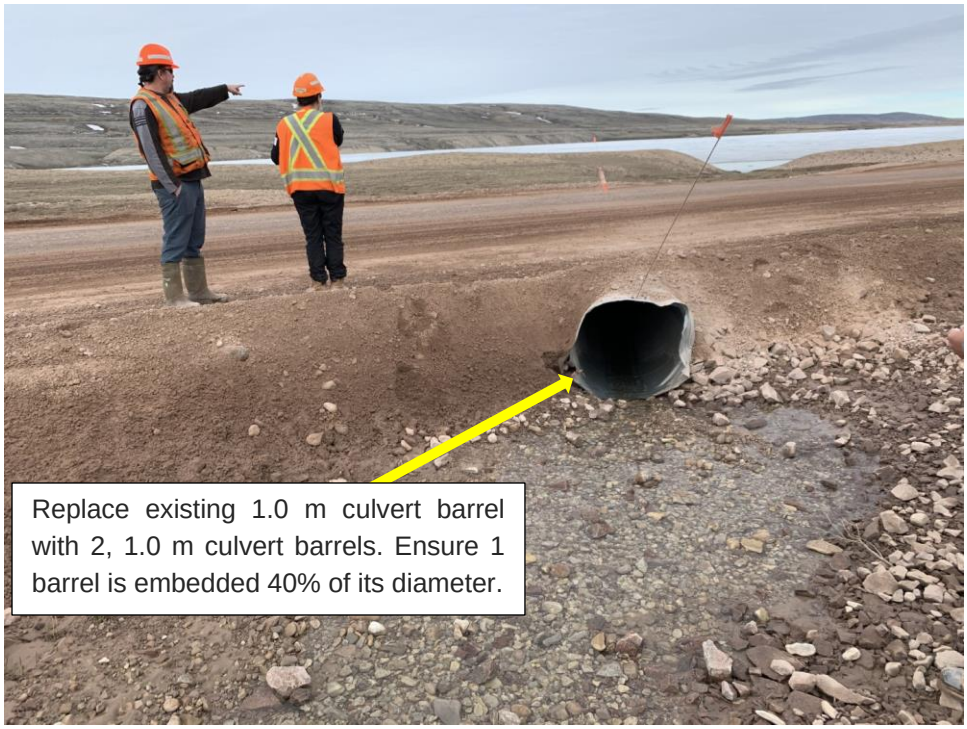


Photo B4.1 CV-106 Culvert Inlet

Photo B4.2 CV-106 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B4.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the embankments with riprap to reduce the potential for embankment erosion.
- Line ditch on the south side of the Tote Road with riprap to reduce the potential for erosion and sediment production.

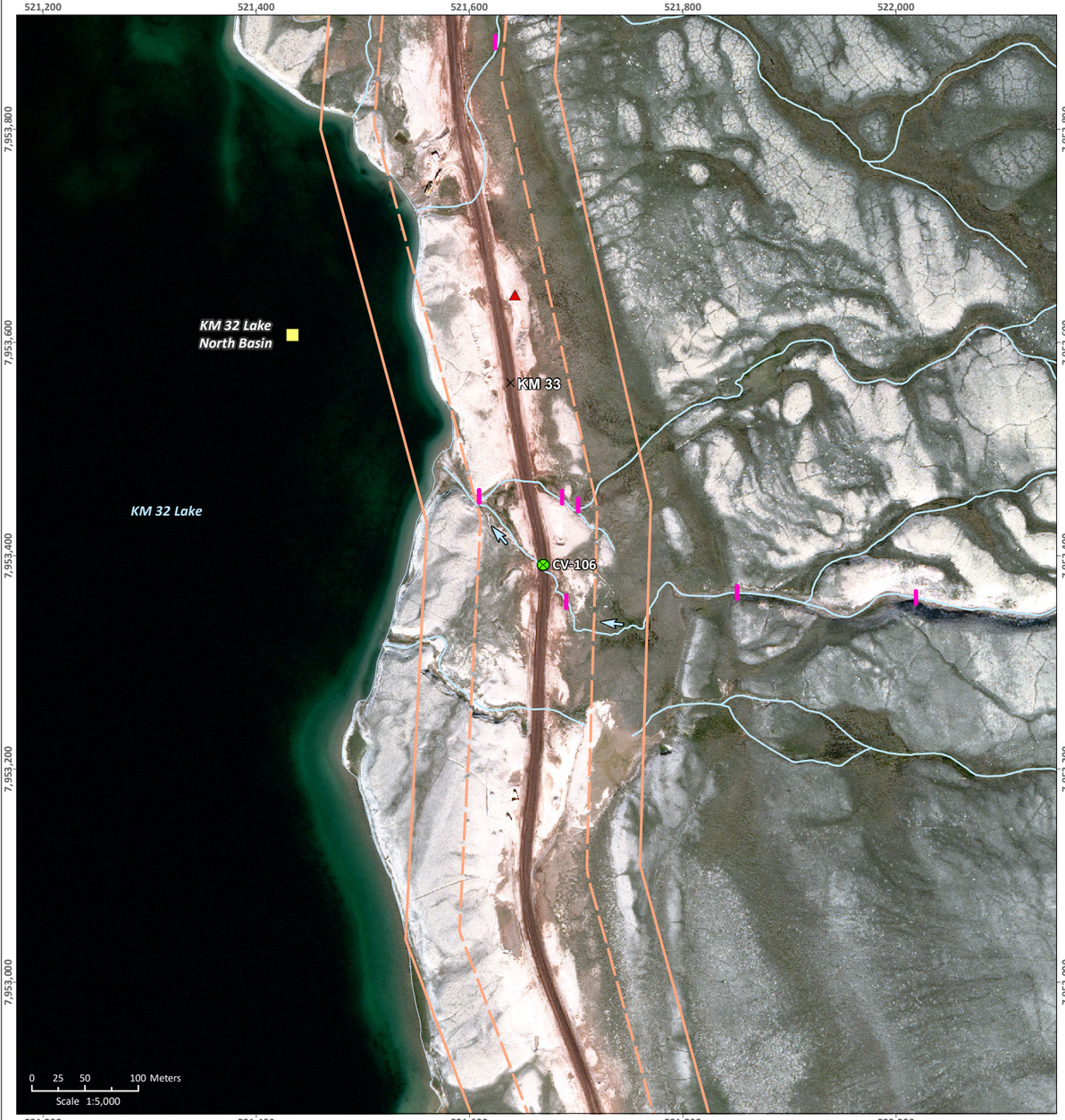
The above remediation measures will ensure the CV-106 water crossing meets the project design criteria.

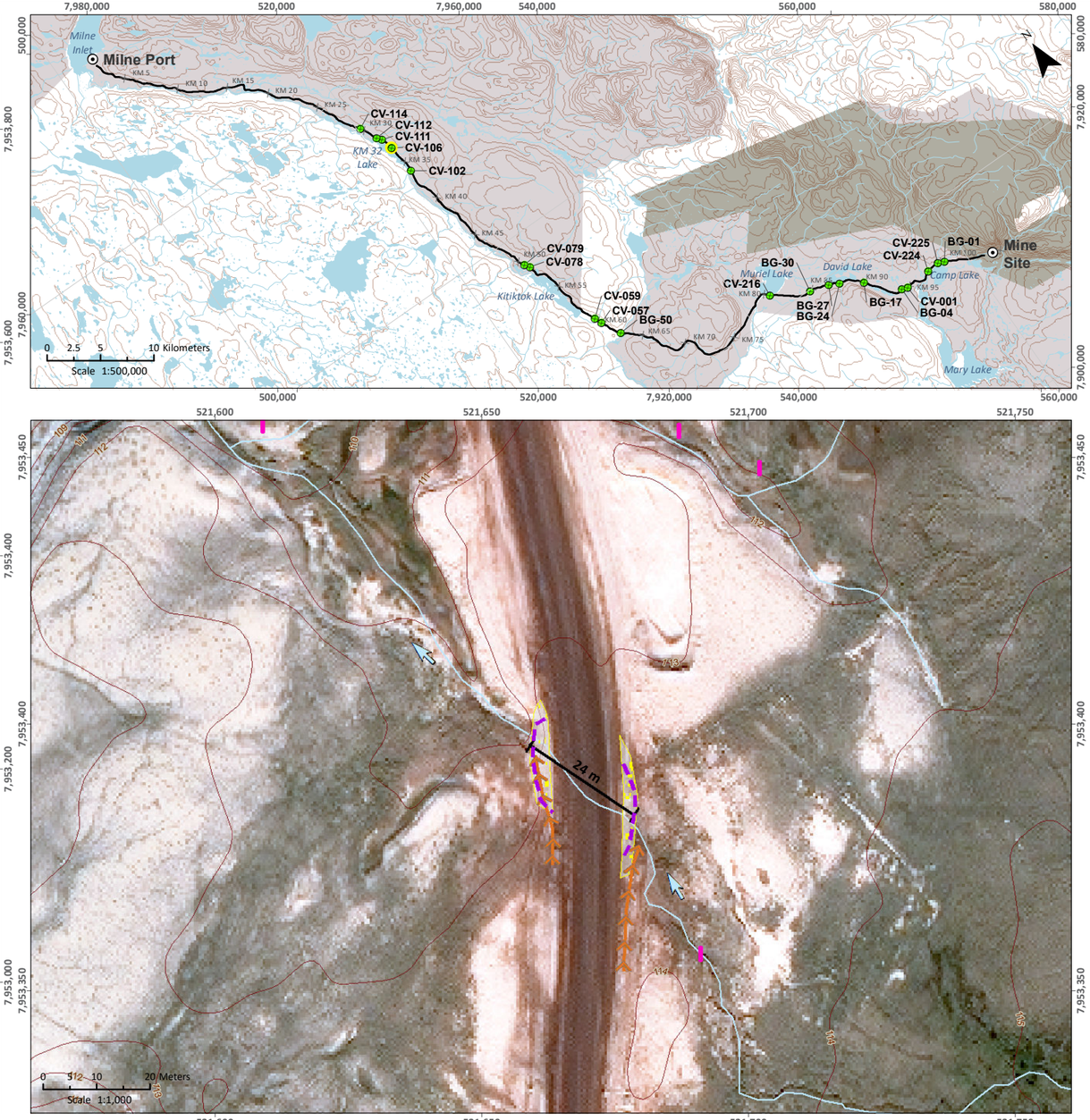
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B4.1.

Table B4.1 Culvert Sizing Details

Peak Flow (m^3/s)	2.23
Culvert diameter (mm)	1,000
Number of culvert barrels	2
Embeddedness	One-barrel embedded 40%
Culvert length (m)	24
Slope	2.54%
Minimum cover over barrels (mm)	600

The fish passage risk assessment fish barrier risk rating of high decreases to low after implementation of the above remediation measures.





LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat
- **Riprap Armoured Slope**: Existing, Proposed
- **Riprap Lined Ditch**: Existing, Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

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Erosion and Sediment Control Plan
Site Specific Drawing - CV-106

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.
© 2022 Digital Globe, Inc. Imagery and Infrastructure are representative as of July 2022.

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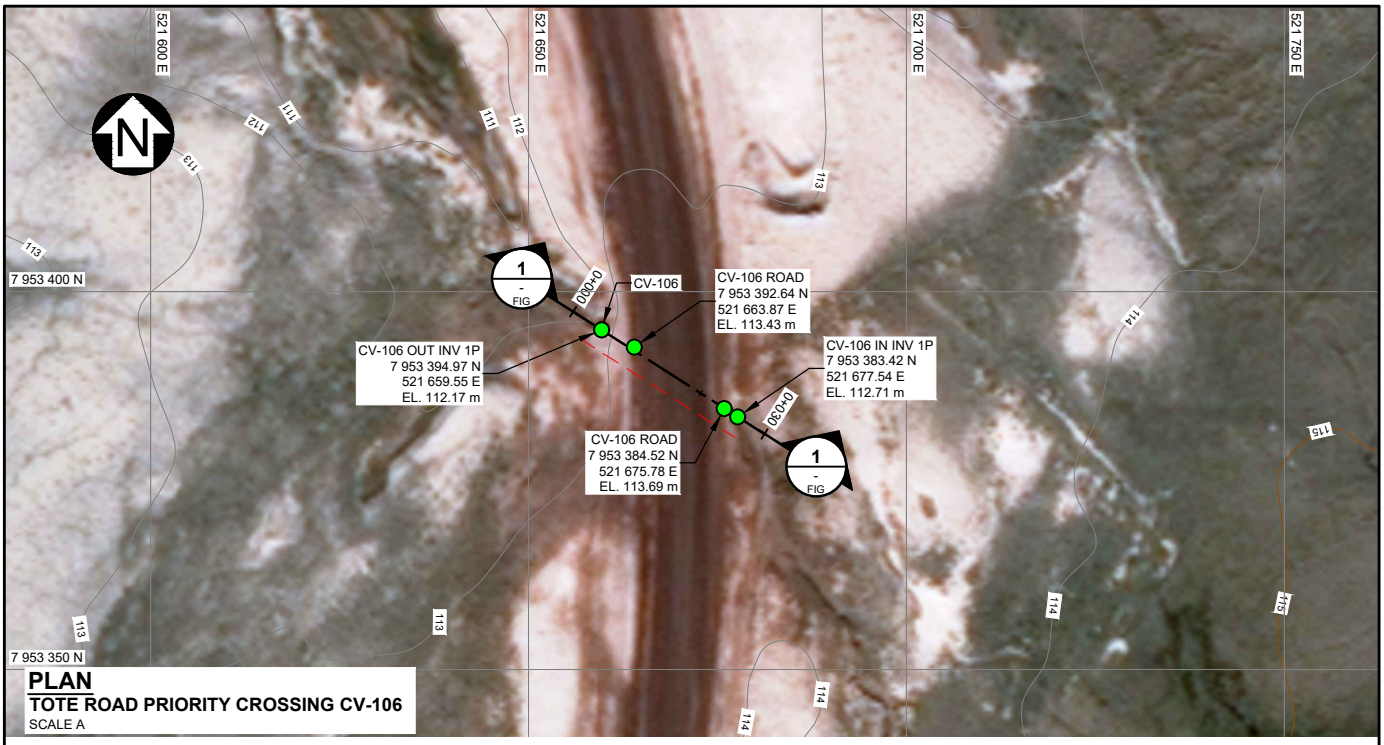
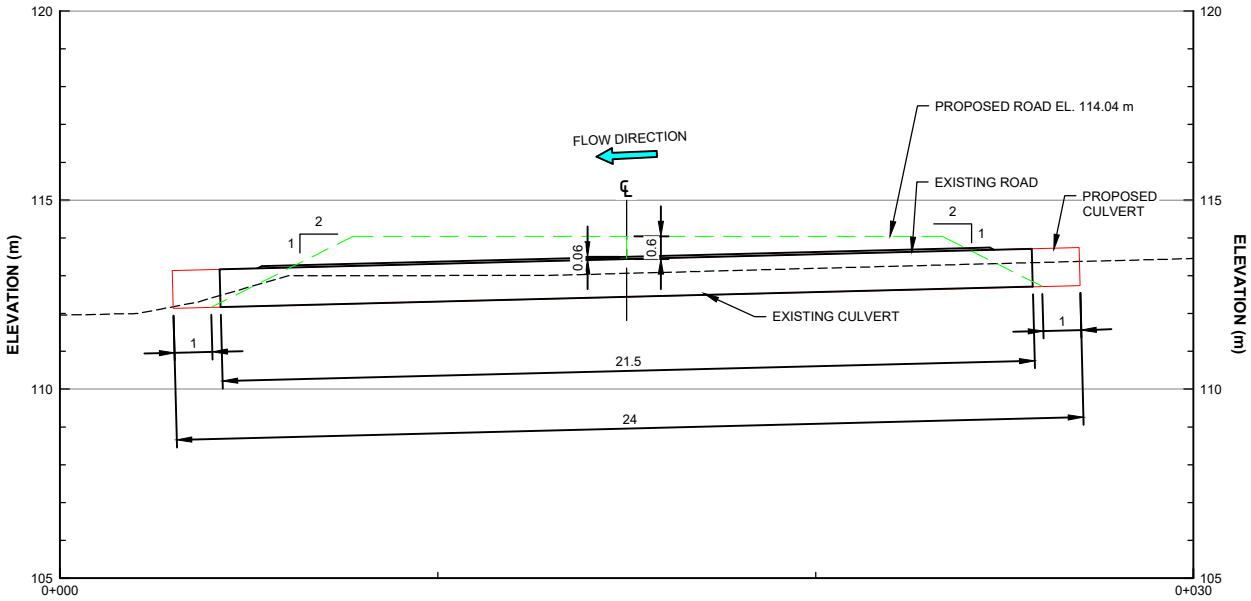
Baffinland

ᑎᑎᕋᐅᓵᖅᓯᒪᔪᑦ **FIGURE** **B4.1**

SAVED: C:\Users\katie.mcgurr\Documents\4 - Maps\Environment\Erosion and Sediment Control\BIM_Fig B4.1_CV-106.mxd: 28-Oct-22



PLAN
TOTE ROAD PRIORITY CROSSING CV-106
SCALE A



1 - FIG
SECTION
TOTE ROAD PRIORITY CROSSING CV-106
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 2 1 0 2 4 6 8 10 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CV-106
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/77	3

FIGURE B4.2 REV 0

APPENDIX B5

Crossing CV-102

(Pages B5-1 to B5-6)

APPENDIX B5
CROSSING CV-102

1.0 CURRENT CONDITIONS

The water crossing CV-102 is located at KM36 of the Milne Inlet Tote Road and contains four culvert barrels consisting of three, 0.5 m culvert barrels and one, 1.0 m culvert barrel with an estimated contributing catchment area of approximately 1.78 km^2. In September 2022, DFO identified that the culvert barrels are not embedded and will likely become perched (DFO, 2022).

Based on the information provided by North/South Consultants (NSC), the stream flowing through the culvert at CV-102 is a 3rd order stream that drains west to Phillips Creek 90 m downstream (NSC, 2022). The nearest potential overwintering lake is KM32 Lake located 860 m upstream from where CV-102 flows into Phillips Creek (NSC, 2022).

This stream provides some open-water season rearing habitat for small size classes of juvenile Arctic Char (60-80 mm in spring and 40-50 mm in summer/fall) from the confluence with Phillips Creek to 170 m of the culverts where there is a permanent subsurface flow barrier (NSC, 2022). Ninespine Stickleback have not been observed in this stream since monitoring began in 2009 (NSC, 2022). Water velocities and substrates are not within the preferred ranges/sizes for stickleback in the Mary River study area (NSC, 2022).

Stream habitat is typically shallow (<0.10 m) with low to moderate velocity (0.07-0.26 m/s) and generally cascade/riffle over rocky habitat until 80 m upstream of crossing where there is a transition to run/pool habitat with increasing proportions of fines (NSC, 2022). The channel is also braided into three channels from 120-160 m upstream (NSC, 2022).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B5.1 (culvert inlet) and Photo B5.2 (culvert outlet):

- No Embedment - The culvert barrels are not embedded within the stream bottom (Photos B5.1 and B5.2).
- Erosion of Slopes - The embankment slopes are steep and contain fines leading to erosion of the embankment slope (Photos B5.1 and B5.2).

The existing water crossing at CV-102 was rated high risk for the potential to be a barrier to fish movement (Appendix C).

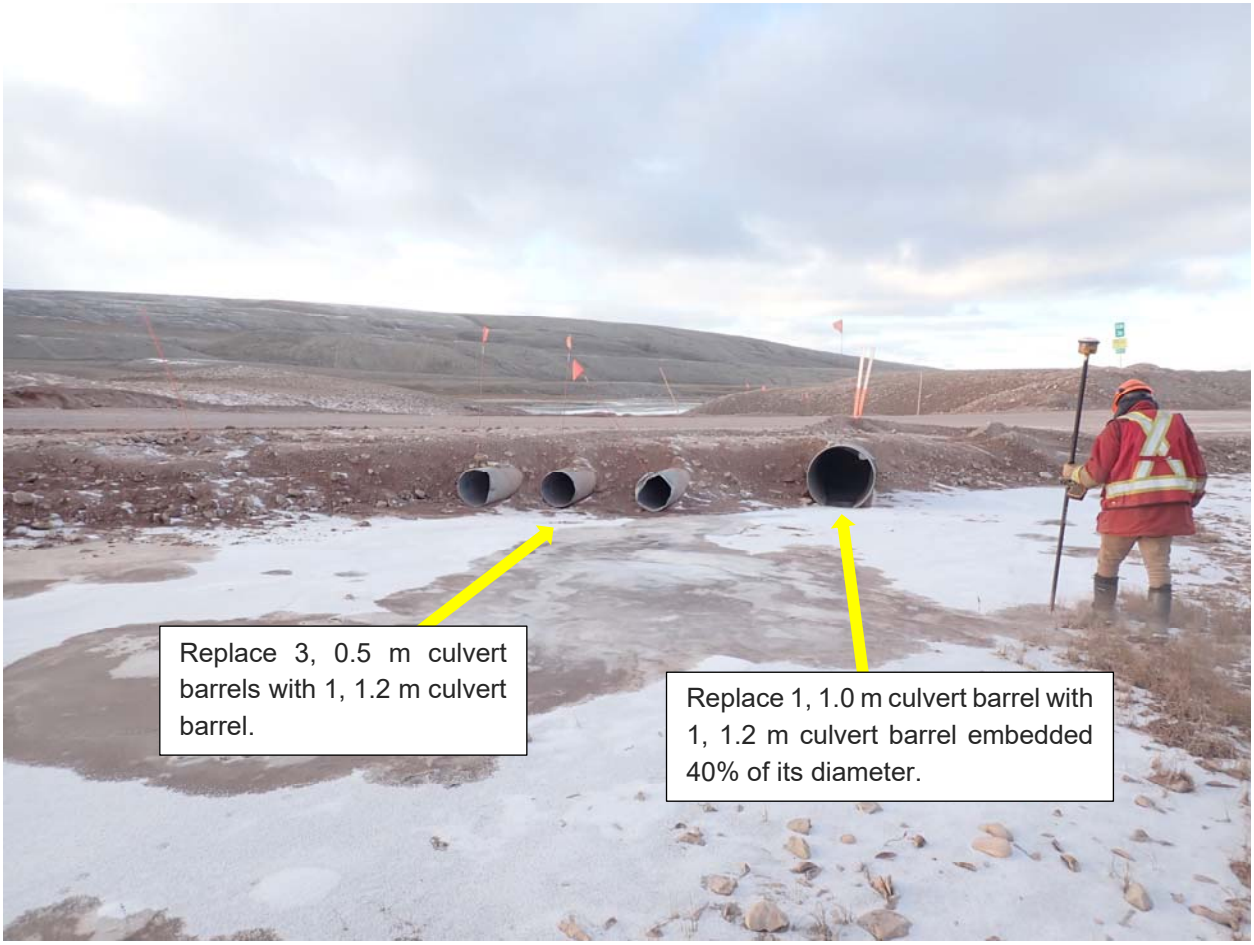


Photo B5.1 CV-102 Culvert Inlet

Photo B5.2 CV-102 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B5.1.
- Lengthen the culvert to allow for a 2H:1V downstream embankment side slope to reduce the potential for downstream embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.

- Armour the downstream embankment with riprap to reduce the potential for embankment erosion.
- Line the ditches on the northwest side of the Tote Road with riprap to reduce the potential for erosion and sediment production.

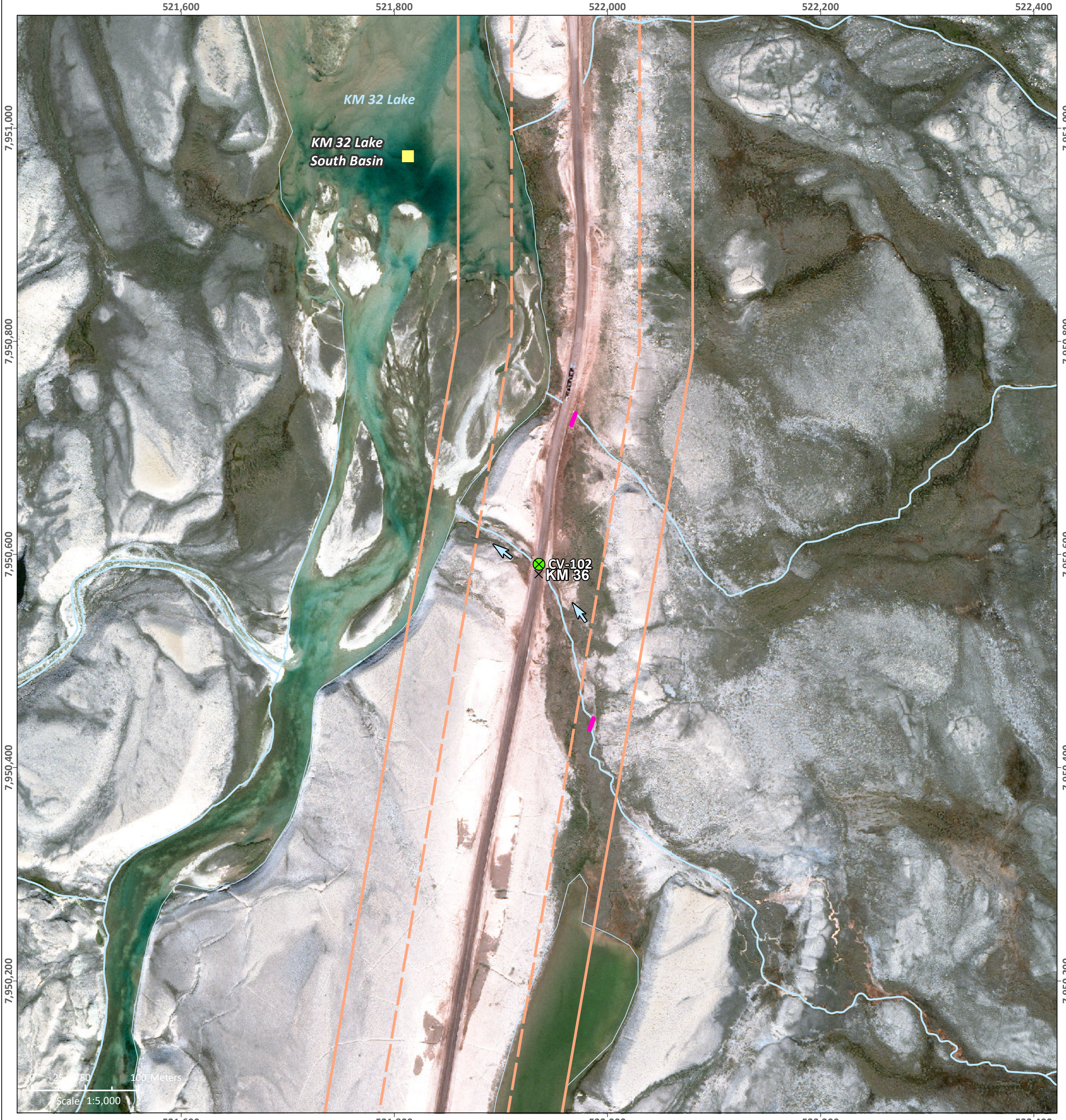
The above remediation measures will ensure the CV-102 water crossing meets the project design criteria.

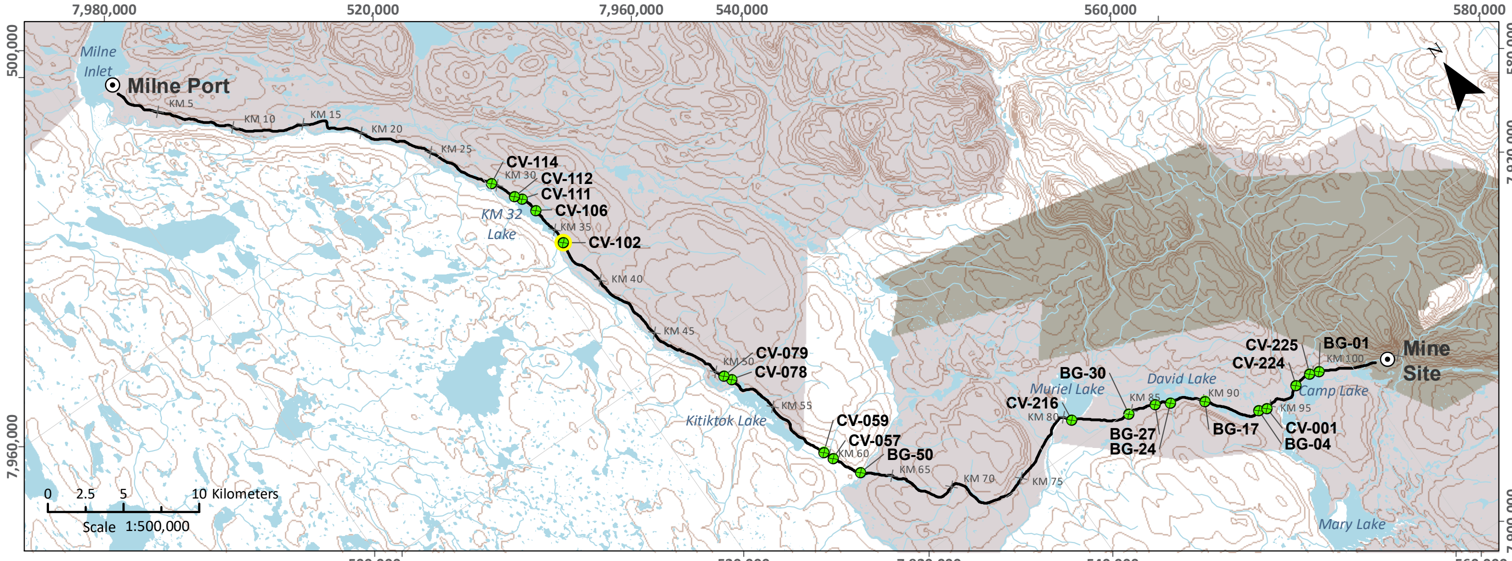
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B5.1. The plan and section of CV-102 is shown in Figure B5.2.

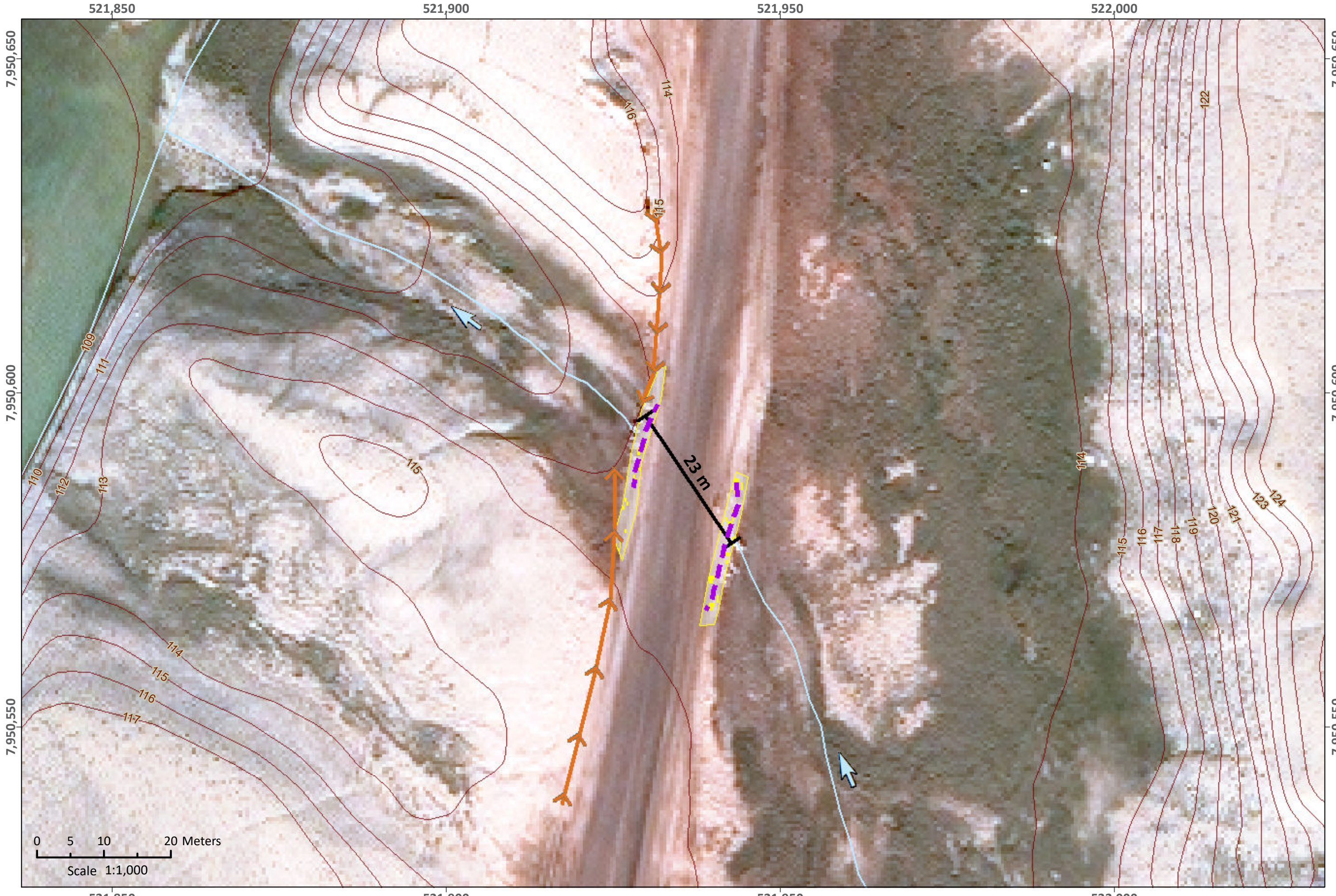
Table B5.1 Culvert Sizing Details

Peak Flow (m^3/s)	3.60
Culvert diameter (mm)	1,200
Number of culvert barrels	2
Embeddedness	One-barrel embedded 40%
Culvert length (m)	37
Slope	2.04%
Minimum cover over barrels (mm)	600

The fish passage risk assessment fish barrier risk rating of high decreases to moderate after implementation of the above remediation measures.







LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat

Riprap Armoured Slope

- Existing
- Proposed

Riprap Lined Ditch

- Existing
- Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

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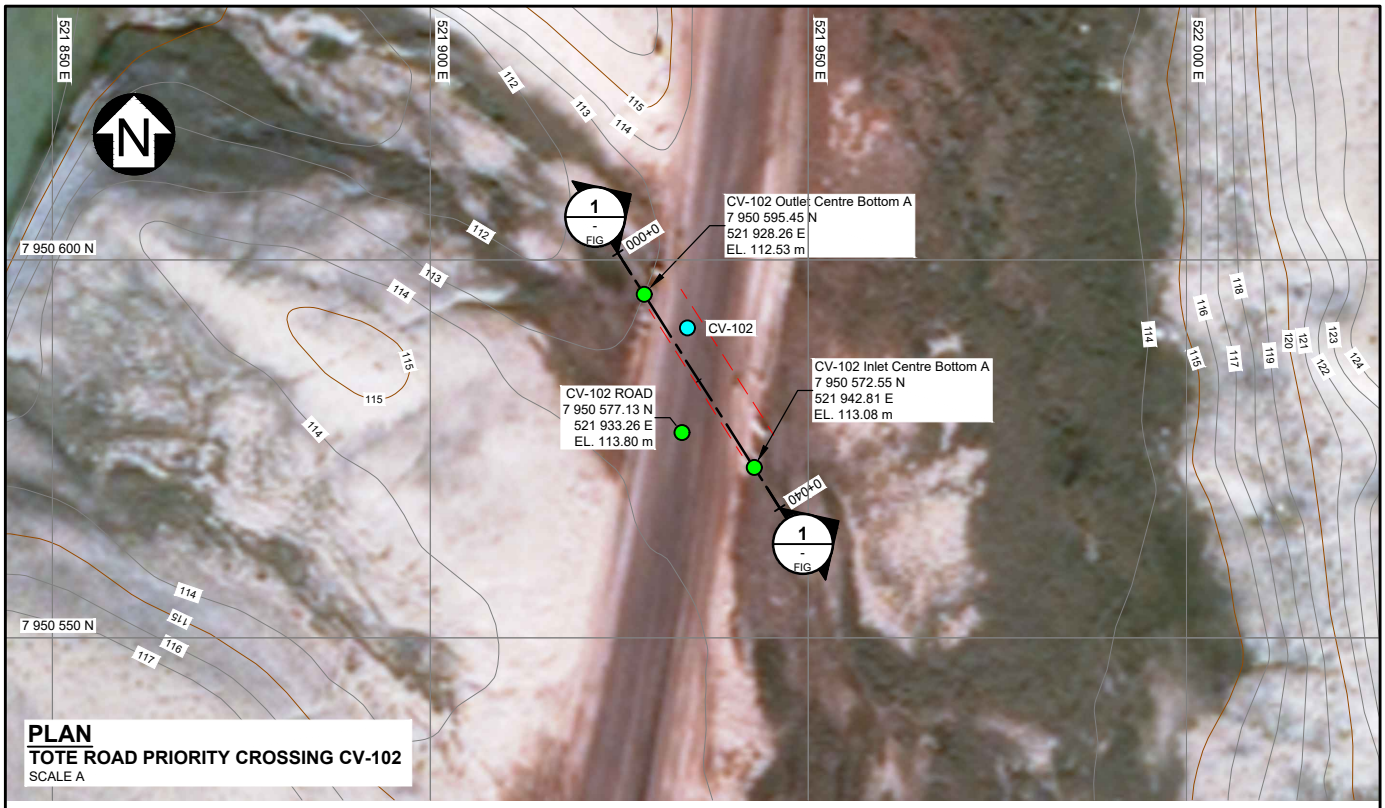
Erosion and Sediment Control Plan
Site Specific Drawing - CV-102

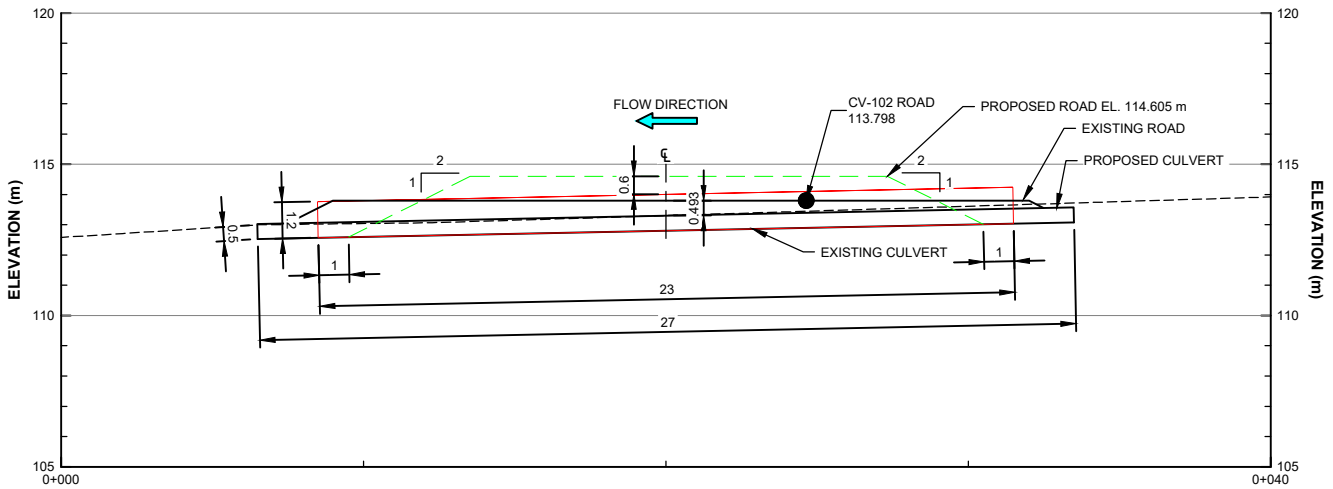
Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.

Baffinland

ᑎᑎᕋᐅᓯᐊᖅ FIGURE B5.1



PLAN
TOTE ROAD PRIORITY CROSSING CV-102
SCALE A



1 - FIG **SECTION**
TOTE ROAD PRIORITY CROSSING CV-102
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 2.5 1.25 0 2.5 5 7.5 10 12.5 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CV-102
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO. NB102-181/77
REF NO. 3
FIGURE B5.2
REV 0

APPENDIX B6

Crossing CV-079

(Pages B6-1 to B6-5)

APPENDIX B6
CROSSING CV-079

1.0 CURRENT CONDITIONS

The water crossing CV-079 is located at KM51 of the Milne Inlet Tote Road and contains two culvert barrels each approximately 1.2 m in diameter with an estimated contributing catchment area of approximately 22.36 km^2. Baffinland identified that the culvert is damaged, partially buried and collapsed with sloughing road material in its initial remediation plan provided to the DFO (Baffinland, 2022a,b).

The stream flowing through the culvert is a 3rd+ order stream that drains west to a potential overwintering lake on Phillips Creek (POWL-7), 750 m downstream of the Tote Road crossing (Figure B6.1). The stream is highly braided with culvert crossings at multiple channels within the floodplain. All channels split from a single stream approximately 300 m upstream of the road. Some of these channels dry up during periods of low water, but the main channel (most northerly) maintains flows throughout the open water period. The stream provides abundant riffle-pool-run open water rearing habitat for juvenile land-locked Arctic Char from 40-175 mm (NSC, 2021). Ninespine Stickleback have not been captured or observed in the stream during any surveys and are thought to be absent from the watershed (NSC, 2021). Habitat is primarily riffle/pool over cobble/boulder.

