TMAC Resources Inc.

Revisions to TMAC Resources Inc. Amendment Application No. 1 of Project Certificate No. 003 and Water Licence 2AM-DOH1323

Package 4: Identification of Potential Environmental Effects and Proposed Mitigation

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Revisions to TMAC Resources Inc. - Amendment Application No. 1 of Project Certificate No. 003 and Water Licence 2AM-DOH1323

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Package 4

Identification of Potential Environmental Effects and Proposed Mitigation

TMAC RESOURCES

Package 4
Identification of Potential
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TMAC Resources Inc.

DORIS NORTH PROJECT

Revisions to TMAC Resources Inc. Amendment Application No. 1 of Project Certificate No. 003 and Water Licence 2AM-DOH1323 - Package 4 Identification of Potential Environmental Effects and Proposed Mitigation

June 2015

Project # 0236830

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EXECUTIVE SUMMARY

TMAC Resources Inc. (TMAC) has retained ERM Canada Consultants Limited (ERM) to conduct an assessment of the potential for effects to the natural and human environment arising from the proposed changes to the Phase 1 Doris North Project. TMAC also retained Points West Heritage Consulting Ltd. to specifically consider potential for impacts on heritage resources (Appendix A).

The conclusion of the effects assessment to the natural and human environment from the proposed changes to the Project are presented in this report and include:

- The proposed expansion to the Roberts Bay laydown area involves two sections, one to the south toward the airstrip and another, smaller area to the west near the jetty. This change in Project footprint results in a direct loss of vegetation within the constructed footprint, however, the aerial extent of this effect is minimized by reducing the footprint of the proposed amendment infrastructure footprint.
- The proposed change from subaqueous to subaerial deposition of tailings in the TIA is expected to lead to increased dust generation, however, mitigation measures including the use of proven dust suppression methods will be used to maintain dust at acceptable levels.
- The maximum potential water level decrease due to the extraction of the currently permitted 480,000 mcm/year from Doris Lake is within the range of natural variability, and no adverse effects are predicted in the Doris North FEIS. Additional water losses from Doris Lake are anticipated as a result changes to the Project as the proposed mine plan will now intersect talik zones that are interconnected with the lake. The cumulative water losses from Doris Lake, included the permitted withdrawal volume combined with the loss to the underground mine, are predicted to result in serious harm to fisheries and an Offset Plan and DFO Authorization will be obtained.
- TMAC anticipates that saline groundwater will be encountered in the talik under Doris Lake during mining of Doris Central and Doris Connector and below the permafrost in Doris Deep. In order to manage saline groundwater as well as reduce potential for negative impacts on the freshwater environment, TMAC will revise management of the underground saline groundwater so that it is collected within sumps (underground) and used as much as possible for underground drilling activities. The excess will be discharged directly to Roberts Bay via pipeline and a diffuser on the ocean floor. The on-land portion of the discharge pipeline will follow the existing all-weather road to Roberts Bay with the alignment and entrance to marine environment not at existing jetty but an independent structure on the western side of Roberts Bay.
- Along with the saline groundwater, TMAC is planning to discharge compliant TIA effluent to Roberts Bay. The potential effects of discharging compliant TIA water into Roberts Bay is not expected to result in significant adverse effects on water quality, sediment quality, marine fish, marine fish habitat, or marine wildlife. The Project has been designed such that the water quality in Roberts Bay will meet MMER limits and CCME guidelines for the

protection of marine and estuarine aquatic life for the duration of the operation and decommissioning of the TIA.

- The majority of the Project area has been surveyed in detail and archaeological sites within most of the proposed expanded footprint area are known, documented and mitigable.
- The potential for environmental effects to physical, biological and traditional resources as a result of proposed changes to the Project can be mitigated through incorporation of design considerations and accepted management practices. (except for the vegetation loss due to footprint expansion).
- For employment and economy, the proposed amendment to extend the mine life increases overall total benefits. There remains the potential for adverse effects on other community employers if the labour demands of the Project result in a shortage of skilled workers.
- Minimal adverse effects are predicted on health care services, community well-being and delivery of social services, and public safety and protection services. Effects such as increased demand for housing and conditions of overcrowding can be mitigated by collaborating and partnering with local education/training institutions to increase the number of skilled people already in the community.
- The mitigation measures originally proposed for the Doris North Project remain appropriate to address potential socio-economic effects to employment and income, education and training, business opportunities, health services, social services, and safety and protection services.

Revisions to TMAC Resources Inc. Amendment Application No. 1 of Project Certificate No. 003 and Water Licence 2AM-DOH1323 - Package 4 Identification of Potential Environmental Effects and Proposed Mitigation

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1. INTRODUCTION

TMAC Resources Inc. (TMAC) is seeking to advance the Doris North Project and is submitting this amendment application in order to complete construction and transition the Doris North Project into production. To accommodate a new mine plan TMAC is seeking approval for an amendment to the Doris North Type A water licence and Project Certificate as a result of changes to some of the activities and infrastructure originally considered in the Doris North FEIS and subsequent water licensing.

