# ATTACHMENT 16

## Detailed Water Withdrawal Plan

(72 Pages)

Prepared for
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**NB102-181/65-1**

# MARY RIVER PROJECT
# DETAILED WATER WITHDRAWAL PLAN

| Rev | Description | Date |
|---|---|---|
| 0 | Issued in Final | September 3, 2021 |

# EXECUTIVE SUMMARY

Baffinland Iron Mines Corporation (Baffinland) is permitted to withdrawal water from various locations at its Mary River Project under Type A Water Licence 2AM-MRY1325 issued by the Nunavut Water Board (NWB, 2015). Additional water stations will be required during the Phase 2 Proposal to support improved dust suppression efforts along the Tote Road and the North Railway construction right-of-way from mid-June to mid-September of each year.

Knight Piésold Ltd. (KP) previously provided a desktop hydrology assessment of the potential effects of water withdrawal from the 15 permitted sites and 13 proposed new sites to support the Addendum to the Final Environmental Impact Statement (FEIS) for the Phase 2 Proposal (KP, 2018). During an ongoing reconsideration of Baffinland's Project Certificate by the Nunavut Impact Review Board (NIRB, 2020), Baffinland agreed to develop this Detailed Water Withdrawal Plan in response to a request by the Fisheries and Oceans Canada (DFO).

Fish use and fish habitat features as well as site access constraints were assessed at 44 existing and proposed water withdrawal locations between August 29 and September 1, 2019. Refined information has also been received from Baffinland regarding pumping rates and updated water requirements from each site. Based on the results of these surveys and additional information, Baffinland now expects to withdraw water from a total of 21 sites along the road and rail alignment (10 approved and 11 proposed).

The potential impacts of flow withdrawal on fish and fish habitat can be assessed by understanding the mechanisms and stressors that cause effects in the aquatic environment. Water withdrawal has the potential to impact fish and fish habitat through the following mechanisms (DFO, 2010a):

- Placement of structures in water
- Entrainment in pumps / impingement on screens
- Use of industrial equipment
- Oxygen depletion, loss of over-wintering habitat, and/or reductions in littoral habitat during winter water withdrawal from ice-covered waterbodies
- Changes in flow volumes or timing, duration, and frequency of flow

This assessment consists of hydrological assessments and site-specific assessments of fish habitat.

The method to assess potential impacts of water withdrawals on fish habitat in streams has been revised. Rather than comparing maximum pumping rates to mean monthly and 10-year dry unit runoff flows, the withdrawal rates were compared against mean daily flows calibrated to site hydrology stations with watersheds of similar size for which long-term hydrological data are available. The percentage of time that the withdrawal rate meets or exceeds the threshold of 10% in magnitude of the instantaneous flow in the river was determined relative to a "natural flow regime" (DFO, 2013a). Water withdrawals from lakes during open water were assessed against mean monthly and 10-year annual low flow lake outflows, and water withdrawals from lakes during ice cover were compared against the 10% of under-ice water volume threshold established by DFO (2010b).

Site-specific habitat assessments were undertaken for each of the water stations except Camp Lake, which is already equipped with a permanent jetty.

Water can be extracted at the maximum pumping rate of 5.7 $m^3$/min at any time between mid-June and mid-September without exceeding 10% of the instantaneous flow at seven stations within the lower Phillips Creek catchment: MP-MRY-2, WS9.2, WS13.3, WS17.4, WS20.5, WS23.3 and WS37.0.

Water can be extracted at lower pumping rates at any time between mid-June and mid-September without exceeding 10% of the flow 99% of the time between mid-June to mid-September at six stations including: WS42.0 (2.6 $m^3$/min), WS45.0 (2.5 $m^3$/min) and WS47.1 (2.3 $m^3$/min) within the upper portion of the Phillips Creek catchment, WS63.5A and WS63.5B on the Ravn River (2.5 $m^3$/min), and WS97.0 on the Tom River (3.4 $m^3$/min). The flows are adequate to extract water at the maximum pumping rate (5.7 $m^3$/min) at these stations 90% to 95% of the time.

The cumulative water withdrawal from thirteen (13) water stations located on Phillips Creek was assessed, based on the maximum quantity of water that could be withdrawn by 11 water trucks (7,700 $m^3$.day) during construction of the North Railway. This daily extraction volume represents 3% of the flow that is exceeded 99% of the time between mid-June to mid-September in lower Phillips Creek.

Eight (8) lake water stations have been identified on seven lakes: WS27.1 (KM27 Lake), WS32.8 (KM32 Lake), WS52.9 (Katiktok Lake), WS79.9 and WS80.2 (Muriel Lake), WS87.7 (David Lake), WS94.0 (unnamed lake) and Camp Lake. The proposed water withdrawals from these lake water stations during open water will not exceed 10% of the mean monthly lake outflow or the 10-year annual low flow values, and winter water withdrawals from KM27 Lake, KM32 Lake and Camp Lake will not exceed DFO's under ice water withdrawal threshold of 10% of the under-ice volume. For the lakes that are subject to winter water withdrawals, the winter drawdown was included in the quantity of water considered extracted during the month of June, as this volume of water could potentially delay lake outflows in the spring.

Water withdrawal activity will not result in changes in channel morphology or shoreline morphometry. Riparian vegetation is sparse and comprised of grasses and mosses; there is typically no vegetation along the immediate shoreline of the waterbodies. Riparian vegetation clearing is not required to access the water withdrawal sites, and there is no disturbance to the stream banks.

The hose and screened intake will not result in a constriction of flow or interfere with fish passage. The hose and screened intake are submerged near the stream bottom and have a minimal footprint. The stream channels at the intake sites will have sufficient wetted width and depth to allow placement of the hose and pump with full submergence, allowing water to flow over the hose rather than around it.

No residual effects are anticipated on fish and fish habitat from the footprint of the pumps at the top of bank or the hose and screened intake in the wetted channel.

Water extraction can result in entrainment (when a fish is drawn into a water intake) or impingement (when an entrapped fish is held in contact with the intake screen). Baffinland has committed to following the interim code of practice for designing, installing, maintaining, and cleaning small end-of-pipe water intake fish screens (DFO, 2020). The interim code of practice applies to small-scale water intakes, where the water intake flow rate is up to 0.150 $m^3$/s and to fish that have a minimum fork length of 25 mm, requiring that the design opening of the screen material does not exceed 2.54 mm.

No residual effects are expected from entrainment or impingement with the implementation of mitigation measures and following the interim code of practice for fish screens.

The risks to fish and fish habitat from water withdrawal were determined to be low at all sites with the implementation of mitigation measures.