A permanent fish barrier consisting of a 2 m vertical drop is located approximately 370 m upstream from the road crossing (Figure B6.1). The stream at road crossing CV-078 to the south is part of the same system flowing into POWL-7. There is also a permanent upstream barrier on CV-078, so POWL-7 is the only accessible potential overwintering habitat for all juvenile char in the watershed. It was noted that no fish passage issues were identified at the CV-079 water crossing of the main channel in 2021, though the slight perch at the culvert outlet may limit movements of the smallest char, particularly during periods of high flow (NSC, 2021).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B6.1 (culvert inlet) and Photo B6.2 (culvert outlet):

- Damaged Culverts - The culvert barrels appear to be damaged and collapsing (Photo B6.1).
- Erosion of Slopes - The embankment slopes are steep, lack armouring and contain fines leading to erosion of the embankment slopes (Photo B6.1 and Photo B6.2).
- Perched Culvert - The furthest culvert barrel in the photo is perched above the stream (Photo B6.2).

The existing water crossing was rated high risk and identified as a barrier to 88 mm Arctic Char passage (Appendix C).

Photo B6.1 CV-079 Culvert Inlet

Photo B6.2 CV-079 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

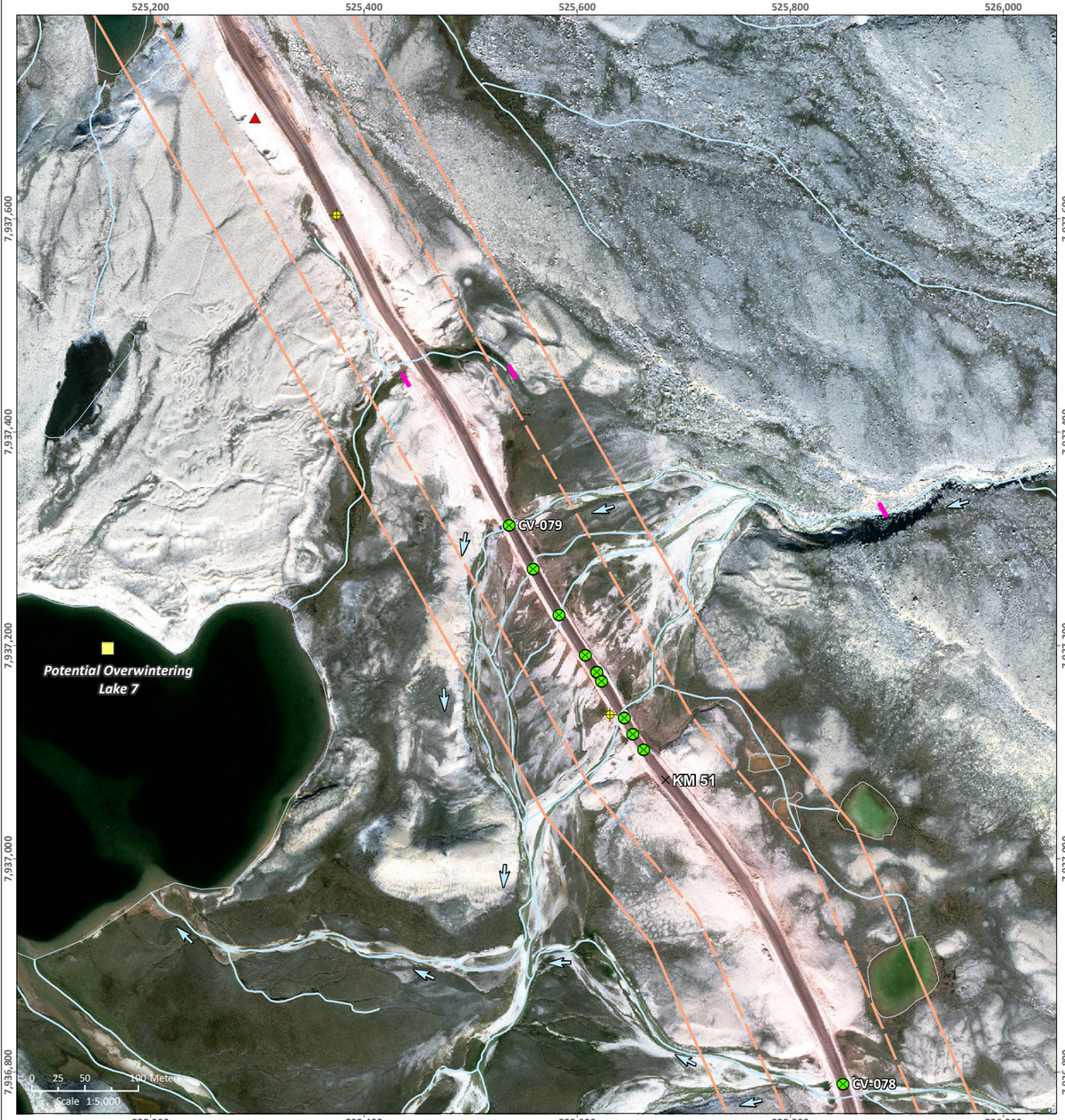
- Install new culverts as identified in Table B6.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- The road at this location is narrow and should be widened for safety reasons. As such, the proposed culvert length is based on widening the road surface to achieve the nominal 15 m road width.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the embankments adjacent to the culvert and along the road embankments extending to cover all the braids of the stream with riprap to reduce the potential for embankment erosion.
- Lined the ditch on the northwest side of the Tote Road to reduce the potential for erosion and sediment production.

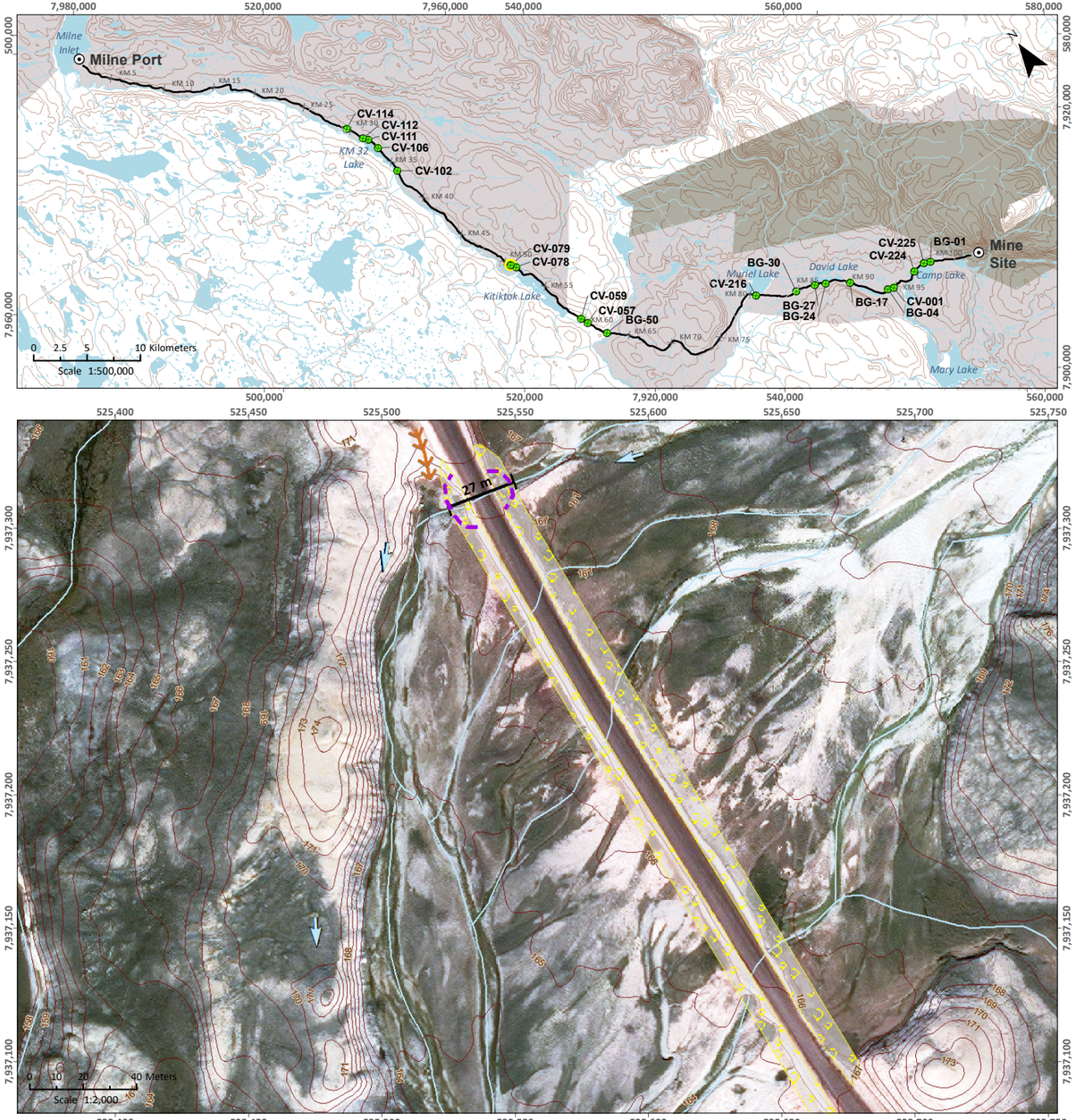
The above remediation measures will improve the fish passage risk rating to low at water crossing CV-079.

The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B6.1. The plan and section of CV-079 is shown in Figure B6.2.

Table B6.1 Culvert Sizing Details

Peak Flow (m^3/s)	27.26
Culvert diameter (mm)	1,800
Number of culvert barrels	4
Embeddedness	One-barrel embedded 40%
Culvert length (m)	27
Slope	0.67%
Minimum cover over barrels (mm)	900





LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat
- **Riprap Armoured Slope**: Existing, Proposed
- **Riprap Lined Ditch**: Existing, Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

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Erosion and Sediment Control Plan
Site Specific Drawing - CV-079

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.

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Baffinland

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FIGURE B6.1

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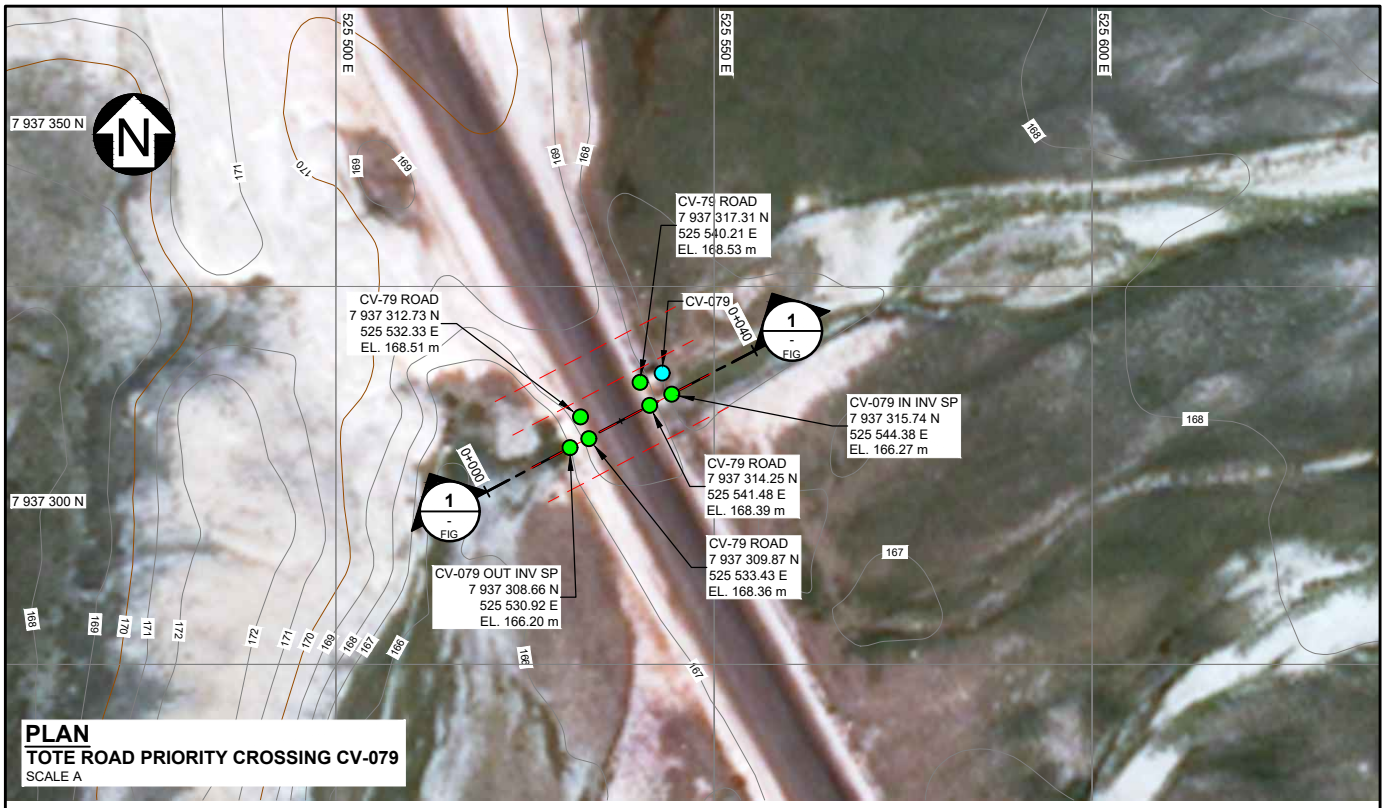
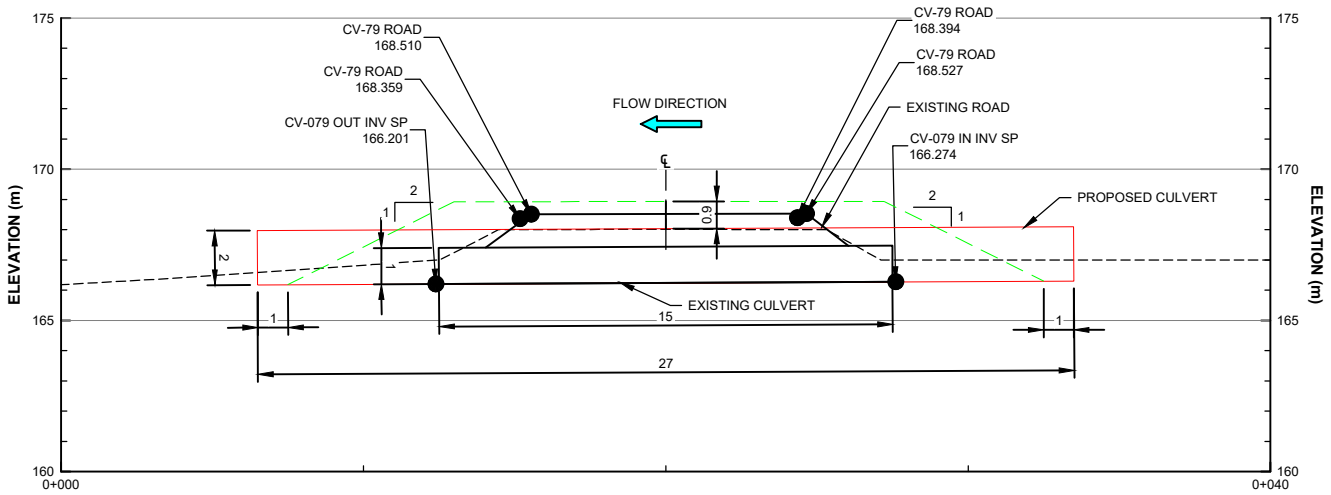


PLAN
TOTE ROAD PRIORITY CROSSING CV-079
SCALE A



SECTION
TOTE ROAD PRIORITY CROSSING CV-079
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 2.5 1.25 0 2.5 5 7.5 10 12.5 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CV-079
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/77	3

FIGURE B6.2 REV 0

APPENDIX B7

Crossing CV-078

(Pages B7-1 to B7-5)

APPENDIX B7
CROSSING CV-078

1.0 CURRENT CONDITIONS

The water crossing CV-078 is located at KM51.5 of the Milne Inlet Tote Road and contains five culvert barrels consisting of 3, 1.2 m barrels and 2, 2.4 m culvert barrels with an estimated contributing catchment area of approximately 21.72 km^2. In September 2022, DFO identified culvert damage, a downstream outlet perch of approximately 0.15 m and frozen conditions were observed at this location (DFO, 2022)

Based on information provided by North/South Consultants (NSC), the stream flowing through the culvert at CV-078 is a large 3^+ order stream that flows west for approximately 1 km, merging with flows from CV-079, before draining into a potential overwintering lake (NSC, 2022). This lake has not been surveyed for bathymetry and substrate, but maximum depth is thought to be >3 m.

The CV-078 stream provides abundant open-water season rearing habitat for juvenile Arctic Char ranging in size from 60-260 mm downstream and upstream of the culverts (NSC,2022). Habitat is primarily riffle//run over cobble substrate from the downstream lake to the permanent falls barrier approximately 2.5 km upstream from the road crossing. Ninespine Stickleback have not been captured since monitoring began and may be absent from the watershed (NSC, 2022).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B7.1 (culvert inlet) and Photo B7.2 (culvert outlet):

- Erosion of Slopes - The embankment slopes above the culvert barrels appears to be eroding (Photos B7.1 and B7.2).
- Perched Culvert - A slight perch is present at the downstream end of the smaller culvert barrels (Photo B7.2).
- No Embedment - At least one culvert barrel should be embedded 40% of its diameter (Photos B7.1 and B7.2).

The existing water crossing was rated high risk and was identified as a barrier to 88 mm Arctic Char fish passage (Appendix C).

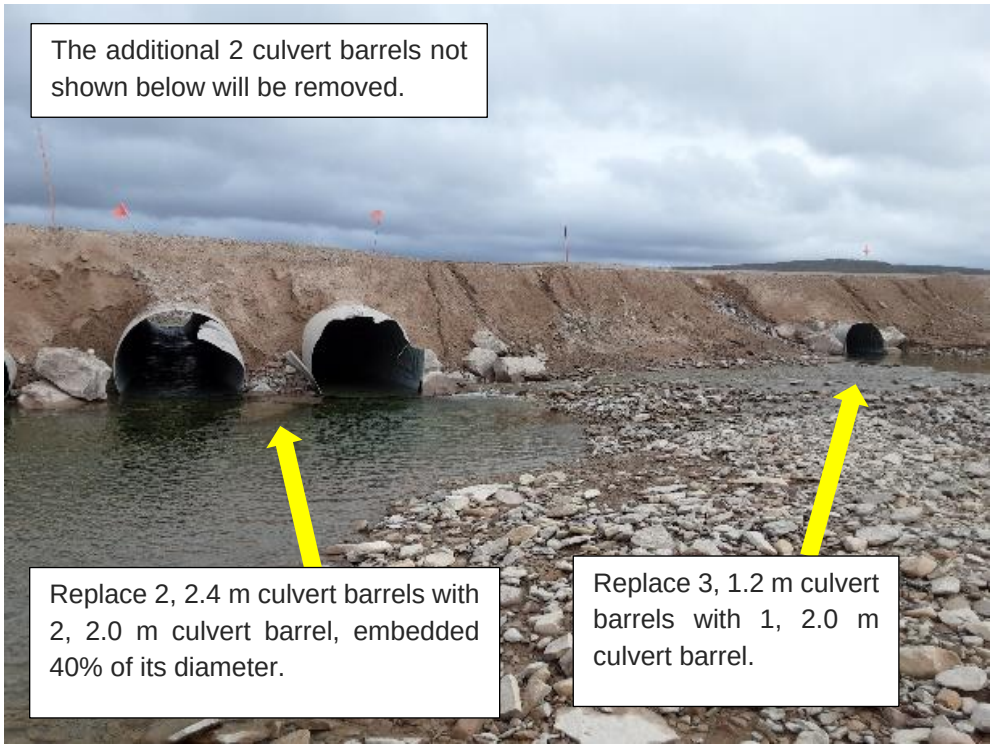


Photo B7.1 CV-078 Culvert Inlet

Photo B7.2 CV-078 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified In Table B7.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the embankments with riprap to reduce the potential for embankment erosion.
- Line the ditch to the northwest of the Tote Road with riprap to reduce the potential for erosion and sediment production.

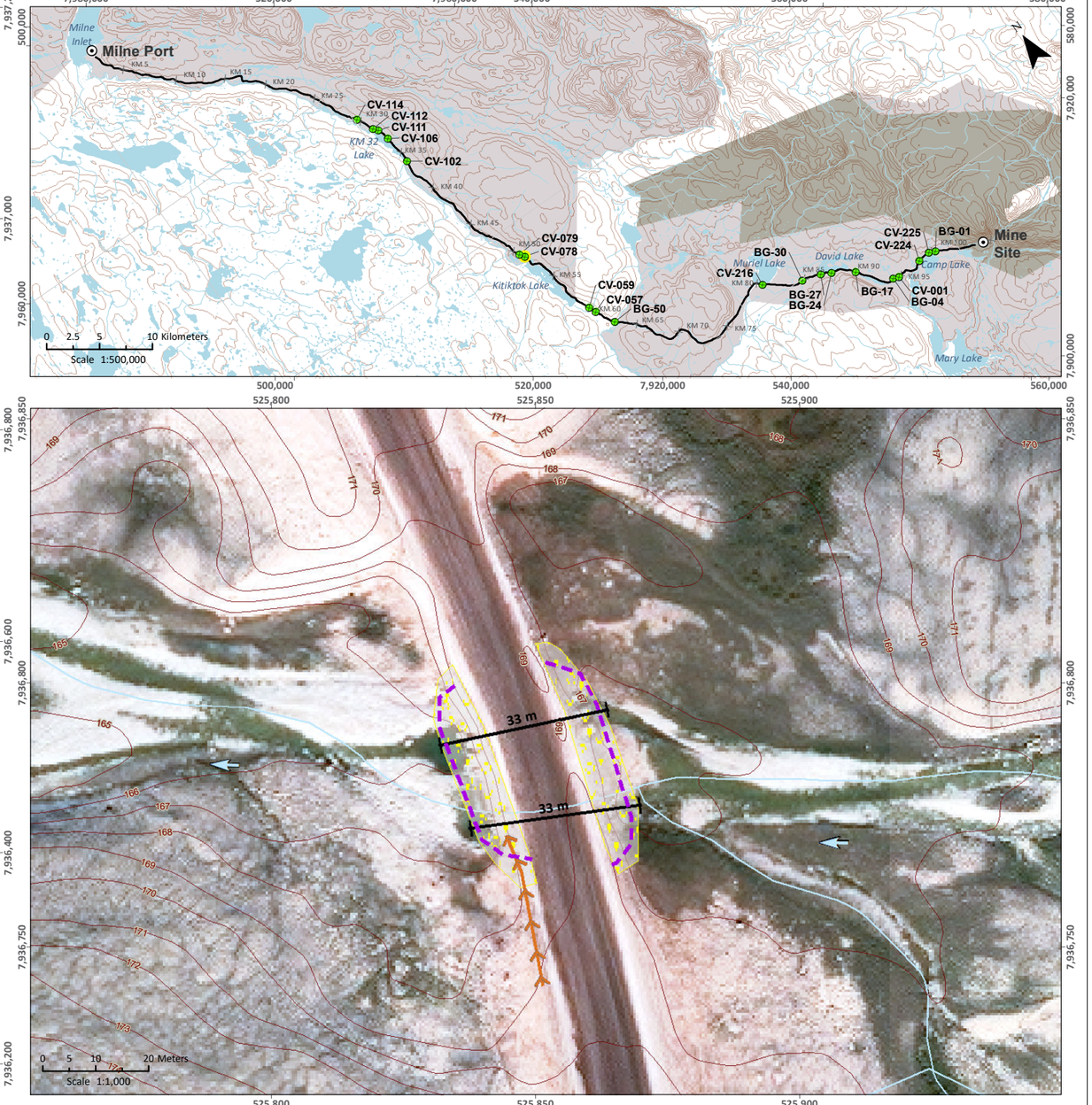
The above remediation measures will ensure the CV-078 water crossing meets the project design criteria.

The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B7.1. The plan and section of CV-078 is shown in Figure B7.2.

Table B7.1 Culvert Sizing Details

Peak Flow (m^3/s)	26.64
Culvert diameter (mm)	2,000
Number of culvert barrels	3
Embeddedness	One-barrel embedded 40%
Culvert length (m)	33
Slope	3.50%
Minimum cover over barrels (mm)	1000

The fish passage risk assessment fish barrier risk rating of high decreases to moderate after implementation of the above remediation measures.



LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- **Riprap Armoured Slope**
  - Existing
  - Proposed
- **Riprap Lined Ditch**
  - Existing
  - Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

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Erosion and Sediment Control Plan
Site Specific Drawing - CV-078

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.

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Baffinland

ᑎᑎᕋᐅᖏᓐᓄᑦ **FIGURE** **B7.1**

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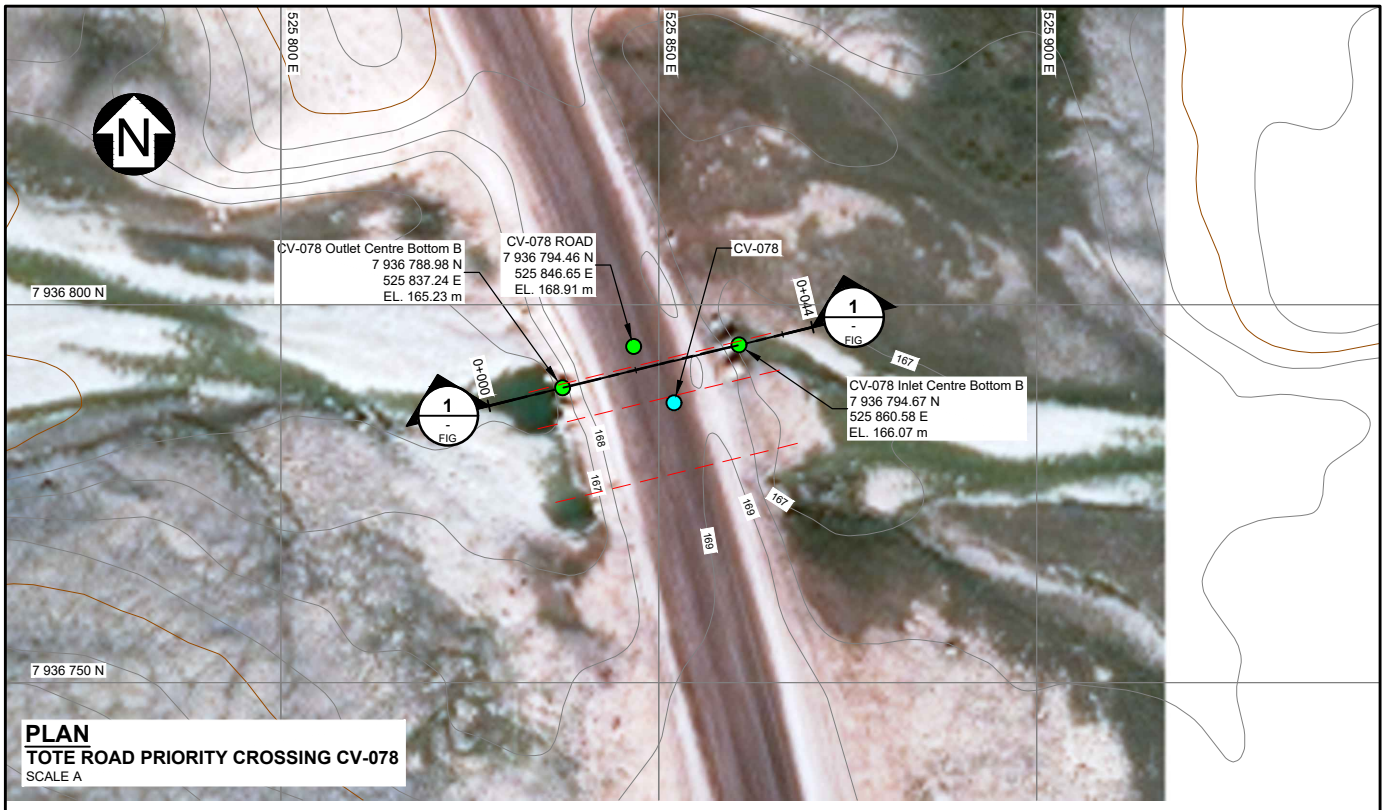
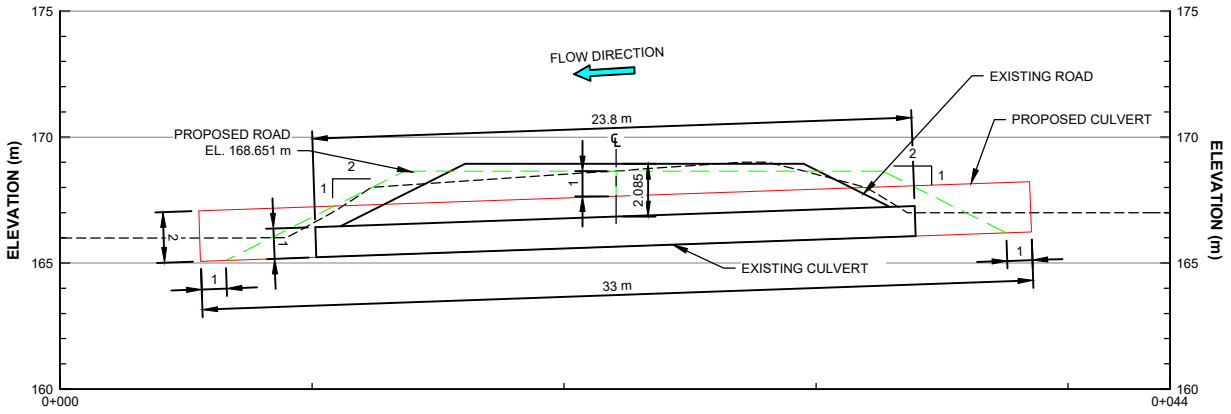


PLAN
TOTE ROAD PRIORITY CROSSING CV-078
SCALE A



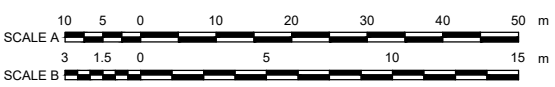
1 - FIG
SECTION
TOTE ROAD PRIORITY CROSSING CV-078
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.



REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CV-078
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/77	3

FIGURE B7.2 REV 0

APPENDIX B8

Crossing CV-059

(Pages B8-1 to B8-5)

APPENDIX B8
CROSSING CV-059

1.0 CURRENT CONDITIONS

The water crossing CV-059 is located at KM60 of the Milne Inlet Tote Road and contains 4 culvert barrels each approximately 0.5 m in diameter with an estimated contributing catchment area of approximately 2.7 km^2. Baffinland identified that the culverts are damaged and partially collapsed with sloughing road material in its initial remediation plan (Baffinland, 2022a, b).

According to the 2021 survey by North/South Consultants Inc. (NSC) the stream flowing through the culvert is a 3rd order stream that drains 2.2 km northwest towards the south end of Katiktok Lake, which is the nearest potential overwintering habitat (Figure B8.1; NSC, 2021). The stream provides low velocity pool-run open water rearing habitat for juvenile land-locked Arctic Char from 60-160 mm (NSC, 2021). Ninespine Stickleback have not been captured or observed in the stream during any surveys and are thought to be absent from the watershed (NSC, 2021).

A permanent fish barrier is present approximately 800 m upstream of the road crossing located on a rocky slope where water falls over boulders with steep vertical drops (Figure B8.1). Additional intermittent barriers, located from 550-650 m upstream of the road, consist of reaches of very shallow water that may dry up during periods of low flows. There is no upstream overwintering habitat. It was noted that no fish passage issues were identified at the water crossing in 2021 (NSC, 2021).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B8.1 (culvert inlet) and Photo B8.2 (culvert outlet):

- Damaged and Plugged with Sediment - The culvert barrels appear to be damaged, collapsed and completely plugged with sediment resulting in ponded water (Photos B8.1 and B8.2).
- Erosion of Slopes - The embankment slope above the culvert barrels appears to be eroding (Photos B8.1 and B8.2).
- Minimum Diameter - The minimum diameter for fish bearing culverts should be 1 m (Hatch, 2018) (Photos B8.1 and B8.2).

The existing water crossing was rated high risk result as a barrier for fish passage (Appendix C).

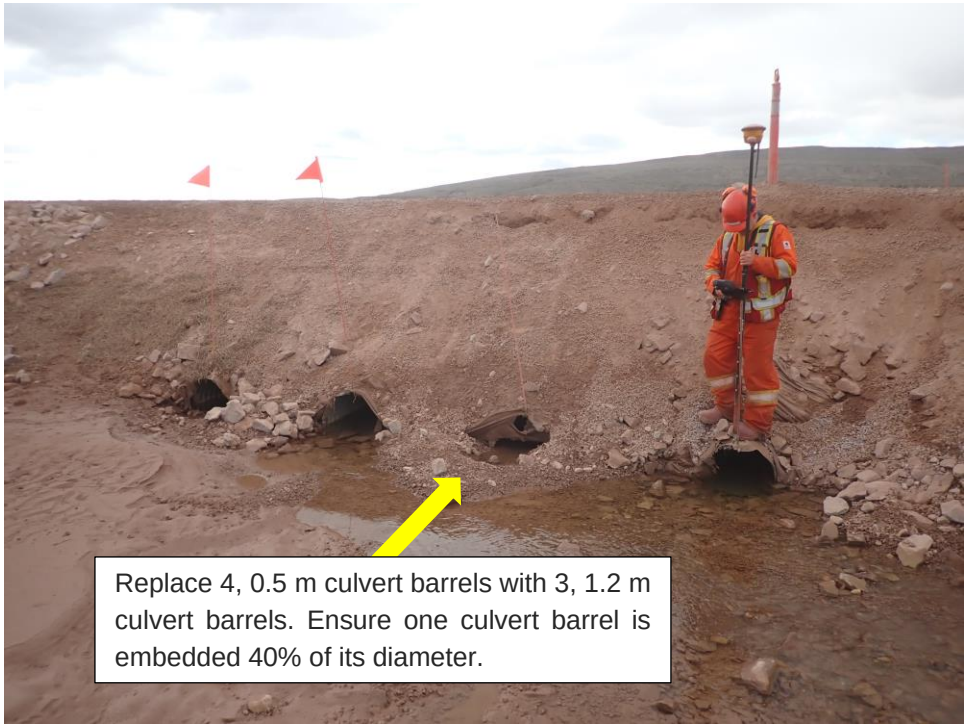


Photo B8.1 CV-059 Culvert Inlet

Photo B8.2 CV-059 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Install new culverts as identified in Table B8.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the embankments with riprap to reduce the potential for embankment erosion.
- Line the ditches on either side of the Tote Road with riprap to reduce the potential for erosion and sediment production.

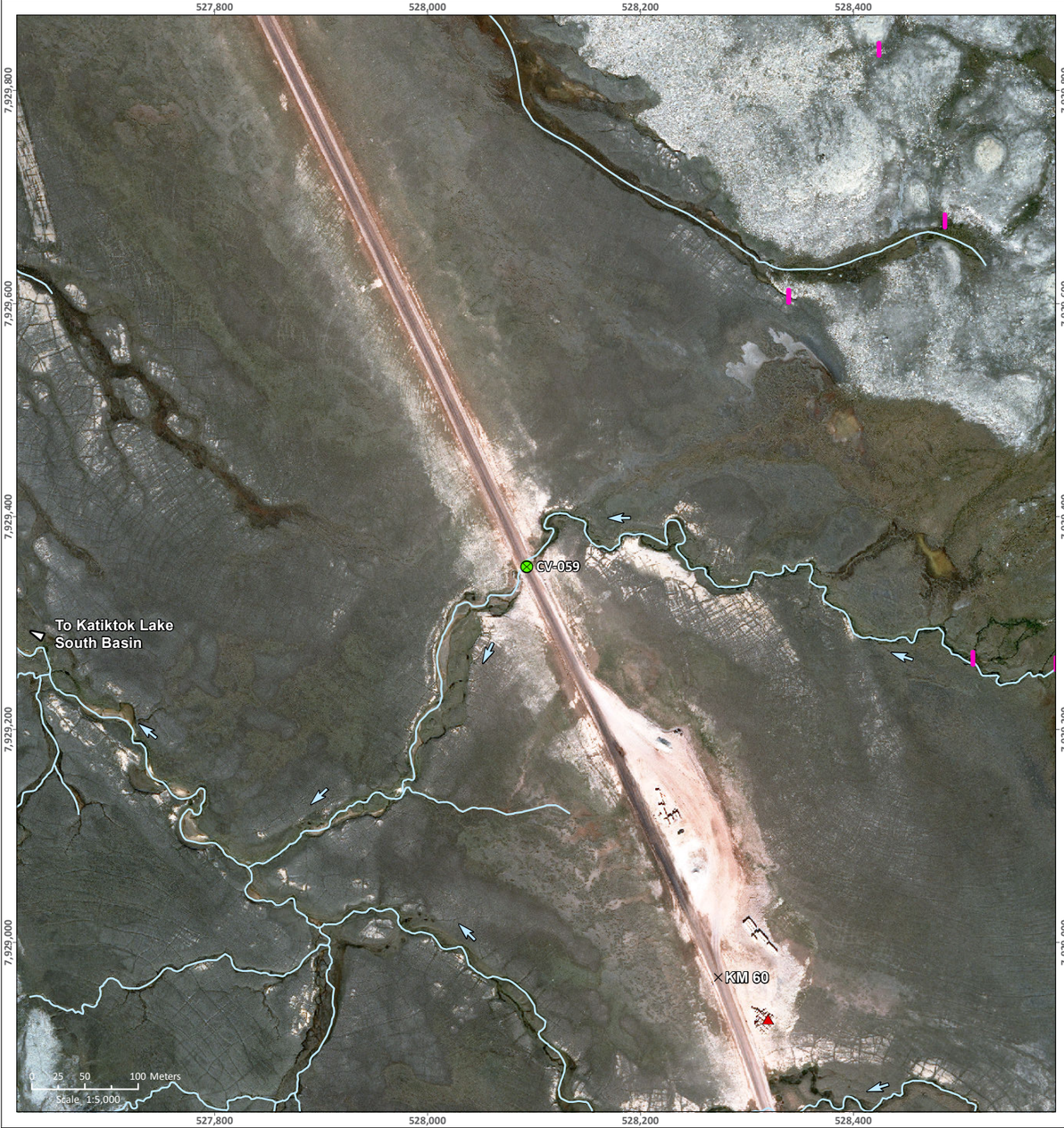
The above remediation measures will ensure the CV-059 water crossing meets the project design criteria.

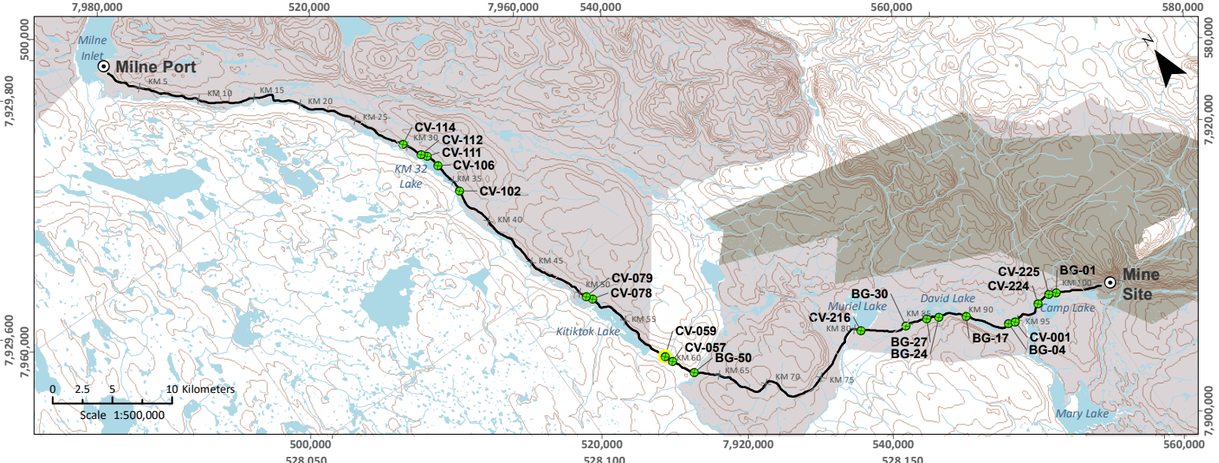
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B8.1. The plan and section of CV-059 is shown in Figure B8.2.

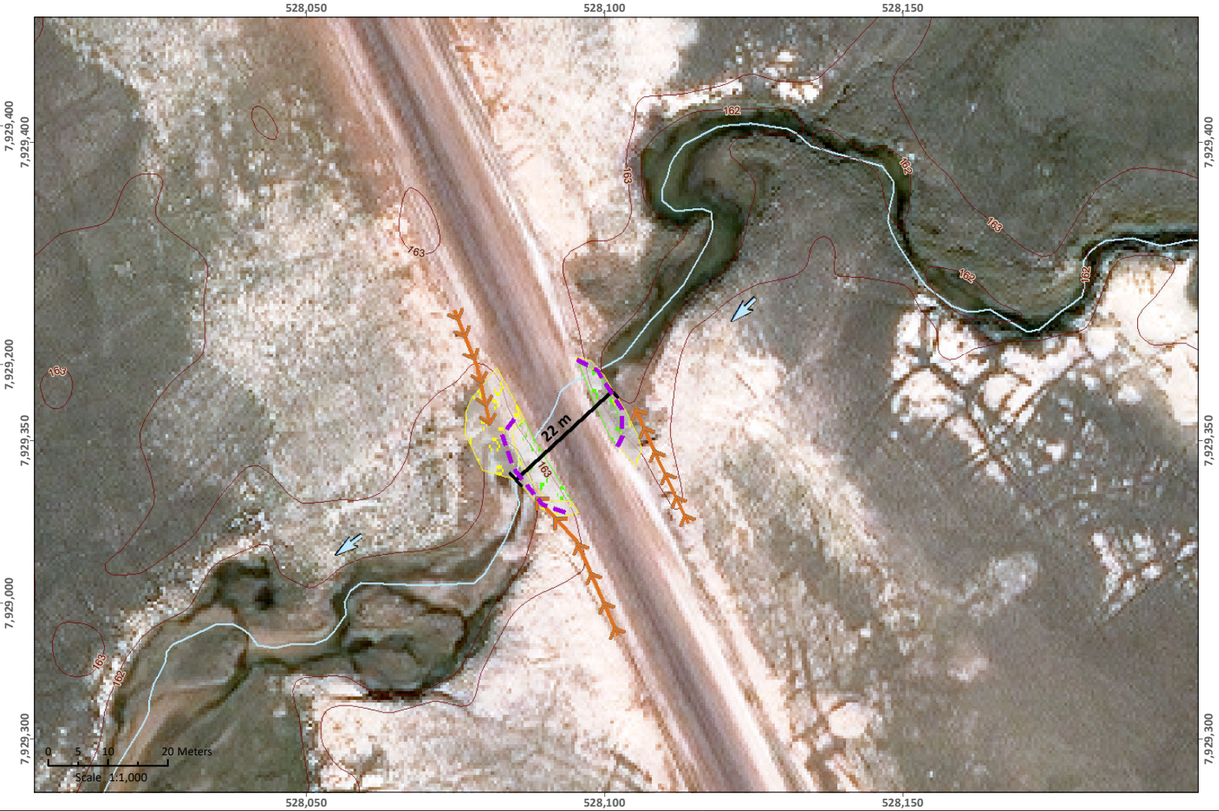
Table B8.1 Culvert Sizing Details

Peak Flow (m^3/s)	5.02
Culvert diameter (mm)	1,200
Number of culvert barrels	3
Embeddedness	One-barrel embedded 40%
Culvert length (m)	22
Slope	4.8%
Minimum cover over barrels (mm)	600

The fish passage risk assessment fish barrier risk rating of high decreases to moderate after implementation of the above remediation measures.







LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- **Riprap Armoured Slope**: Existing, Proposed
- **Riprap Lined Ditch**: Existing, Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

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Erosion and Sediment Control Plan
Site Specific Drawing - CV-059

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.
© 2022 Digital Globe, Inc. Imagery and Infrastructure are representative as of July 2022.

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ᑎᑎᕋᐅᓯᖏᓐᓄᑦ **FIGURE** **B8.1**

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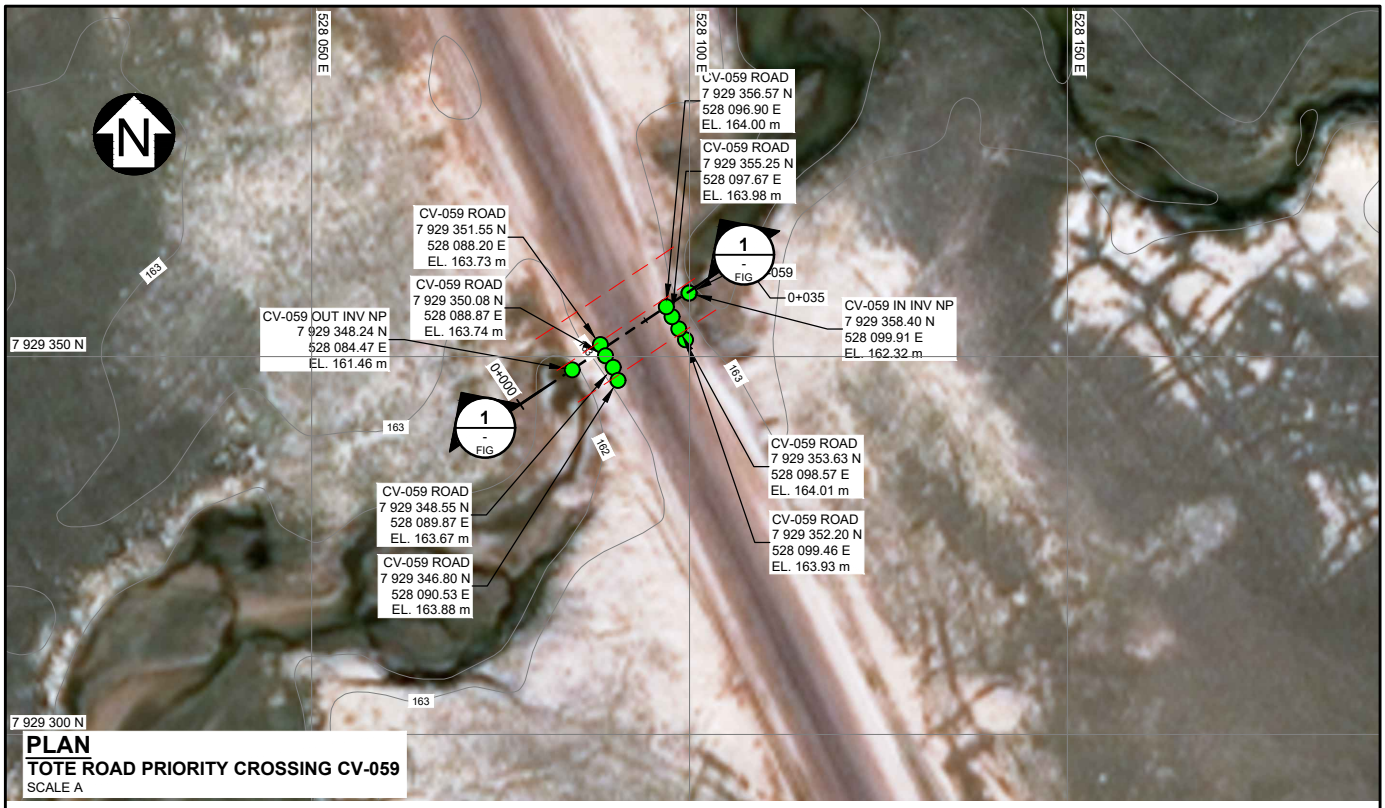
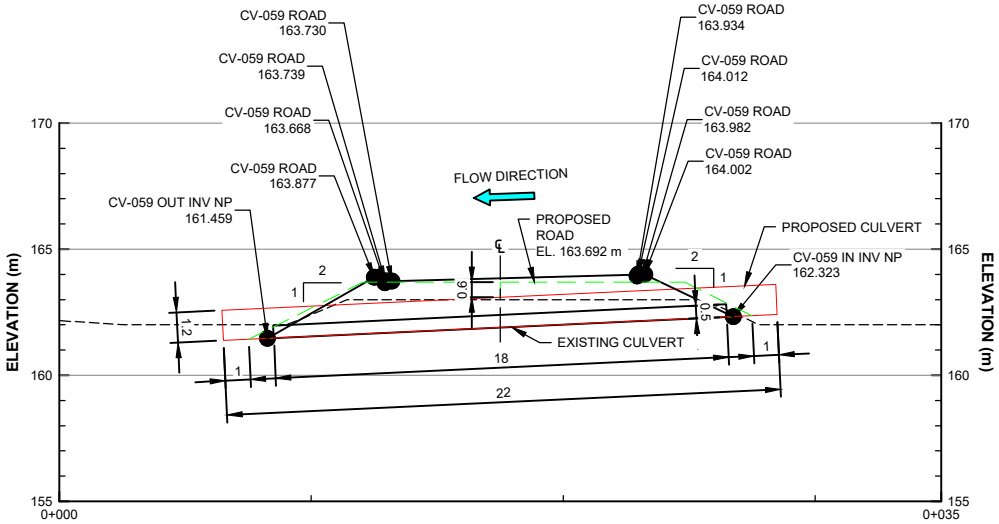


PLAN
TOTE ROAD PRIORITY CROSSING CV-059
SCALE A



SECTION
TOTE ROAD PRIORITY CROSSING CV-059
SCALE B

LEGEND:
- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:
1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 3 1.5 0 5 10 15 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CV-059
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO. NB102-181/77
REF NO. 3
FIGURE B8.2
REV 0

APPENDIX B9

Crossing CV-057

(Pages B9-1 to B9-5)

APPENDIX B9
CROSSING CV-057

1.0 CURRENT CONDITIONS

The water crossing CV-057 is located at KM60.6 of the Milne Inlet Tote Road and contains two culvert barrels each approximately 0.5 m in diameter with an estimated contributing catchment area of approximately 0.79 km^2. Baffinland identified that sediment had built up at the culvert inlet and outlet potentially caused by erosion from the road embankment in its initial remediation plan provided to DFO (Baffinland, 2022a,b).

According to the 2021 survey by North/South Consultants Inc. (NSC) the stream flowing through the culvert is a 2nd order stream that flows 2.9 km downstream to the south end of Katiktok Lake, which is the nearest potential overwintering lake (Figure B9.1; NSC, 2021). The stream provides open water rearing habitat for juvenile land-locked Arctic Char from 60-180 mm (NSC, 2021). Ninespine Stickleback have not been captured or observed in the stream during any surveys and are thought to be absent from the watershed (NSC, 2021). Habitat consists of a series of shallow and deep pools with low to negligible velocities over predominantly fine substrate.

Approximately 1 km upstream, at the base of the rocky hills to the east, the stream collects subsurface water from several locations; all are permanent barriers, and the most upstream location is identified on Figure B9.1. There are no downstream barriers to fish movement in this stream. Natural habitat in the stream is mainly pools with low velocity runs and riffles. Because of the slow flows, it was noted in the 2021 survey that the culverts are becoming full of sediment and may block fish movements if not remediated (NSC, 2021).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B9.1 (culvert inlet) and Photo B9.2 (culvert outlet):

- Plugged with Sediment - The culvert barrels appear to be completely plugged with sediment resulting in ponded water (Photo B9.1).
- Erosion of Slopes - The embankment slope above the culvert barrels appears to be eroding (Photos B9.1 and B9.2).
- Damaged Culverts - The culvert barrels appear to be damaged, collapsing and beginning to be plugged with sediment (Photo B9.2).
- Adequate Cover - Loading over culvert pipes should be in accordance with the design criteria with the minimum cover for culverts being 600 mm, or as required by the differing specific design vehicle (Hatch, 2018) (Photos B9.1 and B9.2).
- Minimum Diameter - The minimum diameter for fish bearing culverts should be 1 m (Hatch, 2018) (Photos B9.1 and B9.2).

The existing water crossing was rated high risk as a barrier for fish passage (Appendix C).

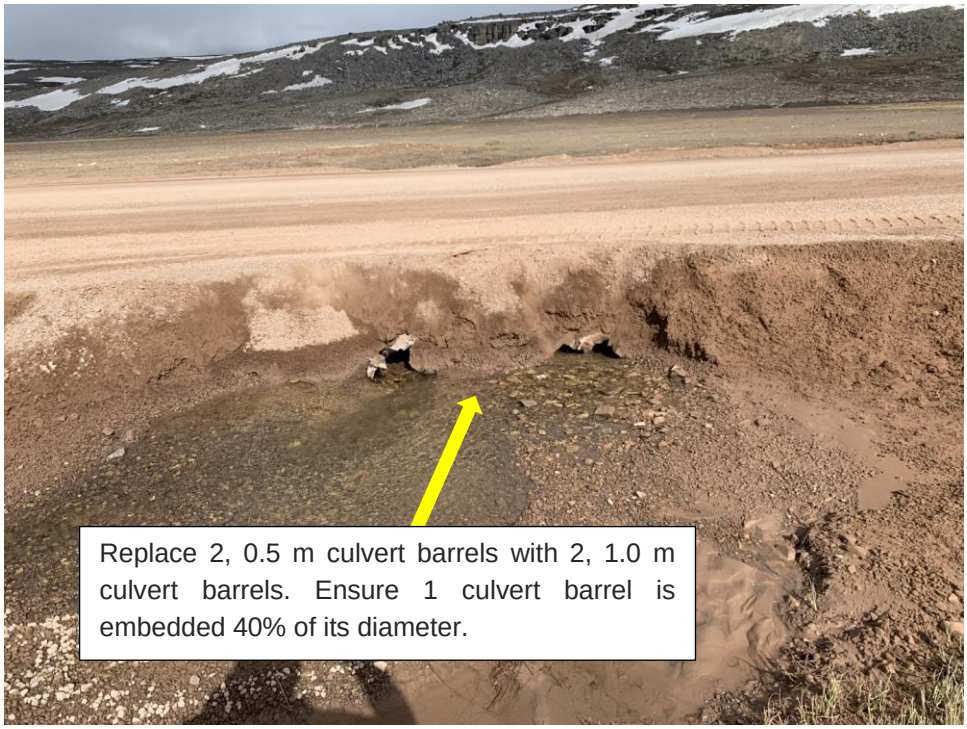


Photo B9.1 CV-057 Culvert Inlet

Photo B9.2 CV-057 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B9.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the embankments with riprap to reduce the potential for embankment erosion.
- Lined the ditch on the west side of the Tote Road with riprap to reduce the potential for erosion and sediment production.

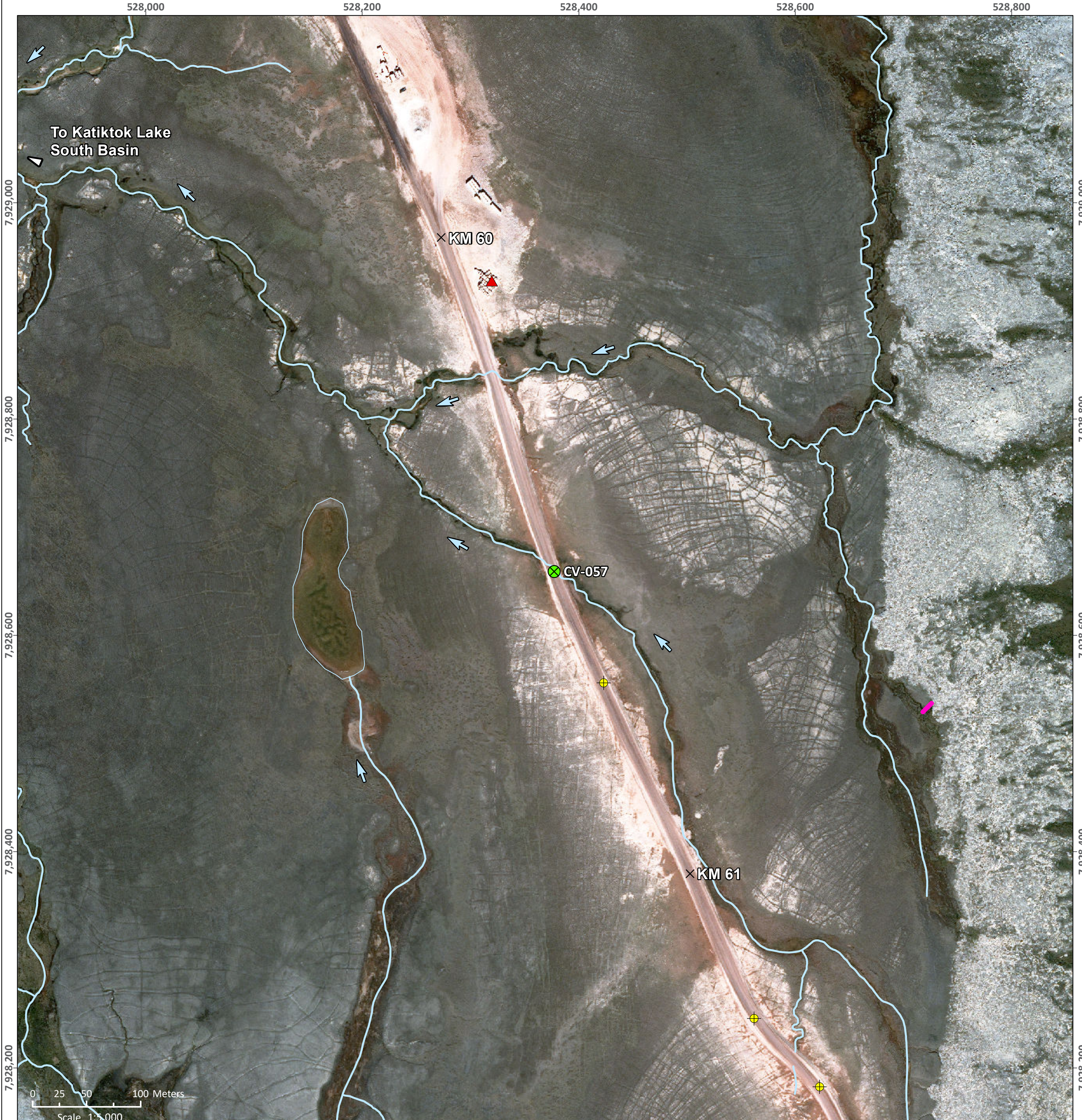
The above remediation measures will ensure the CV-057 water crossing meets the project design criteria.

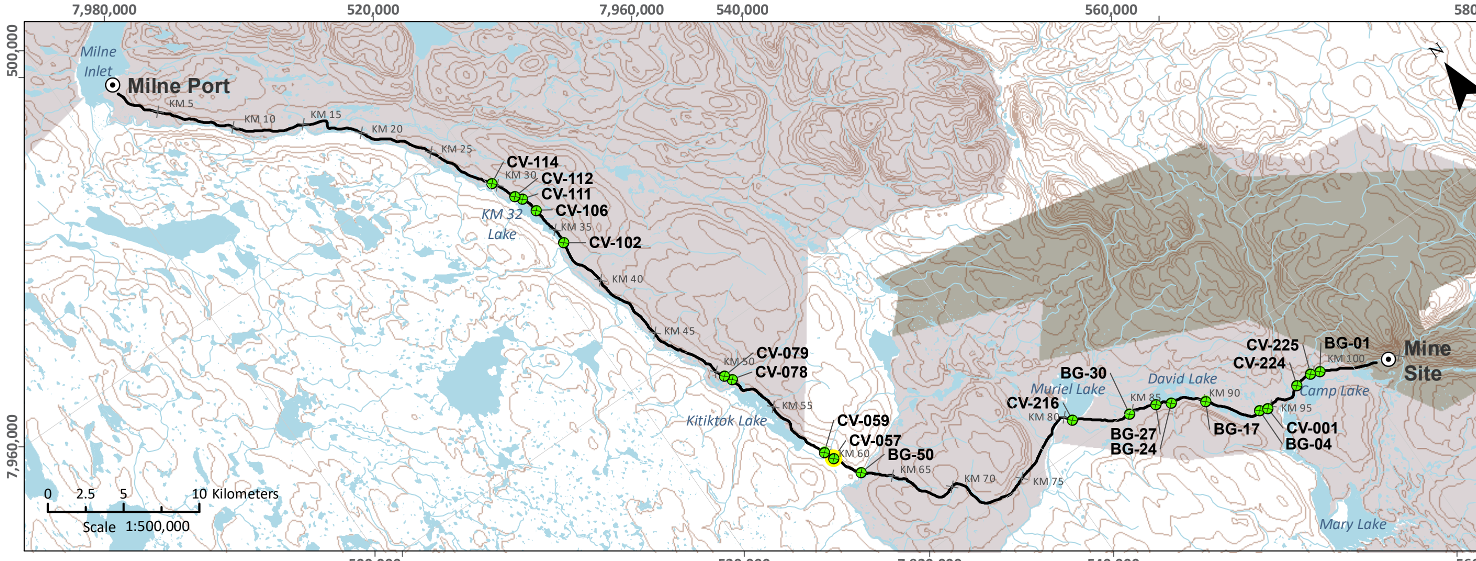
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B9.1. The plan and section of CV-057 is shown on Figure B9.2.

Table B9.1 Culvert Sizing Details

Peak Flow (m^3/s)	1.87
Culvert diameter (mm)	1,000
Number of culvert barrels	2
Embeddedness	One-barrel embedded 40%
Culvert length (m)	22
Slope	1.29%
Minimum cover over barrels (mm)	600

The fish passage risk assessment fish barrier risk rating of high decreases to low after implementation of the above remediation measures.





LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit

Riprap Armoured Slope

- Existing
- Proposed

Riprap Lined Ditch

- Existing
- Proposed

Note

1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. The culvert replacement will be completed in two stages to allow for continued use of the access road. Traffic control and barriers to follow the designated work plan.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

ᓄᓘᔮᓂ ᐅᔭᖅᓯᐅᕐᑐᑦ MARY RIVER PROJECT

Erosion and Sediment Control Plan
Site Specific Drawing - CV-057

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.
 Imagery and Infrastructure are representative as of July 2022.

Baffinland

ᑎᑎᕋᐅᔭᕐᓯᒪᔪᖅ FIGURE B9.1

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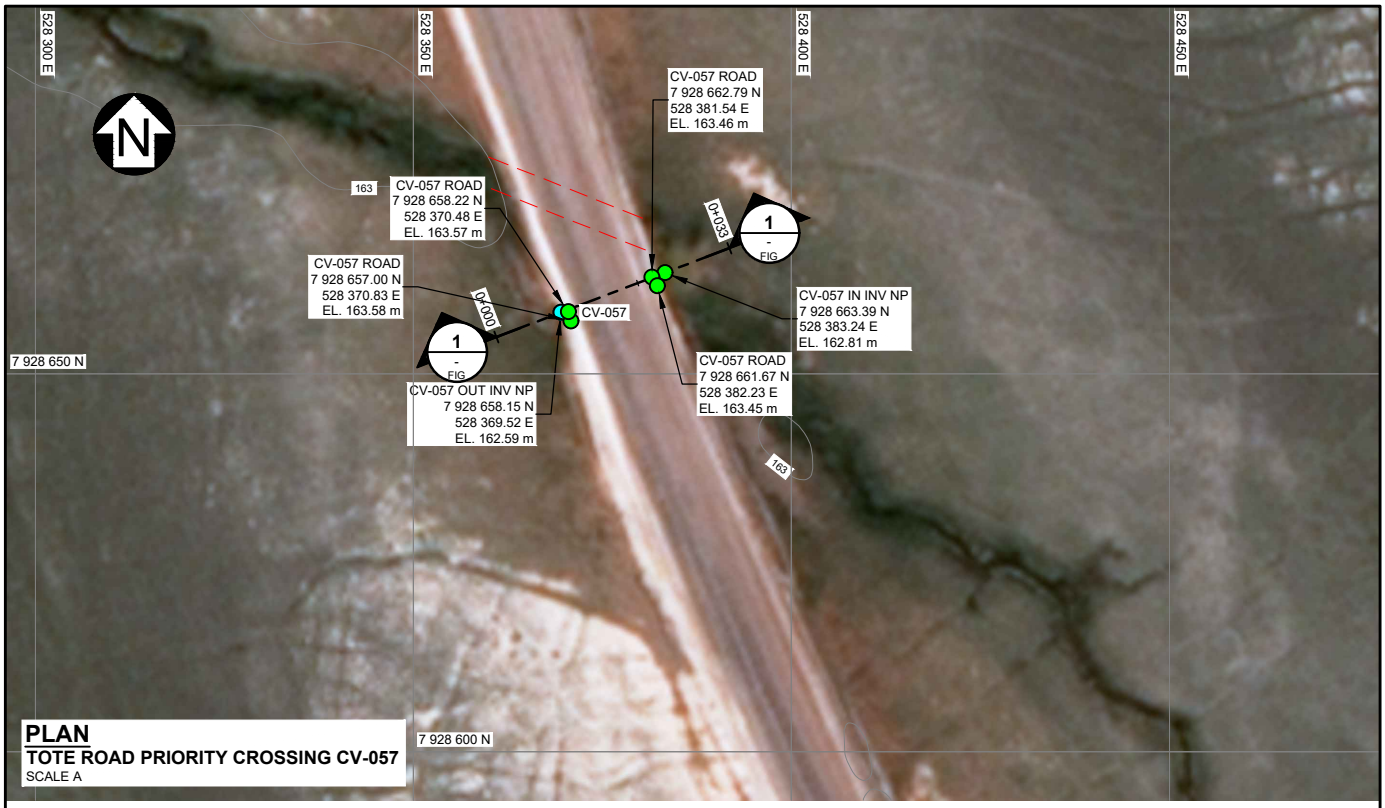
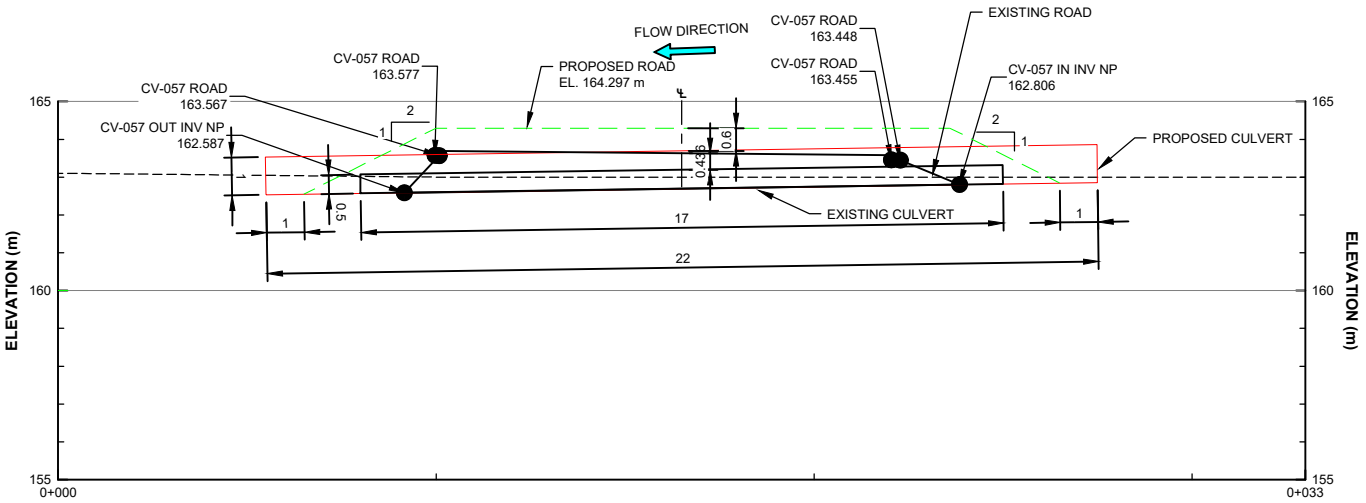


PLAN
TOTE ROAD PRIORITY CROSSING CV-057
SCALE A



1 - FIG
SECTION
TOTE ROAD PRIORITY CROSSING CV-057
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 2 1 0 2 4 6 8 10 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CV-057
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/77	3

FIGURE B9.2 REV 0

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APPENDIX B10

Crossing BG-50

APPENDIX B10
CROSSING BG-50

1.0 CURRENT CONDITIONS

The water crossing BG-50 is located at KM62 of the Milne Inlet Tote Road and contains two culvert barrels each approximately 1.2 m in diameter. The main river has an estimated total contributing catchment area of approximately 207.5 km^2 with an estimated 10% reporting to the culverts located off the main river channel (20.75 km^2). Baffinland identified that the culverts were perched, and previous remediation measures were washed out during freshet. It was noted culvert re-installation may be necessary in its initial remediation plan provided to DFO (Baffinland, 2022a, b).

According to the 2021 survey by North/South Consultants Inc. (NSC) the stream flowing through the culvert is a large 3rd order stream that flows into the northeast end of a potential overwintering lake. POWL-8 (Figure B10.1; NSC, 2021). The river splits into two channels immediately upstream of the Tote Road and merges back into a single channel 320 m downstream from the road (NSC, 2021). The main channel is crossed by a bridge with no fish passage issues. The secondary channel flows through the two culvert barrels at this water crossing. This large, wide river has depths that can exceed 1.0 m and velocities that frequently exceed 1.0 m/s. Habitat is riffle/pool/run with some rapids over cobble substrate. There is a permanent barrier (falls) approximately 13 km upstream from the road on the main channel. There are no downstream barriers to fish movement from the nearest potential overwintering lake (POWL-8) or from the site up to a second more distant upstream potential overwintering lake (approximately 11.2 km upstream). Additional potential upstream overwintering lakes are located on smaller tributaries of the main BG-50 channel to the northeast (Figure B10.1).

Large numbers of juvenile land-locked Arctic Char from 50-280 mm use both channels of this stream for summer rearing/feeding habitat. Small numbers of Ninespine Stickleback also use the river for foraging and to access smaller tributaries for spawning (NSC, 2021). The potential for adult char spawning movements between downstream and upstream lakes is low. No adults have been observed or captured since monitoring began in 2008. The culverts at the road crossing of the smaller channel are completely impassable to all sizes of char due to their very high perch. Any fish using this channel would have to move back downstream to the main channel and swim under the bridge to access additional upstream habitat.

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B10.1 (culvert inlet) and Photo B10.2 (culvert outlet):

- Damaged Culverts - The culvert barrels appear to be damaged and collapsing (Photo B10.1).
- Perched Culverts - The culvert barrels are perched above the stream (Photo B10.2).
- Erosion of Slopes - The embankment slope above the culvert barrels appears to be eroding (Photos B10.1 and B10.2).

The existing water crossing was rated high risk as a barrier for fish passage (Appendix C).

Photo B10.1 BG-50 Culvert Inlet

Photo B10.2 BG-50 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B10.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the embankments with riprap to reduce the potential for embankment erosion.
- Line the ditches on the west and east sides of the Tote Toad with riprap to reduce the potential for erosion and sediment production.
- Install a ditch east of the Tote Road lined with riprap to convey snow stockpile runoff and reduce the potential for erosion and sediment production.

It is noted that the stream is estimated to be approximately 10 m wide. For installation requirements to allow for the four culvert barrels to fit within the stream bed it is recommended that the culvert barrels are spaced approximately 0.5 m apart.

If flowing water is observed during construction re-direct water to the main river channel to ensure a dry construction area.

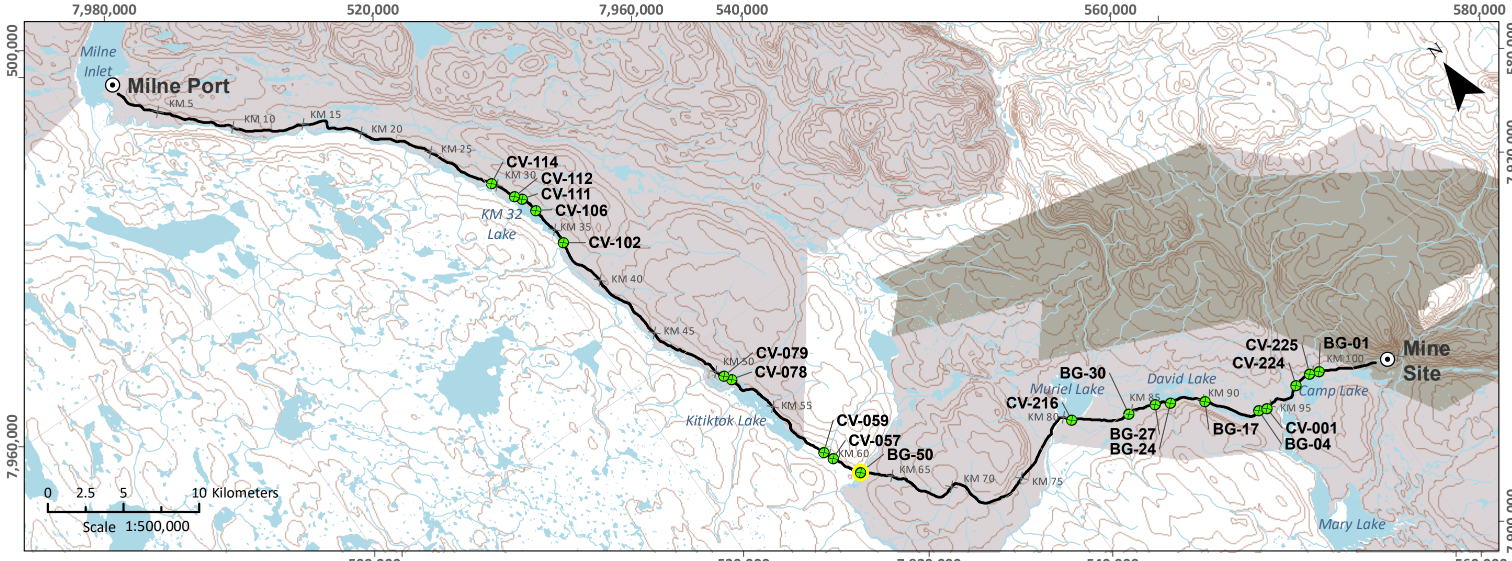
The above remediation measures will ensure the BG-50 water crossing meets the project design criteria.

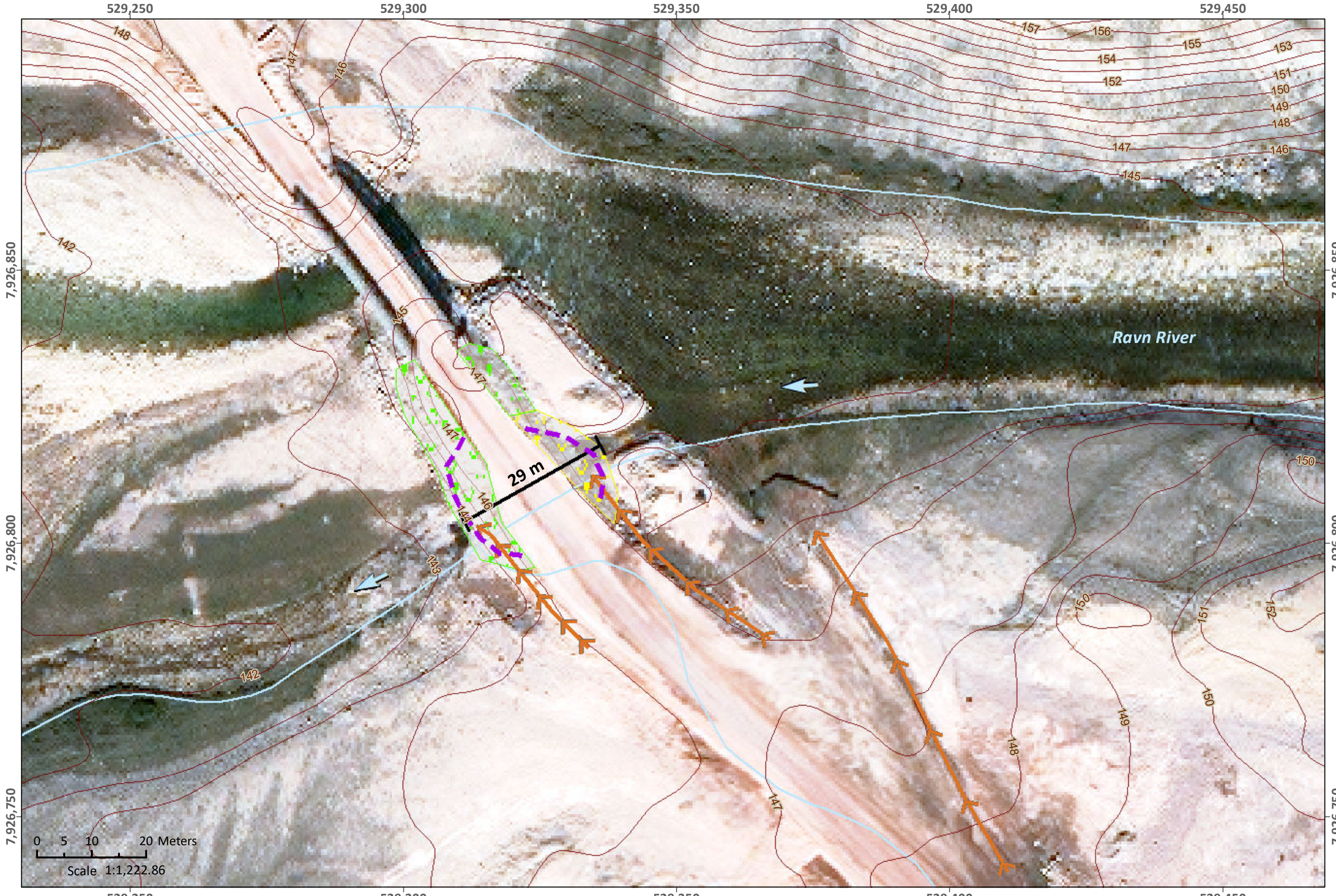
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B10.1. The plan and section of BG-50 is shown in Figure B10.2 attached.

Table B10.1 Culvert Sizing Details

Peak Flow (m^3/s)	25.68
Culvert diameter (mm)	1,800
Number of culvert barrels	4
Embeddedness	One-barrel embedded 40%
Culvert length (m)	29
Slope	0.24%
Minimum cover over barrels (mm)	900

The fish passage risk assessment rating decreases to low after implementation of the above remediation measures.





LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat

Riprap Armoured Slope
- Existing
- Proposed

Riprap Lined Ditch
- Existing
- Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. The culvert replacement will be completed in two stages to allow for continued use of the access road. Traffic control and barriers to follow the designated work plan.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

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Erosion and Sediment Control Plan
Site Specific Drawing - BG-50

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.
© 2022 Digital Globe, Inc. Imagery and Infrastructure are representative as of July 2022.

Baffinland

ᑎᑎᕋᐅᓯᖓ FIGURE B10.1

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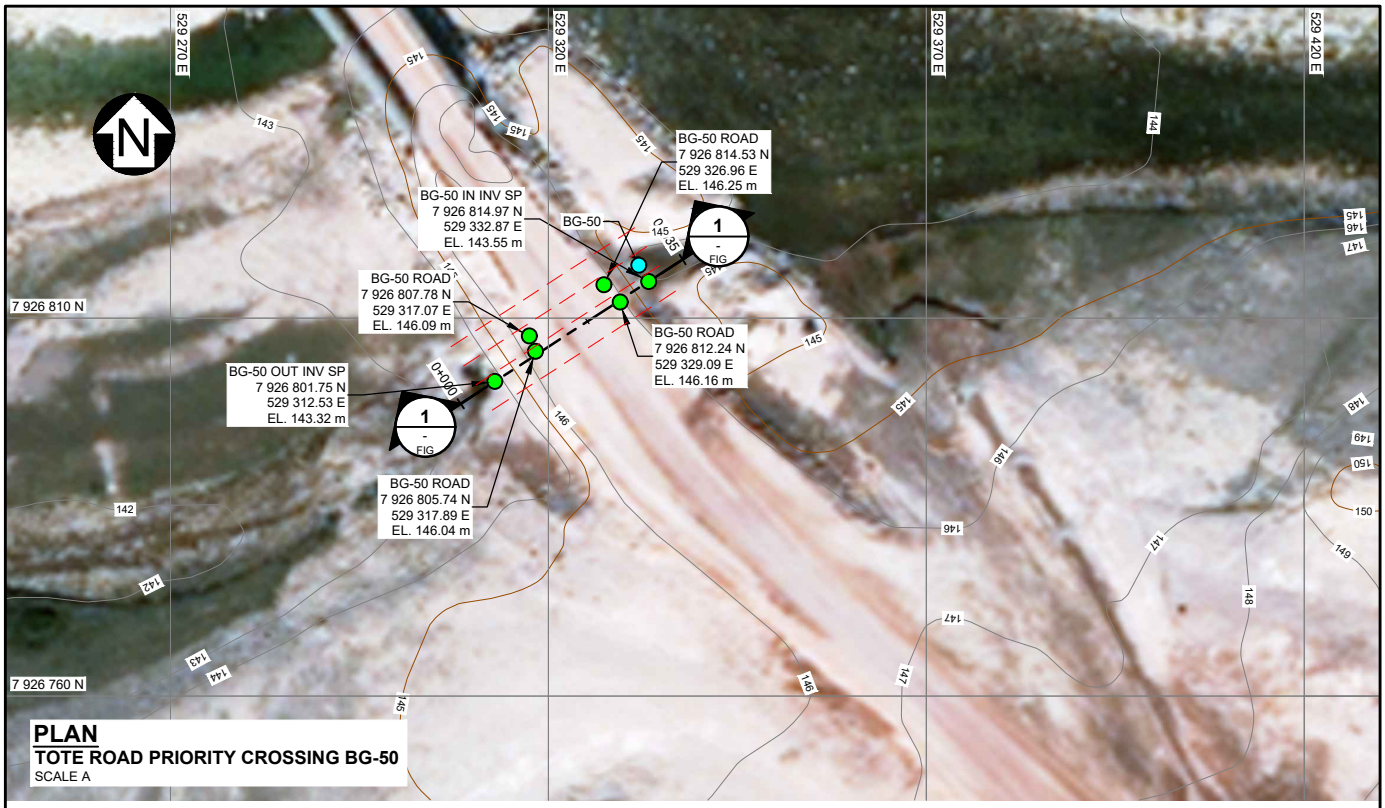
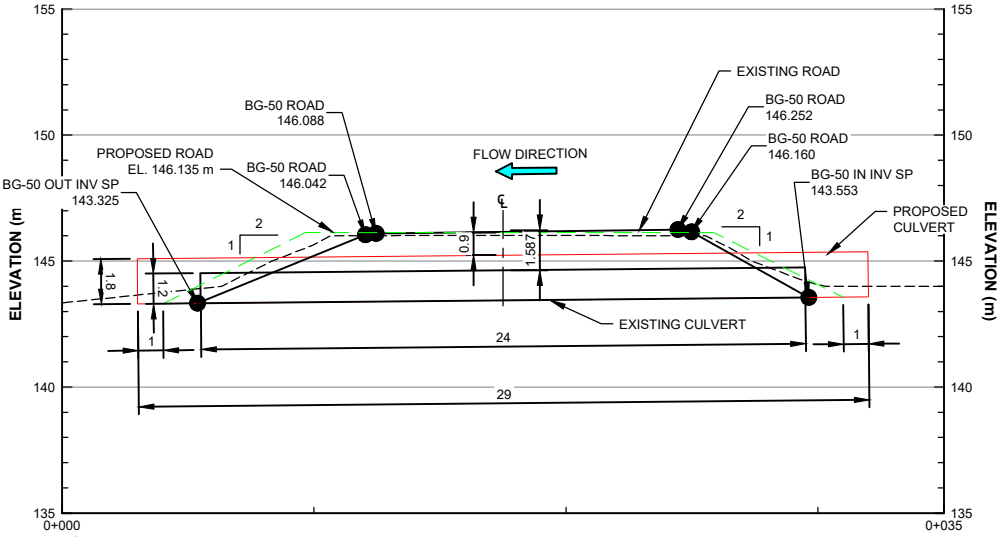


PLAN
TOTE ROAD PRIORITY CROSSING BG-50
SCALE A



1 - FIG
SECTION
TOTE ROAD PRIORITY CROSSING BG-50
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 3 1.5 0 5 10 15 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

BG-50
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/77	3

FIGURE B10.2 REV 0

APPENDIX B11

Crossing CV-216

(Pages B11-1 to B11-5)

APPENDIX B11
CROSSING CV-216

1.0 CURRENT CONDITIONS

The water crossing CV-216 is located at KM80.5 of the Milne Inlet Tote Road and contains three culvert barrels each approximately 1.2 m in diameter with an estimated contributing catchment area of approximately 24.76 km^2. Baffinland identified that the culverts were damaged during freshet or snow clearing activities in early 2021 in its initial remediation plan provided to the DFO (Baffinland 2022a, b). Repairs to the structure are required.