The objective of this document is to provide an overview of the baseline conditions, project interactions and resultant effects to the natural and human environments. In order to focus on interactions from proposed Project component changes, Section 1.1 summarizes the previously screened authorizations submitted to NIRB. These components and activities are not included in the screening presented in this document. Section 1.2 outlines the proposed Project changes that TMAC is seeking approval for an amendment to the Doris North Type A water licence and Project Certificate. Using the NIRB Form 2, Table 1 as a guide, P3-1 provides a summary of potential environmental effects due to Project interactions over Project life, screening of the effect and mitigation measures. Those interactions that are screened to have no effect or mitigable effect are not included in further discussion within the document. The effects carried forward in this document are discussed further and include a description of baseline conditions, Project interactions and potential effects, and mitigation measures for:

- Freshwater Environment (section 2.0)
- Atmospheric and Terrestrial Environment (section 3.0)
- Marine Environment (section 4.0)
- Archaeology (section 5.0)
- Socio-economic Environment (section 6.0)
- Conclusions are presented in (section 7.0)

1.1 PREVIOUS AND CURRENT NIRB SCREENING AND REVIEW, AND OTHER AUTHORIZATIONS

Given the level of exploration and development in the Hope Bay Belt, many of the proposed activities and much of the infrastructure has been previously screened and authorized by the Nunavut Impact Review Board (NIRB). Mine development at the Doris North Project (the Project) has been screened and undergone environmental assessment (screening 05MN047 and Project Certificate 003). Exploration and bulk sampling activities at Boston have been screened and determined to be exempt (the NIRB decision EX148) from environmental assessment and regional exploration activities across the Hope Bay Belt have also been screened and determined to be exempt from environmental assessment. Table 1.1-1 provides a list of the water licences issued by the Nunavut Water Board (NWB) for the permitted use of water and deposit of waste associated with these activities.

Table 1.1-1. Hope Bay Belt Water Licences

Water Licences
• 2AM-DOH1323 Doris North Mining and Milling Undertaking (exp. Aug 15, 2023) • 2BB-BOS1217 Boston Advanced Exploration Project (exp. Jul 31, 2017) • 2BE-HOP1222 Hope Bay Regional Exploration Program (exp. Jun 30, 2022) • 2BE-MAE---- Madrid Advanced Exploration Program (application submitted and in process)

Effective March 30, 2015, TMAC entered into a series of landmark agreements with the KIA with respect to the Inuit owned surface title for the lands on which the Hope Bay Project is located. These agreements replaced certain existing agreements and comprise a 20 year comprehensive Inuit Land Access Agreements (Inuit Land Access AgreementsInuit Land Access Agreements) for surface access in the Hope Bay Belt. The Inuit Land Access Agreements includes an amended and restated Inuit owned lands commercial lease, number KTCL313D001 (Commercial Lease), an Inuit impact and benefit agreement (IIBA), and a water and wildlife compensation agreement (WWCA). In accordance with the Inuit Land Access Agreements, KIA has consolidated and reissued land use licences and advanced exploration leases that permit all of the surface activities previously screened and authorized by the NIRB.

A project proposal for Phase 2 of the Hope Bay Belt, which is intended to cover the reasonable and foreseeable proposed incremental development of the Belt, has been submitted and the NIRB EIS Guidelines (NIRB Dec 2012) have been issued. Phase 2 may include the development of the Madrid and/or Boston areas, including infrastructure and waste management facilities to support underground and open pit mining and processing in both districts.

TMAC is submitting this amendment application so TMAC can complete construction and transition Doris North into production based on a new mine plan, which requires changes to some existing facilitites, as well as some additional facilities. TMAC is seeking approval for an amendment to the Doris North Type A water licence and Project Certificate as a result of changes to some of the activities and infrastructure originally considered in the Doris North FEIS and subsequent water licensing.

1.2 SUMMARY OF PROJECT DESCRIPTION AND AMENDMENT REQUEST

The summary of proposed changes to the Doris North Project is presented in Table 1.2-1

Table 1.2-1. Summary of Proposed Doris North Mine Project Components and Activities

Project Component or Activity	Rationale
Camp Size	Expand to 280 person. No need for accommodation barges.
Drinking water	Source will remain Windy Lake. Water will be trucked to Doris Camp.

(continued)

Table 1.2-1. Summary of Proposed Doris North Mine Project Components and Activities (continued)

Project Component or Activity	Rationale
TIA Effluent and Groundwater Discharge System	Discharge to Roberts Bay via Roberts Bay Discharge System, consisting of the discharge pipe, the marine outfall, the marine outfall berm and the marine diffuser pipe, with access via the Roberts Bay Discharge Access Road. Effluent to meet MMER limits at the end of pipe and marine CCME guidelines in Roberts Bay. This effluent system is designed to support year round discharge, and has a maximum capacity of 7,000 m^3/day. Normally , excess TIA effluent will be discharged only during summer at a maximum rate of 4,000 m^3/day. When groundwater is required to be discharged, it will be pumped at a rate of up to 3,000 m^3/day. If combined, the TIA effluent and groundwater discharge will occur during summer only, to a maximum of 7,000 m^3/day. Groundwater inflows into the mine while mining in the talik are expected to be up to 0.61M m^3/year. After an initial flush of saline pore water, the groundwater is expected to exhibit declining salinity as a result of flow originating in Doris Lake.
Explosives	Use of prepackaged explosives with the main explosives magazine to be located at Quarry A. Unchanged. No ANFO mixing facility to be located on surface.
Landfill	Non-hazardous waste only from Doris construction, operations and closure. Located in Quarry 3.
Laydown areas	Expanded to include: • Roberts Bay West (9,100 m^2); • Roberts Bay Southwest (14,150 m^2); • Roberts Bay Southeast (23,450 m^2); and • Pad U (31,300 m^2).
Mill process	Resin in leach. The revised mill process will not include the Merrill Crowe Process.
Mill rate	1000 tpd with installation of first mill stage. Subsequent increase to 2000 tpd once second mill stage is installed.
Project Life	6 years
Mine plan	Includes: • Doris North (Hinge); • Doris Connector; and • Doris Central.
Ore	2,500,000 t
Security	Closure Plan and security estimate have been revised to include proposed changes.
Tailings Dam	The South Dam design has been changed to a frozen foundation dam consisting of a compacted rock fill dam with a geosynthetic clay liner (GCL) keyed into the permafrost overburden foundation. Interim dike will be constructed within TIA to contain tailings; is solids-retaining and liquid-permeable.