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# ABBREVIATIONS

Project ........................................ the project
Baffinland ........................................ Baffinland Iron Mines Corporation
DFO ........................................ Fisheries and Oceans Canada
FEIS ........................................ Final Environmental Impact Statement
FDC ........................................ Flow Duration Curve
GIS ........................................ Geographical Information System
KP ........................................ Knight Piésold Ltd.
MAD ........................................ mean annual discharge
NIRB ........................................ Nunavut Impact Review Board
NSC ........................................ North/South Consultants Inc.
Tote Road ........................................ Milne Inlet Tote Road
WSC ........................................ Water Survey of Canada

# 1.0 INTRODUCTION

The existing Type A Water Licence held by Baffinland Iron Mines Corporation (Baffinland) for the Mary River Project (the Project) includes 15 water stations for use in dust suppression efforts on the Milne Inlet Tote Road (Tote Road). Additional water stations will be required during the Phase 2 Proposal to support improved dust suppression efforts along the Tote Road and the North Railway construction right-of-way from mid-June to mid-September of each year. Knight Piésold Ltd. (KP) previously provided a desktop hydrology assessment of the potential effects of water withdrawal from the 15 permitted sites and 13 proposed new sites to support the Addendum to the Final Environmental Impact Statement (FEIS) for the Phase 2 Proposal (KP, 2018).

The methodology to determine potential effects to fish and fish habitat used in the 2018 desktop assessment differed for lakes and streams:

- For lakes, the required volume from each site was compared to the mean monthly outflow and the 10-year dry monthly outflow
- For streams, environmentally protective thresholds were identified as 20% of the mean flow for fish-bearing streams and 40% of the mean flow for non fish-bearing streams, and the maximum pumping rate (14.7 Litres per second) was compared to these thresholds for each site.

This Detailed Water Withdrawal Plan has been prepared as requested by Fisheries and Oceans Canada (DFO) in their final written submission on the FEIS to the Nunavut Impact Review Board (NIRB). DFO's information requests in the written submission are summarized in Table 1.1.

**Table 1.1 Information Requested in DFO's Final Written Submissions**

| Technical Review Comment | DFO Final Written Submission |
|---|---|
| DFO-3.14.1 | Provide detailed water withdrawal plan that includes an in-depth risk analysis informed by site specific fish and fish habitat features for the waterbodies chosen for water withdrawal as part of any 'DFO Request for Review' submission. |
| DFO-3.14.2 | Conduct a thorough localized assessment on the waterbodies selected for water withdrawal in order to adequately assess the potential impacts on the fish habitat resulting from 20% of the 10-year dry unit runoff water withdrawal on fish-bearing watercourses and connecting waterbodies. This assessment should include, but not be limited to, an assessment of the effects to littoral/shore/riparian areas from the proposed water withdrawal, the specific withdrawal locations proposed for each waterbody including fish habitat in the area and updated rationale on how this level of withdrawal will be environmentally protective threshold. |
| DFO-3.14.3 | Provide additional rational/ assessment to support the assertion that 40% of the 10-year dry unit runoff water withdrawal from non-fish-bearing streams will not negatively affect downstream fish-bearing waterbodies. |

Since submission of the Addendum to the FEIS for the Phase 2 Proposal (Baffinland, 2018), fish use and fish habitat features as well as site access constraints were assessed at each site through field surveys. Refined information has also been received from Baffinland regarding pumping rates and updated water requirements from each site. Based on the results of these surveys and additional information, Baffinland now expects to withdraw water from a total of 21 sites along the road and rail alignment (10 approved and 11 proposed). The method to assess potential impacts on fish habitat in streams has also been revised: rather than comparing maximum pumping rates to mean monthly and 10-year dry unit runoff flows, they have been compared against mean daily flows calibrated to site hydrology stations with watersheds of similar size for which long-term hydrological data are available to determine the percentage of time that the withdrawal rate meets or exceeds the threshold of 10% in amplitude of the instantaneous flow in the river relative to a “natural flow regime” suggested by DFO in the *Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada* (DFO, 2013a).

Details regarding water withdrawal are provided in Section 2. The hydrological assessment results are presented in Section 3 and the habitat assessment results are presented in Section 4.

# 2.0 WATER EXTRACTION DETAILS

The period of water withdrawal for dust control is expected to be mid-June to mid-September. Camp water withdrawals for domestic and industrial use is year-round for the approved water withdrawal sites on Camp Lake and lower Phillips Creek.

Details on Baffinland's proposed fleet of water trucks for the Phase 2 Proposal are provided in Table 2.1.

**Table 2.1 Operations Water Truck Fleet Capacities**

| Water Truck Description | No. of Trucks | Truck Water Capacity ($m^3$) | No. of Loads per 24-hour Day | Maximum Amount of Water ($m^3$/day) |
|---|---|---|---|---|
| Road Operations | 2 | 40 | 22 | 3,740 |
| | 3 | 30 | 22 | |
| Railway Construction | 6 | 30 | 22 | 3,960 |
| **Total** | **11** | | | **7,700** |

The truck fleet is expected to change over time, and hence the maximum amount of water drawn daily by the fleet is also subject to change.

Baffinland's experience to date suggests that the cycle time for each water truck to reach a water station, fill the truck, and to transit to and deposit the water on the road is one hour. Therefore, allowing for shift changes, two shifts on a water truck could conceivably extract 22 loads from the same water station over a 24-hour workday.

The trucks are filled using stationary pumps that are positioned at the water station, as shown on Figure 2.1. The pumps currently at site are equipped with either 4-inch (10 cm) or 6-inch (15 cm) diameter hoses. Pumping capacities are presented in Table 2.2.