According to the 2021 survey by North/South Consultants Inc. (NSC) the stream flowing through the culvert is a 3rd order stream that flows into the southwest of Muriel Lake (Figure B11.1; NSC, 2021). The stream provides rearing/feeding habitat for small numbers of young of the year or 1+ year old Arctic Char, primarily downstream of the road crossing (NSC, 2021). Habitat upstream of the crossing is naturally very shallow (<0.05 m), sandy and provides little cover and is, therefore, less suitable for Char use. Ninespine Stickleback use habitat in the stream on both sides of the road for foraging and likely for spawning and are more abundant than Artic Char (NSC, 2021).

There are no identified fish barriers within this stream (Figure B11.1; NSC, 2021). During periods of low water there is a small perch at the downstream end of the main fish passage culvert that could prevent upstream movements of Stickleback and the small size classes of Char that use this stream.

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B11.1 (culvert inlet) and Photo B11.2 (culvert outlet):

- Damaged Culverts - The culvert barrels appear to be damaged and collapsing (Photo B11.1).
- Perched Culverts - Two of the culvert barrels are perched above the stream (Photo B11.1).
- Erosion of Slopes - The embankment slope above the culvert barrels appears to be eroding (Photo B11.1).
- Adequate Cover - The minimum cover for culvert shall be 600 mm, or as required by the differing specific design vehicle (Hatch, 2018) (Photo B11.2).

The existing water crossing was rated high risk result and was identified as a barrier to 88 mm Arctic Char passage. (Appendix C).

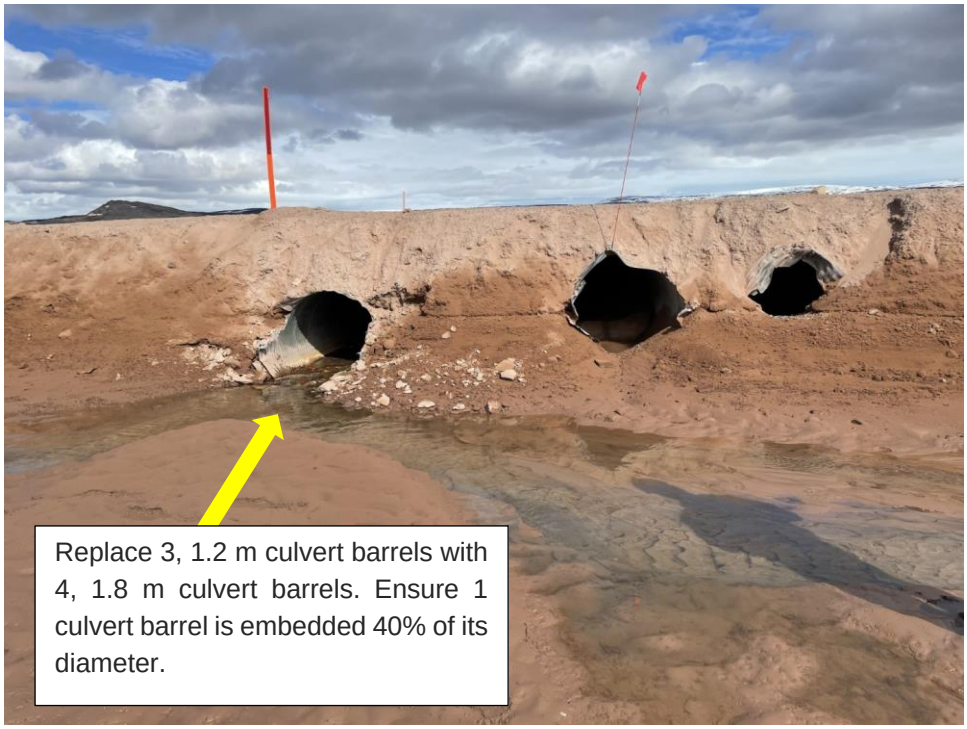


Photo B11.1 CV-216 Culvert Inlet

Photo B11.2 CV-216 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B11.1
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the embankments with riprap to reduce the potential for embankment erosion

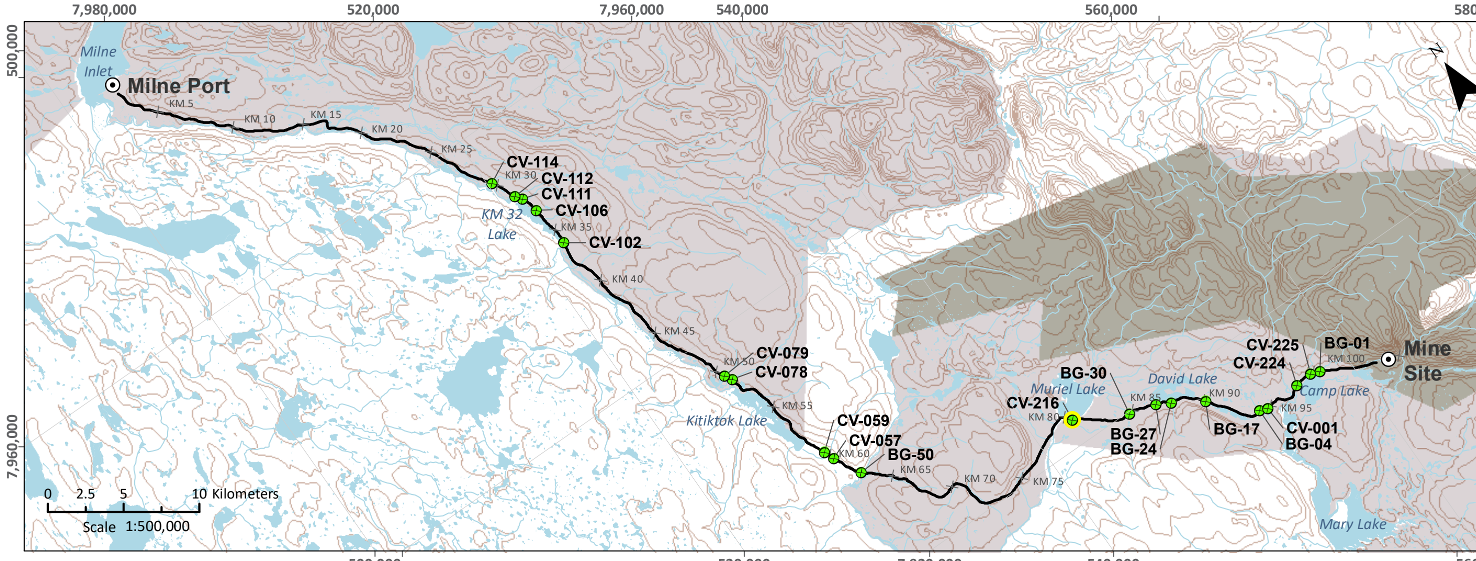
The above remediation measures will ensure the CV-216 water crossing meets the project design criteria.

The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B11.1. The plan and section of CV-216 is shown in Figure B11.2.

Table B11.1 Culvert Sizing Details

Peak Flow (m^3/s)	29.58
Culvert diameter (mm)	1,800
Number of culvert barrels	4
Culvert length (m)	29
Slope	1.46
Minimum cover over barrels (mm)	900

The fish passage risk assessment “High” fish barrier risk rating lowers to “Moderate” after implementation of the above remediation measures.



LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Riprap Inlet Pool
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat

Riprap Armoured Slope

- Existing
- Proposed

Riprap Lined Ditch

- Existing
- Proposed

Note

1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. The culvert replacement will be completed in two stages to allow for continued use of the access road. Traffic control and barriers to follow the designated work plan.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

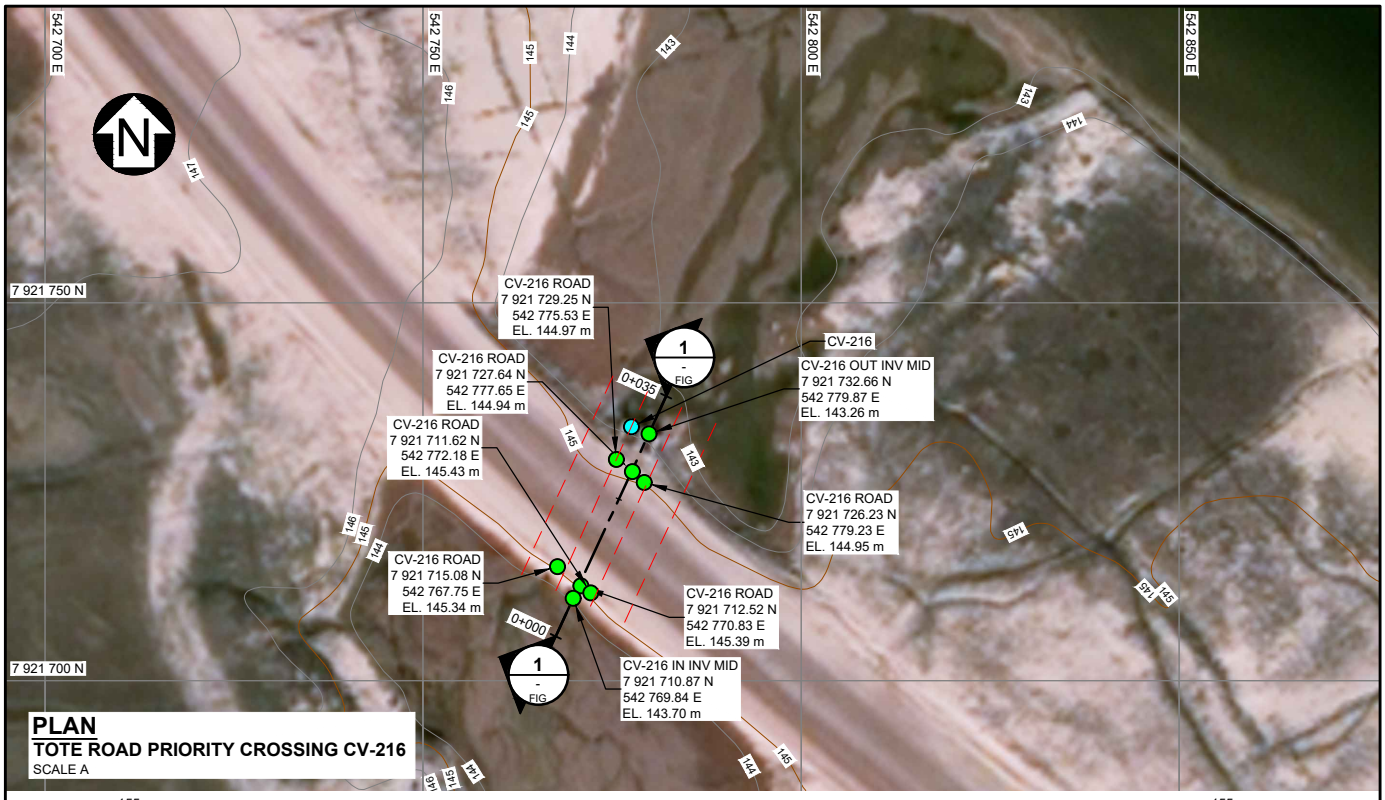
ᓄᓚᕐᓂ ᐅᑲᕐᓯᐅᕐᑦ MARY RIVER PROJECT

Erosion and Sediment Control Plan
Site Specific Drawing - CV-216

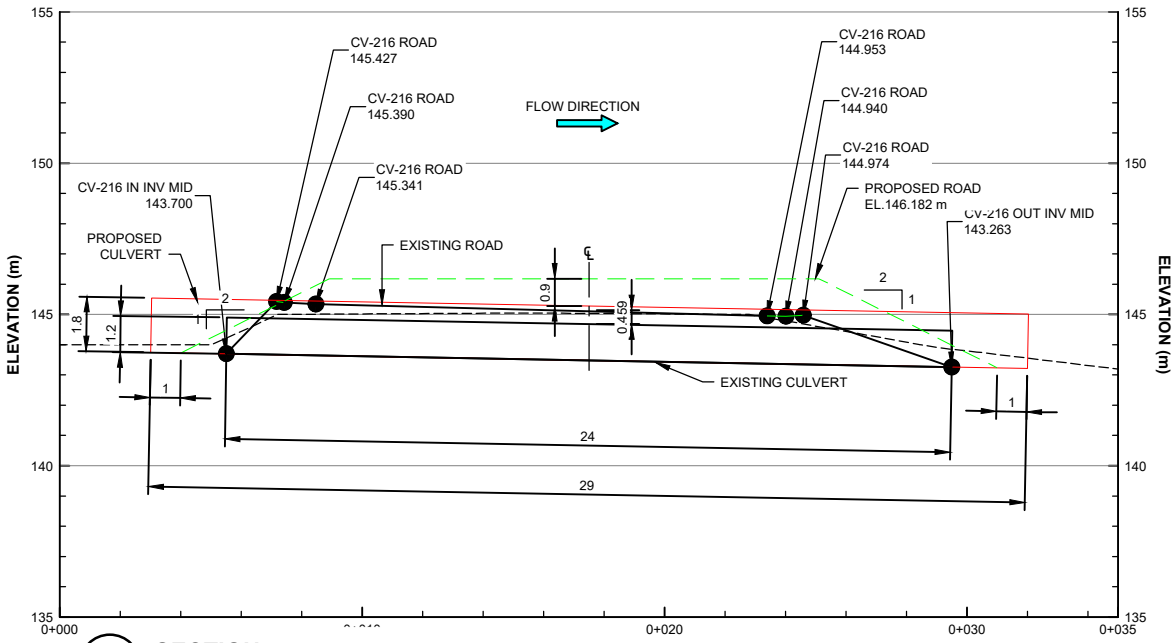
Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.

Baffinland

ᑎᑎᕋᐅᓯᐊᒃ FIGURE B11.1



PLAN
TOTE ROAD PRIORITY CROSSING CV-216
SCALE A



1 - FIG
SECTION
TOTE ROAD PRIORITY CROSSING CV-216
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 4 2 0 4 8 12 16 20 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CV-216
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO. NB102-181/77
REF NO. 3
FIGURE B11.2
REV 0

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APPENDIX B12

Crossing BG-30

(Pages B12-1 to B12-5)

APPENDIX B12
CROSSING BG-30

1.0 CURRENT CONDITIONS

The water crossing BG-30 is located at KM84.5 of the Milne Inlet Tote Road and contains one culvert barrel approximately 1 m in diameter with an estimated contributing catchment area of approximately 1.50 km^2. In September 2022, DFO identified that the culvert is partially caved in on the upstream side with a small tear on the downstream side of the culvert (DFO, 2022).

Based on information provided by North/South Consultants (NSC), the stream flowing through the culvert at BG-30 is a 2nd order stream that flows into another small stream approximately 70 m downstream from the culvert crossing (NSC, 2022). Approximately 130 m upstream from this confluence of the two streams there is another road crossing at BG-29 with a small, potential overwintering lake immediately upstream. This upstream lake has been surveyed for bathymetry and substrate and it has sufficient depth for Arctic Char overwintering and spawning (NSC, 2022).

The BG-30 stream provides open-water season rearing habitat for juvenile Arctic Char ranging in size from 50-175 mm (NSC, 2022). Ninespine Stickleback are uncommon and usually restricted to the lower reaches near the confluence with the BG-29 stream, which has more suitable habitat for the species (NSC, 2022).

Downstream from the Tote Road crossing, the BG-30 stream habitat is largely riffle/run/pool over cobble substrate (NSC, 2022). Immediately upstream from the road crossing is a large pond (20 x 75 m) with a maximum depth of >1 m and predominantly silt/organic substrate (NSC, 2022). Juvenile Char have been observed feeding on emerging insects at the surface of this pond every summer since monitoring began in 2010 (NSC, 2022). Upstream from the pond is primarily low velocity riffle/pool stream habitat that flows alongside the Tote Road. Approximately 1.2 km upstream from the Tote Road is another small pond with no surface water inflows (NSC, 2022).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B12.1 (culvert inlet) and Photo B12.2 (culvert outlet) identifying the inlet and outlet of the culvert respectively.

- Damaged Culvert - The culvert is damaged and beginning to collapse (Photos B12.1 and B12.2).
- Erosion of Slopes - The embankment slopes above the culvert appears to be eroding (Photos B12.1 and B12.2).
- Perched Culvert - A slight perch is present at the downstream end of the culvert (Photo B12.2).

The existing water crossing was rated high risk for potential to be a barrier to fish movement (Appendix C).

Photo B12.1 BG-30 Culvert Inlet

Photo B12.2 BG-30 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B12.1.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the embankments with riprap to reduce the potential for embankment erosion.

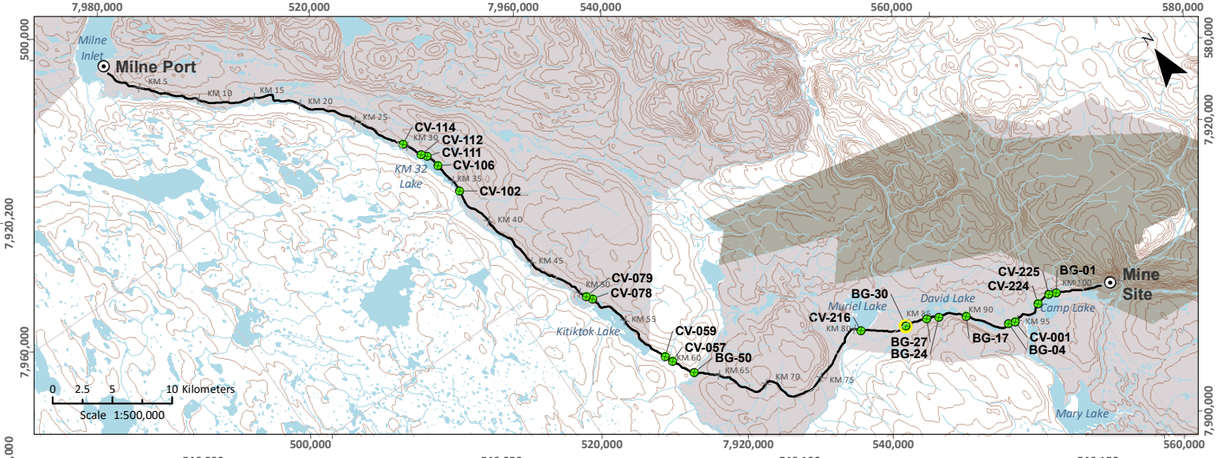
The above remediation measures will ensure the BG-30 water crossing meets the project design criteria.

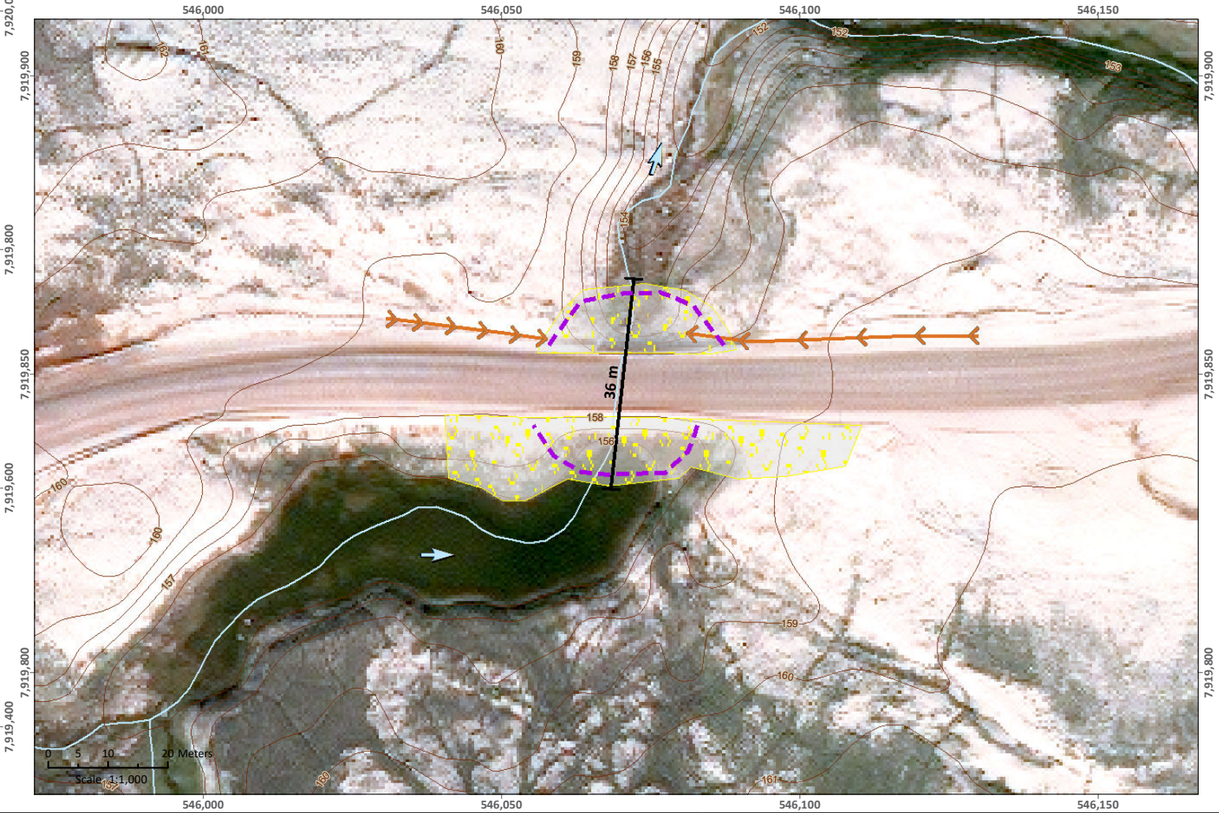
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B12.1. The plan and section of BG-30 Is shown in Figure B12.2.

Table B12.1 Culvert Sizing Details

Peak Flow (m^3/s)	3.14
Culvert Diameter (mm)	1,200
Number of culvert barrels	2
Embeddedness	One-barrel embedded 40%
Culvert Length (m)	36
Slope	0.88%
Minimum cover over barrels (mm)	600

The fish passage risk assessment high fish barrier risk rating decreases to a moderate fish passage risk assessment rating after implementation of the above remediation measures.





LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat
- **Riprap Armoured Slope**
  - Existing
  - Proposed
- **Riprap Lined Ditch**
  - Existing
  - Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

MARY RIVER PROJECT

Erosion and Sediment Control Plan
Site Specific Drawing - BG-30

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.

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FIGURE B12.1

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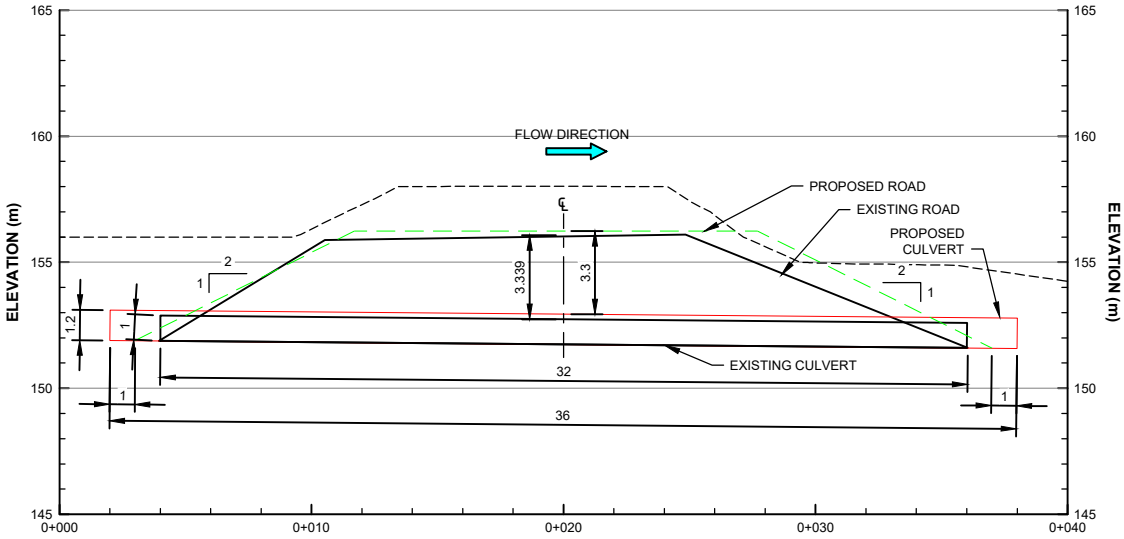
PLAN
TOTE ROAD PRIORITY CROSSING BG-30
SCALE A



1 - FIG
SECTION
TOTE ROAD PRIORITY CROSSING BG-30
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 15 7.5 0 25 50 75 m
SCALE B: 5 2.5 0 5 10 15 20 25 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

BG-30
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/77	3

FIGURE B12.2 REV 0

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APPENDIX B13

Crossing BG-27

(Pages B13-1 to B13-5)

APPENDIX B13
CROSSING BG-27

1.0 CURRENT CONDITIONS

The water crossing BG-27 is located at KM86.5 of the Milne Inlet Tote Road and contains three culvert barrels each approximately 0.5 m in diameter with an estimated contributing catchment area of approximately of 0.66 km^2. Baffinland identified that the culverts are damaged and partially buried with sloughing road material in its initial remediation plan provided to the DFO (Baffinland, 2022a, b).

According to the 2021 survey by North/South Consultants Inc. (NSC) the stream flowing through the culvert is a 2nd order stream that drains 50 m north from the road crossing to David Lake, which is the nearest potential overwintering lake (Figure B13.1; NSC, 2021). The stream provides rearing and feeding habitat for juvenile, land-locked Arctic Char from 30-170 mm (NSC, 2021). Habitat transitions from riffle-pool downstream of the road to higher velocity cascade-pool upstream from the road, so the smaller size classes (<100 mm) of char are naturally more common in the lower reaches of this stream. Ninespine Stickleback appear to be absent from the stream as they have never been captured since monitoring began (NSC, 2021).

There is a permanent barrier 465 m upstream of the road where the water flows out of a rocky hillside (Figure B13.1). There are additional intermittent barriers upstream from the road that consist of small vertical drops that may be difficult for even the larger juveniles to pass during periods of high flows when water velocity over the drops can exceed 1.0 m/s.

2.0 IDENTIFIED ISSUES

KP Identified the following issues with this crossing shown on Photo B13.1 (culvert inlet) and Photo B13.2 (culvert outlet):

- Damaged Culvert - The central culvert is damaged and collapsing (Photo B13.1).
- Plugged with Sediment - The right culvert is fully plugged with sediment due to erosion of the embankment material (Photo B13.1).
- Erosion of Slope - The steep embankment slope may contribute to continued erosion and the possibility of the remaining two culvert barrels being plugged (Photo B13.1 and Photo B13.2).
- Minimum Diameter - The culvert barrels have a diameter of 0.5 m. The minimum culvert diameter for fish bearing streams is 1 m (Hatch, 2018) (Photo B13.1 and Photo B13.2).
- Adequate Cover - Cover over the culverts is approximately 0.4 m. The minimum cover for culverts shall be 600 mm, or as required by the differing specific design vehicle (Hatch, 2018) (Photo B13.1).

The existing water crossing was rate high risk result as a barrier for fish passage (Appendix C).

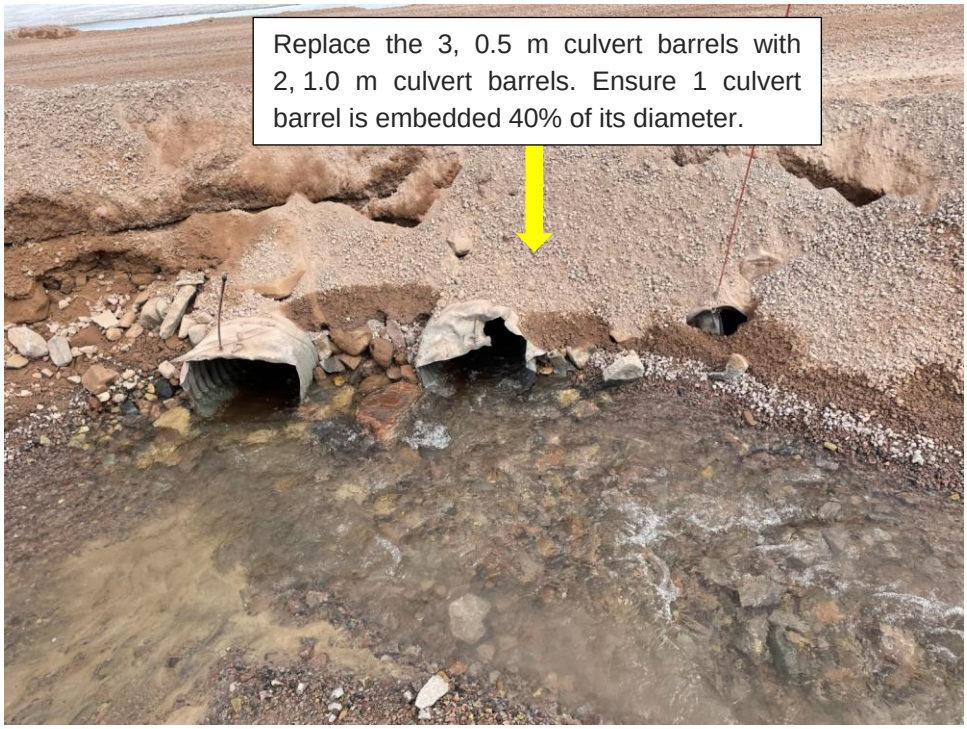


Photo B13.1 BG-27 Culvert Inlet

Photo B13.2 BG-27 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B13.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- The road at this location is narrow and should be widened for safety reasons. As such, the proposed culvert length is based on widening the road surface to achieve the nominal 15 m road width.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the embankments with riprap to reduce the potential for embankment erosion.
- Line the ditches to the south and north of the tote road with riprap to reduce the potential for erosion and sediment production.

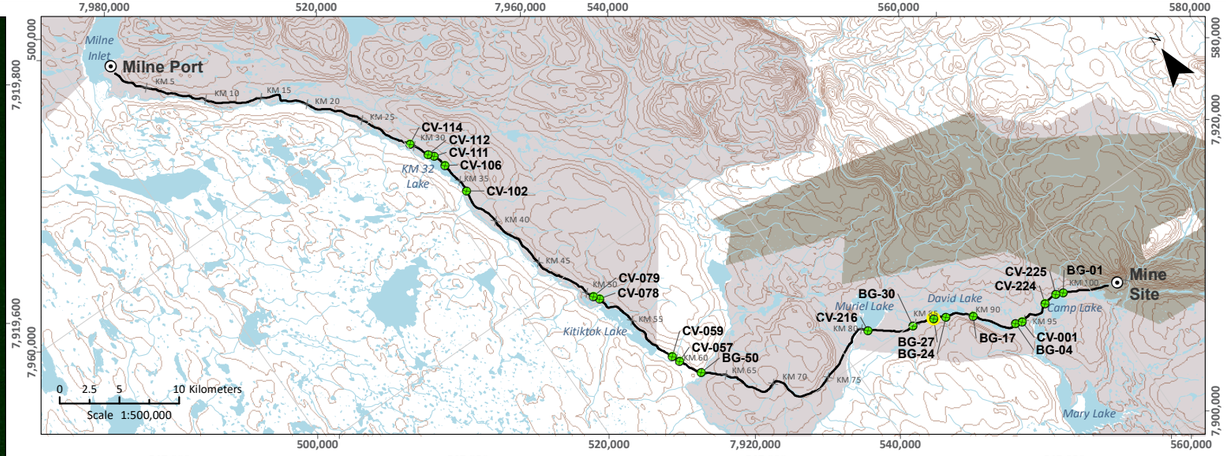
The above remediation measures will ensure the BG-27 water crossing meets the project design criteria.

The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B13.1. The plan and section of BG-27 is shown on Figure B13.2.

Table B13.1 Culvert Sizing Details

Peak Flow (m^3/s)	1.64
Culvert diameter (mm)	1,000
Number of culvert barrels	2
Embeddedness	One-barrel embedded 40%
Culvert Length (m)	24
Slope	6.03%
Minimum cover over barrels (mm)	600

The proposed remediation plan will improve fish passage and decrease the fish passage risk assessment rating of “High” to “Low”.



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LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat
- **Riprap Armoured Slope**: Existing, Proposed
- **Riprap Lined Ditch**: Existing, Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. A temporary road closure will be constructed while the work is being completed on this culvert location.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

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Erosion and Sediment Control Plan
Site Specific Drawing - BG-27

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.

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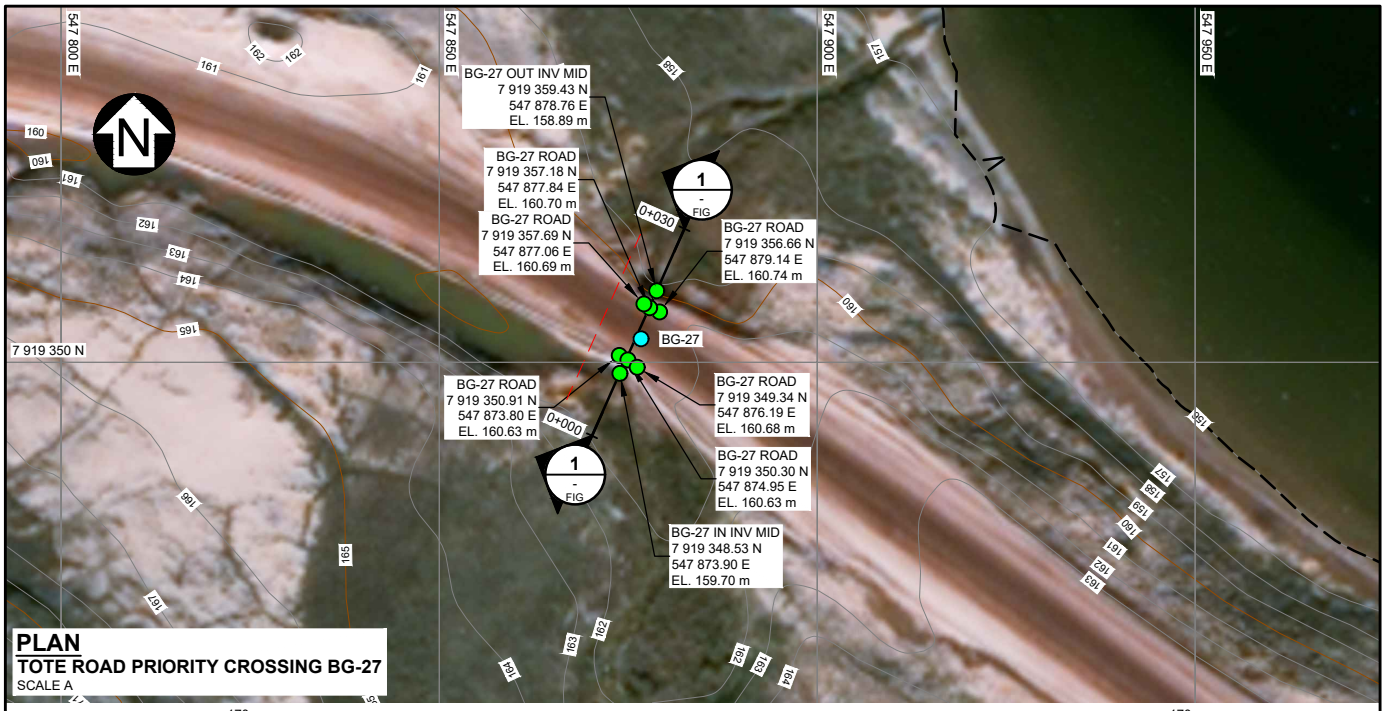
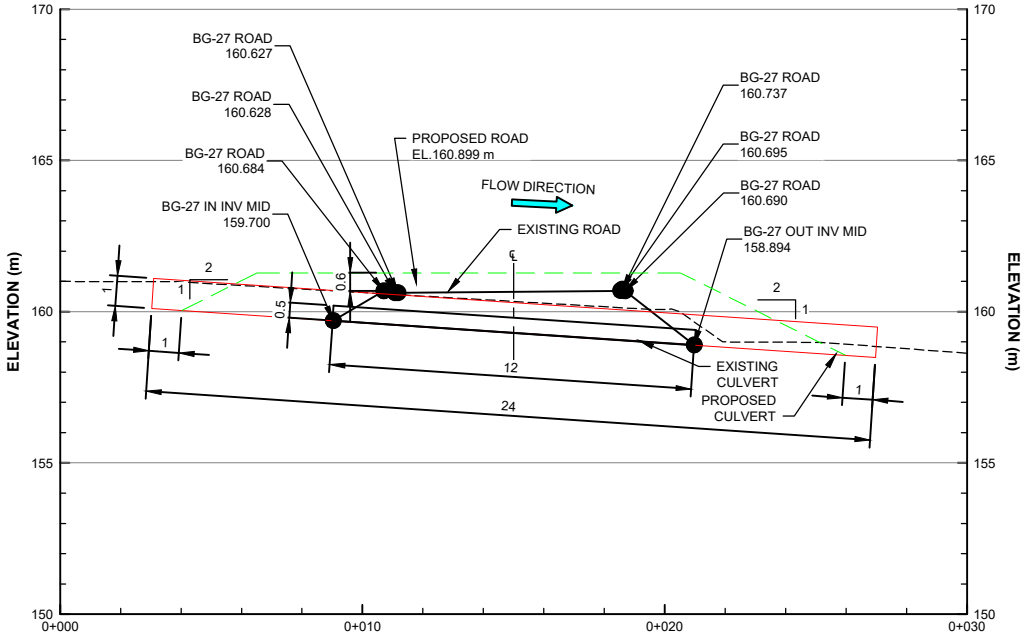
ᑎᑎᕋᐅᓯᖏᓐᓄᑦ FIGURE **B13.1**



PLAN
TOTE ROAD PRIORITY CROSSING BG-27
SCALE A



1 - FIG **SECTION**
TOTE ROAD PRIORITY CROSSING BG-27
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 2.5 1.25 0 2.5 5 7.5 10 12.5 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

BG-27
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO. NB102-181/77 | REF NO. 3

FIGURE B13.2 | REV 0

APPENDIX B14

Crossing BG-24

(Pages B14-1 to B14-6)

APPENDIX B14
CROSSING BG-24

1.0 CURRENT CONDITIONS

The water crossing BG-24 is located at KM87.5 of the Milne Inlet Tote Road and contains four culvert barrels approximately 1.2 m in diameter with an estimated contributing catchment area of approximately 5.99 km^2. In September 2022, DFO identified upstream and downstream culverts tears and frozen culverts identified on the downstream side (DFO, 2022).

Based on information provided by North/South Consultants (NSC), the stream flowing through the culvert at BG-24 is a 3rd order stream that flows into the west end of David Lake approximately 110 m downstream (NSC, 2022). The stream provides abundant open-water season rearing habitat for large numbers of juvenile Arctic Char ranging in size from 40-230 mm. The lower reaches occasionally have sufficient depth for potential adult use; a char 378 mm in length was captured in 2008 (NSC, 2022). Any adult use of this stream would be restricted to foraging as the stream freezes completely during winter. Ninespine Stickleback have never been captured in this stream, though they are known to occur in other tributaries of David Lake. It is thought that the typical velocities and substrates found in this stream are unsuitable for the species.

The stream typically has low to moderate depths (0.05-0.20 m) and moderate to high velocities (0.15-0.90 m/s) throughout most of its length and habitat is largely riffle/run over cobble/gravel substrate. However, naturally higher water velocities and small vertical drops in the upstream reaches of this watershed may restrict habitat use upstream of the culverts to juveniles larger than 200 mm. Upstream from the Tote Road there are two branches to this stream, both of which have permanent barriers approximately 500-600 m upstream from the road where the water flows out of a rocky hillside.

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B14.1 (culvert inlet) and Photo B14.2 (culvert outlet):

- Perched culvert - Based on the DFOs September 2022, a culvert perch of approximately 0.6 m is present (Photo B14.2).
- Damaged culverts - The culvert barrels appear to be damaged (Photo B14.1 and Photo B14.2)
- Erosion of Slope - The embankment slope is steep and contains fines leading to erosion of the embankment slope (Photo B14.1)

The existing water crossing at BG-24 was rated high risk as a potential barrier for fish movement (Appendix C).