(continued)

Table 1.2-1. Summary of Proposed Doris North Mine Project Components and Activities (completed)

Project Component or Activity	Rationale
Tailings Deposition	Subaerial tailings deposition of gravity flotation tailings into TIA. Tailings to be deposited from 6 spigots: 3 located along the south dam; 3 located along the east flank of the TIA to the Interim Dike. Cyanide-destructed concentrated leach tailings to be disposed in the underground mine workings.
Groundwater (underground operations contact water) Management	Talik water will be collected in sumps underground and used in drilling where possible. Excess talik water will be discharged to the Roberts Bay via the Roberts Bay Discharge System.
Temporary Ore Storage	Pad U.
TIA Capacity	2,500,000 t using subaerial deposition as described above.
Waste Rock	Temporarily stored on surface within built Pad. All waste rock to go underground and non-mineralised waste rock can be used for construction.
Water Use-Doris Lake	<480,000 m^3/year, as per under 2AM-DOH1323 , for industrial use. There will be no change to Doris Lake withdrawal volume.
Water Use-Windy Lake	22,995 m^3/year, as permitted under 2BE-HOP1222, for domestic use.
Vent Raise	2 new vent raises planned, exhaust only, no power on surface, no quarrying. Site infrastructure includes access road, rockfill pad, plenum and emergency shelter: • Doris Connector: access via Float Plane Dock Access Road. • Doris Central: access via Doris-Windy AWR.

1.3 IDENTIFICATION AND ASSESSMENT OF ENVIRONMENTAL IMPACTS

Application package P3-1 identifies the environmental effects associated with the amended Doris North Project throughout the project phases. Identification of the effects is presented as:

- positive (P); or
- negative and mitigable (M); or
- negative and non-mitigable (N); or
- unknown (U); or
- If no impact is expected cell is blank

The methods used to predict effects associated with the proposed Project changes was guided by the approach used for the Doris North Project Final EIS (Miramar 2005). Valued Ecosystem Components (VECs) for the Doris North Project were selected based on both western scientific data and Inuit *Qaujimajatuqangit*. For screening purposes of the proposed Project changes, the identification of environmental impacts considered the identified VECs for the Doris North Project.

Those interactions that are screened to have no effect or mitigable effect are not included in further discussion within the document. The effects presented within include a description of baseline conditions, Project interactions and potential effects, and mitigation measures for:

- Freshwater Environment (section 2.0)

- Atmospheric and Terrestrial Environment (section 3.0)
- Marine Environment (section 4.0)
- Archaeology (section 5.0)
- Socio-economic Environment (section 6.0)

2. FRESHWATER ENVIRONMENT

2.1 INTRODUCTION

This section of the report presents the potential effects of the proposed changes to the Doris North Project to the freshwater environment of Doris Lake focussing on hydrology (water quantity) and fisheries. The existing baseline freshwater conditions in the regional area and at the Project site are discussed and the potential environmental effects on water quantity and fisheries are identified. A summary of the mitigation and management measures are provided and information on the various monitoring programs which have been undertaken at Doris North are identified.

2.2 REGIONAL SETTING

The Hope Bay Belt is located within the Queen Maud Gulf Lowlands, which covers the east-central portion of the West Kitikmeot region. The northern portion of the Hope Bay Belt consists of several watersheds that drain into Roberts Bay near mine infrastructure and the Koignuk River that drains into Hope Bay west of mining activities. Watersheds in the southern portion of the belt flow into the upper Koignuk River.

Climate in the region can be described as a subarctic desert with limited rainfall. Prevailing winds are from the northwest. Most precipitation falls as rain during the summer, and a mean of 10 cm of snow per month falls during the winter (WKRLUP 2005). The region is characterized by long dark winters and short bright summers. The ground is covered in snow from October to June most years. Lakes are ice-covered from approximately October to June most years, with ice thickness reaching depths of 2.0 m.

2.3 EXISTING PHYSICAL FRESHWATER BASELINE CONDITIONS

2.3.1 Hydrology

2.3.1.1 Regional Hydrologic Regime

Rivers in the Hope Bay Belt area have streamflow typical of the Arctic nival regime (Church 1974). The long and severe Arctic winter, and brief time when air temperatures are above freezing, limit surface water activity to a short period. Surface water flow typically begins in late May or early June, and rapidly rises to peak annual flow by early- to mid-June. Snow that accumulated over the long winter is usually the dominant contributor of water to streamflow on an annual basis. Shortly after air temperature rises above freezing, the snow melts rapidly.

After the snowmelt-fed freshet, streamflow steadily decreases to a summertime minimum, which typically occurs in August. Due to the presence of permafrost, there is limited groundwater supply to smaller streams; however, there may be interaction between groundwater systems and larger rivers and/or lakes through taliks. Autumn rain events often augment streamflow and produce moderate flow after the summer minimum. Although snowmelt is typically responsible for the majority of runoff in most years, this may not be the case in exceptionally rainy seasons. In October, air temperature

normally dips below freezing, precipitation begins to fall as snow, and streamflow ceases for the winter except in rivers with very large watersheds. Based on the results of hydrometric monitoring in the Project area, all monitored streams freeze solid in the winter with the exception of the Koignuk River, which retains under-ice liquid water in isolated pools separated by frozen sections of the river (Rescan 2009b; Recan 2011). However, no under-ice flow has been measured in the Koignuk River.