**Table 2.2 Water Truck Pumping Capacities and Filling Times**

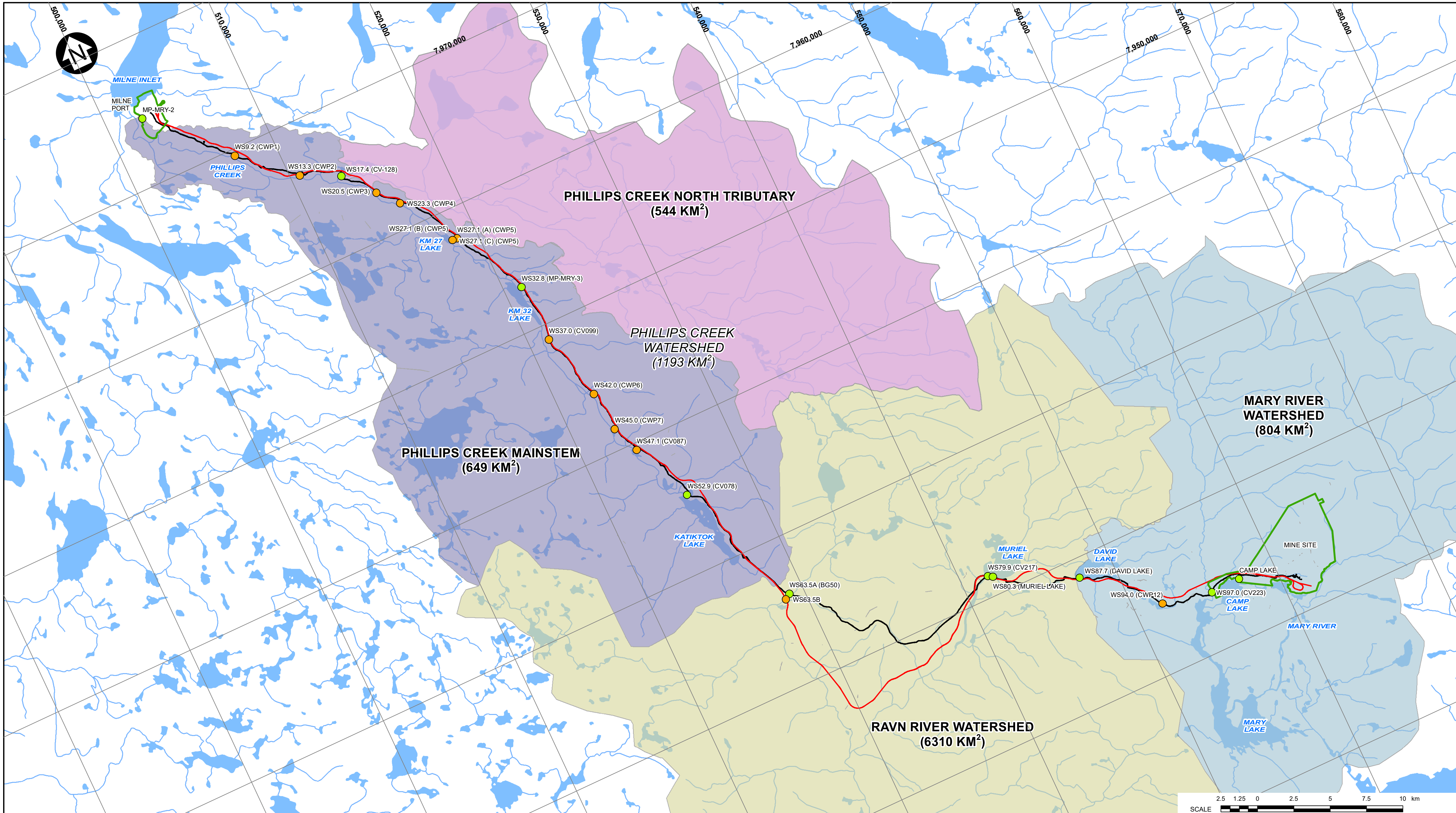
| Pump | Pumping Rate | | | Truck Fill Time (minutes) | |
|---|---|---|---|---|---|
| | (US gpm) | ($m^3$/s) | ($m^3$/min) | 30 $m^3$ | 40 $m^3$ |
| Lower pumping rate | 200 | 0.0125 | 0.75 | 40 min | 53.5 min |
| Maximum pumping rate | 1,520 | 0.095 | 5.7 | 5.5 min | 7 min |

**NOTES:**

1. MAXIMUM PUMPING RATE SHOWN FOR THE 6" PUMP IS BASED ON A 3 M SUCTION LIFT; THIS IS REDUCED TO 1.5 $M^3$/MIN AT A SUCTION LIFT OF 8.3 M.
2. PRESSURE REDUCING VALVES CAN BE INSTALLED TO LIMIT PUMPING RATES.

The location of the approved and proposed water withdrawal stations assessed in this plan are presented on Figure 2.2.


**Figure 2.1 Example Water Pump**




**LEGEND:**

- APPROVED WATER STATION
- PROPOSED WATER STATION
- MILNE INLET TOTE
- PROPOSED NORTH RAILWAY
- POTENTIAL DEVELOPMENT AREA

**NOTES:**

1. COORDINATE GRID IS IN KILOMETRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N.
2. BASE MAP/IMAGERY: © ESRI AND DATA (ONLINE) SERVICE LAYERS (2017). REDLANDS, CA: ENVIRONMENTAL SYSTEM RESEARCH INSTITUTE. ALL RIGHTS RESERVED.

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MARY RIVER PROJECT

**OVERVIEW OF APPROVED AND PROPOSED WATER STATIONS**

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**FIGURE 2.2** REV 0

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# 3.0 HYDROLOGICAL ASSESSMENT

Each of the proposed water stations was assessed to determine the effects of extraction of water from fish-bearing waterbodies, applying DFO's thresholds.

## 3.1 WATERBODY CATCHMENTS

Geographical Information System (GIS) was used to delineate catchments for both lakes and streams that were identified as potential sources of water for the Project. The catchment boundaries for those waterbodies identified for use in this plan are presented on figures in Appendix A.

## 3.2 STREAMFLOW DATA

The hydrological assessment relies on streamflow data collected by Baffinland since 2006 and regional data collected by Water Survey of Canada (WSC). The Project's hydrometric stations are listed in Table 3.1 and are shown on Figure 3.1.

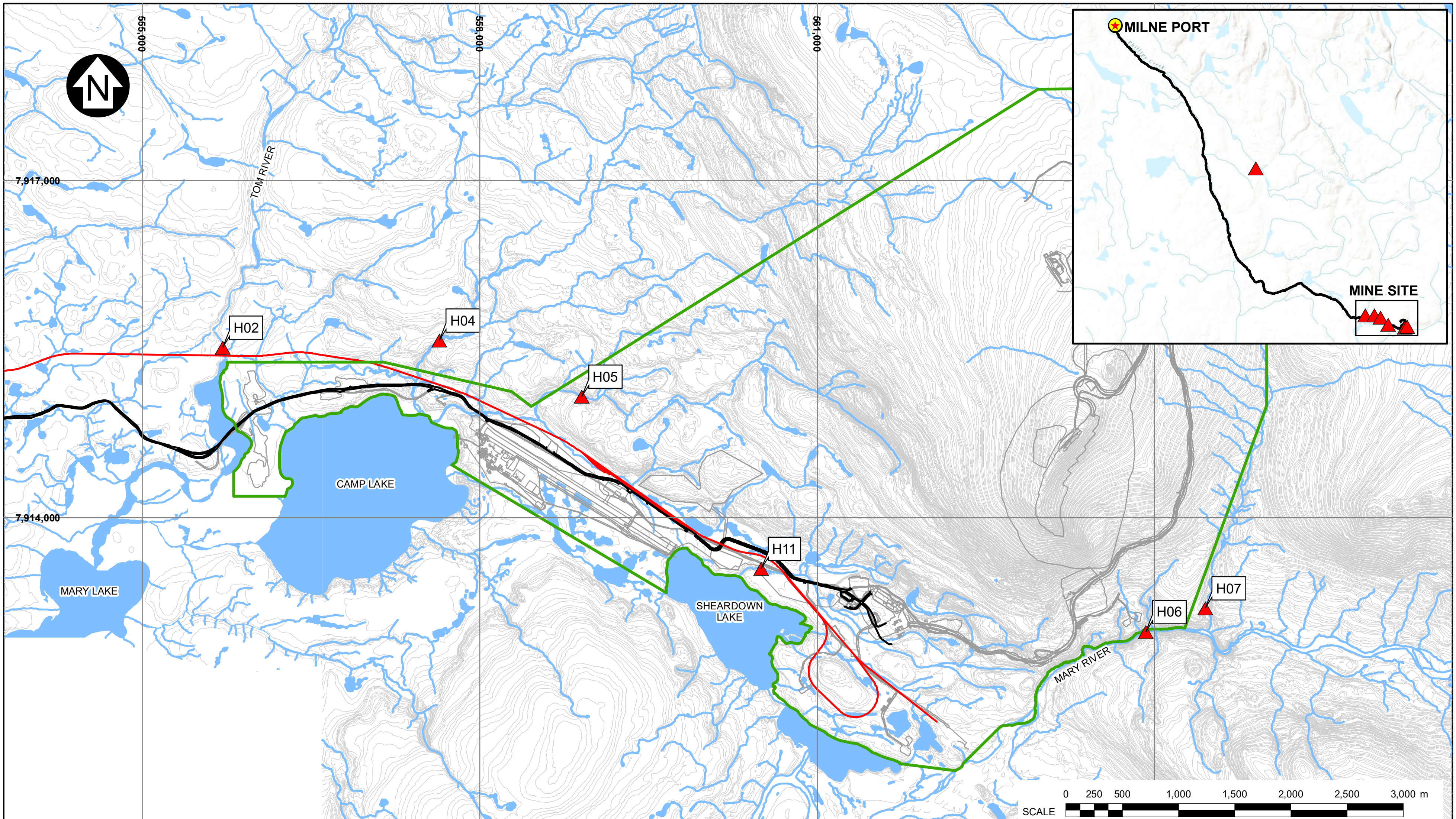
**Table 3.1 Active Regional Hydrometric Stations**