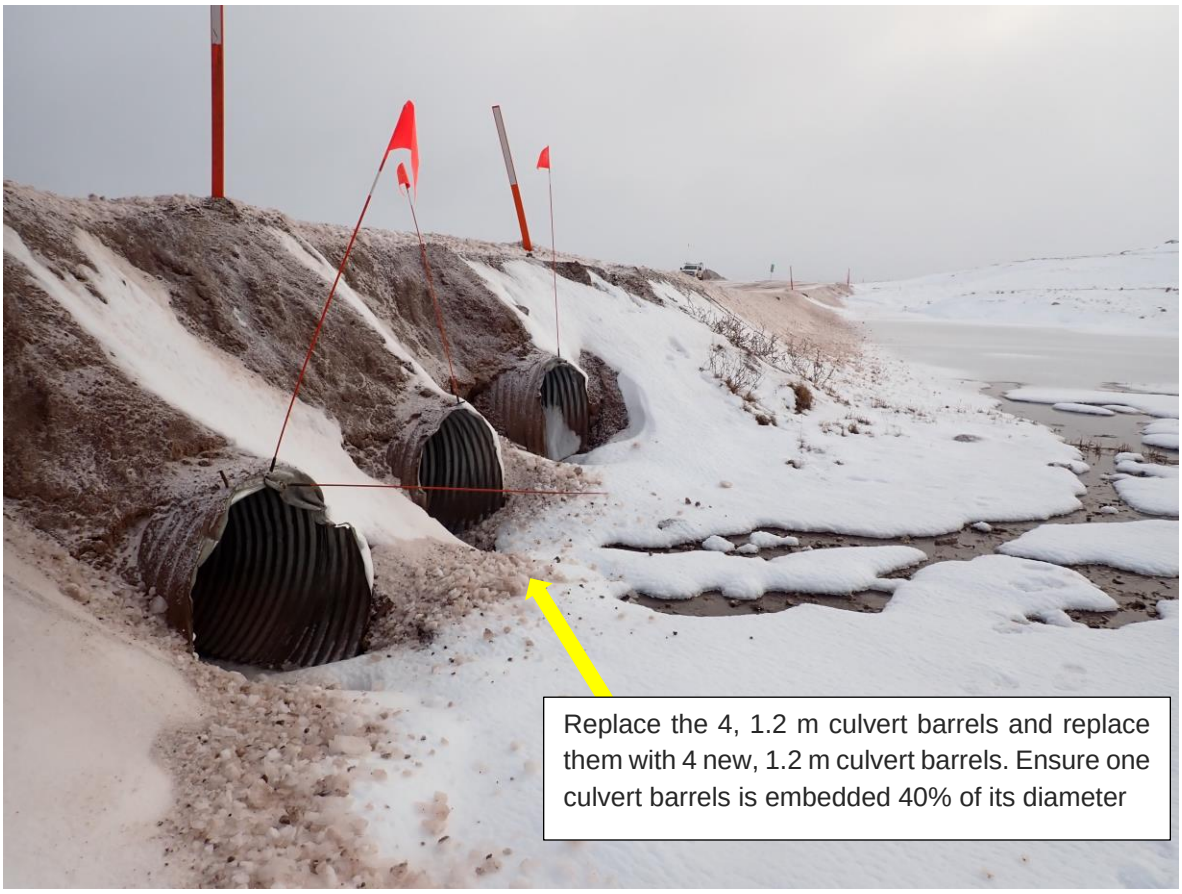


Photo B14.1 BG-24 Culvert Inlet

Photo B14.2 BG-24 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B14.1
- Lengthen the culvert to allow for a 2H:1V downstream embankment side slope to reduce the potential for downstream embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the downstream embankment with riprap to reduce the potential for embankment erosion.

- Line the ditch to the north of the tote road with riprap to reduce the potential for erosion and sediment production.
- Armour the two slopes as indicated on Figure B14.1 with riprap to stabilize the slopes.

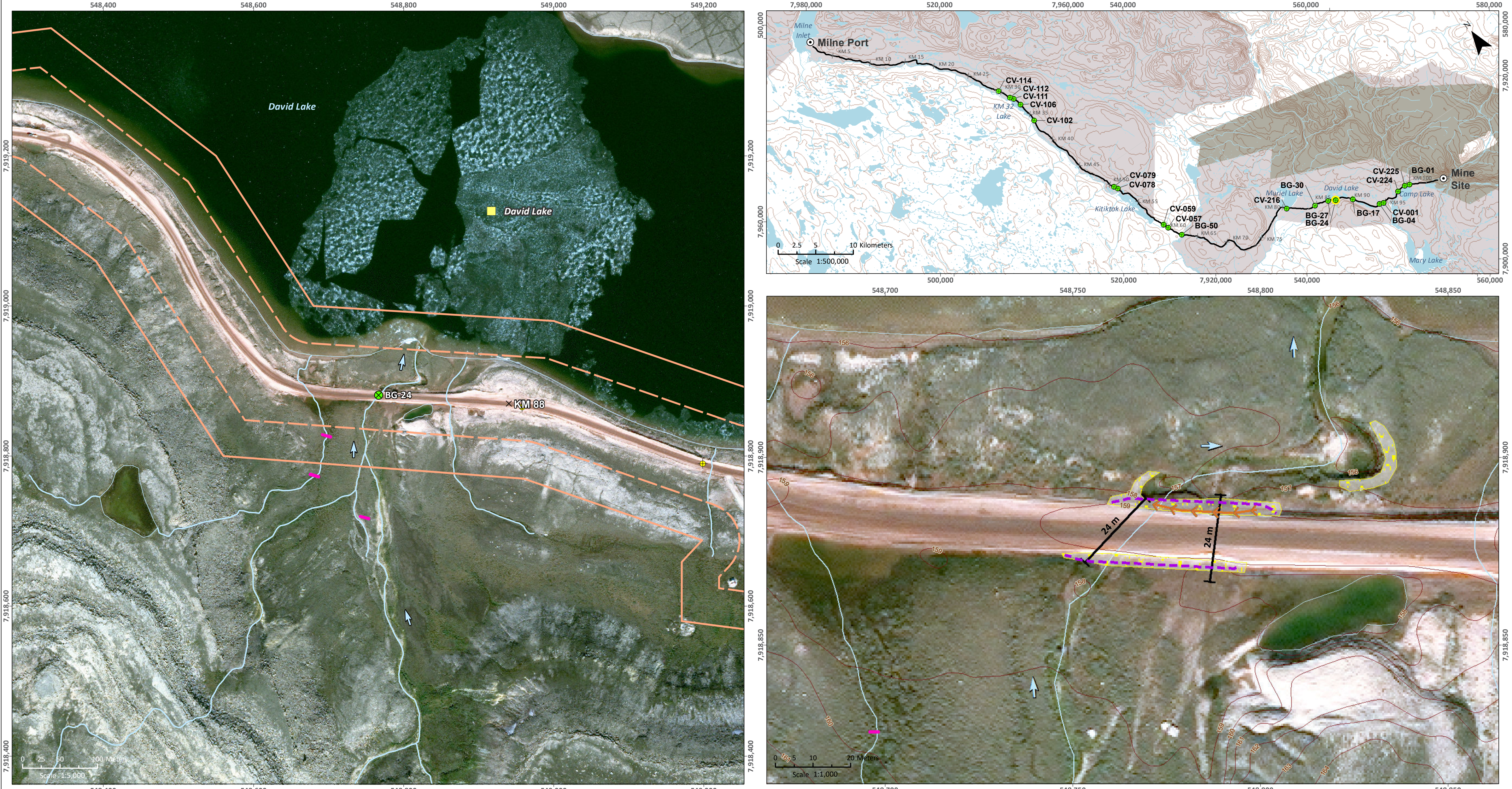
The above remediation measures will ensure the BG-24 water crossing meets the project design criteria.

The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B14.1. The plan and section of BG-24 is shown on Figure B14.2.

Table B14.1 Culvert Sizing Details

Peak Flow (m^3/s)	9.51
Culvert diameter (mm)	1,200
Number of culvert barrels	4
Embeddedness	One-barrel embedded 40%
Culvert length (m)	22
Slope	3.55%
Minimum cover over barrels (mm)	600

The fish passage risk assessment fish barrier risk rating of high decreases to moderate after implementation of the above remediation measures.



LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat

Riprap Armoured Slope
- Existing
- Proposed

Riprap Lined Ditch
- Existing
- Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

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Erosion and Sediment Control Plan
Site Specific Drawing - BG-24

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.
© 2022 Digital Globe, Inc. Imagery and Infrastructure are representative as of July 2022.

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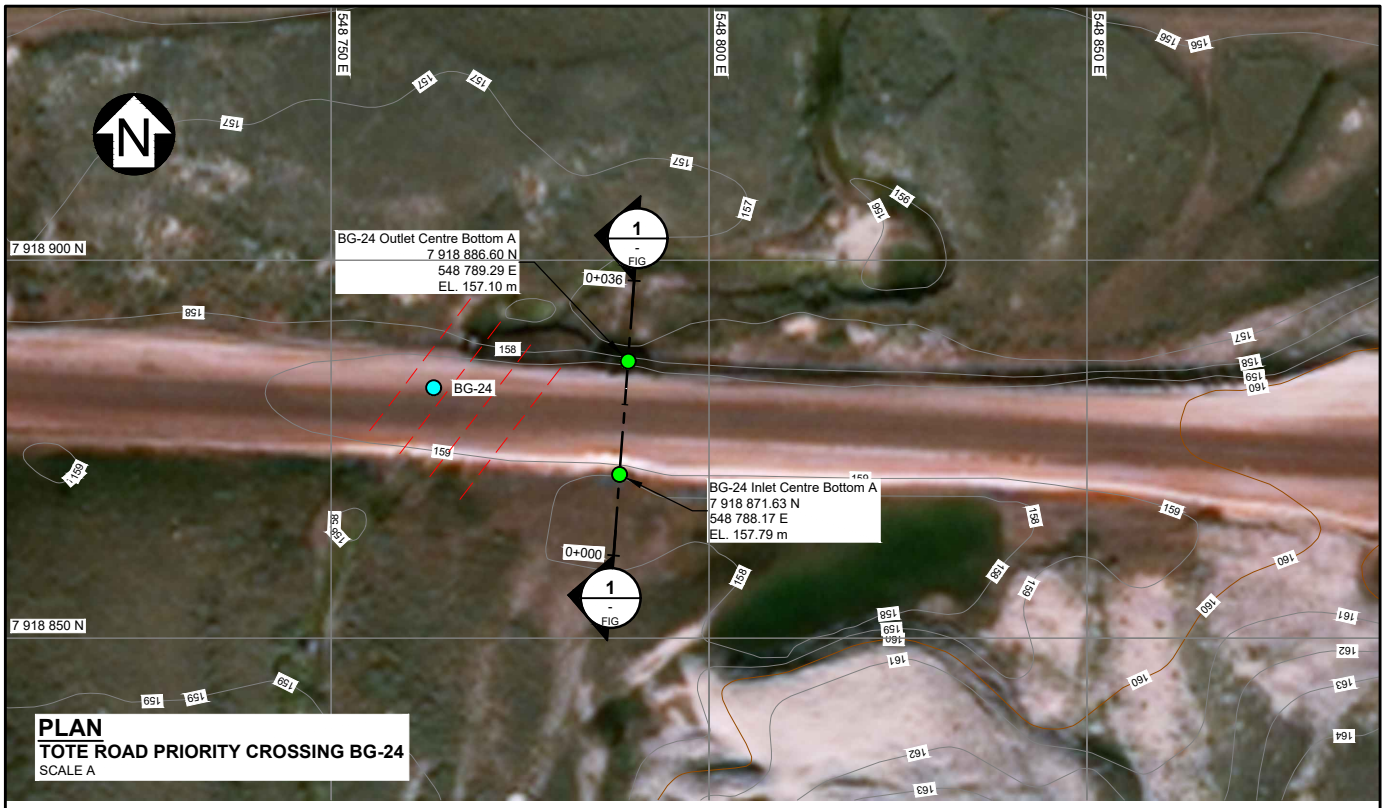
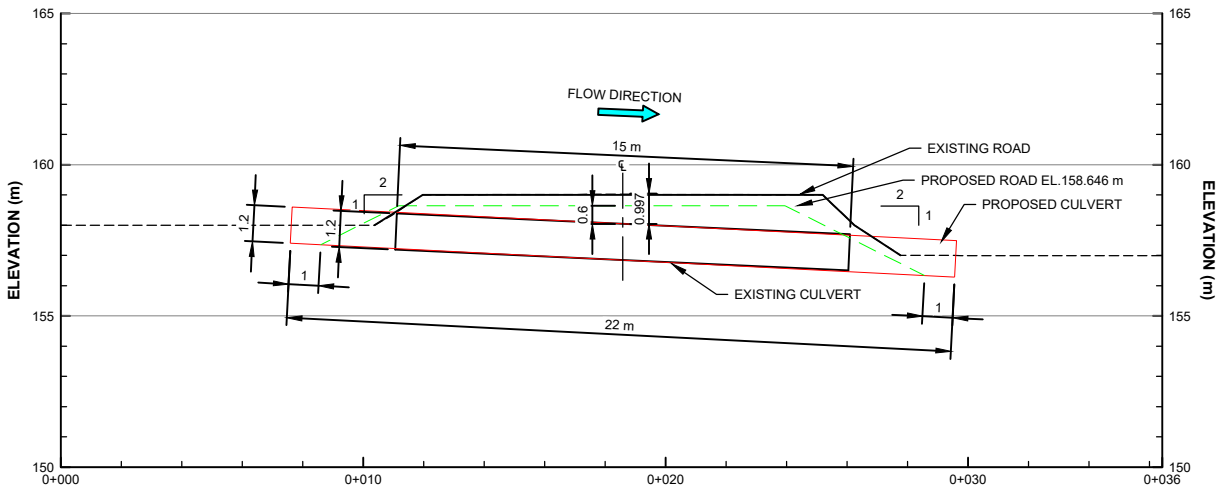
ᑎᑎᕋᒃᓯᒪᔪᖅ FIGURE B14.1



PLAN
TOTE ROAD PRIORITY CROSSING BG-24
SCALE A



1 - FIG

SECTION
TOTE ROAD PRIORITY CROSSING BG-24
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 2.5 1.25 0 2.5 5 7.5 10 12.5 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

BG-24
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO. NB102-181/77
REF NO. 3
FIGURE B14.2
REV 0

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APPENDIX B15

Crossing BG-17

(Pages B15-1 to B15-6)

APPENDIX B15
CROSSING BG-17

1.0 CURRENT CONDITIONS

The water crossing BG-17 A/B is located at KM90 of the Milne Inlet Tote Road and contains two culvert barrels each approximately 1.0 m in diameter (BG17A) and 1 culvert barrel approximately 2.0 m in diameter (BG17B) with an estimated contributing catchment area of approximately of 17.03 km^2. Baffinland identified that the culverts are damaged and steep embankments are contributing to erosion issues in its initial remediation plan provided to the DFO (Baffinland, 2022a, b).

According to the 2021 survey by North/South Consultants Inc. (NSC) the stream flowing through the culvert is a 3rd order stream that flows northwest from an unnamed lake to David Lake (Figure B15.1; NSC, 2021). Both are potential overwintering lakes, and both are approximately 900 m from the road crossing. The stream provides abundant rearing and feeding habitat for large numbers of both juvenile, land-locked Arctic Char (30 mm to 250 mm) and Ninespine Stickleback (40 mm to 70 mm) (NSC, 2021). The stream may also serve as a movement corridor for some fish between the two lakes (NSC, 2021). Ninespine Stickleback may also use the stream habitat for spawning as there is suitable habitat for nest building (NSC, 2021). There are several smaller tributaries that flow into this stream from hills on either side, but none of these provide fish habitat due to several permanent barriers (Figure B15.1).

Natural habitat in the stream is generally low velocity pool/run with a mixture of fine and coarse substrates and abundant cover. There were no barriers to fish movement identified between this crossing and upstream or downstream lakes (NSC, 2021). Water velocity at the culvert outlet can be higher than natural stream habitat, but it does not appear to affect upstream movements of the juvenile char using this stream for rearing. No fish passage issues at the water crossing were identified in 2021 (NSC, 2021).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B15.1 (culvert inlet), Photo B15.2 (culvert outlet) and Photo B15.3 (upstream embankment):

- Damaged Culverts - The two culvert barrels appear to be damaged and are perched above the stream (Photo B15.1).
- Erosion of Slopes - Erosion is occurring on the embankment slopes above and adjacent to the culvert barrels and due to the presence of fine material and steep embankment slopes (Photos B15.1 and B15.3).
- Perched Culverts - The perched culverts in Photo B15.1 are also perched and damaged in Photo B15.2.

The water crossing at BG-17 was rated high risk as a barrier for fish passage (Appendix C).

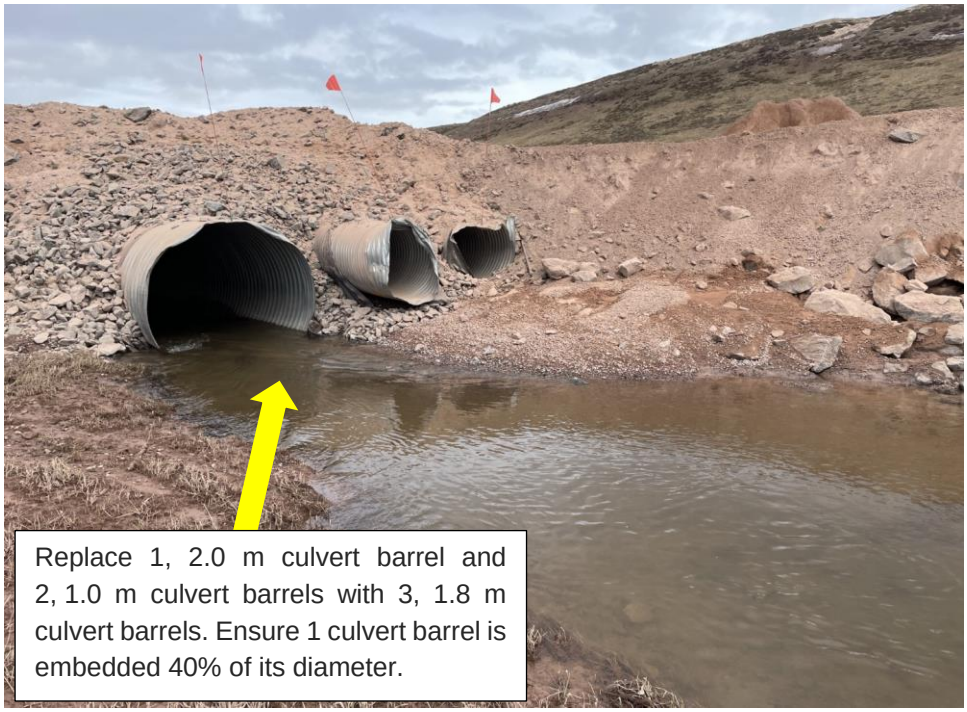


Photo B15.1 BG-17 Culvert Inlet

Photo B15.2 BG-17 Culvert Outlet

Photo B15.3 BG-17 Culvert Downstream Bank Erosion

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified In Table B15.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the downstream embankment with riprap to reduce the potential for embankment erosion.
- Line the ditches to the north and south of the tote road with riprap to reduce the potential for erosion and sediment production.

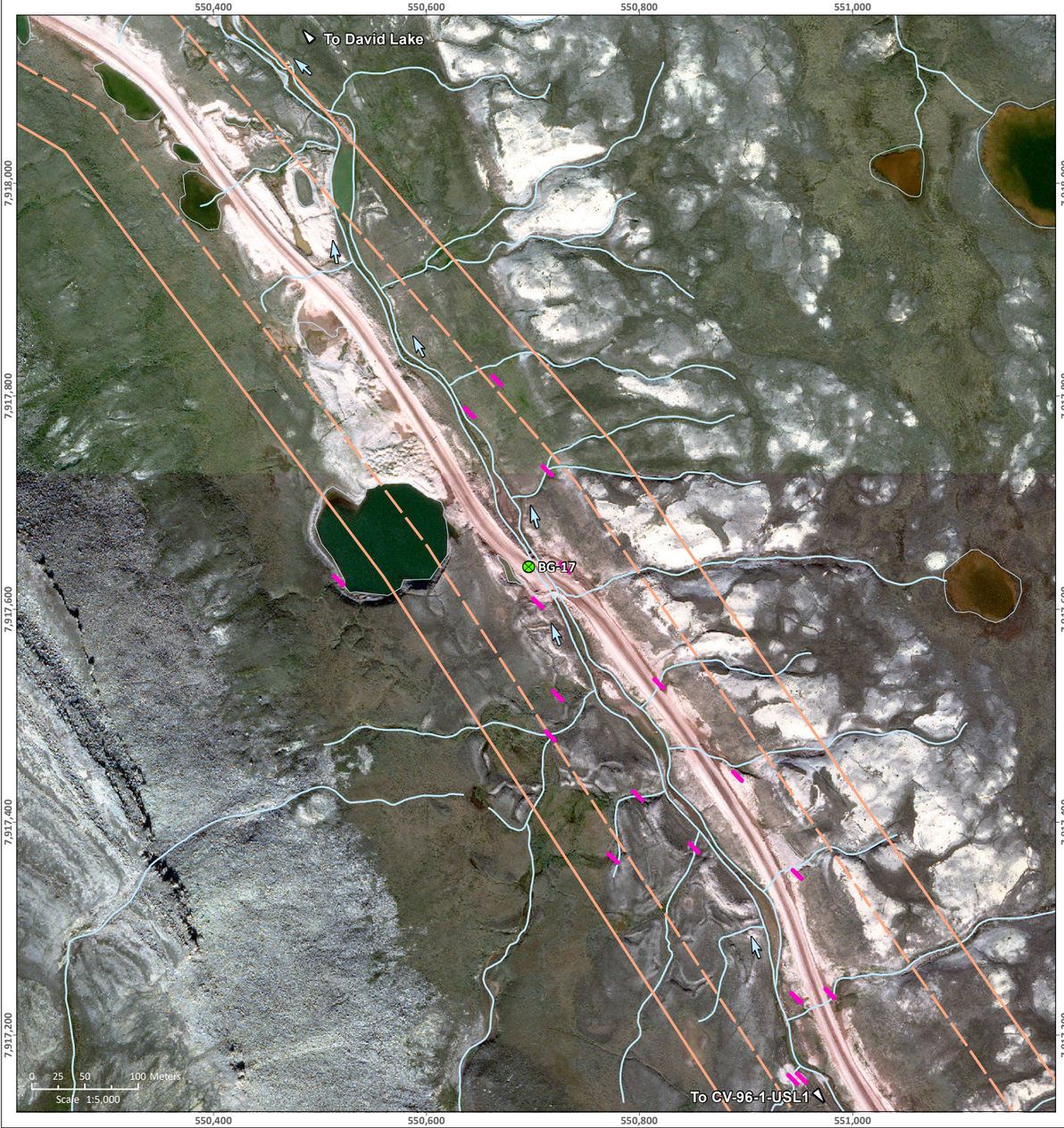
The above remediation measures will ensure the BG-17 water crossing meets the project design criteria.

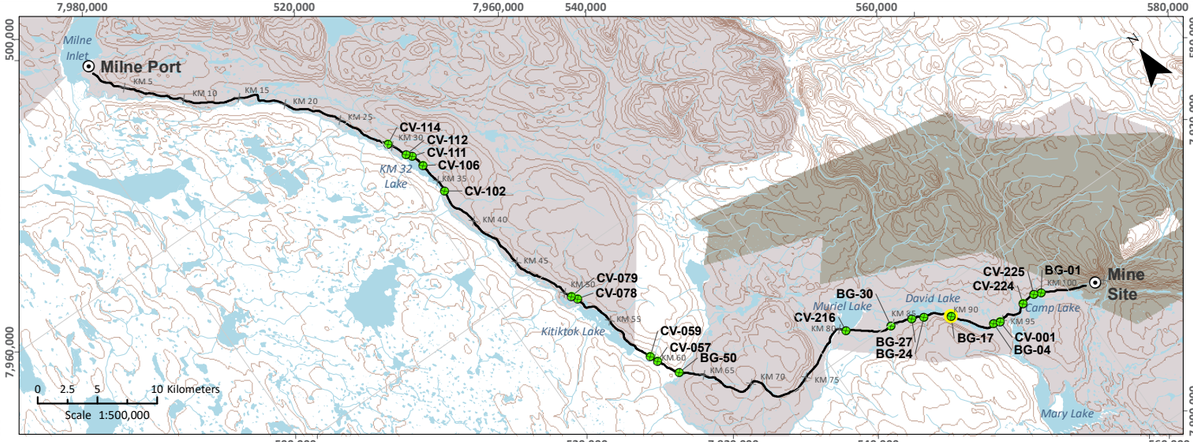
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B15.1. The plan and section of BG-17 is shown in Figure B15.2.

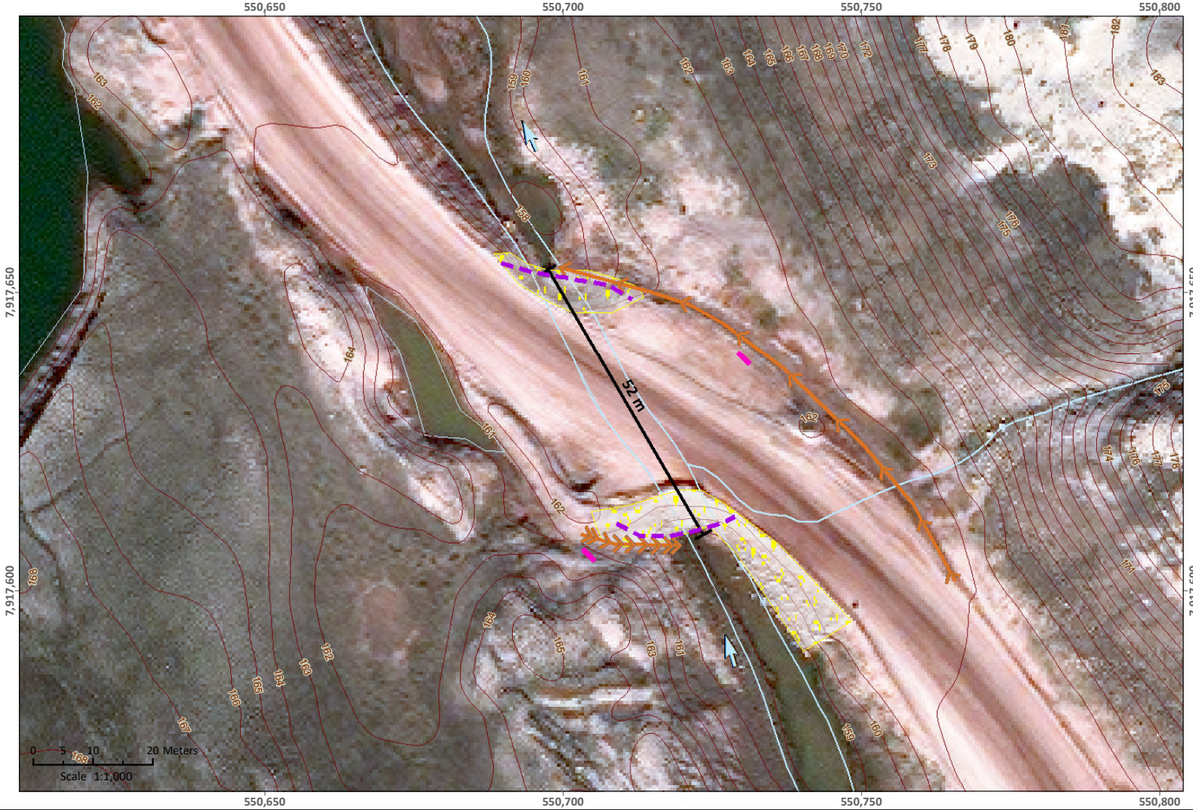
Table B15.1 Culvert Sizing Details

Peak Flow (m^3/s)	21.93
Culvert Diameter (mm)	1,800
Number of Culvert Barrels	3
Embeddedness	One-barrel embedded 40%
Culvert Length	52
Slope	0.54
Minimum Cover over Barrels (mm)	900

The above remediation measures will improve the fish passage risk rating to moderate at water crossing BG-17.







LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- **Riprap Armoured Slope**: Existing, Proposed
- **Riprap Lined Ditch**: Existing, Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. The culvert replacement will be completed in two stages to allow for continued use of the access road. Traffic control and barriers to follow the designated work plan.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

MARY RIVER PROJECT

Erosion and Sediment Control Plan
Site Specific Drawing - BG-17

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.

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FIGURE B15.1

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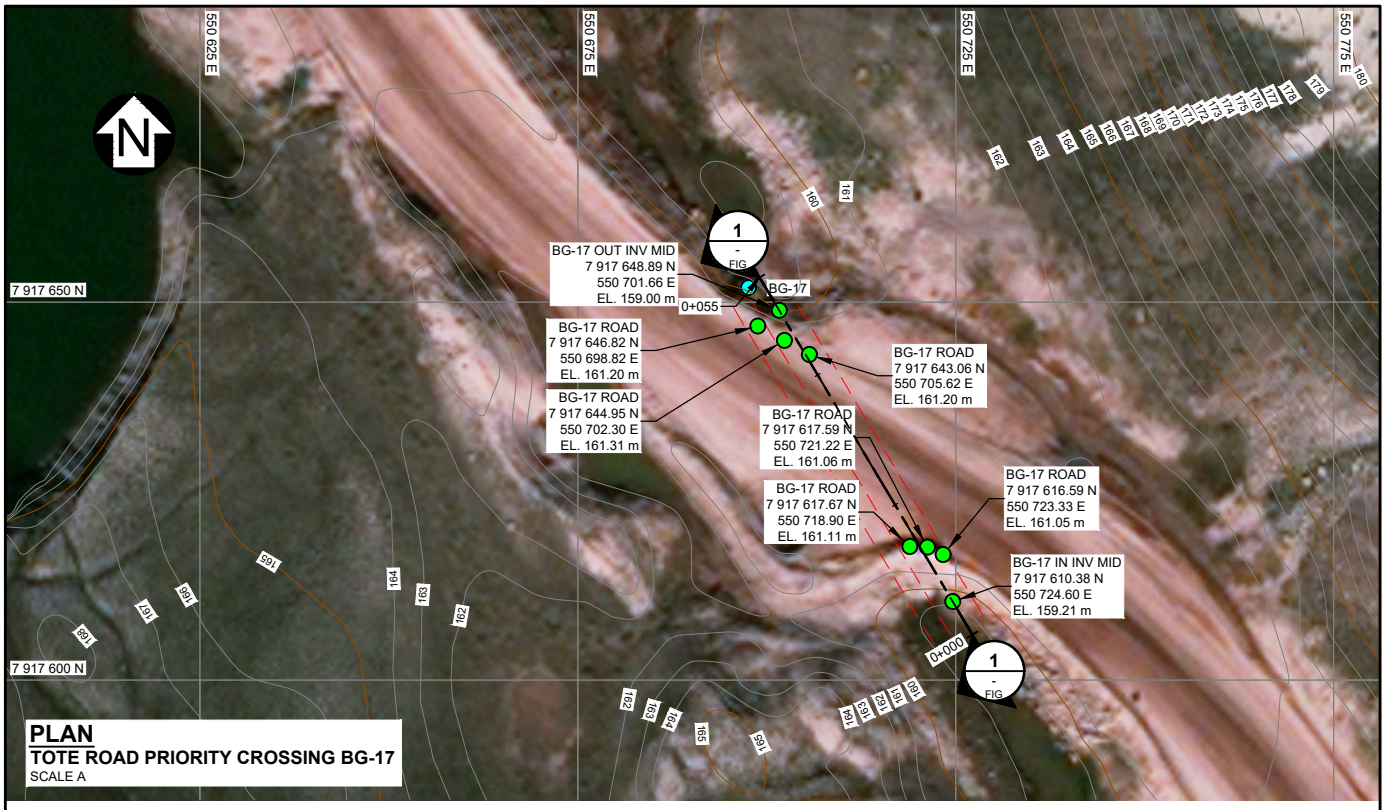
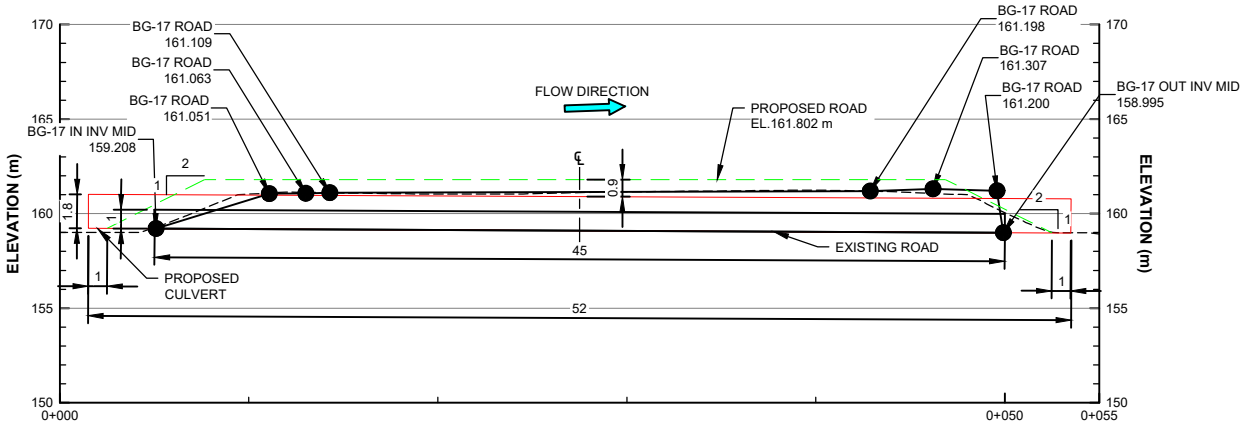


PLAN
TOTE ROAD PRIORITY CROSSING BG-17
SCALE A



1 - FIG

SECTION
TOTE ROAD PRIORITY CROSSING BG-17
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 4 2 0 4 8 12 16 20 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

BG-17
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/77	3

FIGURE B15.2 REV 0

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APPENDIX B16

Crossing BG-04

(Pages B16-1 to B16-6)

APPENDIX B16
CROSSING BG-04

1.0 CURRENT CONDITIONS

The water crossing BG-04 is located at KM94.5 of the Milne Inlet Tote Road and contains two culvert barrels each approximately 1.0 m in diameter with an estimated contributing catchment area of approximately of 7.37 km^2. Baffinland recently identified that the culverts are damaged, and erosion is occurring on the downstream side embankment in its initial remediation plan provided to DFO (Baffinland, 2022a,b).

According to the 2021 survey by North/South Consultants Inc. (NSC) the stream flowing through the culvert is a 3rd order stream that flows west for 1.1 km into potential downstream overwintering lake, POWL-13 (Figure B16.1; NSC, 2021). The stream is characterized by deep pools separated by shallow runs over cobble/gravel/sand substrates. The stream provides abundant rearing and feeding habitat for large numbers of both juvenile, land-locked Arctic Char (60-250 mm) and Ninespine Stickleback and possible spawning habitat for stickleback, particularly in the deep, vegetated upstream pools (NSC, 2021). The stream may also provide a movement corridor for small fish between upstream and downstream lakes. A group of four small, potential overwintering lakes are located 1.2-2.9 km upstream from the road crossing (Figure B16.1). Bathymetry surveys were conducted on three of these lakes in 2019 and all had sufficient depths for both species to overwinter.

There were no barriers to fish movement identified between this crossing and upstream or downstream lakes (NSC, 2021). No fish passage issues at the water crossing were identified in 2021 (NSC, 2021).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photos B16.1 and B16.2 (culvert inlet) and Photo B16.3 (culvert outlet):

- Perched culvert - one of the culvert barrels are perched above the stream (Photo B16.3).
- Damaged Culverts - The two culvert barrels appear to be damaged and collapsing (Photo B16.1).
- Erosion of Slopes - Erosion of the embankment slopes is occurring due to the presence of fine material and steep embankment slopes (Photos B16.2 and B16.3).

The existing water crossing was rated high risk as a barrier for fish passage (Appendix C).

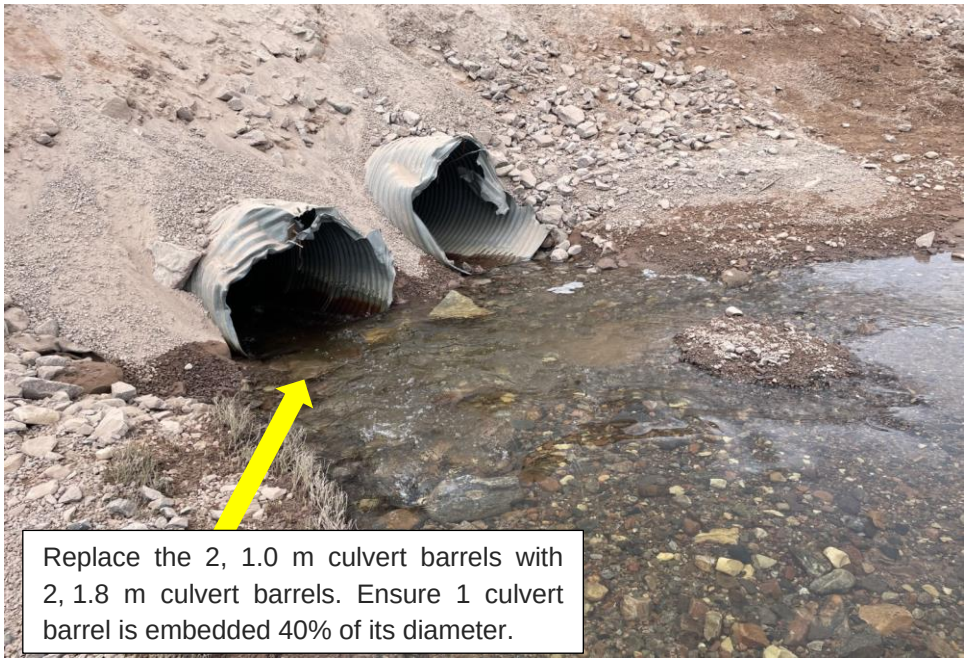


Photo B16.1 BG-04 Culvert Inlet

Photo B16.2 BG-04 Culvert Inlet

Photo B16.3 BG-04 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria, and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B16.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the embankments with riprap to reduce the potential for embankment erosion.

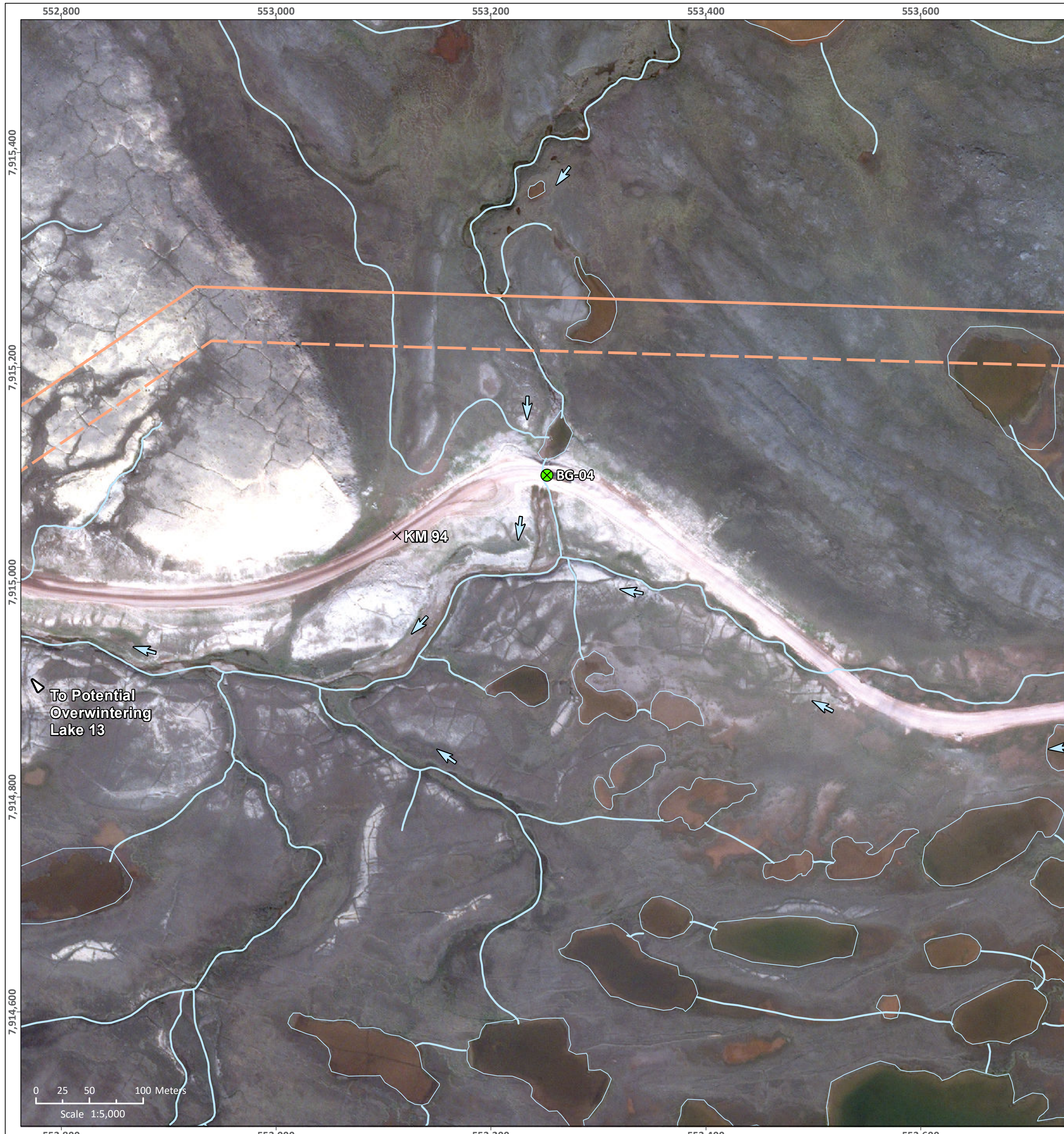
The above remediation measures will ensure the BG-04 water crossing meets the project design criteria.