Lakes are common in the region. Runoff is stored in lakes and gradually released, attenuating hydrologic events that would otherwise cause a rapid response in streamflows, such as the nival peak flood and responses to precipitation events. Evaporation from lake surfaces is greater than evaporation from tundra, so runoff is generally lower in watersheds with extensive open water.

2.3.1.2 Watersheds in the Project Area

The Project area consists of two main watersheds: Windy-Glenn (48 km^2) and Doris-Roberts (194 km^2). Both of these watersheds drain north into Roberts Bay (Figure 2.3-1). A topographic drainage divide separates the Windy-Glenn watershed from the Koignuk River watershed (2,937 km^2; not pictured), which drains into Hope Bay to the west of Roberts Bay.

2.3.1.3 Hydrometric Monitoring in the Project Area

Numerous hydrometric stations have been installed and operated throughout the Project area since the mid-1990s. Multiple years of data are available for many of the major lake drainage outlets within the Windy-Glenn and Doris-Roberts watersheds. Hydrometric monitoring began in 1993 at several sites where streamflow and water levels were manually measured. Automated hydrometric monitoring began in 1996 and has continued to the present, although the size of the monitoring network has varied over time to accommodate changes in project scope.

Hydrometric monitoring in the Windy-Glenn and Doris-Roberts watersheds has included streamflow and lake level monitoring at key locations which are pictured in Figure 2.3-2. The monitoring network has evolved since initiated in 1996 to meet the project needs. Included here are data from the relevant monitoring stations operated between 2004 and present.

Streams in the Windy-Glenn and Doris-Roberts watersheds generally have low gradients and low bank slopes. Lakes may drain through channelized, permanent outlet streams (e.g., Patch Lake and Windy Lake outflows, pictured respectively in Plates 2.3-1 and 2.3-2) or undefined, dispersed, and ephemeral drainages (e.g., Wolverine Lake, pictured in Plate 2.3-3). In defined channels, substrate is generally composed of sand, gravel, and cobbles.

Table 2.3-1 summarizes selected hydrometric indices for the monitoring stations in the Windy-Glenn and Doris-Roberts watersheds (Golder 2009; Rescan 2009b, 2011d, 2012d, 2012c; ERM Rescan 2014a; ERM 2015). These data are presented as observed total runoff and annual total runoff. Due to the ice conditions at the beginning and end of the open water season, hydrometric monitoring stations do not measure the total annual runoff. The stations are installed soon after the onset of flow in the streams and remain in place as long as possible before the streams freeze. Observed total runoff values are then post-processed to estimate annual total runoff. The streams freeze to the bed in winter; therefore, annual low flows are assumed to be zero. Lake level fluctuations at the lake monitoring stations are provided in Table 2.3-2.