| Station No. | Waterbody | Catchment Area ($km^2$) | Years of Operation | Mean Annual Discharge ($L/s/km^2$) |
|---|---|---|---|---|
| H01 | Phillips Creek northern tributary | 250 | 2006-08, 2011-19 | 7.3[1] |
| H02 | Tom River | 210 | 2006-08, 2010-19 | 9.4[2] |
| H04 | Camp Lake tributary 2 (CLT-2) | 8.3 | 2006-08, 2010-19 | 9.0[2] |
| H05 | Camp Lake tributary CLT-1, branch L1 | 5.3 | 2006-08, 2010-19 | 7.9[1] |
| H06 | Mary River mainstem | 240 | 2006-08, 2010-19 | 10.6[1] |
| H07 | Mary River tributary F | 14.7 | 2006-08, 2010-11, 2017-19 | 9.7[2] |
| H11 | Sheardown Lake tributary SDLT-1 | 3.6 | 2011-19 | NC |

**NOTES:**

1. SOURCE: HYDROLOGIC ASSESSMENT FOR WATER CROSSINGS - PROPOSED NORTH RAILWAY - PHASE 2 PROPOSAL - MARY RIVER PROJECT (KP, 2017).
2. SOURCE: HYDROLOGY BASELINE REPORT (KP, 2012).
3. NC = NOT CALCULATED.

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 operated by Baffinland during the open water season. The four stations on larger systems were operated year-round by WSC. Since 2012, Baffinland has continued to operate six hydrometric stations. The hydrology at three stations (H01, H05, and H06) was reviewed and updated based on data available to the end of 2016 (KP, 2017).




**LEGEND:**

- ACTIVE HYDROMETRIC STATION
- MILNE INLET TOTE
- PROPOSED NORTH RAILWAY
- EXISTING INFRASTRUCTURE
- RIVER/STREAM/DRAINAGE
- WATER
- POTENTIAL DEVELOPMENT AREA

**NOTES:**

1. BASE MAP: © ESRI DATA AND MAPS (ONLINE) (2016). REDLANDS, CA: ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE. ALL RIGHTS RESERVED.
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N.

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MARY RIVER PROJECT

**ACTIVE HYDROMETRIC STATIONS**

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**FIGURE 3.1** REV 0

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The mean monthly and mean annual unit runoff values for these three stations are presented in Table 3.2. Flow values with a 10-year return period were calculated for regional WSC stations using Palisade Decision Tools @RISK statistical software on the Sylvia Grinnell River and Apex River, as well as the Qinguq River. The stations were selected based upon the similarity of their mean monthly runoff values with those measured at the Project stations. The Qinguq River station was included in this analysis as neither the Sylvia Grinnell nor Apex rivers provided a very good match with site data during low flows in August and September. Ratios were developed between the mean monthly discharge and return period discharge for each station. The most conservative monthly ratio was then applied to the mean monthly discharge at the project stations to derive 10-year wet and dry monthly and annual discharge values.

**Table 3.2 Estimated Long-Term Mean Streamflow**

| Station | Mean Unit Runoff (l/s/km$^2$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Jan - May | Jun | Jul | Aug | Sept | Oct | Nov – Dec | MAUD | 10-Year Dry Annual Flow |
| H01 | 0 | 33.5 | 32.2 | 14.3 | 6.6 | 0.4 | 0 | 7.3 | 4.4 |
| H05 | 0 | 38.6 | 29.6 | 18.8 | 7.1 | 0.2 | 0 | 7.9 | 4.7 |
| H06 | 0 | 41.4 | 56.6 | 20.2 | 8.3 | 0.2 | 0 | 10.6 | 6.4 |

**NOTES:**

1. MAUD IS MEAN ANNUAL UNIT DISCHARGE.

Different methods were used to assess water withdrawals from streams and lakes. These are discussed further in Sections 3.3 and 3.4, respectively.

## 3.3 HYDROLOGICAL ASSESSMENT - STREAMS

Previous water withdrawal assessments for the Project were supported by hydrology assessments that utilized mean monthly flows and applied thresholds of 20% and 40% withdrawal rates (relative to mean monthly flows) for fish-bearing and non-fish-bearing streams, respectively. As noted in Section 1, DFO suggested during the NIRB review of the Phase 2 Proposal that these thresholds may not be adequately protective.

When determining the impact of flow alteration in fisheries, the National Technical Guidance (Appendix 1 of DFO, 2013a) is as follows:

- *Cumulative flow alterations <10% in amplitude of the actual (instantaneous) flow in the river relative to a “natural flow regime” have a low probability of detectable impacts to ecosystems that support commercial, recreational or Aboriginal fisheries.*
- *Cumulative flow alterations that result in instantaneous flows <30% of the mean annual discharge (MAD) have a heightened risk of impacts to fisheries.*
- *For cumulative water use >10% of instantaneous discharge or that results in flows <30% of the mean annual discharge (MAD), a more rigorous level of assessment is recommended to evaluate potential impacts on ecosystem functions which support fisheries.*

Because none of the proposed water withdrawal sites have real-time flow data, hydrologic estimates were developed for each site based on drainage area proration from representative hydrometric stations. The streams selected for water withdrawals, listed in Table B.1 in Appendix B, have catchments ranging from 170 to 1,193 km$^2$. Thus, historical streamflow data from hydrometric station H01 (catchment size of 249 km$^2$) was used to predict streamflow conditions at the pumping locations.

The open water season flow duration curve (FDC) and mean daily hydrograph for hydrometric station H01 are presented on Figures 3.2 and 3.3. The FDC and hydrograph are based on measured streamflow data from 2006 to 2019. The record typically begins each year in mid-June, once the gauging sites become ice free, and ends in mid-September when ice begins to accumulate in the channel and affect the rating curves. The FDC and hydrograph are useful in understanding the seasonal nature of low flows; flows rise from no-flow in late May or early June and the nival (snowmelt) freshet occurs in late June. Flows then fall through July and August but are sustained by rainfall events. Flows continue to fall through September as air temperature drops and precipitation falls as snow, until streamflow ceases in late September or early October. The 30% MAD flow is shown on Figure 3.3, although this value is skewed low due to eight months of negligible flow. The value representing 30% of the open water season flow is also presented and may be a more representative indicator of heightened risk of impacts to fisheries.