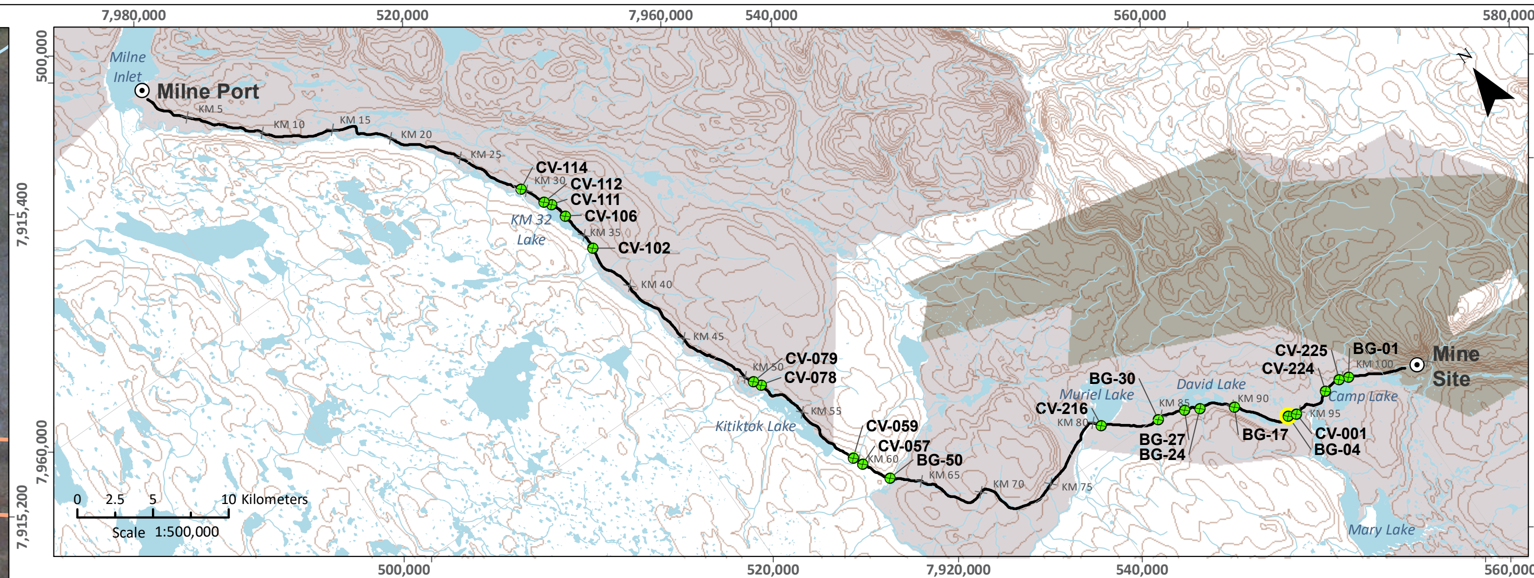
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B16.1. The plan and section of BG-04 is shown in Figure B16.2.

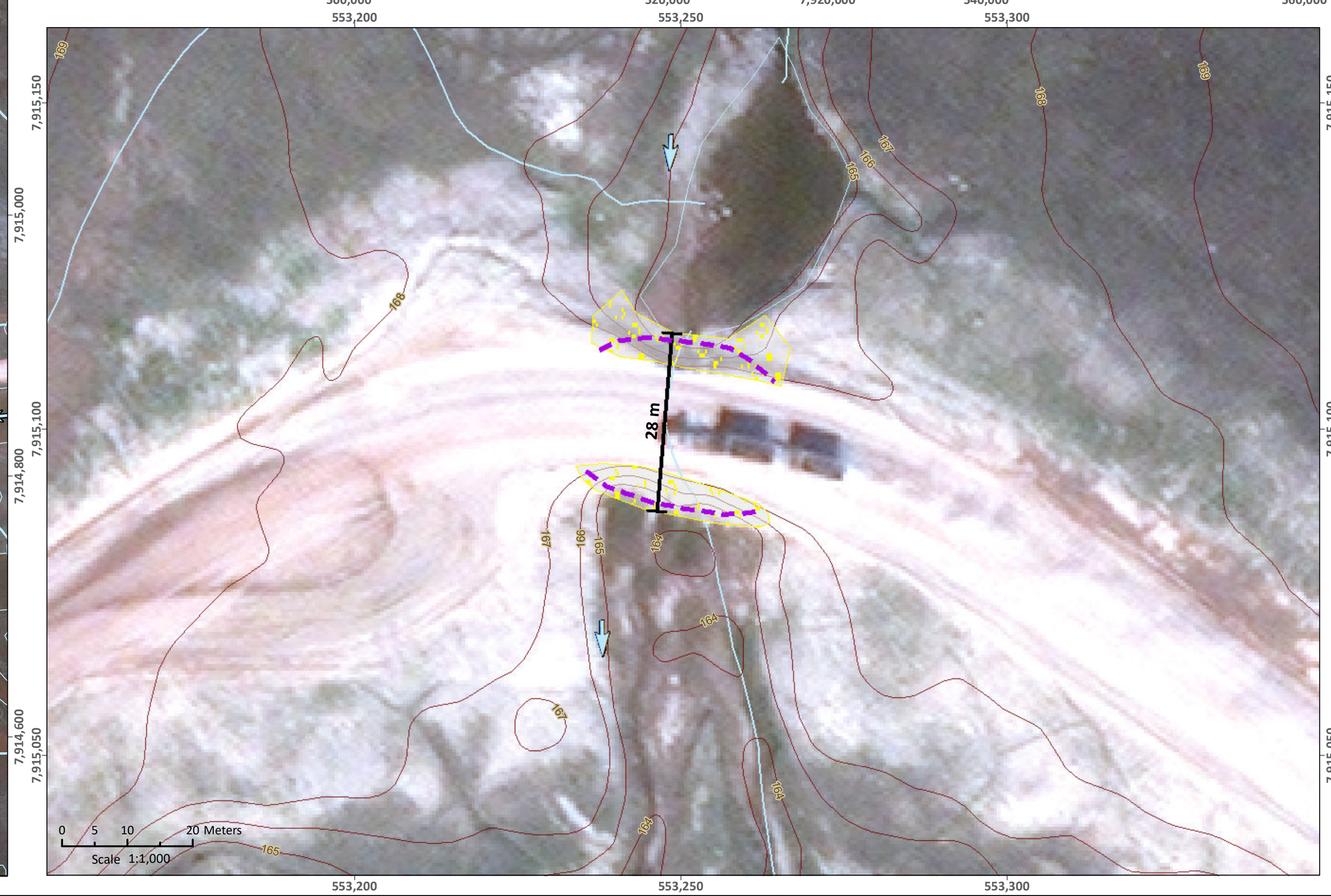
Table B16.1 Culvert Sizing Details

Peak Flow (m^3/s)	11.22
Culvert diameter (mm)	1,800
Number of culvert barrels	2
Embeddedness	One-barrel embedded 40%
Culvert length (m)	28
Slope	1.28%
Minimum cover over barrels (mm)	900

The above remediation measures will ensure the BG-04 water crossing meets the project design criteria. The proposed remediation plan will lower the fish passage risk assessment rating from high to moderate.







LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit

Riprap Armoured Slope

- Existing
- Proposed

Riprap Lined Ditch

- Existing
- Proposed

Note

1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

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MARY RIVER PROJECT

Erosion and Sediment Control Plan
Site Specific Drawing - BG-04

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.
© 2022 Digital Globe, Inc. Imagery and Infrastructure are representative as of July 2022.

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FIGURE B16.1

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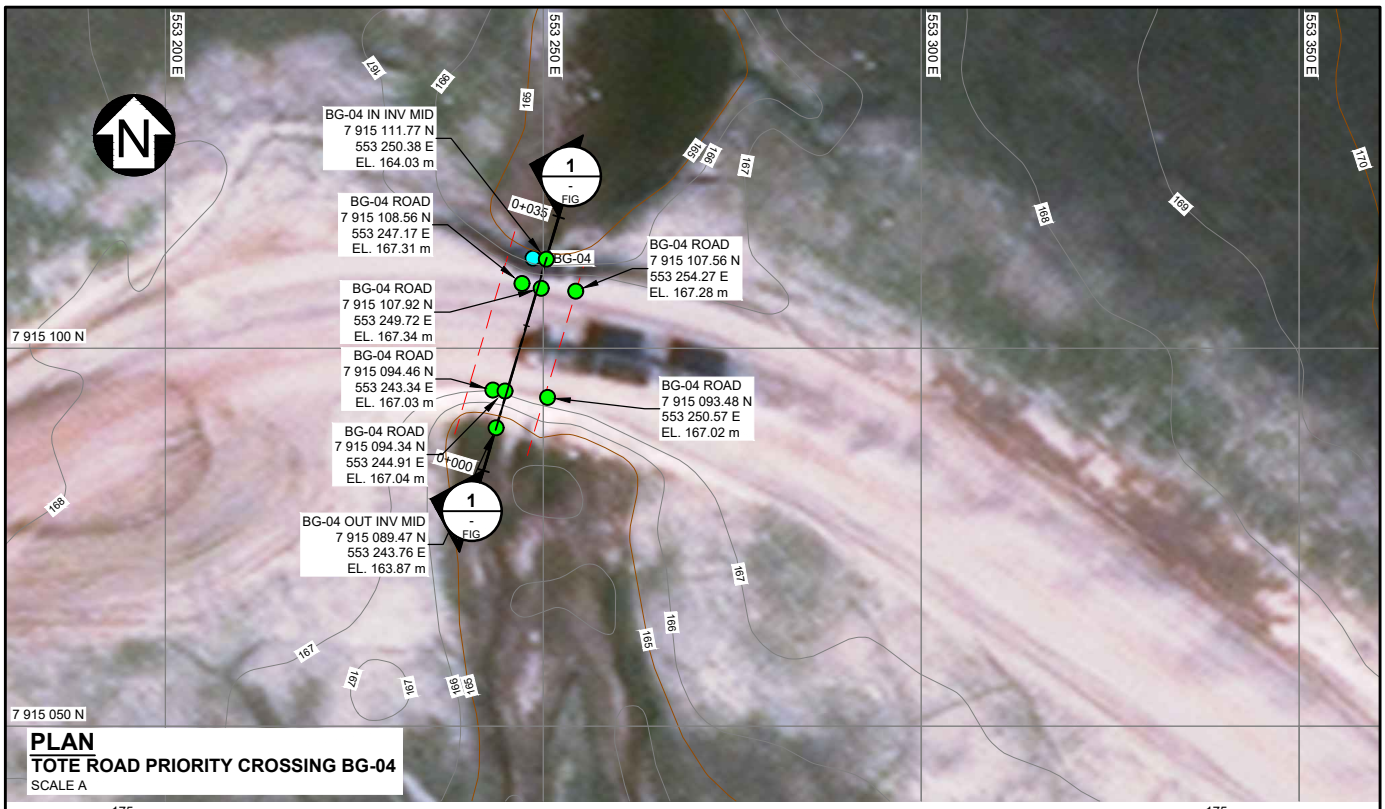
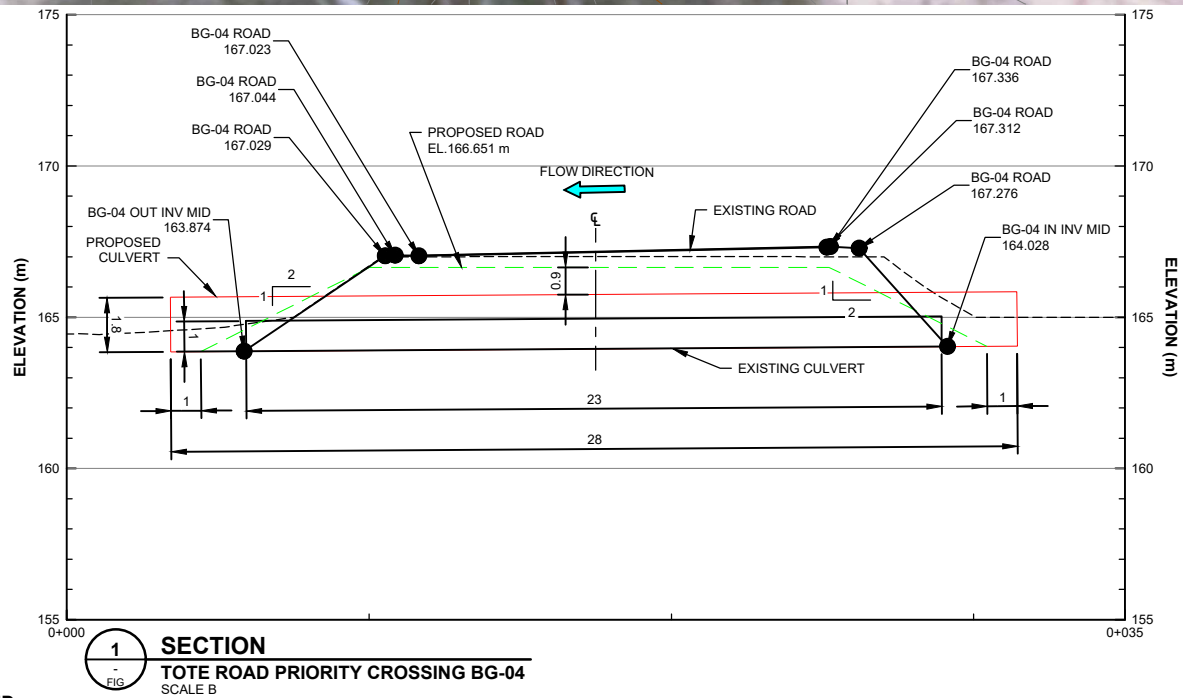


PLAN
TOTE ROAD PRIORITY CROSSING BG-04
SCALE A



SECTION
TOTE ROAD PRIORITY CROSSING BG-04
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m

SCALE B: 2.5 1.25 0 2.5 5 7.5 10 12.5 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

BG-04
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO. NB102-181/77

REF NO. 3

FIGURE B16.2

REV 0

APPENDIX B17

Crossing CV-001

(Pages B17.1 to B17.5)

APPENDIX B17
CROSSING CV-001

1.0 CURRENT CONDITIONS

The water crossing CV-001 is located at KM94.5 of the Milne Inlet Tote Road and contains three culvert barrels, consisting of two 0.5 m culvert barrels and one, 1 m culvert barrel with an estimated contributing catchment area of approximately 1.84 km^2. In September 2022, DFO identified that the culverts are not embedded, and one of the 0.5 m culvert barrels is plugged with sediment rendering the culvert barrel impassable (DFO, 2022)

Based on information provided by North/South Consultants (NSC), the stream flowing through the culvert at CV-001 is a 2nd order tributary of a larger stream approximately 270 m downstream from the culvert crossing (NSC, 2022). This larger stream flows for another 1.1 km west into the southwest end of an unnamed lake with overwintering potential (NSC, 2022). This lake has been surveyed for bathymetry and substrate and it has sufficient depth for Arctic Char overwintering and spawning (NSC, 2022).

The CV-001 stream provides a small quantity of open-water season rearing habitat for small size classes of juvenile Arctic Char (usually 50-90 mm, though occasionally larger). Ninespine Stickleback have also been found in this stream during the open water period (NSC, 2022).

Downstream from the Tote Road crossing, the CV-001 stream habitat is shallow (<0.05) riffle//pool over cobble substrate (NSC, 2022). Intermittent subsurface flow barriers can appear in this stream during periods of low water (NSC, 2022). Immediately upstream from the road crossing habitat is marshy pond with little to no flow and predominantly silt/organic substrate with abundant aquatic and submerged terrestrial vegetation (NSC, 2022). During peak flows there can be an additional 2 km of accessible marshy habitat upstream with a few connected ponds before reaching permanent subsurface flow barriers (NSC, 2022). This upstream habitat is primarily suitable for Ninespine Stickleback, but juvenile Char have also been observed (NSC, 2022). During periods of low flow, much of this accessibility is lost and upstream habitat becomes fragmented, increasing the potential for natural fish strandings (NSC, 2022).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B17.1 (culvert inlet) and Photo B17.2 (culvert outlet):

- Plugged with Sediment - The two 0.5 m culvert barrels appear to be plugged with sediment (Photos B17.1 and B17.2).
- Erosion of Slopes - The embankment slopes are steep and contain fines leading to erosion of the embankment slope (Photos B17.1 and B17.2).
- Perched Culvert - The culvert barrel is slightly perched above the stream (Photo B17.2).

The existing water crossing at CV-001 was rated high risk as a potential barrier to fish movement (Appendix C).

Photo B17.1 CV-001 Culvert Inlet

Photo B17.2 CV-001 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B17.1
- Lengthen the culvert to allow for a 2H:1V downstream embankment side slope to reduce the potential for downstream embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the downstream embankment with riprap to reduce the potential for embankment erosion.
- Line the ditches to the north and south of the tote road to reduce the potential for erosion and sediment production.

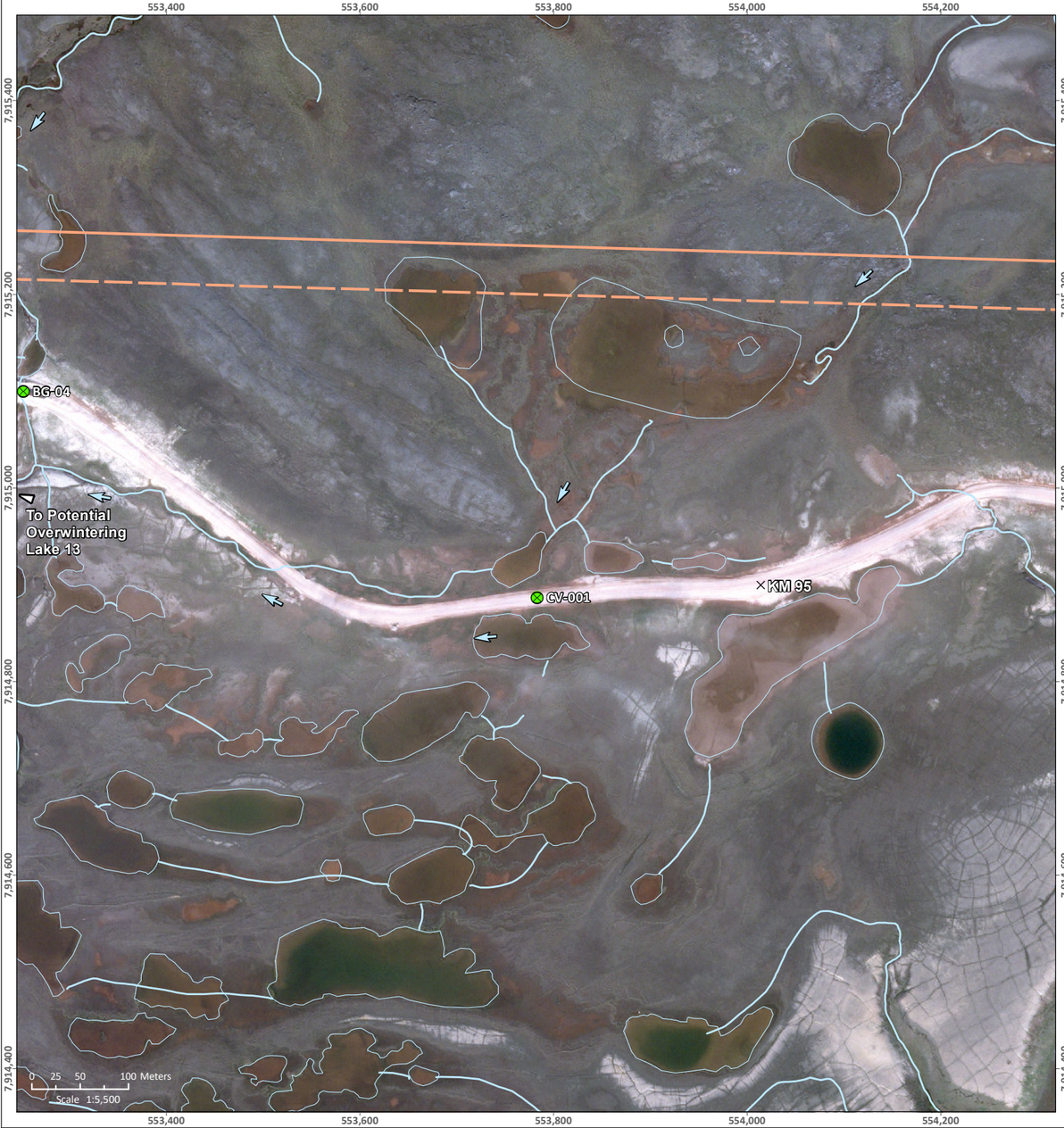
The above remediation measures will ensure the CV-001 water crossing meets the project design criteria.

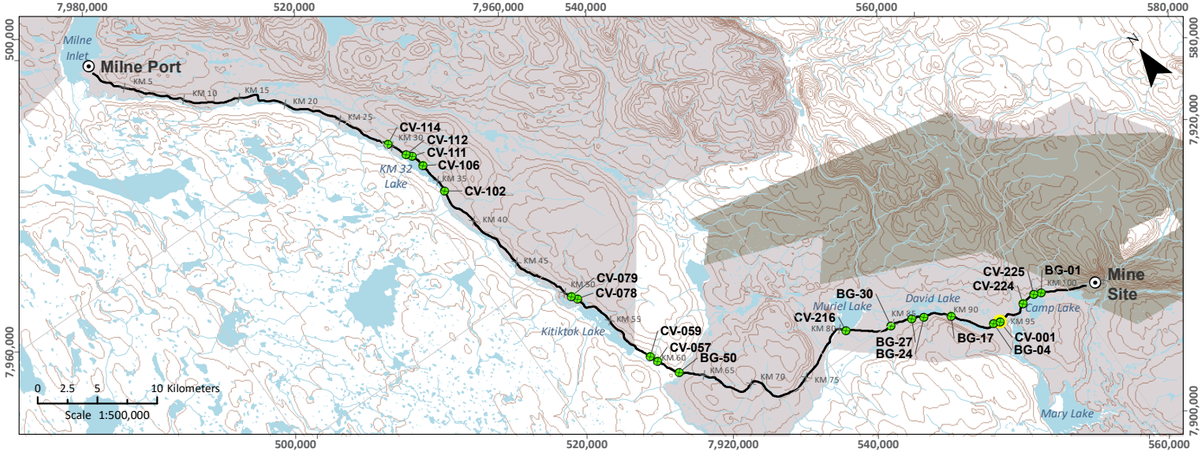
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B17.1. The plan and section of CV-001 is shown in Figure B17.2.

Table B17.1 Culvert Sizing Details

Peak Flow (m^3/s)	3.70
Culvert diameter (mm)	2, 1,000's and 1, 1200
Number of culvert barrels	3
Embeddedness	One-barrel embedded 40%
Culvert length (m)	24
Slope	0.54%
Minimum cover over barrels (mm)	600

The fish passage risk assessment fish barrier risk rating of high decreases to moderate after implementation of the above remediation measures.





LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- **Riprap Armoured Slope**: Existing, Proposed
- **Riprap Lined Ditch**: Existing, Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

MARY RIVER PROJECT

Erosion and Sediment Control Plan
Site Specific Drawing - CV-001

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.

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FIGURE B17.1

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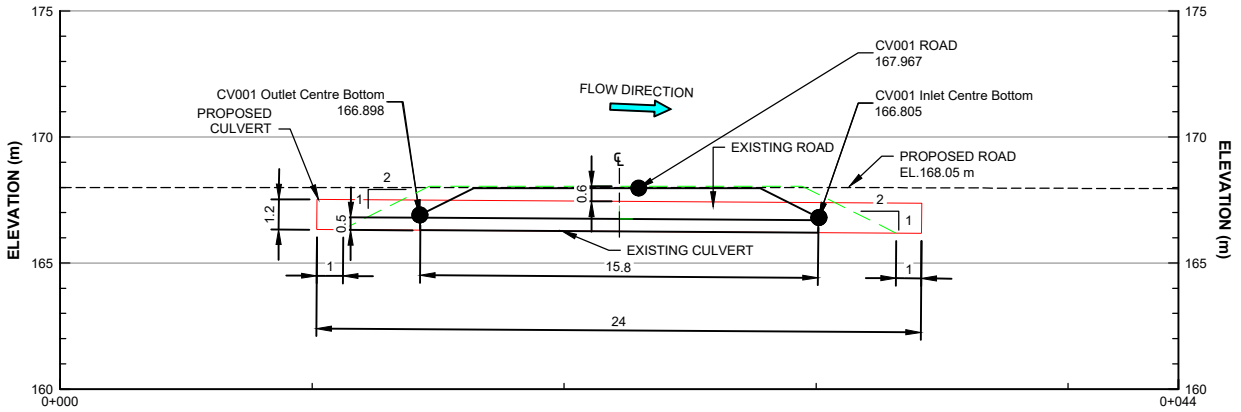
PLAN
TOTE ROAD PRIORITY CROSSING CV-001
SCALE A



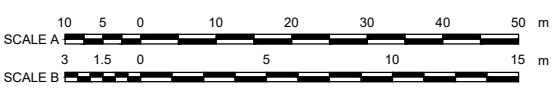
1 - FIG
SECTION
TOTE ROAD PRIORITY CROSSING CV-001
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.



REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CV-001
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/77	3

FIGURE B17.2 REV 0

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APPENDIX B18

Crossing CV-224

(Pages B18.1 to B18.6)

APPENDIX B18
CROSSING CV-224

1.0 CURRENT CONDITIONS

The water crossing CV-224 is located at KM97.5 of the Milne Inlet Tote Road and contains two culvert barrels approximately 1.2 m in diameter with an estimated contributing catchment area of approximately 1.84 km^2. In September 2022, DFO identified that the culverts were perched downstream at the outlet and erosion was observed on the downstream slopes (DFO, 2022).

Based on information provided by North/South Consultants (NSC), the stream flowing through the culvert at CV-224 is a 3rd order stream that drains south into the northwest end of Camp Lake approximately 250 m downstream (NSC, 2022). Camp Lake provides spawning and overwintering habitat for both species of fish (NSC, 2022).

The CV-224 stream provides open-water season rearing habitat for juvenile Arctic Char ranging in size from 30-130 mm (NSC, 2022). Ninespine Stickleback have been frequently observed in the vicinity of the Tote Road crossing (NSC, 2022). Stickleback use the stream for foraging, but it is unknown if spawning occurs (NSC, 2022). More suitable stickleback spawning habitat (shallow areas with submerged vegetation) are found downstream in Camp Lake and in some of the smaller tributaries of CV-224 (NSC, 2022). There is a permanent barrier 910 m upstream of the Tote Road at a large vertical drop (NSC, 2022). Habitat is largely riffle/run/pool over cobble/gravel substrate with increasing proportions of cascades and larger substrates near the upstream barrier (NSC, 2022).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B18.1 (culvert inlet) and Photo B18.2 (culvert outlet):

- Erosion of Slopes - The embankment slopes are steep and contain fines leading to erosion of the embankment slope (Photos B18.1 and B18.2).
- Perched Culvert - The culvert barrel is perched above the stream (Photo B18.2).

The existing water crossing at CV-224 was rated high risk for potential to be a barrier to fish movement (Appendix C).

Photo B18.1 CV-224 Culvert Inlet

Photo B18.2 CV-224 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B18.1.
- Lengthen the culvert to allow for a 2H:1V downstream embankment side slope to reduce the potential for downstream embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the downstream embankment with riprap to reduce the potential for embankment erosion.

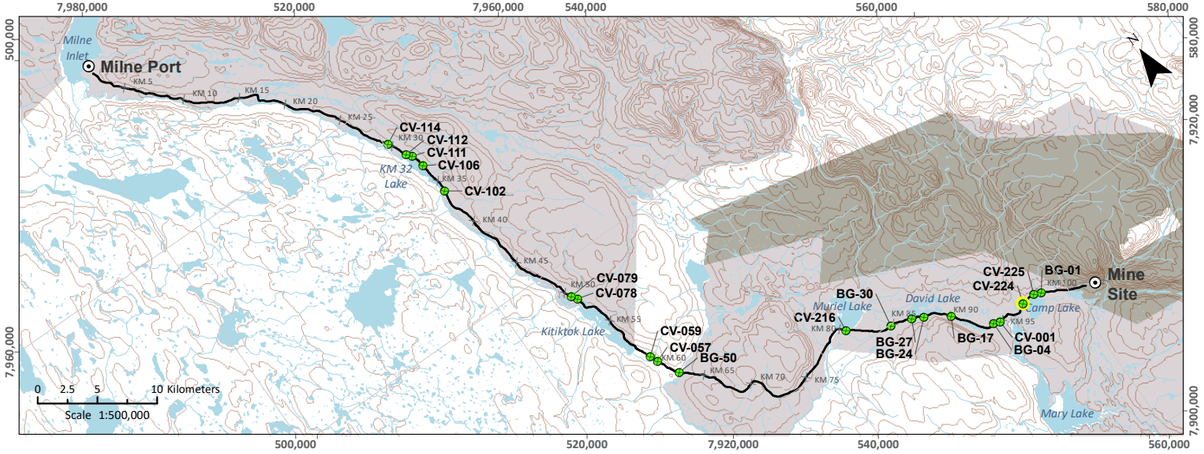
The above remediation measures will ensure the CV-224 water crossing meets the project design criteria.

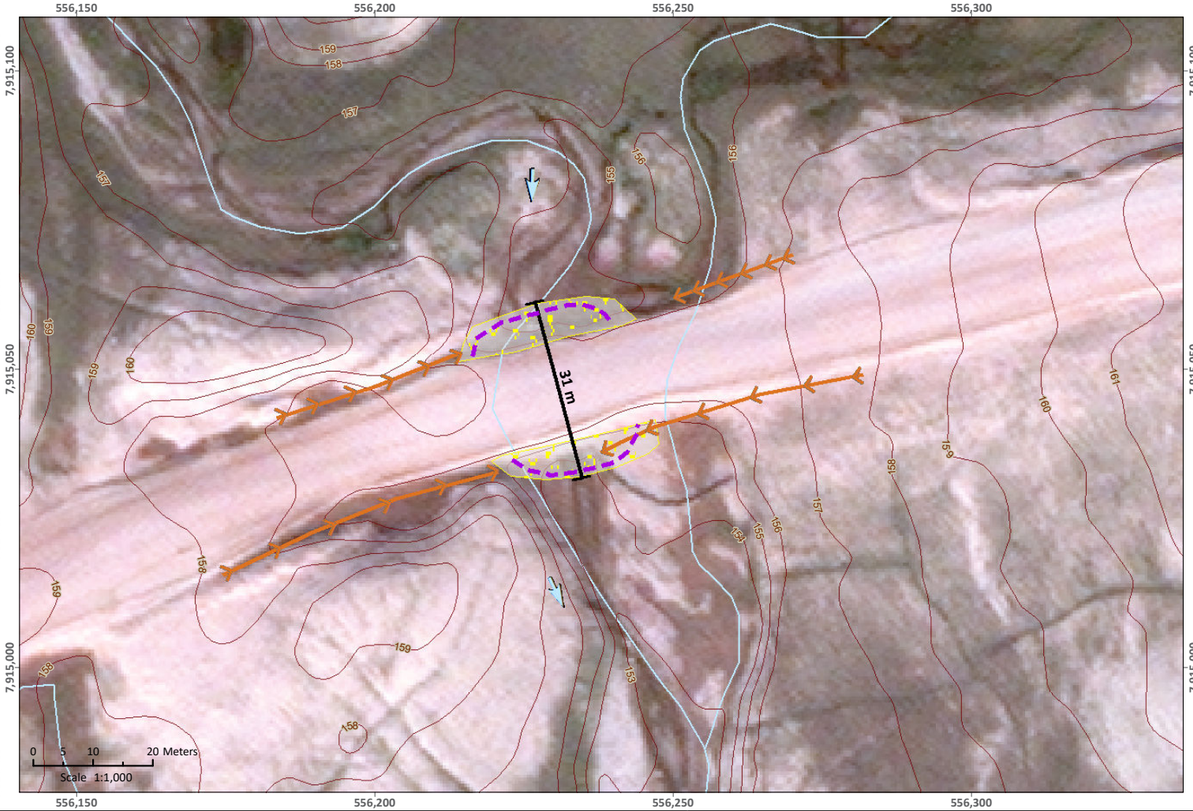
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B18.1. The plan and section of CV-224 is shown in Figure B18.2.

Table B18.1 Culvert Sizing Details

Peak Flow (m^3/s)	3.70
Culvert diameter (mm)	1,200
Number of culvert barrels	2
Embeddedness	One-barrel embedded 40%
Culvert length (m)	31
Slope	1.50%
Minimum cover over barrels (mm)	600

The fish passage risk assessment fish barrier risk rating of high decreases to moderate after implementation of the above remediation measures.





LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat
- **Riprap Armoured Slope**: Existing, Proposed
- **Riprap Lined Ditch**: Existing, Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. An ice road will be established to direct traffic around the construction area. The exact location of the ice road will be determined based on observed field conditions.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

MARY RIVER PROJECT

Erosion and Sediment Control Plan
Site Specific Drawing - CV-224

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.
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Baffinland

FIGURE B18.1

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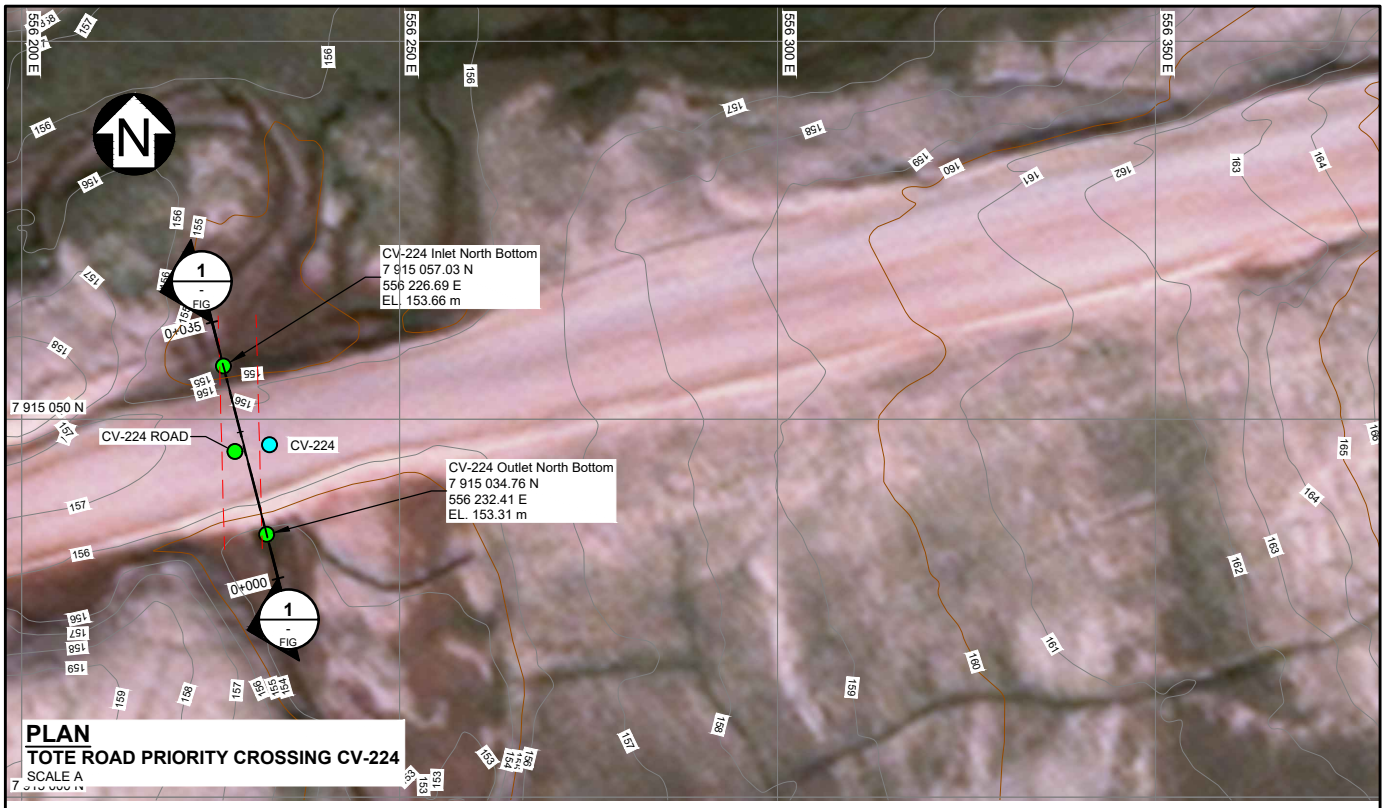
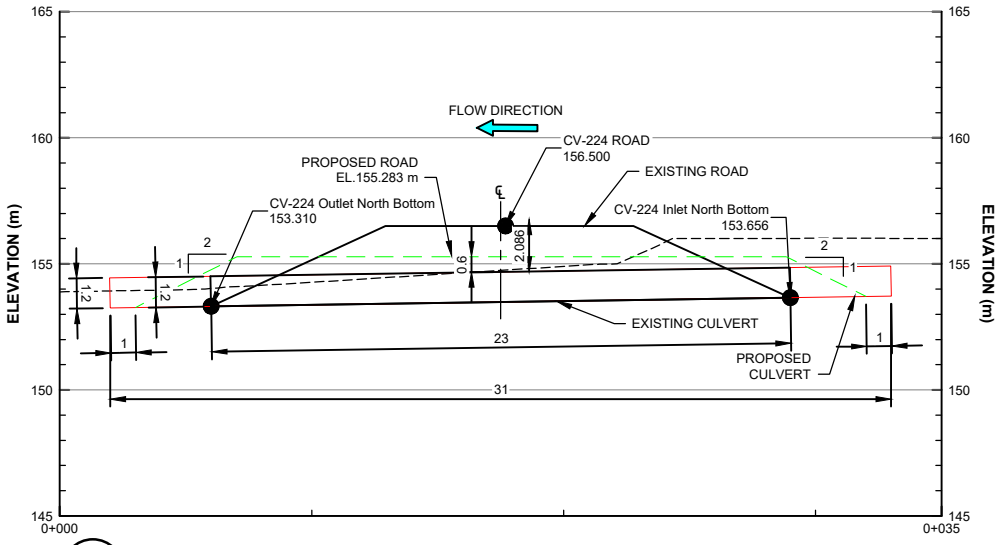


PLAN
TOTE ROAD PRIORITY CROSSING CV-224
SCALE A



SECTION
TOTE ROAD PRIORITY CROSSING CV-224
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 3 1.5 0 5 10 15 m

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0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

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MARY RIVER PROJECT

CV-224
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO. NB102-181/77 | REF NO. 3

FIGURE B18.2 | REV 0

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APPENDIX B19

Crossing CV-225

(Pages B19.1 to B19.6)

APPENDIX B19
CROSSING CV-225

1.0 CURRENT CONDITIONS

The water crossing CV-225 is located at KM99.5 of the Milne Inlet Tote Road and contains two culvert barrels each approximately 1.2 m in diameter with an estimated contributing catchment area of approximately of 8.56 km^2. Baffinland identified that a portion of the old road crossing is obstructing flow to the other stream channel and needs to be removed in its initial remediation plan provided to DFO (Baffinland, 2022a,b).

According to the 2021 survey by North/South Consultants Inc. (NSC) the stream flowing through the culvert is a 3rd order stream that flows into the north end of Camp Lake and is Camp Lake's largest inflow tributary (Figure B19.1; NSC, 2021). Camp Lake is known to provide overwintering and spawning habitat for a mostly resident population of Arctic Char. The CV-225 stream provides abundant open-water season rearing and feeding habitat for large numbers of juvenile, land-locked Arctic Char from 40-250 mm. Habitat is largely cascade/pool/run over cobble/boulder. Ninespine Stickleback use of the stream is rare and restricted to lower reaches near Camp Lake for foraging. Stickleback spawning in the stream is unlikely and more suitable habitat is located in other parts of the Camp Lake watershed (NSC, 2021).

Natural habitat upstream of the Tote Road crossing is less suitable for the smaller juvenile Char (<120 mm) that can be abundant in the lower reaches of the stream. Higher velocity riffles are present immediately upstream from the road crossing, which transition to a series of fast flowing cascades and vertical drops approximately 190 m upstream that may limit further upstream movements to juveniles >200 mm (NSC, 2021). There is a semi-permanent and permanent vertical barrier to upstream movement upstream of the road crossing (yellow and orange diamonds in Figure B19.1). However, during periods of high water, there is some connectivity between the CV-225 and BG-01 (the second largest inflow tributary of Camp Lake) systems that can bypass the permanent vertical barrier on CV-225. See the flow arrows in Figure B19.1 for this potential bypass route. It was noted in the survey that slight perching and culvert outflow velocities remain an issue and spring ice damming inside the culverts is common (NSC, 2021).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B19.1 (culvert inlet) and Photo B19.2 (culvert outlet):

- Damaged Culverts - Culvert barrels are deformed and collapsed slightly (Photo B19.1).
- Perched culverts - Both culvert barrels are perched above the stream (Photo B19.2).
- Erosion of Slopes - Erosion of the embankment slopes is occurring due to the presence of fine material and steep embankment slopes (Photo B19.2).

The existing water crossing was rated high risk as a barrier for fish passage (Appendix C).