Figure 2.3-1

Main Watersheds in the Doris North Project Area

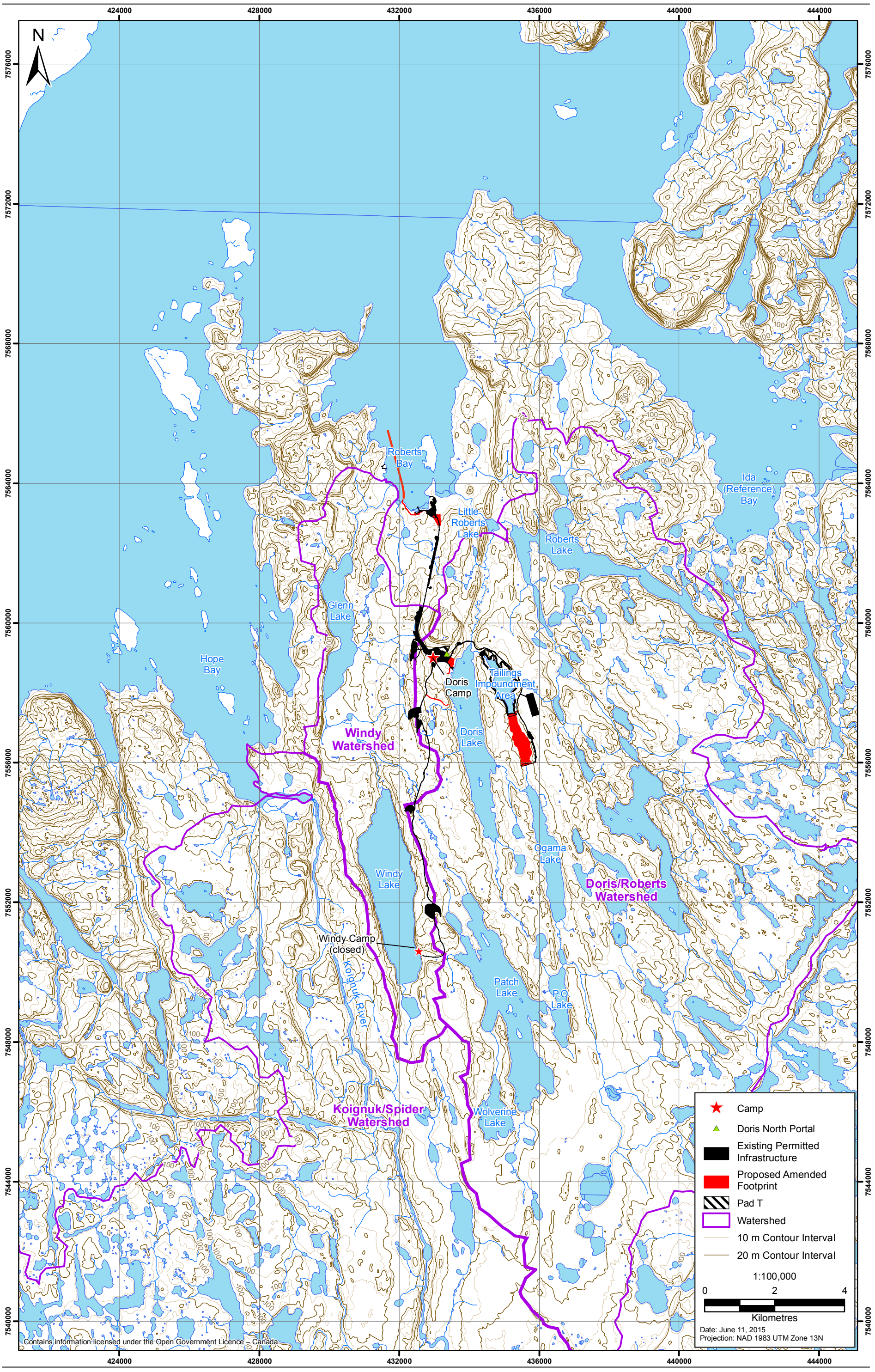

Figure 2.3-2
Hydrometric Monitoring Stations, Doris North Project

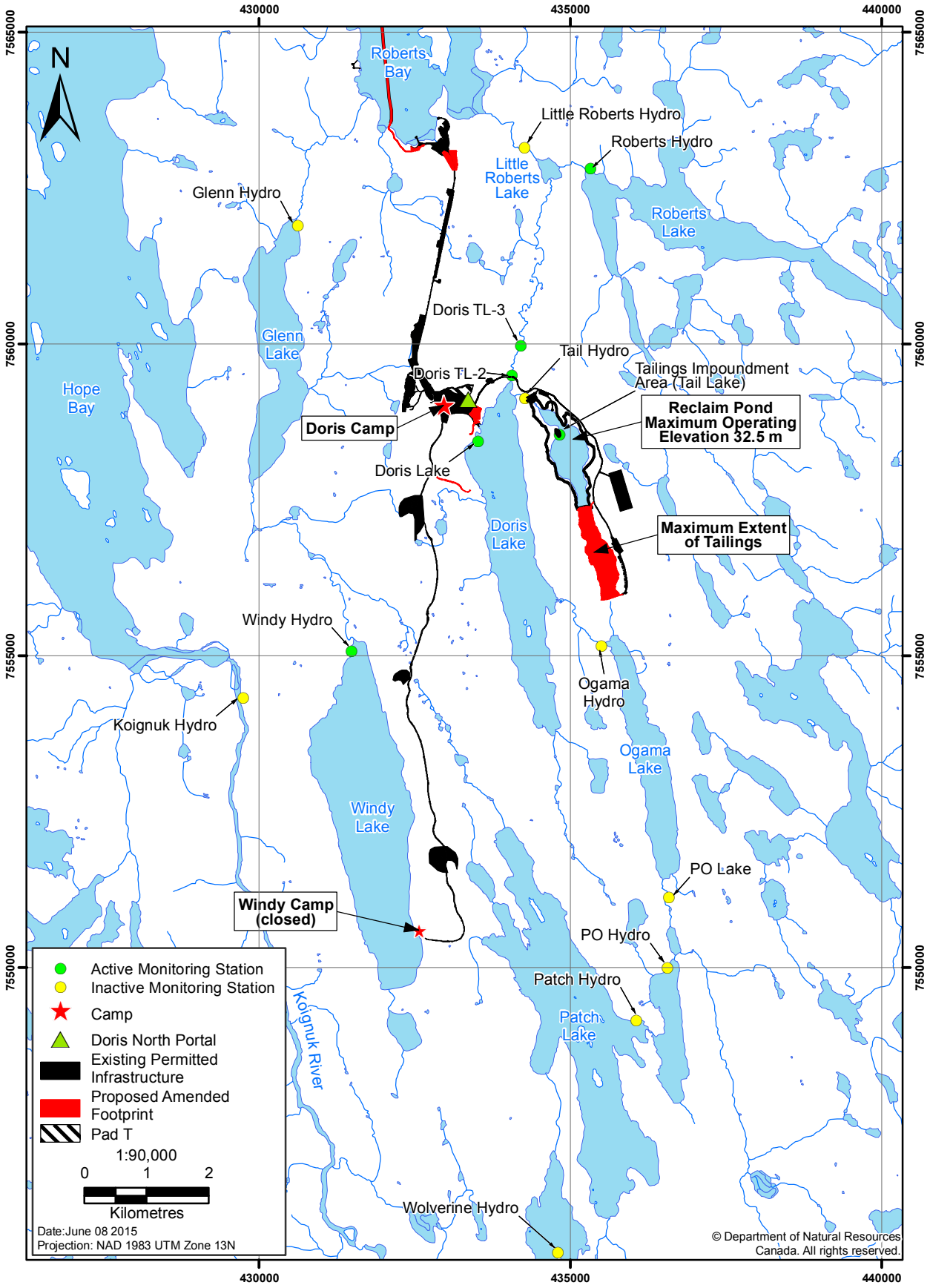

Table 2.3-1. Selected Hydrometric Indices for the Monitoring Stations, Doris North Project, (2004 to 2014)