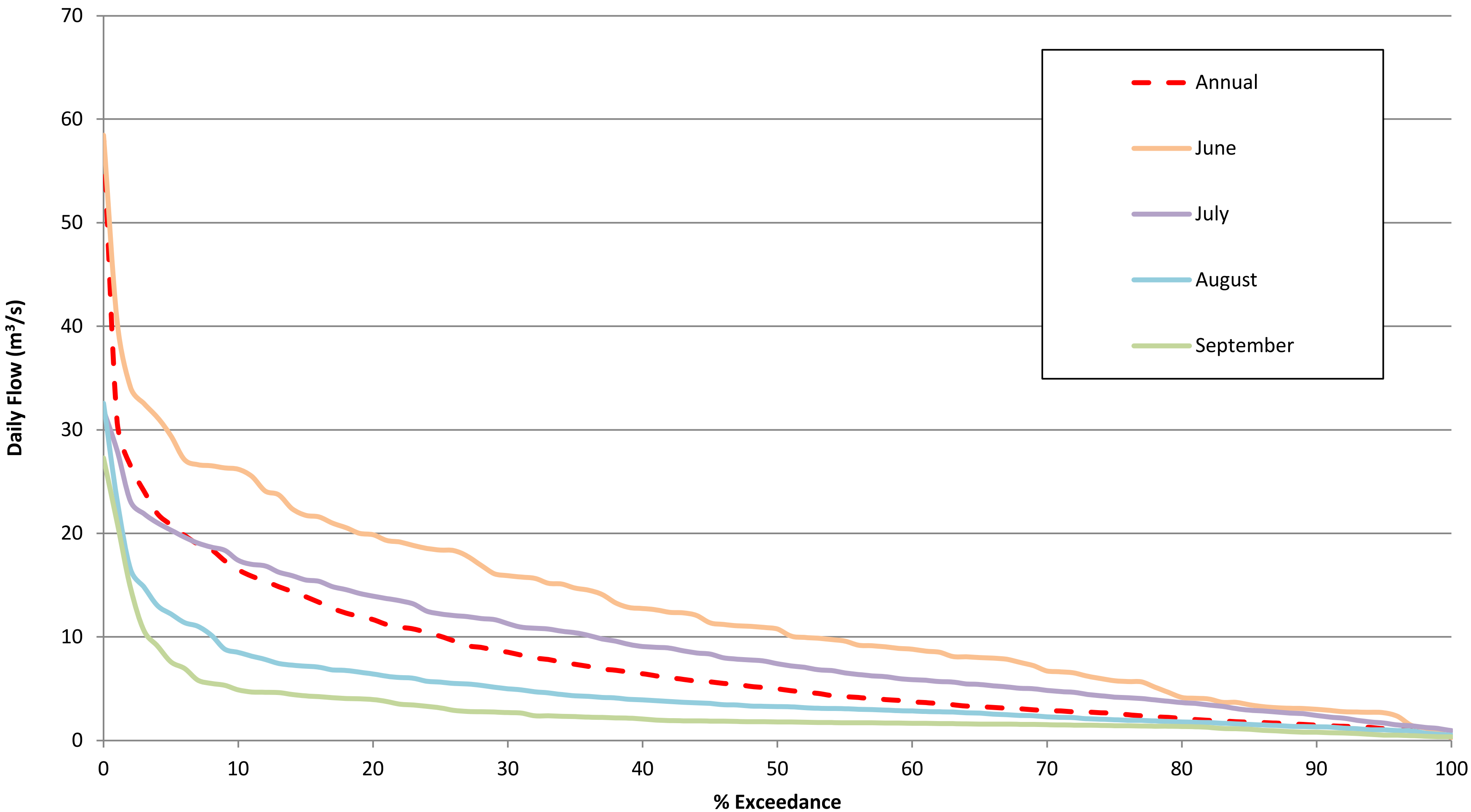
Flow duration curves were developed for each of the selected water stations based on pro-rating the watershed of interest against the gauging record (approximately mid-June to mid-September) FDC for H01. The resultant FDCs at the water withdrawal sites are presented on Figures 3.4 and 3.5.

The streams presented on Figure 3.4 include all those on Phillips Creek from WS37.0 downstream to the mouth. Based on the pro-rated flow duration curves, water can be withdrawn from these stations at the maximum pumping rate at any time between approximately mid-June to mid-September without exceeding 10% of the instantaneous flow.

Streams presented on Figure 3.5 have smaller catchments, and while water can be withdrawn from these streams at the lower pumping rate under any flow condition between approximately mid-June to mid-September without exceeding 10% of the instantaneous flow, the flows will be adequate to extract water at the maximum pumping rate 90% to 95% of the time. This includes water stations WS42.0, WS45.0 and WS47.1 within the upper portion of the Phillips Creek catchment, the two stations on the Ravn River (WS63.5A/B), and the Tom River (WS97.0) near the Mine Site. Pumping rates have been set on these six sites based on the measured 99$^{th}$ percentile low flow value for each of these smaller streams, as summarized in Table B.1.

**Cumulative Withdrawals**

Thirteen (13) water stations are located on Phillips Creek. The quantity of water that might be extracted from Phillips Creek cumulatively is a function of the number and capacity of the water trucks that could be extracting water from various water stations on the creek at the same time. The maximum quantity of water withdrawn from Phillips Creek during construction of the North Railway is 7,700 m$^3$ over a single day from 11 water trucks, which represents 3% of the flow that is exceeded 99% of the time between mid-June to mid-September at the most downstream withdrawal site (WS9.2). Given that pumping only occurs for a relatively short period of time and is not continuous (Section 2), and lag time and attenuation that will occur between water withdrawal sites, the instantaneous cumulative withdraw will not exceed 10%.




**NOTES:**

1. CATCHMENT AREA AT HYDROLOGY STATION H01 IS 249 KM$^2$.
2. BASED ON MEASURABLE FLOWS MID-JUNE TO MID-SEPTEMBER FOR THE YEARS 2006 TO 2019.