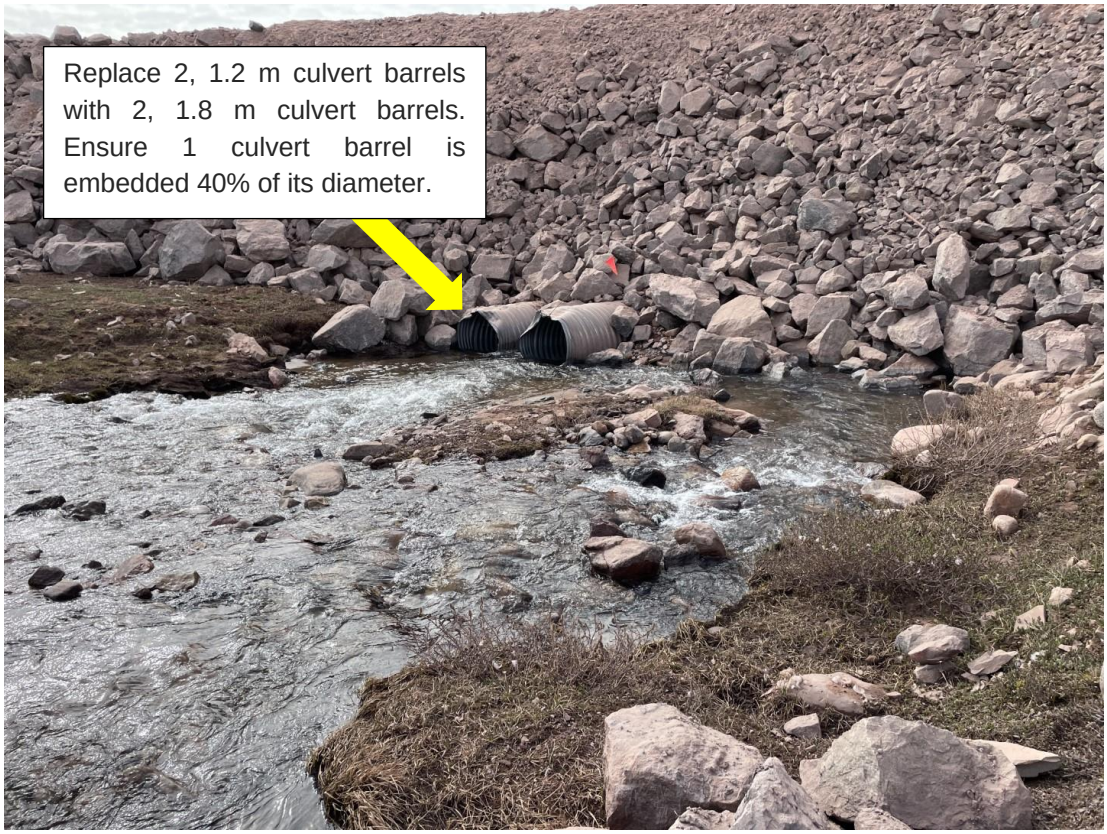


Photo B19.1 CV-225 Culvert Inlet

Photo B19.2 CV-225 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B19.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the downstream embankment with riprap to reduce the potential for embankment erosion.

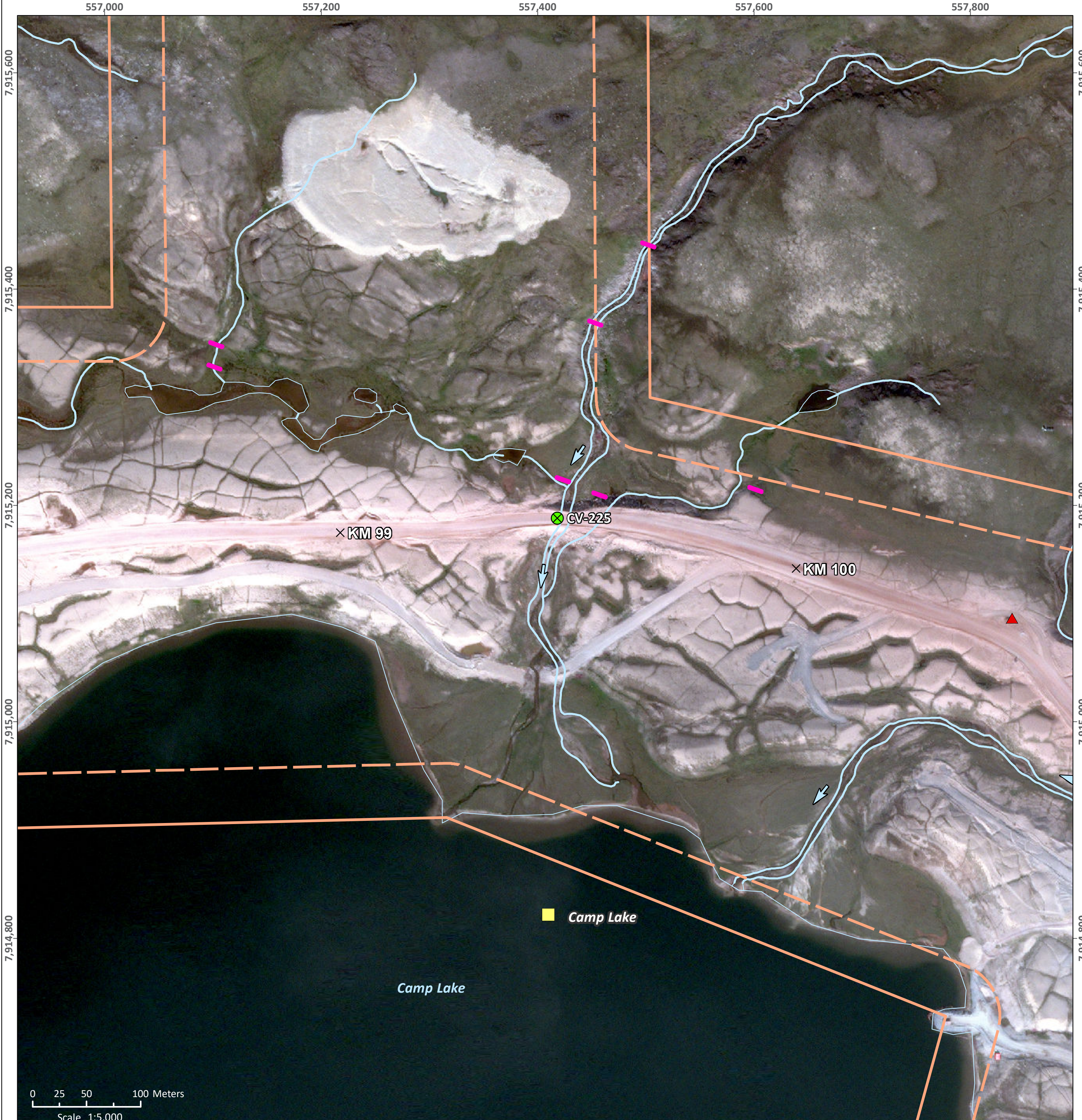
The above remediation measures will ensure the CV-225 water crossing meets the project design criteria.

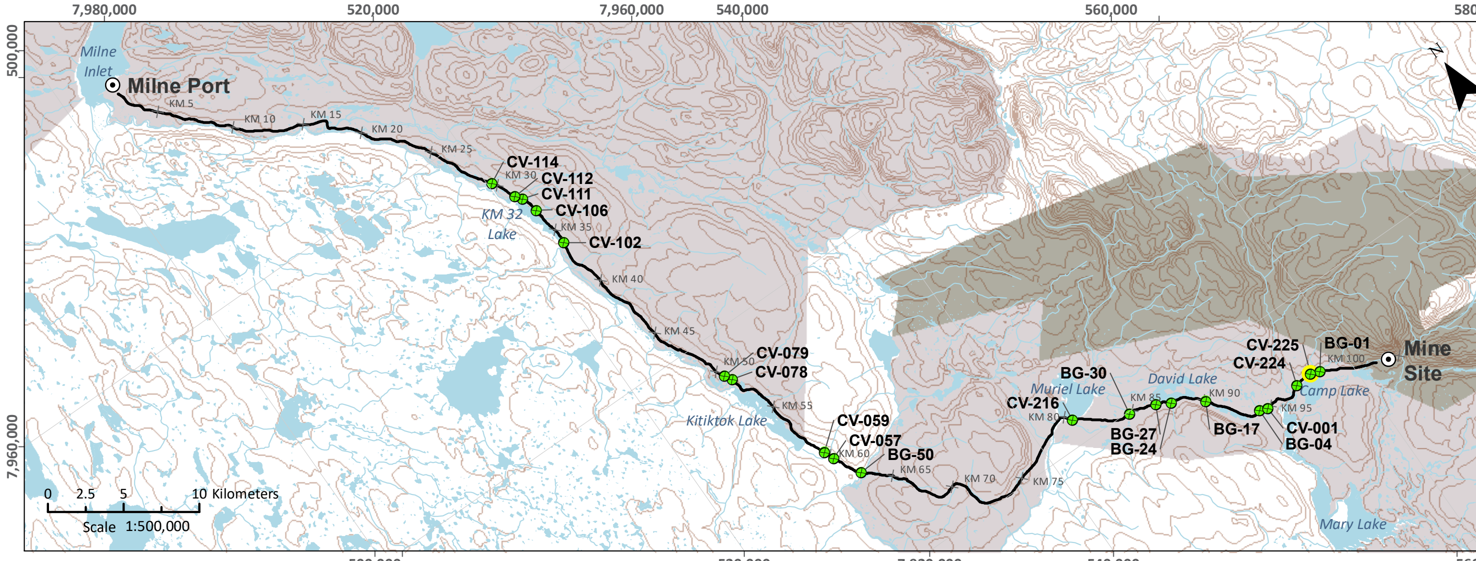
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B19.1. The plan and section of CV-225 is shown in Figure B19.2.

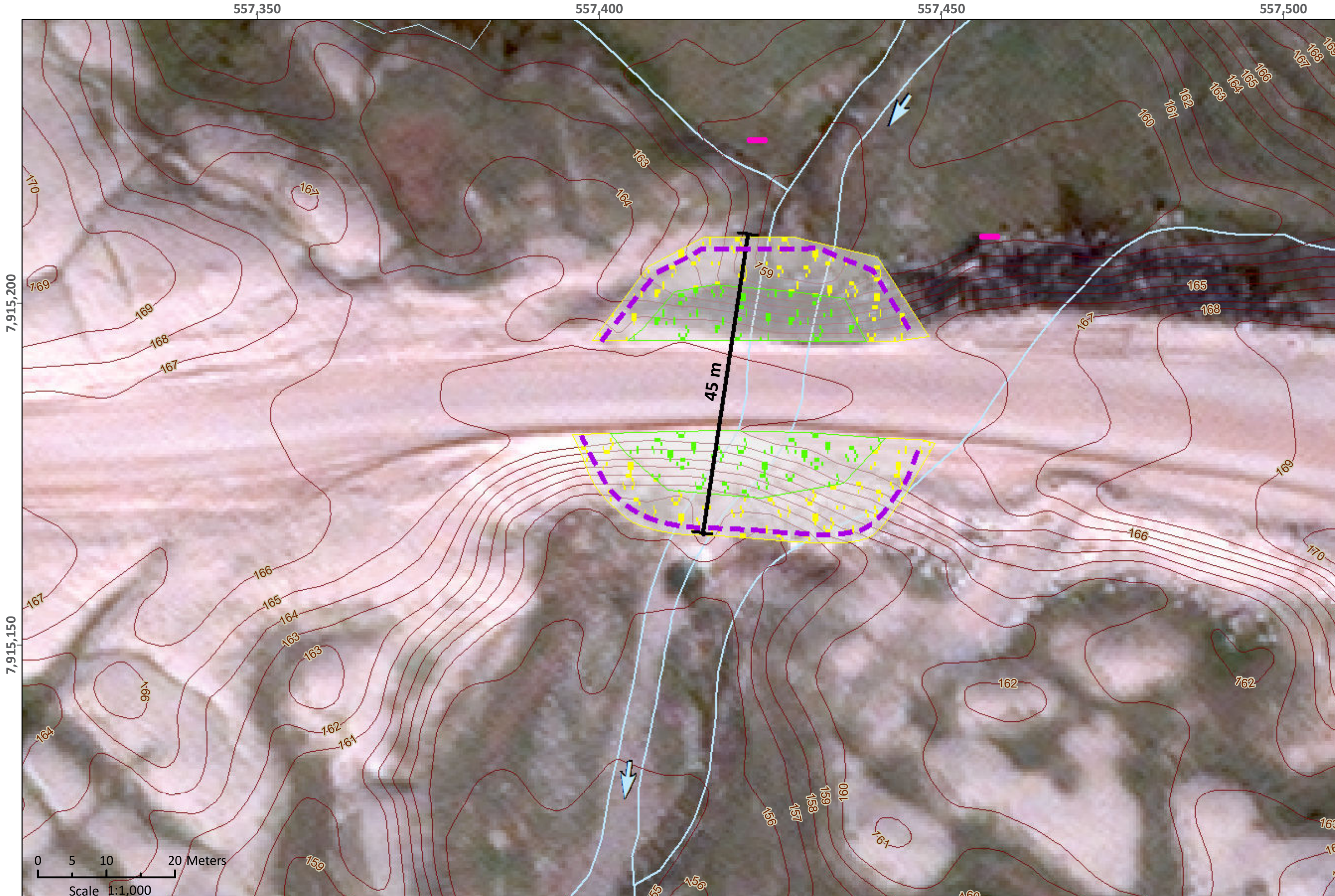
Table B19.1 Culvert Sizing Details

Peak Flow (m^3/s)	12.65
Culvert diameter (mm)	1,800
Number of barrels	2
Embeddedness	One-barrel embedded 40%
Culvert length (m)	45
Slope	0.98%
Minimum cover over barrels (mm)	900

The proposed remediation plan will improve fish passage and decreases the fish passage risk assessment rating from high to moderate. However, as described in Section 1 above, the habitat upstream the culvert includes high velocity flows that would also preclude small size class char from moving further upstream (Appendix B.2; NSC, 2021).







LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Roadside Borrow Pit
- Overwinter Fish Habitat

Riprap Armoured Slope

- Existing
- Proposed

Riprap Lined Ditch

- Existing
- Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. The culvert replacement will be completed in two stages to allow for continued use of the access road. Traffic control and barriers to follow the designated work plan.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

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Erosion and Sediment Control Plan
Site Specific Drawing - CV-225

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.
© 2022 Digital Globe, Inc. Imagery and Infrastructure are representative as of July 2022.

Baffinland

ᑎᑎᕋᐅᓯᐊᖑᓪᓗᒍ FIGURE B19.1

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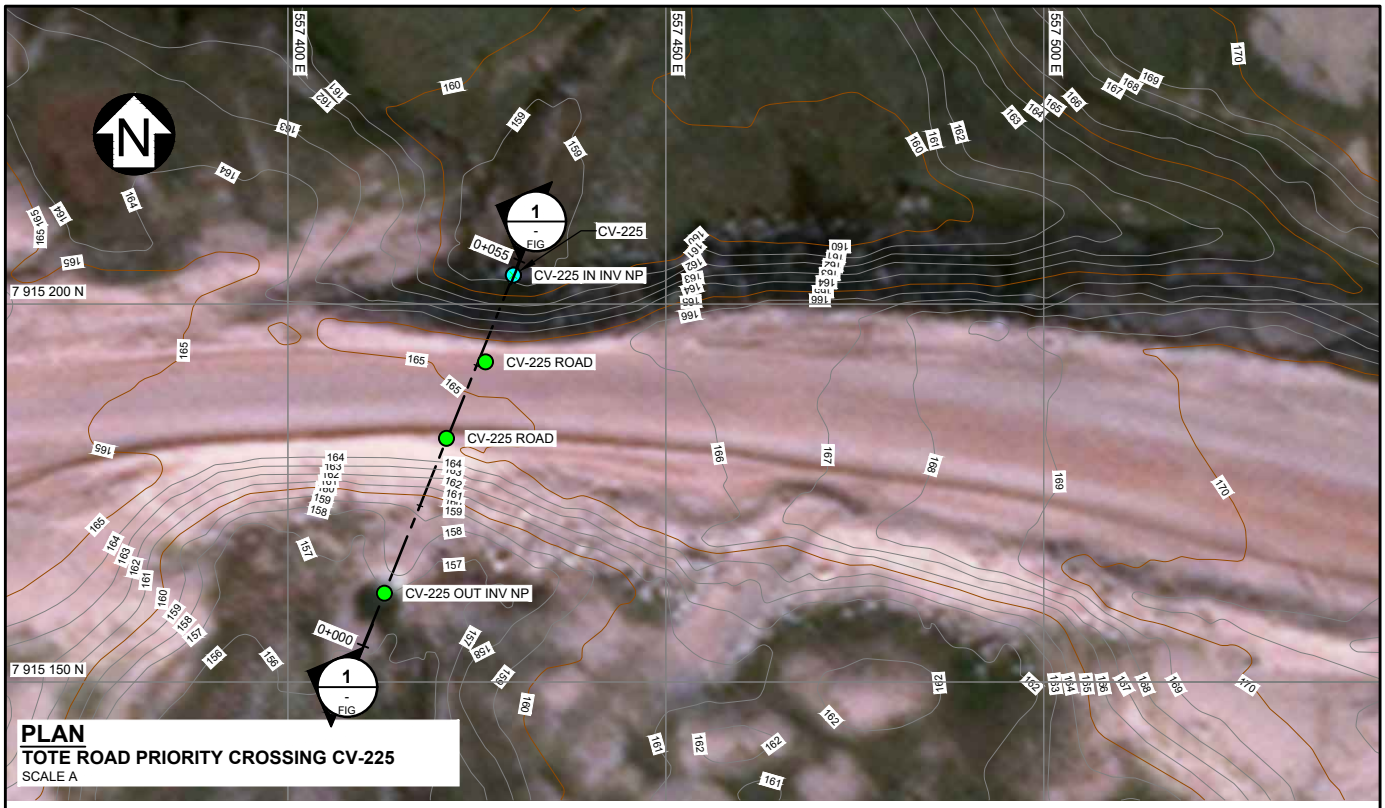
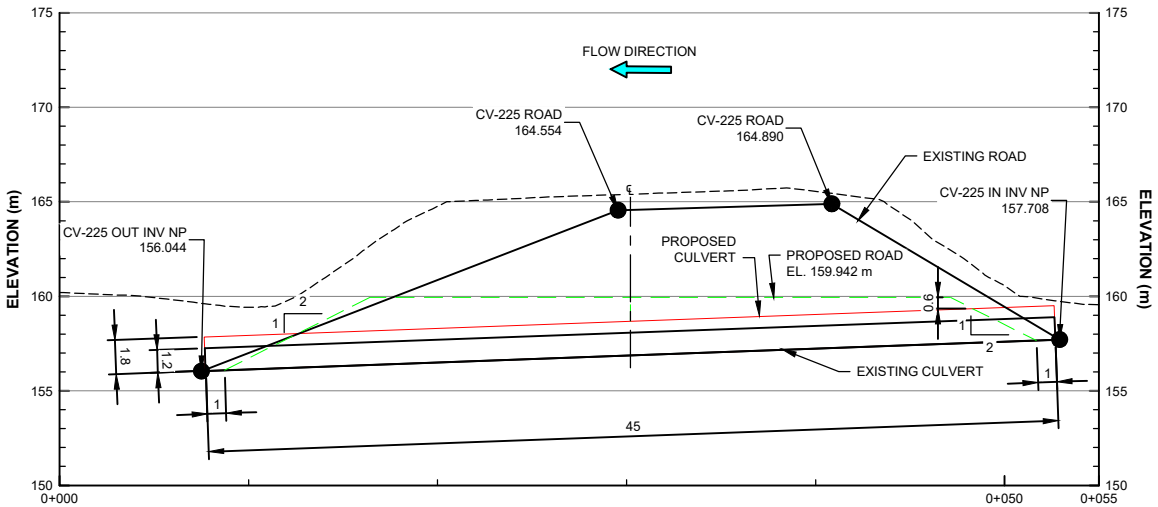


PLAN
TOTE ROAD PRIORITY CROSSING CV-225
SCALE A



SECTION
TOTE ROAD PRIORITY CROSSING CV-225
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m
SCALE B: 4 2 0 4 8 12 16 20 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CV-225
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO. NB102-181/77
REF NO. 3

FIGURE B19.2
REV 0

APPENDIX B20

Crossing BG-01

(Pages B20.1 to B20.5)

APPENDIX B20
CROSSING BG-01

1.0 CURRENT CONDITIONS

The water crossing BG-01 is located at KM100 of the Milne Inlet Tote Road and contains three culvert barrels each approximately 1.2 m in diameter with an estimated contributing catchment area of approximately of 5.8 km^2. In DFOs September 2022 survey, it was identified that the culverts are damaged and perched and erosion and sediment concerns were observed on the downstream embankment (DFO, 2022).

The stream flowing through the culvert is a 3rd order stream that flows into the northeast end of Camp Lake (Figure B20.1; NSC, 2021). The stream provides abundant open-water season rearing habitat for large numbers of juvenile, land-locked Arctic Char from 40-250 mm. It was noted that the more upstream reaches, from approximately 500-750 m upstream of the road crossing are generally restricted to juveniles larger than 200 mm due to steeper gradient and higher velocities (NSC, 2021). There are two smaller tributaries of this stream upstream of the Tote Road. A tributary to the northwest that flows into BG-01 immediately upstream from the road crossing provides open water habitat for smaller juvenile Char (70-120 mm) and connects to the CV-225 watershed approximately 1.1 km upstream during periods of high flows with no permanent barriers to fish movement (Figure B20.1). A second tributary flows from the southeast and provides habitat primarily for Ninespine Stickleback including a small pond that provides overwintering for the species and abundant spawning habitat with submerged vegetation for nesting. Stickleback use of the main BG-01 channel is noted as rare and restricted to lower reaches near Camp Lake where water velocities are reduced (NSC, 2021).

An impassable vertical drop was identified approximately 750 m upstream from the road crossing (orange diamond in Figure B20.2). It was noted in the survey that culvert outflow velocities through the existing culverts may impede smaller fish (NSC, 2021).

2.0 IDENTIFIED ISSUES

KP identified the following issues with this crossing, shown on Photo B20.1 (culvert inlet) and Photo B20.2 culvert outlet):

- Perched culverts - The inlet of the furthest culvert barrel in Photo B20.1 is perched above the stream, and the outlet of the left-most culvert barrel is perched above the stream and damaged (furthest culvert barrel in Photo B20.1).
- Erosion of Slopes - Erosion of the embankment slopes is occurring due to the presence of fine material and steep embankment slopes (Photo B20.2).

The existing water crossing was rated high risk as a barrier for fish passage (Appendix C).

Photo B20.1 BG-01 Culvert Inlet

Photo B20.2 BG-01 Culvert Outlet

3.0 CROSSING REMEDIATION PLAN

Based on a review of the existing crossing conditions, design criteria, and the fish passage assessment, the following remediation measures are recommended:

- Remove existing culverts.
- Install new culverts as identified in Table B20.1.
- Lengthen the culverts to allow for a 2H:1V embankment side slope to reduce the potential for embankment erosion.
- Align culverts so that they are parallel to the stream flow direction. Culverts skewed from perpendicular to the road embankment will require additional culvert length.
- Embed one culvert barrel 40% of the culvert diameter.
- The minimum cover requirement over the culverts is the maximum of the following two criteria:
  - For structural loading, the minimum cover is to be 600 mm.
  - For hydraulic requirements, the minimum cover is to be half of the culvert diameter.
- Armour the embankments with riprap to reduce the potential for embankment erosion.
- Remediate the existing ditch by creating a defined channel and lining the ditch with riprap to reduce the potential for erosion and sediment production.

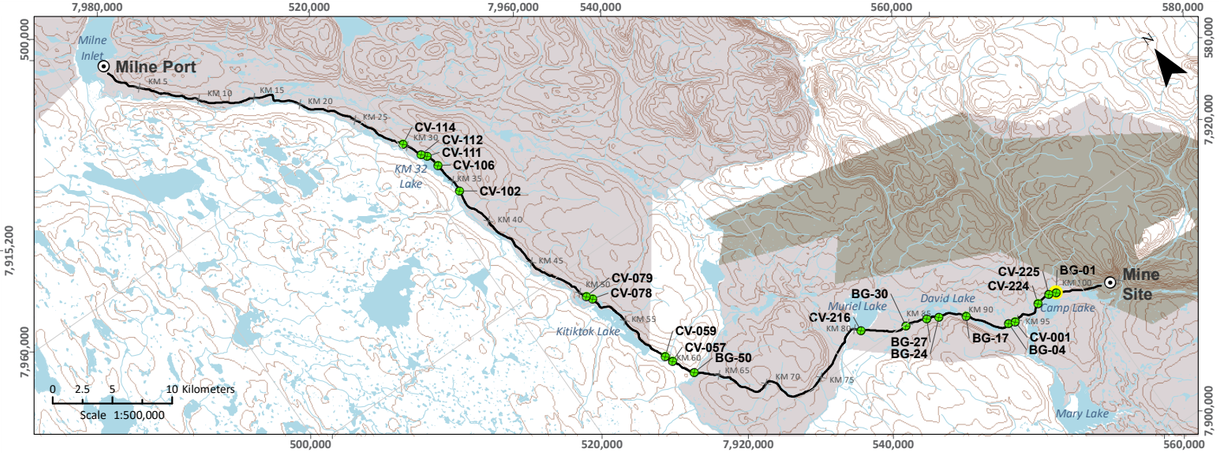
The above remediation measures will ensure the BG-01 water crossing meets the project design criteria.

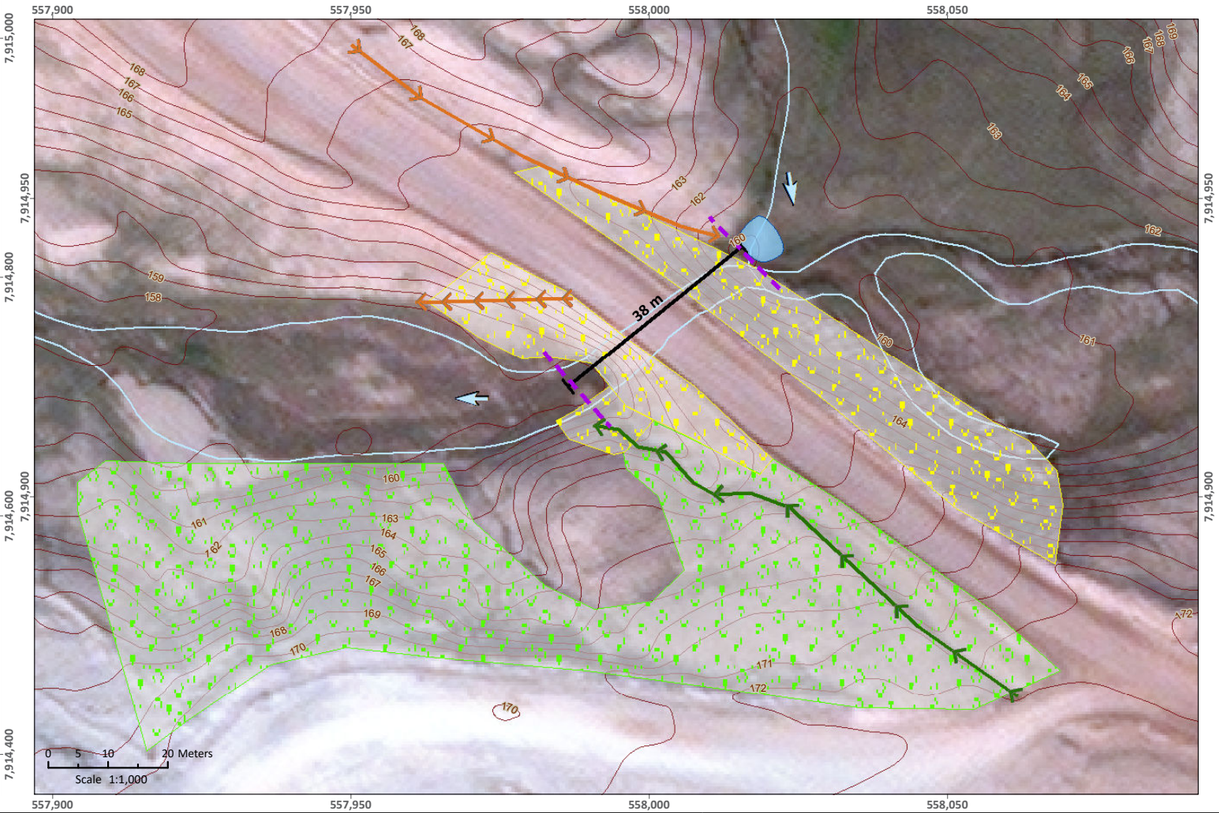
The construction will take place over the 2022/2023 winter season and the erosion and sediment control is highlighted in Figure B20.1. The plan and section of BG-01 is shown in Figure B20.2.

Table B20.1 Culvert Sizing Details

Peak Flow (m^3/s)	9.27
Culvert diameter (mm)	1,800
Number of culvert barrels	2
Embeddedness	One barrel embedded 40%
Culvert length (m)	38
Culvert slope	1.7%
Minimum cover over barrels (mm)	900

The proposed remediation plan will lower the fish passage risk assessment rating from high to moderate.





LEGEND

- Project Facility Location
- Contour (1 m Interval)
- Milne Inlet Tote Road
- IOL Surface Only
- IOL Surface and Subsurface
- Commercial Lease Boundary - 50 m Buffer
- Commercial Lease Boundary
- Proposed Riprap Inlet Pool
- Proposed Culvert Length (m)
- Proposed Road Embankment Widening (Side Slopes Flattened to 2H:1V)
- Temporary Fill Stockpile for Culvert Construction
- Fish Barrier
- Water Flow Direction
- Culvert Location
- Existing Borrow Pit
- Overwinter Fish Habitat
- **Riprap Armoured Slope**: Existing, Proposed
- **Riprap Lined Ditch**: Existing, Proposed

Note
1. All Work to be completed during frozen conditions
2. Blasting mats will be used for blasting of overburden material to remove the existing CSP culvert. Once excavation has reached the culvert, it will be removed and the new culvert installed as per the work plan.
3. All blasting spoils to be removed from Site and disposed at appropriate locations.
4. Culverts to be backfilled to establish road side slopes at 2H:1V. All slopes will be stabilized with 300 mm thick riprap overlying non-woven geotextile as shown on Drawing 190.
5. A temporary road closure will be constructed while the work is being completed on this culvert location.
6. The stream centerline is only for visual aid as it is an approximate depiction of the streams path.
7. Culverts extended will be field fit to ensure positive drainage to downstream watercourses

MARY RIVER PROJECT

Erosion and Sediment Control Plan
Site Specific Drawing - BG-01

Projection: NAD 1983 UTM ZONE 17N.
Base Map: © Queen's Printer for Ontario, 2022.

N

Baffinland

FIGURE B20.1

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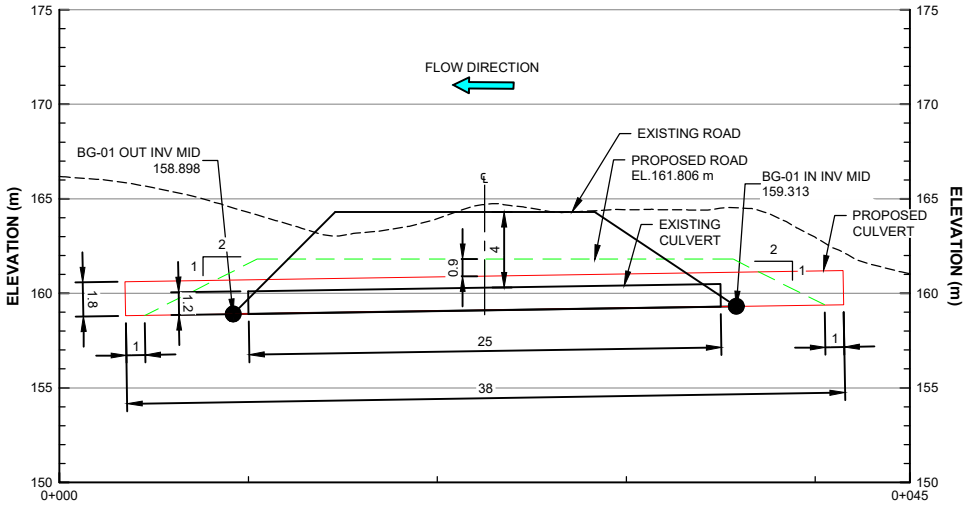
PLAN
TOTE ROAD PRIORITY CROSSING BG-01
SCALE A



1 - FIG
SECTION
TOTE ROAD PRIORITY CROSSING BG-01
SCALE B

LEGEND:

- PROPOSED CULVERT
- EXISTING CULVERT
- PROPOSED ROAD COVER AND EMBANKMENT SLOPES
- PROPOSED CULVERT LOCATION
- EXISTING GROUND BASED ON TOPOGRAPHY
- FLOW DIRECTION
- EXISTING GROUND BASED ON BAFFINLAND'S 2022 SURVEY

NOTES:

1. COORDINATE GRID IS UTM NAD83, ZONE 17.
2. IMAGERY PROVIDED BY BAFFINLAND IRON MINES CORPORATION, AUGUST 2022. © DIGITAL GLOBE, 2022.
3. CONTOUR INTERVAL IS 1 METRE.
4. ONLY ONE CULVERT IS SHOWN FOR CLARITY.
5. ALL WORK TO BE COMPLETED DURING FROZEN CONDITIONS.
6. BLASTING MATS MAY BE USED, IF REQUIRED, FOR BLASTING OF SOIL TO REMOVE THE EXISTING CULVERTS. ONCE EXCAVATION HAS REACHED THE CULVERTS, THEY WILL BE REMOVED AND THE NEW CULVERTS INSTALLED AS PER THE WORK PLAN.
7. ALL BLASTING SPOILS TO BE REMOVED FROM SITE AND DISPOSED AT APPROPRIATE LOCATIONS.
8. CULVERTS TO BE BACKFILLED TO ESTABLISH ROAD SIDE SLOPES AT 2H:1V. ALL SLOPES WILL BE STABILIZED WITH 300 mm THICK RIPRAP OVERLYING NON-WOVEN GEOTEXTILE AS SHOWN ON DRAWING 190.
9. INCOMPLETE SURVEY SO CULVERT POSITIONING IS FOR VISUAL REPRESENTATION ONLY.

SCALE A: 10 5 0 10 20 30 40 50 m

SCALE B: 4 2 0 4 8 12 16 20 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	28OCT'22	ISSUED WITH REPORT	GMJ	TAE	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

BG-01
PLAN AND SECTION

Knight Piésold CONSULTING

P/A NO. NB102-181/77

REF NO. 3

FIGURE B20.2

REV 0

APPENDIX C

Fish Passage Assessment

(Pages C-1 to C-12)

APPENDIX C
FISH PASSAGE ASSESSMENT

1.0 FISH USE

Streams and rivers within the study area dry up or freeze solid during winter, hence fish must overwinter in lakes, or possibly large pools within large rivers, where they exist. Based on literature and fisheries data collected at the Project site, North/South Consultants Inc. (NSC) note that juvenile and young-of-year char move upstream into the smaller tributaries to access rearing and foraging habitat in spring. Spring movements typically begin as streams begin to flow and water temperatures reach approximately 5-7°C. Typically, the number of Arctic Char moving upstream will increase until water temperatures reach about 15°C. Although the general pattern is upstream movement during spring, juveniles may also return to lakes, likely in response to changes in flow or reductions in water temperature. Juvenile Arctic Char are thought to move into these tributaries for early access to warmer water and foraging habitat and to avoid predators. Figure C.1 presents daily catch rates for Arctic char captured in hoop nets set in Sheardown Lake Tributary 1 in the spring of 2008 (NSC, pers. comm.). Two hoop nets were set near the mouth of the stream with the objective of evaluating the timing of fish movements and stream utilization. One faced upstream (US Catch) and one downstream (DS Catch) to look at direction of fish movements.

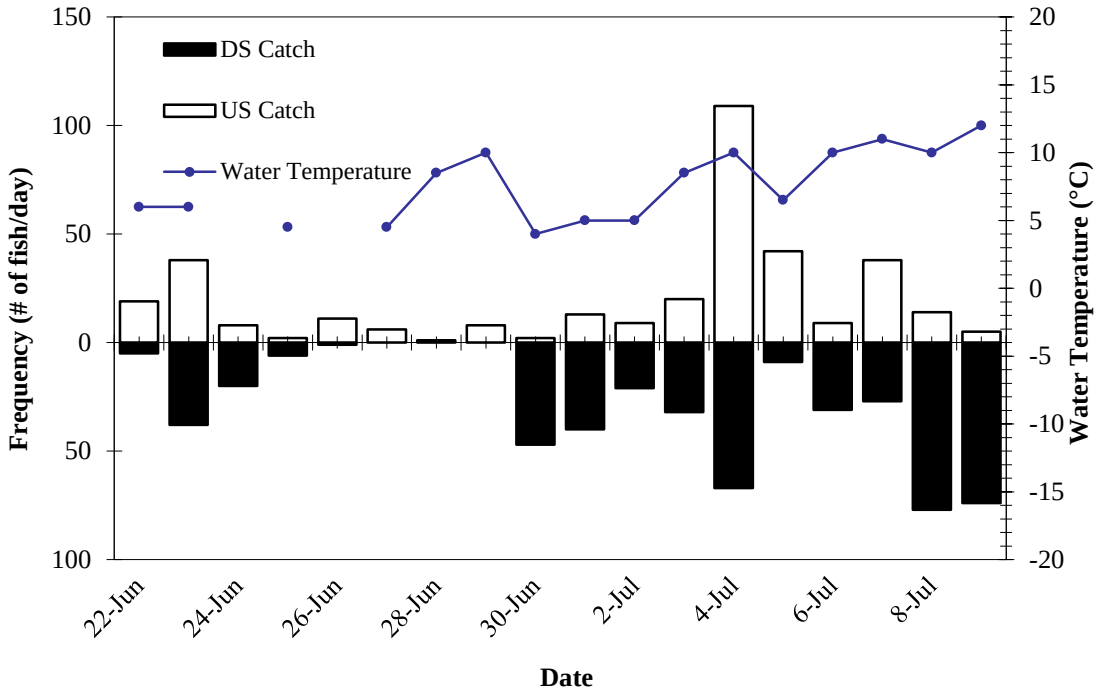


Figure C.1 Hoop Net Catch Rates of Arctic Char, Sheardown Lake Tributary 1, Spring 2008

During fall, juvenile Arctic Char typically initiate return movements to overwintering habitat as water temperature decreases to about 7°C. Peak fall movements occur as temperatures in tributaries decrease from 7° to 2°C after which few fish remain in the streams (Figure C.2; NSC, pers. comm.).

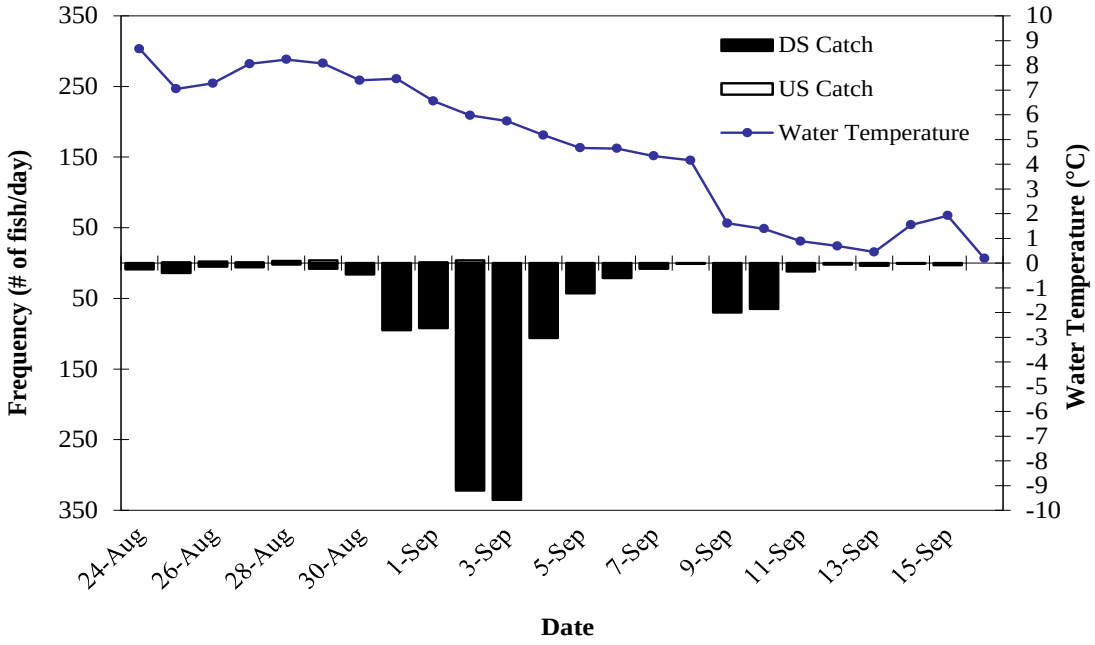


Figure C.2 Hoop Net Catch Rates of Arctic Char, Sheardown Lake Tributary 1, Fall 2007

2.0 HYDROLOGIC ESTIMATES

A hydrologic analysis has been completed to determine mean monthly flows during July and August at the confirmed and potentially fish-bearing tote road alignment crossings.

A hydrology baseline analysis for the Mary River Project was completed previously (KP, 2012). The analysis used the Project streamflow data collected over the period of 2006 to 2011, which included data from up to 16 stations on smaller river/creek systems and from four stations on larger systems. The 16 stations on smaller river/creek systems were managed by KP and operated during the open water season. The four stations on larger systems were operated year-round by the Water Survey of Canada (WSC). Since 2012, Baffinland has continued to operate seven of the baseline hydrometric stations. The hydrology at the seven stations (H01, H02, H04, H05, H06, H07 and H11) was reviewed and updated based on recent data available to the end of 2021. The mean monthly unit runoff for July and August (discharge per km^2) is presented in Table C.1.

Table C.1 Estimated Long-Term Mean Streamflow

	Mean Monthly Unit Discharge (l/s/km^2)						
Hydrometric Station	**H01**	**H02**	**H04**	**H05**	**H06**	**H11**	**Average**
Catchment Area (Km^2)	250	210	8.3	5.3	240	3.6	N/A
July	34.7	60.5	34.8	31.7	57.7	20.4	39.9
August	17.7	24.8	20.8	22.0	23.1	23.0	21.9

The Milne Tote Road crossing catchment areas vary from approximately 0.66 km^2 to 207.47 km^2. Runoff from the crossing catchments is expected to vary with physiographic factors including size, aspect, latitude, and lake content. However, given the hydrology, climate, and physiography datasets available for the catchments upstream of the crossings, it was not possible to develop a model that considered all these factors. Consequently, monthly unit runoff at H6, which has the highest unit runoff was selected to predict watershed runoff. The high unit runoff results in relatively high culvert flow velocities and, as such, is considered conservative for the fish passage assessment.