Hydrometric Station	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Min	Mean	Max
Observed Total Runoff (mm)														
Doris TL-2	58	53	27	69	112	87	121	184	104	40	105	27	87	184
Doris TL-3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	183	105	44	103	44	109	183
Glenn Hydro	n/a	n/a	63	n/a	132	110	n/a	n/a	n/a	n/a	n/a	63	102	132
Koignuk Hydro	n/a	n/a	n/a	56	143	116	134	175	n/a	n/a	n/a	56	125	175
Little Roberts Hydro	61	12	68	100	116	n/a	n/a	n/a	n/a	n/a	n/a	12	71	116
Ogama Hydro	n/a	n/a	74	81	61	78	119	106	n/a	n/a	n/a	61	86	119
Patch Hydro	n/a	n/a	44	n/a	104	85	88	123	n/a	n/a	n/a	44	89	123
PO Hydro	n/a	n/a	n/a	47	88	95	108	200	n/a	n/a	n/a	47	107	200
Roberts Hydro	58	57	17	66	131	87	137	144	98	56	135	17	90	144
Tail Hydro	35	57	11	72	106	86	162	n/a	n/a	n/a	n/a	11	75	162
Windy Hydro	n/a	n/a	n/a	n/a	91	141	197	143	112	42	89	42	116	197
Annual Total Runoff (mm)														
Doris TL-2	61	82	72	79	151	99	129	191	107	41	113	41	102	191
Doris TL-3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	190	109	47	120	47	117	190
Glenn Hydro	n/a	n/a	63	n/a	132	130	n/a	n/a	n/a	n/a	n/a	63	108	132
Koignuk Hydro	n/a	n/a	n/a	56	143	137	140	191	n/a	n/a	n/a	56	133	191
Little Roberts Hydro	64	90	69	107	151	n/a	n/a	n/a	n/a	n/a	n/a	64	96	151
Ogama Hydro	n/a	n/a	74	93	127	99	129	160	n/a	n/a	n/a	74	114	160
Patch Hydro	n/a	n/a	44	n/a	142	95	98	175	n/a	n/a	n/a	44	111	175
PO Hydro	n/a	n/a	n/a	51	118	125	120	213	n/a	n/a	n/a	51	126	213
Roberts Hydro	61	100	71	71	170	98	146	162	99	61	138	61	107	170
Tail Hydro	42	84	53	82	152	109	168	n/a	n/a	n/a	n/a	42	99	168
Windy Hydro	n/a	n/a	n/a	n/a	150	168	222	152	118	43	98	43	136	222

n/a data not available

Table 2.3-2. Recorded Ranges of Seasonal Lake Levels for the Monitoring Stations, Doris North Project, (2004 to 2014)

Lake	Water Level Fluctuation (m)													
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Min	Mean	Max
Doris Lake	0.40	0.58	0.59	0.29	0.66	0.35	0.68	0.74	0.63	0.35	0.68	0.29	0.54	0.74
Monitoring Period	Jun 12 - Sep 10	Jun 8 - Dec 31	Jan 1 - Dec 31	Jan 1 - Dec 31	Jan 1 - Sep 12	May 27 - Sep 21	May 30 - Oct 4	Jan 1 - Sep 29	Jan 1 - Sep 7	May 22 - Sep 10	Jan 1 - Sep 21			
Glenn Hydro	n/a	n/a	0.19	0.22	0.18	0.26	n/a	n/a	n/a	n/a	n/a	0.18	0.21	0.26
Monitoring Period	n/a	n/a	Jun 1 - Sep 11	May 24 - Jul 3	Jun 23 - Sep 9	Jun 17 - Sep 19	n/a	n/a	n/a	n/a	n/a			
Little Roberts Hydro	0.44	0.59	0.49	0.55	0.63	n/a	n/a	n/a	n/a	n/a	n/a	0.44	0.54	0.63
Monitoring Period	Jun 6 - Sep 7	Jun 7 - Sep 29	Jun 30 - Sep 8	Jun 13 - Sep 14	Jun 19 - Sep 12	n/a	n/a	n/a	n/a	n/a	n/a			
Ogama Hydro	n/a	n/a	0.46	0.23	0.28	n/a	n/a	n/a	n/a	n/a	n/a	0.23	0.32	0.46
Monitoring Period	n/a	n/a	Jun 31 - Sep 8	Jun 19 - Sep 14	Jul 2 - Sep 9	n/a	n/a	n/a	n/a	n/a	n/a			
Patch Hydro	n/a	n/a	0.20	0.10	0.23	0.18	0.30	0.44	n/a	n/a	n/a	0.10	0.24	0.44
Monitoring Period	n/a	n/a	Jun 1 - Sep 9	Jun 25 - Sep 12	Jun 23 - Sep 9	Jun 19 - Sep 22	Jun 14 - Sep 29	Jun 22 - Sep 22	n/a	n/a	n/a			
PO Lake	n/a	n/a	n/a	0.34	0.58	0.22	0.34	0.64	n/a	n/a	n/a	0.22	0.42	0.64
Monitoring Period	n/a	n/a	n/a	Jun 18 - Sep 14	Jun 23 - Sep 9	Jun 18 - Sep 21	Jun 14 - Sep 29	Jun 8 - Sep 22	n/a	n/a	n/a			
Roberts Hydro	0.36	0.26	0.58	0.52	0.36	0.20	0.40	0.56	n/a	n/a	n/a	0.20	0.40	0.58
Monitoring Period	Jun 18 - Sep 13	Jun 29 - Sep 17	Jun 3 - Sep 6	Jun 15 - Sep 14	Jun 22 - Sep 12	Jun 17 - Sep 20	Jun 14 - Oct 2	Jun 21 - Sep 25	n/a	n/a	n/a			

(continued)

Table 2.3-2. Recorded Ranges of Seasonal Lake Levels for the Monitoring Stations, Doris North Project, (2004 to 2014) (completed)