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**HYDROMETRIC STATION H01**
**ANNUAL AND MONTHLY FLOW DURATION CURVES**

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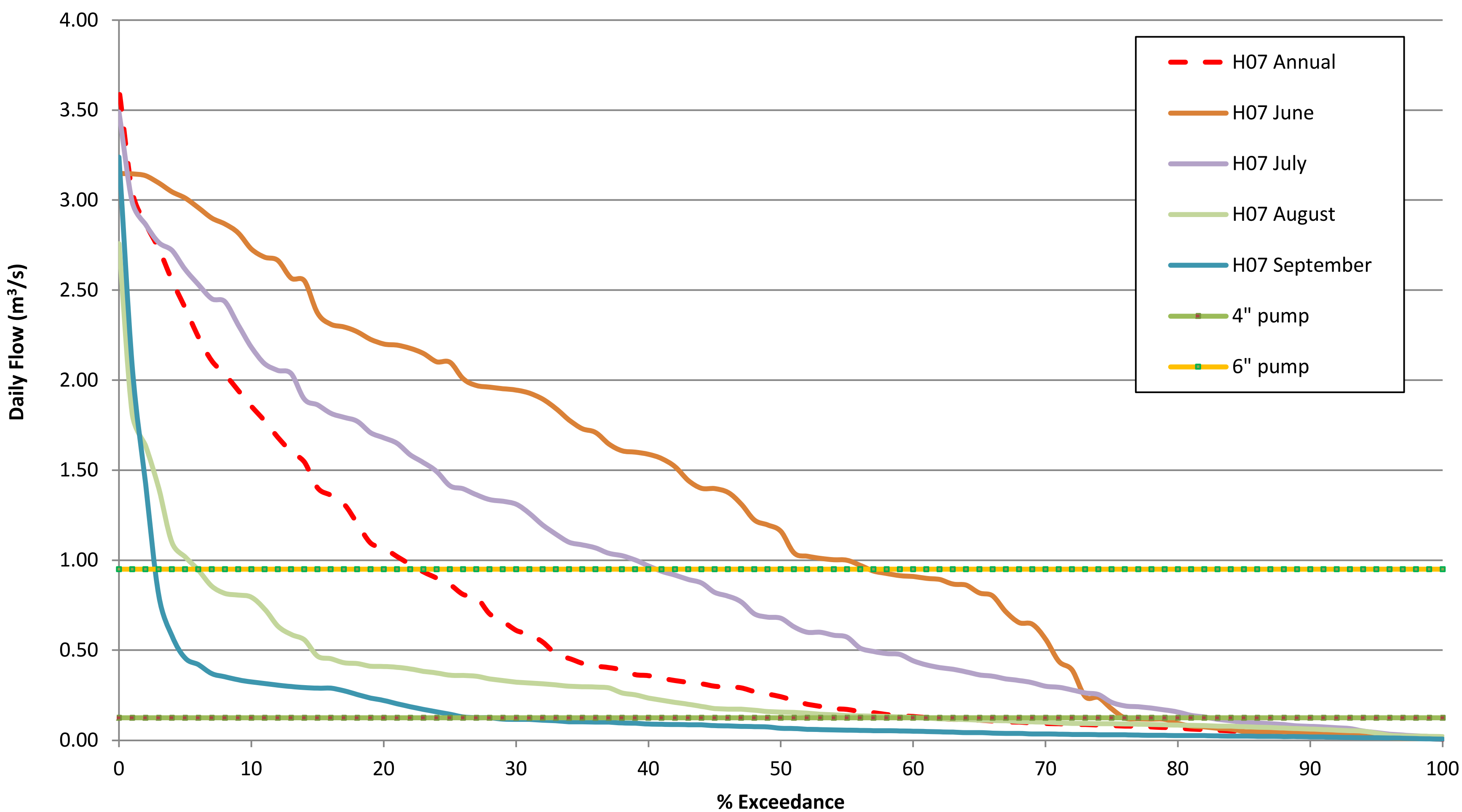
| FIGURE 3.2 | | REV 0 |




**NOTES:**

1. CATCHMENT AREA AT HYDROLOGY STATION H07 IS 15 $KM^2$
2. BASED ON MEASURABLE FLOWS MID-JUNE TO MID-SEPTEMBER
3. 4" PUMP HAS A MAXIMUM PUMPING RATE OF 0.125 M3/S, 6" PUMP HAS A MAXIMUM PUMPING RATE OF 0.95 M3/S

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**HYDROLOGY STATION H07**
**FLOW DURATION CURVE**

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**FIGURE 3.3**

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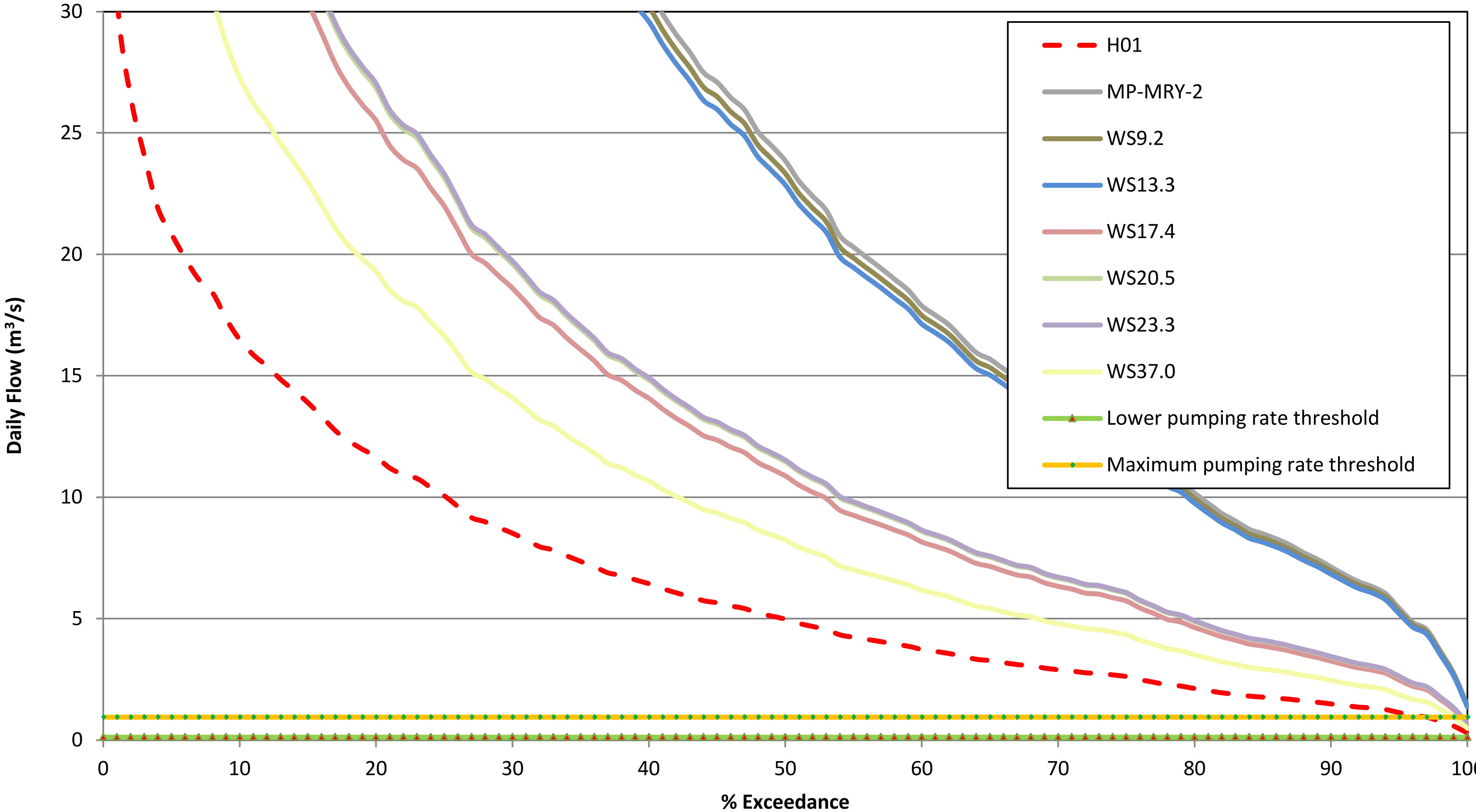


**NOTES:**

1. CATCHMENT AREA AT HYDROLOGY STATION H01 IS 249 $km^2$.
2. BASED ON MEASURED FLOWS BETWEEN MID-JUNE AND MID-SEPTEMBER.
3. THE THRESHOLD IDENTIFIED BY THE LOWER PUMPING RATE IS BASED ON A PUMPING RATE OF 0.75 $m^3$/min (0.0125 $m^3$/s) ASSUMING IT REPRESENTS 10% OF THE TOTAL FLOW IN THE STREAM. THE UPPER PUMPING RATE IS 5.7 $m^3$/min (0.095 $m^3$/s), SO THE THRESHOLD IS SET AT 0.95 $m^3$/s.