3.0 CULVERT DEPTH AND VELOCITIES

The water depth and velocity within the proposed culverts (as per Baffinland, 2022) at each crossing was determined using Manning's equation for open channel flow. A Microsoft Excel model was developed, which uses the goal seek tool within a VBA Macro to determine the resulting depth and velocity in all the culverts from given flows, pipe diameters and pipe slopes. The goal seek tool is an iterative function that determines the culvert water depth that would occur during the given flow at the 20 known or potential char-bearing CSP culvert installations in streams along the Tote Road. Using the flow data at the six hydrometric stations, average July and August mean monthly unit discharges were calculated for each station. The average across all stations for July and August were used to estimate the flow in the 20 CSP culvert crossings (39.9 l/s/km^2 for July and 21.9 l/s/km^2 for August, respectively) and the updated catchment areas. The model determines cross section average velocity and maximum depth at each crossing.

Key assumptions in this hydraulics analysis include:

- The culverts are circular corrugated steel pipe
- Depths and velocities are associated with the hydraulic normal depth (i.e., there is no backwatering from downstream)
- The invert of unembedded culverts is assumed to be at the same elevation as the top of the bed in the embedded culvert
- Where the channel is split into multiple channels (e.g., at fans), flow is assumed to be uniformly distributed amongst the channels
- A Manning's n of 0.024 for CSP culverts (Hatch, 2018)
- A Manning's n of 0.08 for the embedded culverts. This value is based on estimates derived from Jarrett (1984) for typical slopes and hydraulic radius in the culverts and hydraulic model calibration conducted previously for the project (KP, 2011)

All results presented in the following sections are modelled cross-section average velocity and maximum water depth results for the embedded culvert.

4.0 OBSERVED CONDITIONS AND MODEL VALIDATION

The 20 water crossings along the Milne Inlet Tote Road that require remedial measures have been surveyed for fish presence annually beginning between 2006 and 2021, and each of the locations have been sampled 12-25 times across multiple seasons (NSC, 2021). The field surveys were intended to provide empirical assessments of the presence/absence of fish, to identify fish barriers, and to document aquatic habitat in the water crossing streams. The monitoring has included habitat assessments including depth, wetted width, bank full width and velocities and assessment of potential fish use along 50 m reaches upstream and downstream of each applicable crossing.

Because it is assumed that the embedded culvert has a similar gradient and bed material roughness to the adjacent channel, it would be expected that the culvert would have similar hydraulic characteristics to the adjacent channel. The ranges and mean values of the measurement conditions were compared to the calculated values for the culvert depths and velocities. Measured and modelled velocities and depths for July are shown in Table C.2.

In general, the culverts have higher average velocities and higher total depth than the mean velocities and depths at each crossing. Photos of the stream conditions from Baffinland are shown in Appendix B.

The measured conditions were not used to calibrate the culvert hydraulics model and there are many reasons why the measured and modelled conditions would not match (e.g., different flow conditions, field measurements at the stream crossings are point measurements of depths and velocities). However, the comparison is considered to show reasonable agreement between measured velocities in the natural channel and modelled conditions in the culverts.

The measured data also show the variability in depth and velocity within a reach, which will be maintained in the culverts. Katopodis and Gervais (2016) note that fish can detect and utilize zones of lower velocity and that studies of fish movement through culverts have shown that small fish can take advantage of the low velocity boundary layer along the culvert wall to achieve passage where hydraulic conditions permit (Light et al., 2013; Peterson et al., 2013; Powers et al., 1997). The concept of a low velocity “sweet spot” is shown on Figure C.3.

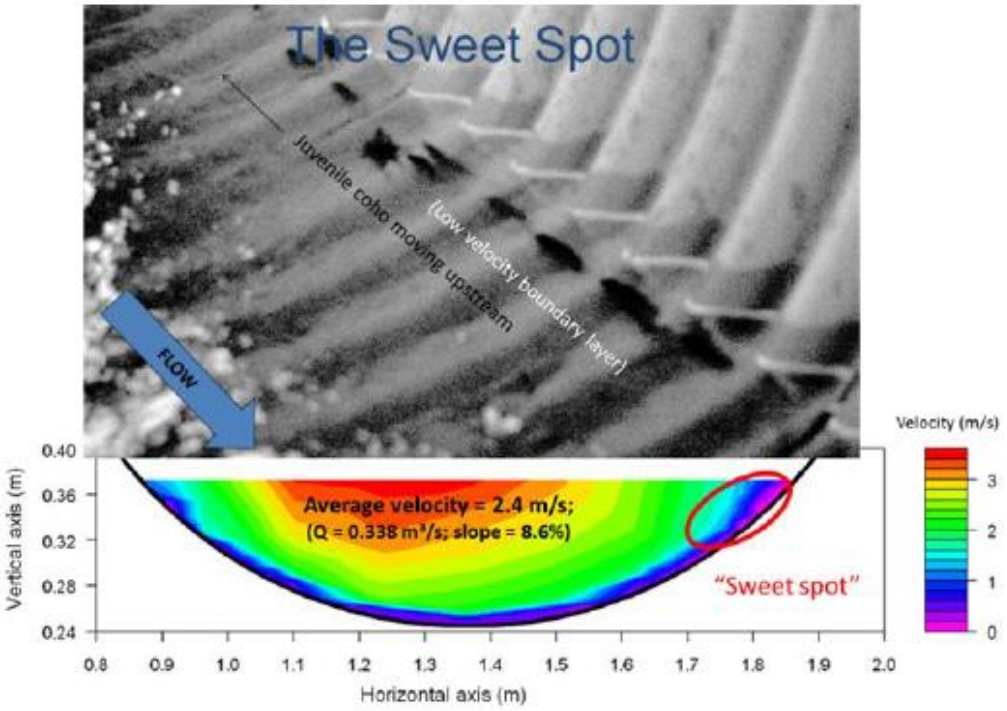


Figure C.3 Low Velocity "Sweet Spot" Used by Smaller Fish (Katopodis and Gervais, 2016)

Katopodis and Gervais (2016) note that misrepresentation of swimming performance can occur when passage success is reported based on average velocity when in fact fish are using zones of lower velocity. The size of the fish relative to low velocity zone is a factor in the ability to exploit these areas during passage. Hence, calculated average velocities should not be strictly interpreted as the flow velocity that the juvenile and young-of-year Arctic Char in the subject streams will need to pass.

Table C.2 Measured and Modelled Depths and Velocities in Existing Culverts

Location	Measured Depth (m)	Modelled Depth (m)	Measured Velocity (m/s)[1]	Modelled Velocity Inside Culvert (m/s)
BG-01	>0.10	0.15	US: 1.08 DS: 2.20	1.13
CV-224[3]	0.05-0.10	0.08	US: 0.66 DS: 0.61	0.83
CV-225	>0.10	0.33	US:0.84 DS: 2.06	1.53
BG-04	0.10-0.50	0.33	US: 0.80 DS: 0.70	1.24
BG-17	0.50	0.40	US: 0.92 DS: 0.78	0.97
BG-24	0.08-0.18	0.09	US: 0.56 DS: 1.23	1.40
BG-27	<0.10	0.07	US: 0.59 DS: 1.05	1.04
BG-30	0.05-0.07	0.11	US: 0.27 DS: 1.16	0.76
CV-216	<0.05	0.74	US: 0.53 DS: 0.95	1.63

Location	Measured Depth (m)	Modelled Depth (m)	Measured Velocity (m/s)[1]	Modelled Velocity Inside Culvert (m/s)
BG-50 5%[2]	<0.50	0.96	<0.25	0.74
BG-50 10%[2]	<0.50	0.96	<0.25	0.96
BG-50 15%[2]	<0.50	0.96	<0.25	1.03
BG-50 25%[2]	<0.50	0.96	<0.25	1.10
CV-001	0.05-0.28	0.10	US: 0.01 DS: 0.43	0.55
CV-057	0.20 with deep pools >0.20	0.15	US: 0.00 DS: 0.05	0.70
CV-059	0.20 with deep pools >0.20	0.13	US: 0.10 DS: 0.08	1.35
CV-078	0.17-0.60	0.12	US: 0.69 DS: 0.10	1.77
CV-079	0.10-0.20	0.63	US: 0.62 DS:0.93	1.65
CV-102	0.07-0.10	0.08	US: 0.54 DS: 0.36	0.82
CV-106	-	0.14	US: 0.17 DS: 0.21	0.94
CV-111	0.05-0.15	0.20	US: 0.63 DS:1.65	1.34
CV-112	0.06-0.25	0.08	US: 0.62 DS: 0.33	0.86
CV-114	0.05-0.15	0.09	US: 0.94 DS: 0.52	1.57

Note(s):

1. Measured velocities during the Spring 2021 Survey (US = Upstream, DS = Downstream).
2. Most of the flow at BG-50 passes under the bridge, and the proportion of the flow that reports to the culverts is unknown. To account for this, varying percentages of the total catchment area (5-25%) were used to evaluate the results.
3. For culvert location CV-224 the Fall 2021 Survey velocities were used since this location was frozen during the Spring 2021 Survey.

5.0 FISH PASSAGE VELOCITY THRESHOLDS

The predicted culvert velocities were used as an indicator of potential fish migration barriers. NSC determined velocity thresholds as a function of culvert length for 88 mm and 256 mm length Arctic Char (i.e., the mean and maximum lengths of char, respectively, captured during field programs conducted in affected drainages from 2006-2018), using the equations provided in Katopodis and Gervais (2016). The velocity thresholds are shown in Table C.3.

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TABLE C.3

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

PERMANENT CROSSING PLAN - 20 TOTE ROAD CROSSINGS
CULVERT PASSAGE FISH SWIMMING VELOCITY THESHOLDS

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Velocity Thresolds (m/s)											
88 mm Arctic Char						256 mm Arctic Char					
Culvert Length (m)	5% Passage (95% High)	25% Passage (75% High)	50% Passage (Mean)	75% Passage (75% Low)	95% Passage (95% Low)	Culvert Length (m)	5% Passage (95% High)	25% Passage (75% High)	50% Passage (Mean)	75% Passage (75% Low)	95% Passage (95% Low)
100	0.64	0.45	0.27	0.16	0.11	100	1.56	1.09	0.65	0.39	0.27
95	0.65	0.45	0.27	0.16	0.11	95	1.59	1.11	0.66	0.39	0.27
90	0.66	0.46	0.28	0.16	0.12	90	1.62	1.13	0.67	0.40	0.28
85	0.68	0.47	0.28	0.17	0.12	85	1.65	1.15	0.68	0.41	0.28
80	0.69	0.48	0.29	0.17	0.12	80	1.68	1.17	0.70	0.42	0.29
75	0.71	0.49	0.29	0.17	0.12	75	1.72	1.20	0.71	0.43	0.30
70	0.72	0.50	0.30	0.18	0.12	70	1.76	1.22	0.73	0.44	0.30
65	0.74	0.52	0.31	0.18	0.13	65	1.81	1.26	0.75	0.45	0.31
60	0.76	0.53	0.32	0.19	0.13	60	1.85	1.29	0.77	0.46	0.32
55	0.78	0.54	0.33	0.19	0.13	55	1.91	1.33	0.79	0.47	0.33
50	0.81	0.56	0.34	0.20	0.14	50	1.97	1.37	0.82	0.49	0.34
45	0.84	0.58	0.35	0.21	0.14	45	2.04	1.42	0.85	0.51	0.35
40	0.87	0.61	0.36	0.22	0.15	40	2.12	1.48	0.88	0.53	0.37
35	0.91	0.63	0.38	0.23	0.16	35	2.22	1.54	0.92	0.55	0.38
30	0.96	0.67	0.40	0.24	0.17	30	2.34	1.62	0.97	0.58	0.40
25	1.02	0.71	0.42	0.25	0.18	25	2.48	1.73	1.03	0.61	0.43
20	1.10	0.76	0.46	0.27	0.19	20	2.68	1.86	1.11	0.66	0.46
15	1.21	0.84	0.50	0.30	0.21	15	2.95	2.05	1.22	0.73	0.51
10	1.38	0.96	0.57	0.34	0.24	10	3.37	2.35	1.40	0.83	0.58
5	1.75	1.21	0.72	0.43	0.30	5	4.25	2.96	1.76	1.05	0.73
Culvert Length (m)	5% Passage (95% High)	25% Passage (75% High)	50% Passage (Mean)	75% Passage (75% Low)	95% Passage (95% Low)	Culvert Length (m)	5% Passage (95% High)	25% Passage (75% High)	50% Passage (Mean)	75% Passage (75% Low)	95% Passage (95% Low)
100	0.85	0.59	0.35	0.21	0.15	100	2.08	1.45	0.86	0.51	0.36
95	0.87	0.60	0.36	0.21	0.15	95	2.12	1.47	0.88	0.52	0.36
90	0.88	0.61	0.37	0.22	0.16	90	2.15	1.50	0.89	0.53	0.37
85	0.90	0.63	0.37	0.22	0.16	85	2.20	1.53	0.91	0.54	0.38
80	0.92	0.64	0.38	0.23	0.16	80	2.24	1.56	0.93	0.55	0.39
75	0.94	0.65	0.39	0.23	0.17	75	2.29	1.59	0.95	0.57	0.39
70	0.96	0.67	0.40	0.24	0.17	70	2.34	1.63	0.97	0.58	0.40
65	0.99	0.69	0.41	0.24	0.17	65	2.40	1.67	1.00	0.59	0.41
60	1.01	0.70	0.42	0.25	0.17	60	2.47	1.71	1.02	0.61	0.42
55	1.04	0.72	0.43	0.26	0.18	55	2.54	1.77	1.05	0.63	0.44
50	1.08	0.75	0.45	0.27	0.19	50	2.62	1.82	1.09	0.65	0.45
45	1.11	0.77	0.46	0.28	0.19	45	2.71	1.89	1.13	0.67	0.47
40	1.16	0.81	0.48	0.29	0.20	40	2.82	1.96	1.17	0.70	0.49
35	1.21	0.84	0.50	0.30	0.21	35	2.95	2.05	1.22	0.73	0.51
30	1.28	0.89	0.53	0.32	0.22	30	3.11	2.16	1.29	0.77	0.53
25	1.36	0.94	0.56	0.34	0.23	25	3.30	2.30	1.37	0.82	0.57
20	1.46	1.02	0.61	0.36	0.25	20	3.56	2.47	1.48	0.88	0.61
15	1.61	1.12	0.67	0.40	0.28	15	3.92	2.72	1.63	0.97	0.67
10	1.84	1.28	0.76	0.46	0.32	10	4.49	3.12	1.86	1.11	0.77
5	2.32	1.61	0.96	0.57	0.40	5	5.66	3.93	2.35	1.40	0.97

I:\1\02\00181\77\A\Data\WF02 - Flow Estimation and Fish Passage Assessment\Refs\REF3 - Culvert Crossing Assessment\Issued with Report 3 - 20 Crossings\[Culvert Crossings Monthly Flow-AfterRemediation-20Crossings.xlsm]Velocity thresholds

NOTES:

1. DATA PROVIDED BY NSC (PERS. COMM., 2 JUNE 2019), CALCULATED FROM EQUATIONS PROVIDED BY KATOPODIS AND GERVAIS (2016)

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	28OCT'22	ISSUED WITH REPORT NB101-181/77-3	GMJ	TJP

6.0 ESTIMATED MEAN FLOW VELOCITIES

Mean culvert velocity under July and August flow conditions was compared to the 75% passage thresholds (i.e., 50% to 75% of fish are expected to be able swim faster than the average culvert velocity). As noted above, average velocity may not reflect the velocity in the area within the culvert used by fish to move up the culvert. Additionally, modelled flows may not represent conditions when fish are moving upstream.

The number of crossings exceeding the velocity thresholds for the two flow conditions and fish sizes are presented in Table C.4. The total number of culverts used for Table C.4 is 24 as it includes the sensitivity analysis of 5%, 10%,15% and 25% of the total catchment area contributing to culvert BG-50 and the two sizes of culverts at BG-17 labelled BG-17A and BG-17B.

Results are presented in Table C.5 for the existing culvert installations, and in Table C.6 for the proposed culvert replacements. The tables identify crossings that exceed the threshold criteria for the given mean flow conditions.

As noted above, fish passage is not necessarily restricted if the average flow velocity exceeds the flow velocity thresholds, as the flow within a channel (even a culvert) can vary considerably across the culvert section.

Table C.4 Existing Culverts with Modelled Average Flow Velocities Exceeding Thresholds

Category	July Velocity Thresholds (75% Passage)		August Velocity Thresholds (75% Passage)	
	88 mm Char	256 mm Char	88 mm Char	256 mm Char
Exceed	24	21	24	14
Do Not Exceed	0	3	0	10
% Exceeding	100%	88%	100%	58%

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TABLE C.5

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

PERMANENT CROSSING PLAN - 20 TOTE ROAD CROSSINGS
FISH PASSAGE RISK ASSESSMENT - EXISTING CULVERTS

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Crossing Name	Culvert?	Catchment Areas (km²)	No. Barrels	Culvert Diameter (mm)	Culvert Length (m)	Slope (%)	Mean Monthly Flow (L/s)		Fish Bearing?	Embedded Culvert Cross-Section Average Velocity (m/s)		Embedded Culvert Cross-Section Max. Depth (m)		July Velocity Thresholds (75% Passage)		August VelocityThresholds (75% Passage)		Risk Assessment								Study Area	Notes
	Y/N						July	August	Y/P[5]	July	August	July	August	88 mm Char	256 mm Char	88 mm Char	256 mm Char	Embedded Score	Outlet drop Score	Passage %	Velocity Score	Depth Score	Length Score	Cumulative Score	Result		
BG-01	Y	5.80	3	1200	25	1.66	231.5	127.1	Y	1.13	0.94	0.12	0.09	Exceeded	Exceeded	Exceeded	Exceeded	1	0	< 5% Passage	4	1	0	6	HIGH	Tote Road	
CV-224	Y	1.84	2	1200	23	1.50	73.5	40.4	Y	0.83	0.68	0.08	0.06	Exceeded	Exceeded	Exceeded	Not Exceeded	2	2	< 25% Passage	3	1	0	8	HIGH	Tote Road	
CV-225	Y	8.56	2	1200	45	3.69	341.7	187.6	Y	1.84	1.53	0.14	0.10	Barrier	Exceeded	Barrier	Exceeded	1	2	Barrier	0	1	1	11	HIGH	Tote Road	
BG-04	Y	7.37	2	1000	23	1.28	294.2	161.5	Y	1.24	1.04	0.19	0.14	Exceeded	Exceeded	Exceeded	Exceeded	1	0	< 5% Passage	4	1	0	6	HIGH	Tote Road	
BG-17A	Y	8.52	2	1000	45	0.54	339.7	186.5	Y	0.94	0.79	0.26	0.19	Exceeded	Exceeded	Exceeded	Exceeded	1	0	< 5% Passage	4	0	1	6	HIGH	Tote Road	
BG-17B	Y	8.52	1	2000	45	0.54	339.7	186.5	Y	0.99	0.81	0.24	0.17	Exceeded	Exceeded	Exceeded	Exceeded	1	0	< 5% Passage	4	0	1	6	HIGH	Tote Road	
BG-24	Y	5.99	4	1200	15	3.54	239.2	131.3	Y	1.40	1.16	0.09	0.07	Exceeded	Exceeded	Exceeded	Exceeded	2	2	< 5% Passage	4	1	0	9	HIGH	Tote Road	
BG-27	Y	0.66	3	500	12	6.03	26.5	14.5	Y	1.04	0.86	0.04	0.03	Exceeded	Exceeded	Exceeded	Not Exceeded	1	2	< 25% Passage	3	1	0	7	HIGH	Tote Road	
BG-30	Y	1.50	1	1000	32	0.88	59.8	32.8	Y	0.76	0.62	0.11	0.08	Exceeded	Exceeded	Exceeded	Not Exceeded	2	2	< 25% Passage	3	1	1	9	HIGH	Tote Road	
CV-216	Y	24.76	3	1200	24	1.46	987.9	542.2	Y	1.63	1.38	0.27	0.20	Barrier	Exceeded	Barrier	Exceeded	1	0	Barrier	0	0	0	11	HIGH	Tote Road	
BG-50 5%	Y	10.37	2	1200	24	0.24	413.9	227.2	Y	0.74	0.62	0.33	0.24	Exceeded	Not Exceeded	Exceeded	Not Exceeded	1	2	< 25% Passage	3	0	0	6	HIGH	Tote Road	
BG-50 10%	Y	20.75	2	1200	24	0.24	833.7	454.4	Y	0.96	0.75	0.48	0.35	Exceeded	Exceeded	Exceeded	Not Exceeded	1	2	< 5% Passage	4	0	0	7	HIGH	Tote Road	
BG-50 15%	Y	31.12	2	1200	24	0.24	1241.7	681.5	Y	1.03	0.84	0.62	0.44	Exceeded	Exceeded	Exceeded	Exceeded	1	2	< 5% Passage	4	0	0	7	HIGH	Tote Road	
BG-50 25%	Y	51.87	2	1200	24	0.24	2069.5	1135.9	Y	1.10	1.02	0.93	0.58	Exceeded	Exceeded	Exceeded	Exceeded	1	2	< 5% Passage	4	0	0	7	HIGH	Tote Road	
CV-001	Y	1.84	3	1000	17	0.54	73.4	40.3	Y	0.55	0.46	0.10	0.07	Exceeded	Not Exceeded	Exceeded	Not Exceeded	2	2	< 50% Passage	2	1	0	7	HIGH	Tote Road	
CV-057	Y	0.79	2	500	17	1.29	31.4	17.2	Y	0.70	0.58	0.08	0.05	Exceeded	Not Exceeded	Exceeded	Not Exceeded	2	0	< 25% Passage	3	1	0	6	HIGH	Tote Road	
CV-059	Y	2.70	4	500	18	4.80	107.7	59.1	Y	1.35	1.14	0.08	0.06	Exceeded	Exceeded	Exceeded	Exceeded	2	0	< 5% Passage	4	1	0	7	HIGH	Tote Road	
CV-078	Y	21.72	5	2400	24	3.50	866.6	475.7	Y	1.77	1.47	0.12	0.09	Barrier	Exceeded	Barrier	Exceeded	1	0	Barrier	0	1	0	11	HIGH	Tote Road	
CV-079	Y	22.36	2	1200	15	1.26	892.0	489.6	Y	1.65	1.40	0.32	0.23	Barrier	Exceeded	Exceeded	Exceeded	1	0	Barrier	0	0	0	11	HIGH	Tote Road	
CV-102	Y	1.77	4	1000	27	2.04	70.8	38.9	Y	0.82	0.68	0.06	0.04	Exceeded	Exceeded	Exceeded	Not Exceeded	2	0	< 25% Passage	3	1	0	6	HIGH	Tote Road	
CV-106	Y	0.98	1	1000	21.5	2.54	39.1	21.4	Y	0.94	0.76	0.06	0.04	Exceeded	Exceeded	Exceeded	Not Exceeded	1	2	< 25% Passage	3	1	0	7	HIGH	Tote Road	
CV-111	Y	2.66	1	1000	31	2.69	106.1	58.3	Y	1.34	1.10	0.11	0.08	Barrier	Exceeded	Exceeded	Exceeded	1	2	Barrier	0	1	1	11	HIGH	Tote Road	
CV-112	Y	2.70	3	1200	24	1.47	107.8	59.2	Y	0.86	0.71	0.08	0.06	Exceeded	Exceeded	Exceeded	Not Exceeded	2	2	< 25% Passage	3	1	0	8	HIGH	Tote Road	
CV-114	Y	3.27	2	1000	22.5	5.08	130.5	71.6	Y	1.57	1.29	0.08	0.06	Barrier	Exceeded	Exceeded	Exceeded	1	2	Barrier	0	1	0	11	HIGH	Tote Road	

I:\1\02\00181\77\A\Data\WF02 - Flow Estimation and Fish Passage Assessment\Refs\REF3 - Culvert Crossing Assessment\issued with Report 3 - 20 Crossings\[Culvert Crossings Monthly Flow-BeforeRemediation-20Crossings.xlsm]Results Table

NOTES:

1. JULY AND AUGUST VELOCITY RESULTS ARE CALCULATED FROM MEAN MONTHLY FLOWS DURING THOSE MONTHS IN EMBEDDED CULVERTS. ALL VELOCITIES ARE CROSS SECTION AVERAGE VALUES.
2. JULY AND AUGUST DEPTH RESULTS ARE CALCULATED FROM THE MEAN MONTHLY FLOWS DURING THOSE MONTHS. ALL DEPTHS ARE CROSS SECTION MAXIMUM VALUES.
3. PLATE ARCH CULVERTS AND BRIDGES ARE NOT ASSESSED IN THIS TABLE.
4. "Y" = YES, "P" = POTENTIALLY.
5. EMBEDDED CULVERT SCORES: > 20% OF DIAMETER AND CONTINUOUS = 1, < 20% OF DIAMETER AND/OR DISCONTINUOUS = 0.
6. OUTLET DROP CULVERT BARRIER SCORES: NO DROP = 0, DROP = 1.
7. VELOCITY SCORES: VELOCITY THRESHOLD NOT EXCEEDED = 0, VELOCITY THRESHOLD EXCEEDED = 1.
8. FISH SCORES: P = 0, Y = 1.
9. LENGTH BARRIER SCORE: < 30 m = 0, > 30 m = 1.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	28'OCT22	ISSUED WITH REPORT NB101-181/77-3	GMJ	TJP

Knight Piésold CONSULTING

TABLE C.6

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

PERMANENT CROSSING PLAN - 20 TOTE ROAD CROSSINGS
FISH PASSAGE RISK ASSESSMENT - PROPOSED REPLACEMENT CULVERTS

Print Oct-28-22 16:19:58

Crossing Name	Culvert?	Catchment Areas (km²)	No. Barrels	Culvert Diameter (mm)	Culvert Length (m)	Slope (%)	Mean Monthly Flow (L/s)		Fish Bearing?	Embedded Culvert Cross-Section Average Velocity (m/s)		Embedded Culvert Cross-Section Max. Depth (m)		July Velocity Thresholds (75% Passage)		August VelocityThresholds (75% Passage)		Risk Assessment							Study Area	Notes
	Y/N						July	August	Y/P[5]	July	August	July	August	88 mm Char	256 mm Char	88 mm Char	256 mm Char	Embedded Score	Outlet drop Score	Passage %	Velocity Score	Depth Score	Length Score	Cumulative Score	Result		
BG-01	Y	5.80	2	1800	38	1.09	231.5	127.1	Y	0.39	0.32	0.17	0.12	Exceeded	Not Exceeded	Exceeded	Not Exceeded	0	0	< 50% Passage	2	1	1	4	MODERATE	Tote Road	
CV-224	Y	1.84	2	1200	31	1.50	73.5	40.4	Y	0.32	0.26	0.10	0.07	Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	0	0	< 50% Passage	2	1	1	4	MODERATE	Tote Road	
CV-225	Y	8.56	3	1800	45	3.69	341.7	187.6	Y	0.58	0.48	0.12	0.09	Exceeded	Not Exceeded	Exceeded	Not Exceeded	0	0	< 25% Passage	3	1	1	5	MODERATE	Tote Road	
BG-04	Y	7.37	2	1800	28	1.05	294.2	161.5	Y	0.46	0.34	0.19	0.14	Exceeded	Not Exceeded	Exceeded	Not Exceeded	0	0	< 50% Passage	2	1	0	3	MODERATE	Tote Road	
BG-17	Y	17.03	4	1800	52	0.46	679.5	373.0	Y	0.36	0.30	0.25	0.18	Exceeded	Not Exceeded	Exceeded	Not Exceeded	0	0	< 50% Passage	2	0	1	3	MODERATE	Tote Road	
BG-24	Y	5.99	4	1200	22	3.54	239.2	131.3	Y	0.51	0.42	0.10	0.08	Exceeded	Not Exceeded	Exceeded	Not Exceeded	0	0	< 50% Passage	2	1	0	3	MODERATE	Tote Road	
BG-27	Y	0.66	2	1000	24	3.01	26.5	14.5	Y	0.30	0.24	0.05	0.04	Not Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	0	0	< 75% Passage	1	1	0	2	LOW	Tote Road	
BG-30	Y	1.50	2	1200	36	0.88	59.8	32.8	Y	0.25	0.21	0.10	0.07	Not Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	0	0	< 75% Passage	1	1	1	3	MODERATE	Tote Road	
CV-216	Y	24.76	5	1800	29	1.21	987.9	542.2	Y	0.53	0.40	0.21	0.16	Exceeded	Not Exceeded	Exceeded	Not Exceeded	0	0	< 25% Passage	3	0	0	3	MODERATE	Tote Road	
BG-50 10%	Y	20.75	4	1800	29	0.20	827.8	454.4	Y	0.29	0.24	0.34	0.25	Not Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	0	0	< 75% Passage	1	0	0	1	LOW	Tote Road	
CV-001	Y	1.84	3	1000	24	0.54	73.4	40.3	Y	0.23	0.17	0.11	0.08	Not Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	0	0	> 95% Passage	0	1	0	1	LOW	Tote Road	
CV-057	Y	0.79	2	1000	22	1.00	31.4	17.2	Y	0.22	0.18	0.08	0.05	Not Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	0	0	> 95% Passage	0	1	0	1	LOW	Tote Road	
CV-059	Y	2.70	3	1200	22	3.93	107.7	59.1	Y	0.44	0.36	0.08	0.06	Exceeded	Not Exceeded	Exceeded	Not Exceeded	0	0	< 50% Passage	2	1	0	3	MODERATE	Tote Road	
CV-078	Y	21.72	3	2000	33	3.50	866.6	475.7	Y	0.76	0.62	0.19	0.14	Exceeded	Exceeded	Exceeded	Not Exceeded	0	0	< 25% Passage	3	1	1	5	MODERATE	Tote Road	
CV-079	Y	22.36	4	1800	27	0.70	892.0	489.6	Y	0.46	0.38	0.26	0.19	Exceeded	Not Exceeded	Exceeded	Not Exceeded	0	0	< 50% Passage	2	0	0	2	LOW	Tote Road	
CV-102	Y	1.77	2	1200	23	2.04	70.8	38.9	Y	0.35	0.29	0.09	0.06	Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	0	0	< 50% Passage	2	1	0	3	MODERATE	Tote Road	
CV-106	Y	0.98	2	1000	24	2.28	39.1	21.4	Y	0.31	0.25	0.07	0.05	Not Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	0	0	< 75% Passage	1	1	0	2	LOW	Tote Road	
CV-111	Y	2.66	1	1800	34	2.45	106.1	58.3	Y	0.48	0.38	0.12	0.09	Exceeded	Not Exceeded	Exceeded	Not Exceeded	0	0	< 50% Passage	2	1	1	4	MODERATE	Tote Road	
CV-112	Y	2.70	2	1200	25	1.47	111.5	59.2	Y	0.41	0.30	0.12	0.09	Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	0	0	< 50% Passage	2	1	0	3	MODERATE	Tote Road	
CV-114	Y	3.27	3	1200	26	4.40	130.5	71.6	Y	0.49	0.40	0.08	0.06	Exceeded	Not Exceeded	Exceeded	Not Exceeded	0	0	< 50% Passage	2	1	0	3	MODERATE	Tote Road	

I:\1\02\00181\77\A\Data\WF02 - Flow Estimation and Fish Passage Assessment\Refs\REF3 - Culvert Crossing Assessment\Issued with Report 3 - 20 Crossings\[Culvert Crossings Monthly Flow-AfterRemediation-20Crossings.xlsm]Results Table

NOTES:

1. JULY AND AUGUST VELOCITY RESULTS ARE CALCULATED FROM MEAN MONTHLY FLOWS DURING THOSE MONTHS IN EMBEDDED CULVERTS. ALL VELOCITIES ARE CROSS SECTION AVERAGE VALUES.
2. JULY AND AUGUST DEPTH RESULTS ARE CALCULATED FROM THE MEAN MONTHLY FLOWS DURING THOSE MONTHS. ALL DEPTHS ARE CROSS SECTION MAXIMUM VALUES.
3. PLATE ARCH CULVERTS AND BRIDGES ARE NOT ASSESSED IN THIS TABLE.
4. "Y" = YES, "P" = POTENTIALLY.
5. EMBEDDED CULVERT SCORES: > 20% OF DIAMETER AND CONTINUOUS = 1, < 20% OF DIAMETER AND/OR DISCONTINUOUS = 0.
6. OUTLET DROP CULVERT BARRIER SCORES: NO DROP = 0, DROP = 1.
7. VELOCITY SCORES: VELOCITY THRESHOLD NOT EXCEEDED = 0, VELOCITY THRESHOLD EXCEEDED = 1.
8. FISH SCORES: P = 0, Y = 1.
9. LENGTH BARRIER SCORE: < 30 m = 0, > 30 m = 1.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	28OCT'22	ISSUED WITH REPORT NB101-181/77-3	GMJ	TJP

7.0 FISH PASSAGE RISK ASSESSMENT

A fish passage risk assessment has been conducted to determine if the existing water crossings require remediation or if the water crossings support fish passage as is. As discussed in appendix B, for each water crossing that requires remediation either based on the fish passage assessment or based on the crossing not meeting the project design criteria, the fish passage assessment was completed on the water crossing after remediation measures are implemented to determine if the remediation measures will be effective.

The assessment is based on methods presented in the BC Ministry of Environment guide, *Field Assessment for Determining Fish Passage Status of Closed Bottom Structures* (BC MoE, 2011), which presents a fish barrier scoring based on culvert embeddedness, outlet drop, stream width ratio, culvert slope and culvert length. We have modified the assessment to align with the available datasets and primary passage considerations at this Project. The assessment is described below.

Embeddedness

A score is assigned to each crossing based on the degree of embeddedness, with a 2 for perched culverts, a 1 for culverts installed up to 10%, and 0 for culverts embedded >10%.

Outlet Drop

If an outlet drop is present above the stream a score of 2 is given. For culverts that match the adjacent channel grade without an outlet drop. The outlet drop score for is assigned a 0.

Velocity

A score is assigned to each crossing based on the velocity thresholds for 88 mm char (see Appendix C) and July flow velocities. Scores are assigned as follows:

- <5% Passage, score = 4
- <25% Passage, score = 3
- <50% Passage, score = 2
- <75% Passage, score = 1
- >95% Passage, score = 0

Water Depth

A score of 1 is assigned to crossings where the August water depth in the culvert is predicted to be less than 0.15 m. If water depth is greater than 0.15 m a score of 0 is assigned.

Culvert Length

If culvert length is less than 30 m, a score of 0 is assigned. If culvert length is greater than 30 m but less than 60 m, a score of 1 is assigned. Culverts longer than 60 m receive a score of 2.

Risk Rating

The minimum and maximum possible scores are 0 and 11, respectively. If the cumulative score of the five metrics is ≤ 2, the risk of fish migration impacts is considered low, if the cumulative score is between 3 and 5 the risk of fish migration impacts is considered moderate and if the cumulative score of the five metrics is ≥6, the risk of impediments to fish passage is considered high. A high-risk rating usually occurs when the culvert contains an outlet drop, a velocity score of ≥3 and combined with a depth score of 1.

All twenty (20) of the existing crossings were rated as high risk.

None of the 20 proposed replacement crossings were rated as high risk, 13 were rated as moderate risk and 7 were rated as low risk.

Mitigation measures will be employed to reduce the risk, including embedding one culvert (or the only culvert) by 40% of its diameter consistent with best practices (Government of British Columbia, 2010) instead of the previous 10% embedment requirement. This level of embeddedness will increase the amount of rough substrate within the culvert (reducing velocity) and will reduce the potential for the culverts to become perched in the future.

An additional culvert was added as a further mitigation measure at several crossings to help reduce the fish passage barrier risk from high to moderate.

8.0 REFERENCES

Baffinland Iron Mines Corporation (Baffinland), 2022. *Milne Inlet Tote Road Remediation Plans*. March 1.

BC Ministry of Environment (BC MoE), 2011. *Field Assessment for Determining Fish Passage Status of Closed Bottom Structures*. 4th Ed., August 2011.

Hatch Ltd. (Hatch), 2018. *Baffinland Iron Mines Corporation - Mary River Expansion Project - Design Criteria: Civil Design Philosophy*. March 12. Ref. No. H353004-00000-200-210-0001, Rev 2.

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Light, J.T., N.P. Peterson, and R.K. Simmons, 2013. Passage of native Cutthroat Trout through small culverts on steep slopes: What are the limits? [PowerPoint slides].

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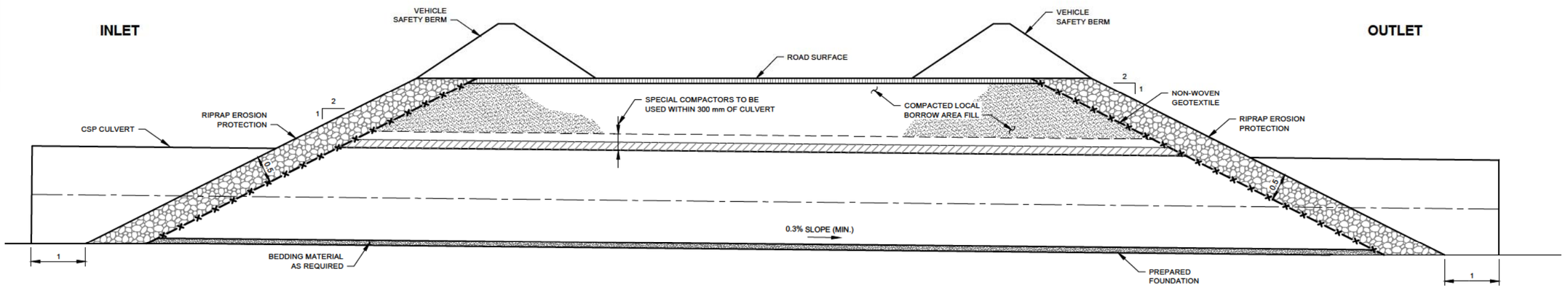
Powers, P. D., Bates, K., Burns, T., Gowen, B., and Whitney, R. 1997. Culvert hydraulics related to upstream juvenile salmonid passage. Washington State Department of Fish and Wildlife, Lands and Restoration Services Program, Project 982740, Olympia.

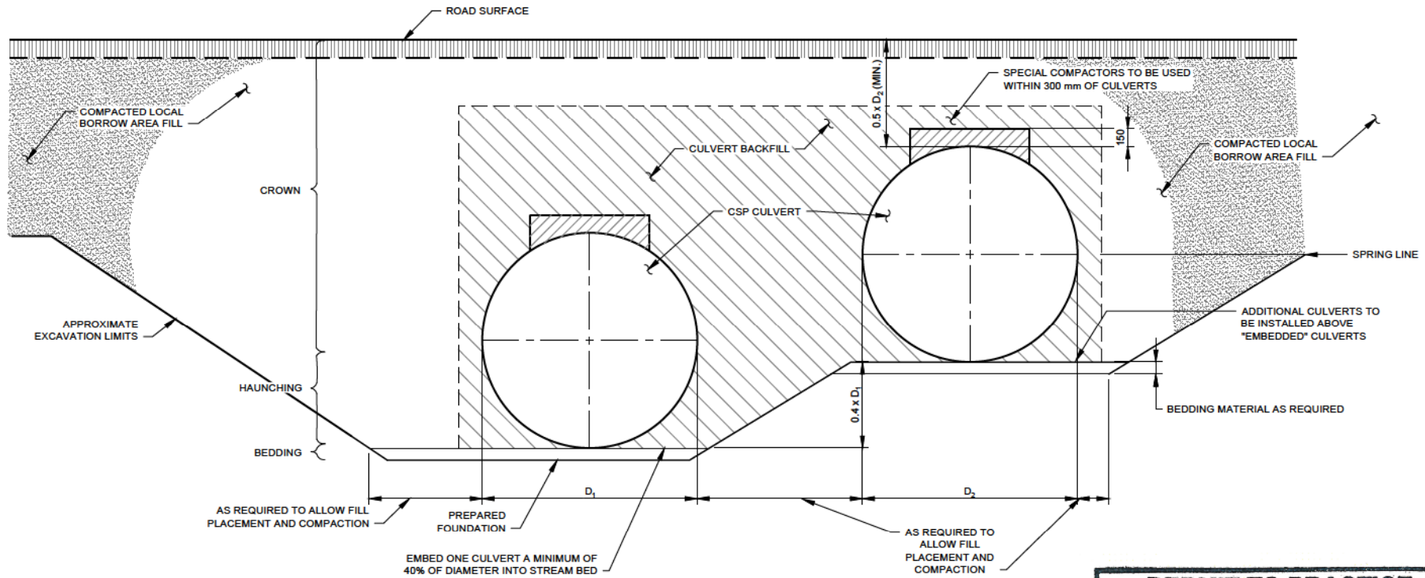
APPENDIX D

Culvert Typical Drawing

(Page D-1)



1 - **SECTION**
TYPICAL CULVERT
SCALE A



A - **DETAIL**
TYPICAL CULVERT INSTALLATION DETAILS
SCALE B

LEGEND:

- COMPACTED LOCAL BORROW AREA FILL
- LOOSE LOCAL BORROW AREA FILL
- CULVERT BACKFILL
- ROAD SURFACING MATERIAL
- RIPRAP
- NON-WOVEN GEOTEXTILE

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

SCALE A 0.8 0.4 0 1 2 3 4 m
SCALE B 0.5 0.25 0 0.5 1.0 1.5 2.0 2.5 m

PERMIT TO PRACTICE
KNIGHT PIESOLD LTD.
Signature
Date 2022-09-07
PERMIT NUMBER: P 547
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
2022-09-07
NWT/NU

Knight Piésold CONSULTING

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

TOTE ROAD CULVERT REMEDIATION
TYPICAL SECTIONS AND DETAILS

REFERENCE DRAWINGS			
DRG. NO.	DESCRIPTION		
-	-		

REVISIONS							
REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED	

REVISIONS							
REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED	
0	07SEP'22	ISSUED IN FINAL	CAP	AS			

CAD FILE NO.	DRAWING NO.	REVISION
NB102-181/77	190	0