Lake	Water Level Fluctuation (m)													
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Min	Mean	Max
Tailings Impoundment Area (Tail Lake)	0.17	0.19	0.25	0.23	0.20	0.14	0.17	0.63	0.50	0.34	0.41	0.14	0.29	0.63
Monitoring Period	Jun 13 - Dec 31	Jan 1 - Dec 31	Jan 1 - Dec 31	Jan 1 - Dec 31	Jan 1 - Sep 12	Jan 1 - Sep 21	Jun 2 - Oct 4	May 12 - Sep 29	Jan 1 - Sep 12	May 22 - Sep 9	Mar 16 - Sep 18			
Windy Hydro	n/a	n/a	n/a	0.24	0.06	0.23	0.10	0.24	0.18	0.10	0.13	0.06	0.16	0.24
Monitoring Period	n/a	n/a	n/a	Jun 21 - Aug 4	Jul 2 - Sep 9	Jun 16 - Sep 23	Jun 10 - Sep 24	Jun 21 - Sep 22	Jun 7 - Sep 13	Jun 5 - Sep 8	Jun 5 - Sep 8			
Wolverine Hydro	n/a	n/a	0.16	n/a	0.06	0.25	0.24	0.26	n/a	n/a	n/a	0.06	0.19	0.26
Monitoring Period	n/a	n/a	Jun 1 - Sep 7	n/a	Jun 18 - Sep 9	Jun 20 - Jul 26	Jun 13 - Sep 28	Jun 21 - Sep 21	n/a	n/a	n/a			

n/a data not available

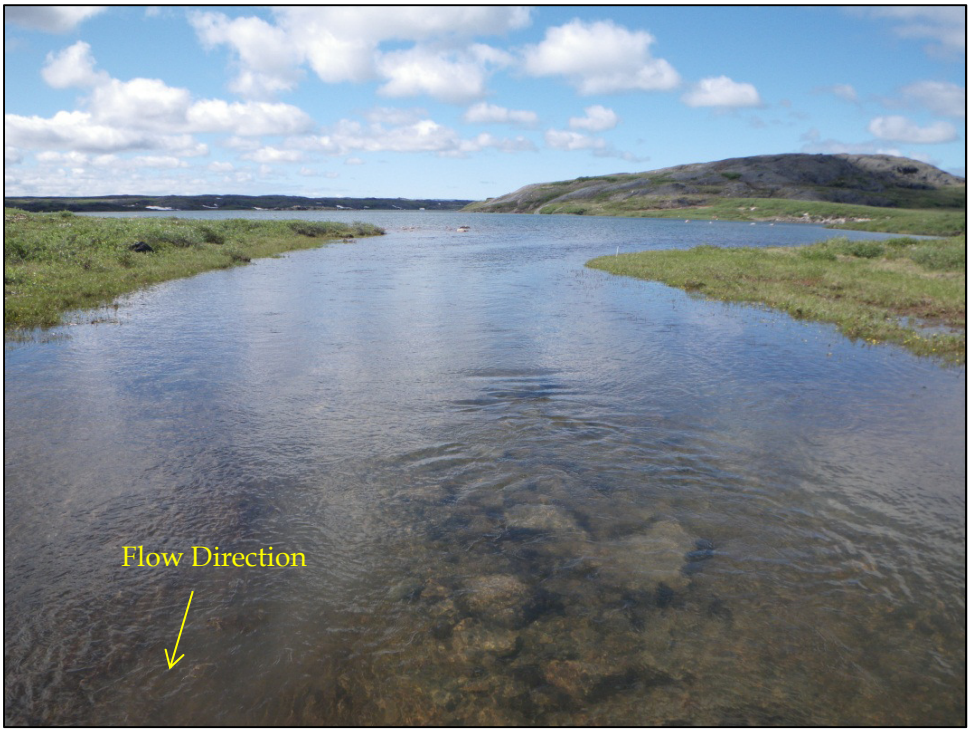

Plate 2.3-1. Patch Lake Outflow Stream. View is upstream (west) towards the lake. Channel width is approximately 10 metres. Photo taken August 23, 2011.

Plate 2.3-2. Windy Lake Outflow Stream. View is upstream (south) towards the lake. Channel width is approximately 1 metre. Photo taken September 8, 2013.