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**FLOW DURATION CURVES FOR LARGER STREAMS**

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**FIGURE 3.4**

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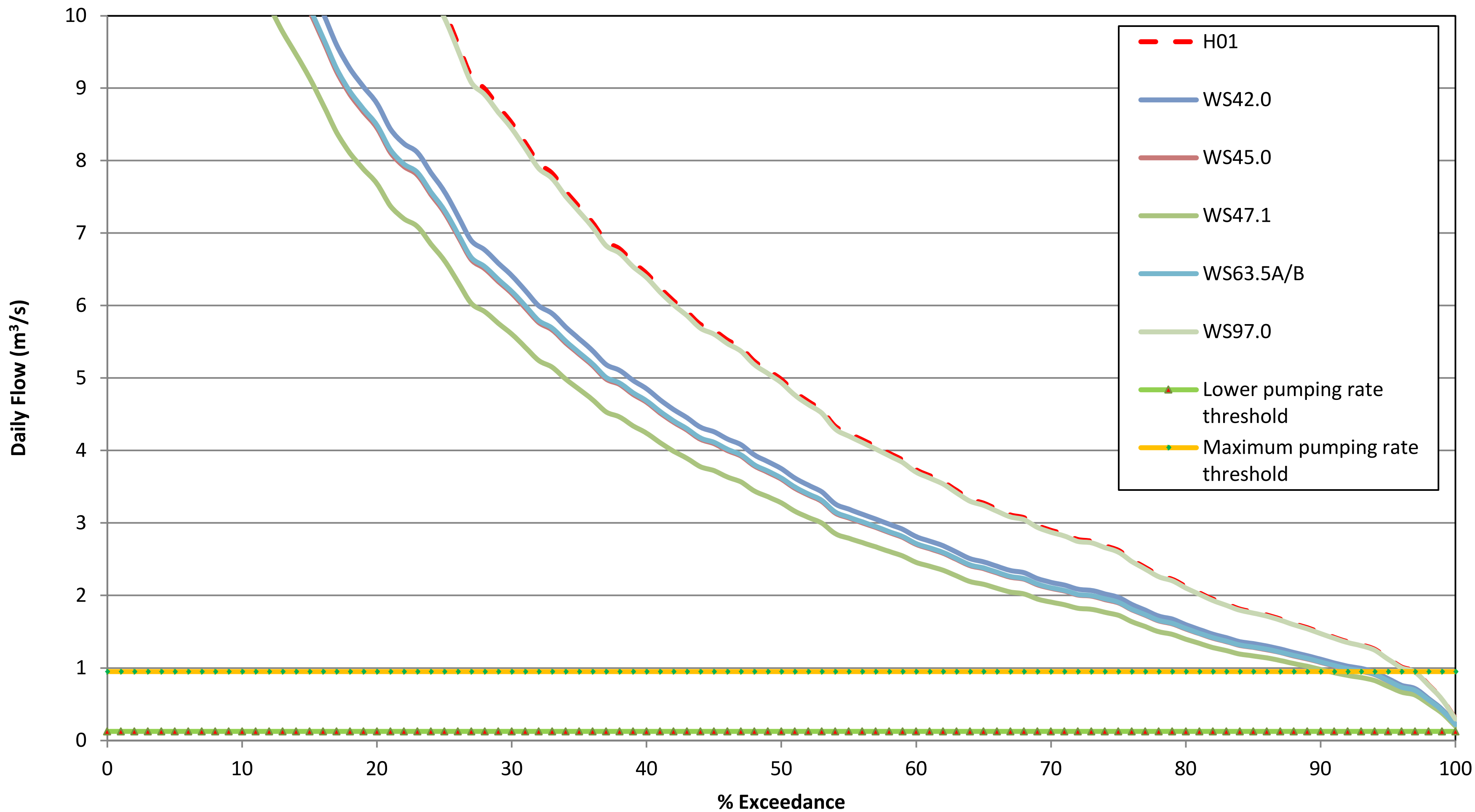


**NOTES:**

1. CATCHMENT AREA AT HYDROLOGY STATION H01 IS 249 $km^2$.
2. BASED ON MEASURED FLOWS MID-JUNE TO MID-SEPTEMBER.
3. THE THRESHOLD IDENTIFIED BY THE LOWER PUMPING RATE IS BASED ON A PUMPING RATE OF 0.75 $m^3$/min (0.0125 $m^3$/s) ASSUMING IT REPRESENTS 10% OF THE TOTAL FLOW IN THE STREAM. THE UPPER PUMPING RATE IS 5.7 $m^3$/min (0.095 $m^3$/s), SO THE THRESHOLD IS SET AT 0.95 $m^3$/s.

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**FLOW DURATION CURVES FOR SMALLER STREAMS**

Knight Piésold CONSULTING

P/A NO. NB102-181/65

REF. NO. 1

**FIGURE 3.5**

REV 0

## 3.4 HYDROLOGICAL ASSESSMENT - LAKES

The effect of a single water take from these sources is very small; however, repeated water takes have the potential to lower lake levels and reduce lake outflows.

### 3.4.1 WATER WITHDRAWALS DURING ICE COVER

Regarding the extraction of water from lakes through ice during the ice-covered period, DFO published a protocol that states that the total water withdrawal from a single waterbody over one ice-covered season is not to exceed 10% of the available water volume calculated using the appropriate maximum expected ice thickness of 2 m (DFO, 2010b). This threshold was applied to the assessment of winter water withdrawals, with winter withdrawals assumed to occur between mid-September to mid-June.

### 3.4.2 WATER WITHDRAWALS DURING OPEN WATER

Regarding the extraction of water from lakes during the open water season, the FEIS identified the reduction in lake outflow of 10% as a commonly applied threshold value (FEIS Volume 7, Page 19; Baffinland, 2012). Water can be withdrawn from a lake, without further evaluation, providing that the monthly water withdrawal volume did not exceed 10% of the mean monthly lake outflow volume. The 10% threshold was also applied to the annual 10-year return period dry year. For lakes that have been subject to water withdrawals during the winter, the winter drawdown was included in the quantity of water considered extracted during the month of June, as winter withdrawals could potentially delay lake outflows in the spring. Open water withdrawals were assumed to occur between mid-June to mid-September. The proposed withdrawal volumes did not exceed the 10% reduction in mean monthly outflow or 10% reduction in 10-year return period dry flow at any of the nine lake withdrawal locations. The results are presented in Appendix B.