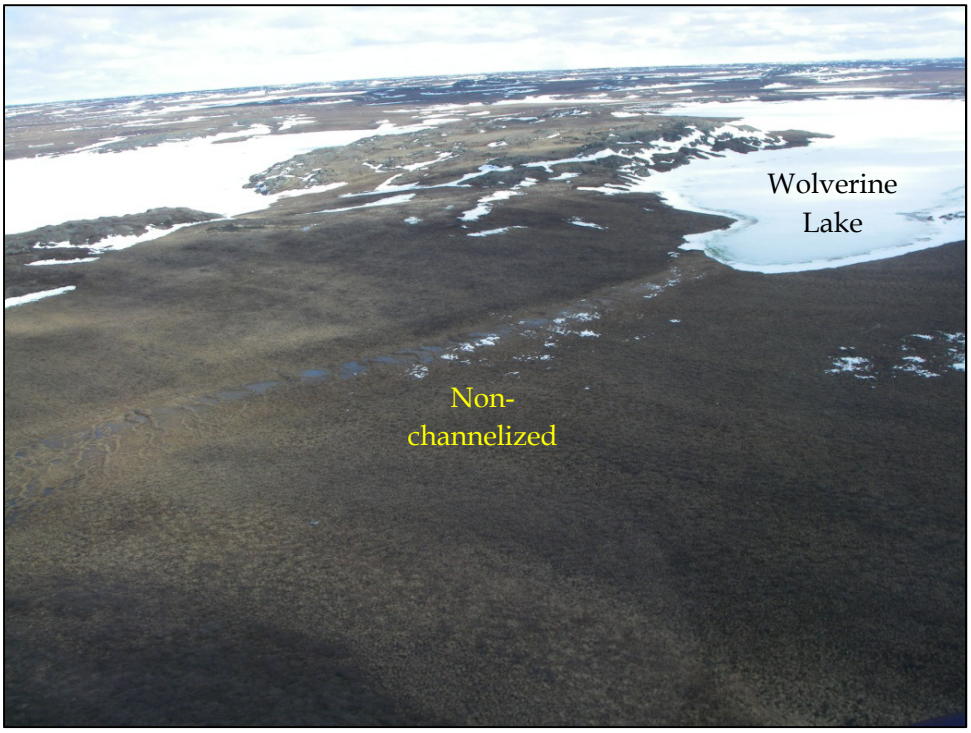

Plate 2.3-3. Southeast side of Wolverine Lake. View is northwest. Note non-channelized water in marsh-like outflow area of lake. Photo taken June 12, 2009.

2.4 EXISTING BIOLOGICAL FRESHWATER BASELINE CONDITIONS

2.4.1 Freshwater Fisheries

The Project is located in the Doris-Roberts watershed; Wolverine Lake drains into Patch Lake in the upper reaches of the watershed. The watershed then drains through a series of lakes, including P.O., Ogama, and Doris Lake. Downstream of Doris Lake, Doris Creek flows over a 4 m high waterfall, and then joins the Roberts Watershed in Little Roberts Lake (downstream of Roberts Lake). Roberts Creek flows from Little Roberts Lake northwest for approximately 1.5 km where it enters Roberts Bay. Table 2.4-1 summarizes sampling effort and species distributions, by waterbody, throughout watershed affected by proposed Project changes.

Table 2.4-1. Historical Sampling of Freshwater Fish Habitats and Fish Communities, 1995 to 2014

Watershed	Waterbody or Site	Environment	Species	Sampling Years
Doris-Roberts	Roberts Lake	Lake	AC, LT, LW, CS, NSB	2002, 2004, 2010, 2011, 2012
	Doris Lake	Lake	LT, LW, CL, NSB	1995, 1996, 1997, 1999, 2003, 2005, 2009
	Little Roberts Lake	Lake	AC, LT, LW, CS, NSB	2000, 2002, 2003, 2009, 2010
	Roberts Outflow	Stream	AC, LT, LW, CS, NSB	2002, 2003, 2004, 2005, 2006, 2007, 2010, 2011, 2012, 2013, 2014
	Doris Outflow (U)[2]	Stream	LT, LW, CS, NSB	1996, 1997, 2003, 2005, 2009

(continued)

Table 2.4-1. Historical Sampling of Freshwater Fish Habitats and Fish Communities, 1995 to 2014 (completed)

Watershed	Waterbody or Site	Environment	Species	Sampling Years
Doris-Roberts	Doris Outflow (D)[2]	Stream	AC, LT, NSB	1996, 1997, 2003, 2005, 2009
	Little Roberts Outflow	Stream	AC, LT, LW, CS, NSB	2000, 2002, 2003, 2010

Fish Species Codes: CS = Least Cisco[1], NSB = Ninespine Stickleback, CL = Lake Cisco[1], LT = Lake Trout, LW = Lake Whitefish, AC = Arctic Char.
[1] It is difficult to identify Cisco to the species level, so these identifications should be interpreted with caution.
[2] A 4-m high waterfall located approximately 420 m downstream from Doris Lake acts as a barrier to upstream fish migration. Fish species presence is separated by those known to exist upstream (U) or downstream (D) of the waterfall.

2.4.1.1 Doris-Roberts Watershed

Doris Lake

Doris Lake is a large fish-bearing waterbody in the Doris-Roberts Watershed. It has a surface area of 337.8 ha, a volume of 27,275,094 m^3, an average depth of 8.1 m, and a maximum depth of 20.0 m (Rescan 2010a). The maximum length of the lake is 5.6 km, and the maximum width is 0.85 km.

The fish habitat and fish community of Doris Lake has been sampled extensively (Table 2.4-1). Habitat assessments of the shoreline of Doris Lake found that approximately 50% of the shore is bedrock, and the remainder is a diverse mixture (Figure 2.4-1; Rescan 2001). The southern end of the lake is dominated by sand over roughly 500 m on each side of the lake. The accumulation of sand may originate from the small stream located at the south end of the lake.

Hydroacoustic surveys were used to characterize substrate composition in Doris Lake below 1.5 m water depth in 2009. Substrates consist primarily of soft sediments (75%), with 'very soft fines' and 'mud', representing 53% and 22% of the overall lake bottom area (Figure 2.4-2; Rescan 2010a). Hard substrates (i.e., gravel, cobble and boulder; 25%), associated primarily with near-shore locations and islands, comprise remaining lake habitat.

In 2009, gill nets and hydroacoustics were used to provide an indication of the distribution of fish in Doris Lake (Figure 2.4-3, 2.4-4). As the scale between methods is different, direct comparisons cannot be made but general trends can compared. Both methods indicated that there was a general increase fish density with increases in water depth. The highest densities in both assessments were clustered in the central basin of the lake where water depths exceeded 10 m.

Doris Lake is connected to upstream lakes including Ogama, P.O., and Patch lakes throughout the open water season. Approximately 420 m downstream of the lake, a 4 m waterfall creates a permanent barrier to upstream fish movement, isolating Doris Lake from ocean migrants.

Figure 2.4-1

Doris Lake Shoreline Substrate Assessment, Doris North Project, 2000