# 4.0 HABITAT ASSESSMENT

The habitat assessment is designed to provide the in-depth risk analysis requested by DFO in their final written submission on the FEIS. Potential impacts of water withdrawal were assessed by identifying the interactions between water withdrawal activities and fish and fish habitat; and mitigation measures or best practices to prevent or minimize any adverse effects resulting from the interactions. This section will provide a brief overview of the fish species and habitat requirements, waterbodies in the study area, and potential impacts and mitigation measures. Site-specific information on fish and fish habitat at each of the withdrawal locations is presented in Section 4.4.

The fish habitat assessment, fish utilization information, and photos presented in this section are based on site investigations conducted by NSC (2012a, 2012b, 2019).

## 4.1 FISH SPECIES AND HABITAT REQUIREMENTS

Arctic char (*Salvelinus alpinus*) and ninespine stickleback (*Pungitius pungitius*) are the only fish species that have been captured or observed in the project area lakes and streams. Their habitat requirements and life history characteristics, based on an extensive literature review, are summarized in Table 4.1.

**Table 4.1 Habitat Requirements of Arctic Char and Ninespine Stickleback in the Study Area**

| Life History Timing / Habitat Requirement | Arctic char | Ninespine stickleback |
|---|---|---|
| Spawning | Spawn September to October; eggs in April and fry emerge after ice-off<br>Substrate: Gravel and rock<br>Water depth: 1 m – 4.5 m along lake shorelines or quiet pools in rivers | Spawn May to late July, or later during the open water season<br>Substrate: densely vegetated or in muddy organic bottoms or between rocks when aquatic vegetation is sparse<br>Water depth: Shallow |
| Fry / Juvenile Rearing | Younger, smaller fish remain in shallow littoral areas in lakes or move into small tributary streams with sufficient cover (cobble, boulders, vegetation) and connections to overwintering habitat | Shallow littoral areas with sand or silty organic substrates<br>Prefer heavily vegetated habitat but also be found in open water areas, on gravel beaches, or in shallow, silty ponds with sparse aquatic vegetation |
| Adult rearing | Most often found in <5 m of water over cobble/boulder/gravel substrate<br>Typically found only in lakes and in a select few large rivers | Cool, quiet, weedy habitat in large, slow streams, shallow bays, tundra ponds, brackish pools, and sloughs<br>Depth 0.5 - 2.5 m<br>Velocity <0.30 m/s |
| Overwintering | Lakes with maximum depths >3 m | Lakes with maximum depths >3 m, in deep water or shallow bays of lakes |

**NOTES:**

1. SOURCE: APPENDIX 4.4-3 OF NSC (2011) AND NSC AND KP (2008).

## 4.2 OVERVIEW OF FISH HABITAT IN THE PROJECT AREA

The following description of the major watersheds along the Tote Road and North Rail alignment has been summarized from NSC (2012a):

- Milne Port Area includes Phillips Creek, a major coastal watershed that drains into Milne Inlet. Upper reaches of the river are used extensively by Arctic char. There are impassable falls approximately 15 km upstream from Milne Inlet. There is minimal potential for overwintering or spawning downstream of the falls, as depths in this section are shallow (< 2.0 m) and the river likely freezes to the bottom during winter.
- Within Phillips Creek upstream of the falls, a small lake at approximately km 27 is characterized by mean depths of 20 m and maximum depths of 59 m. Another lake at km 32 is larger in terms of surface area and depth/volume, and the maximum depth is greater than 100 m. During early baseline surveys, large numbers of Arctic juveniles of all sizes were observed using nearshore habitat; and the lakes were assumed to support spawning, based on the presence of young of year fish.
- The mine site lies within the Mary River drainage, which forms part of the headwaters of the Ravn River watershed. There are three major lakes (Camp, Sheardown, and Mary Lakes) within the Mary River drainage in the Mine Area.
- Camp Lake flows into the north arm of Mary Lake and has a surface area of approximately 211 ha and shoreline length of 6.2 km. The average depth in the lake is approximately 13 m and the maximum depth is estimated as 35 m.
- Sheardown Lake is composed of two basins: a larger basin located to the northwest approximately 70 ha in area, with a shoreline length of 4.6 km, and an average depth of 12 m; and a smaller basin to the southeast with a surface area of 24 ha, a shoreline length of 2.8 km, and an average depth of 7.4 m. Several small tributaries in the area drain into Sheardown Lake, which in turn discharges to the Mary River.

Flow typically begins in streams and rivers in early to mid-June with the onset of snow and ice melt, peaking in June or July. Lakes and streams in the area experience long periods of ice cover, and rivers and creeks, with the exception of very large systems, freeze to the bottom in winter.

## 4.3 POTENTIAL EFFECTS AND MITIGATION MEASURES

The potential impacts of flow withdrawal on fish and fish habitat can be assessed by understanding the mechanisms and stressors that cause effects in the aquatic environment. DFO has created Pathway of Effect diagrams to illustrate the type of cause-effect relationships that are known to exist for developments in or near water; water withdrawal has the potential to impact fish and fish habitat through the following mechanisms (DFO, 2010a):

- Placement of structures in water
- Entrainment in pumps / impingement on screens
- Use of industrial equipment
- Oxygen depletion, loss of over-wintering habitat, and/or reductions in littoral habitat during winter water withdrawal from ice-covered waterbodies
- Changes in flow volumes or timing, duration, and frequency of flow

Potential effects and mitigation measures for these mechanisms, as well as residual effects, are described below.

### 4.3.1 PLACEMENT OF STRUCTURES IN WATER

Structures placed in water could result in:

- Changes in channel morphology or shoreline morphometry through removal of instream and riparian vegetation, resulting in loss or alteration of habitat and reduced channel stability
- Constriction of flow: instream structures could change hydraulic characteristics, resulting in a change in substrate composition (scour and deposition)
- Obstruction or interference with the movement and migration of fish

The water withdrawal activity will not result in changes in channel morphology or shoreline morphometry. Baffinland uses a 4” or 6” Gorman-Rupp pump to fill the water trucks; the pumps are located on the top of the bank; the only structure placed in the water is the hose and screened intake. Examples of the pumps used are shown in Figure 4.1. Riparian vegetation at the majority of sites is sparse and comprised of grasses and mosses; there is typically no vegetation along the immediate shoreline of the waterbodies. Riparian vegetation clearing is not required to access the water withdrawal sites, and there is no disturbance to the stream banks.


**Figure 4.1 Baffinland Water Pumps**

The hose and screened intake will not result in a constriction of flow or interfere with fish passage. The hose and intake are fitted with a cam lock 4” or 6” fish screen; an example of the instream hose and intake is shown in Figure 4.2. The hose and screened intake are submerged near the stream bottom and have a minimal footprint. The stream channels at the intake sites will have sufficient wetted width and depth to allow placement of the hose and pump with full submergence, allowing water to flow over the hose rather than around it.