Kiggavik Project

Environmental Impact Statement

Tier 3 Technical Appendix 5L

Conceptual Fish Habitat Compensation Plan

December 2011

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1 INTRODUCTION

The Kiggavik Uranium Mine Project (the Project) is a proposed uranium ore mining and milling operation located in the Kivalliq region of Nunavut approximately 80 kilometres (km) west of the community of Baker Lake. There are three main geographical areas incorporated in the Kiggavik Project; these are the Kiggavik site, the Sissons site, and the proposed Winter Access Road and optional North All-Weather Access Road between Baker Lake and the Kiggavik site. The main base of operations will be the Kiggavik site, which will include open pit mining, power generation, ore processing, warehousing, administration, and personnel accommodation. The proposed activities at the Sissons site include open pit mining, underground mining, and the ancillary activities required to support these mining operations.

1.1 OBJECTIVES

Several Project development activities are expected to result in the alteration and/or loss of fish habitat. Although the in-water construction activities will be designed to reduce effects to fish habitat, it is expected that some of these activities will result in the harmful alteration, disruption or destruction (HADD) of fish habitat, and the subsequent need for compensation under the Fisheries and Oceans Canada (DFO) “No-Net-Loss” (NNL) Policy.

Fish habitat is comprised of a combination of lake and stream characteristics such as lake morphometry (e.g., size, shape, mean and maximum depths.), stream channel type (e.g., runs, pools, riffles), substrate type (e.g., sand, gravel, cobbles, boulders), and fish use (e.g., spawning, rearing, and foraging activities), and can be quantified by area (square metres [m^2]) and type of habitat. Existing environment baseline habitat quality has been identified by previous fieldwork, so changes in fish habitat can be measured by the change in area of available fish habitat.

In order to address the Project concerns relating to fish habitat, this conceptual Fish Habitat Compensation Plan (FHCP) was prepared following consultation with DFO. Before an authorization to proceed is issued by DFO, a plan for the mitigation and replacement of fish habitat losses must be in place and approved by DFO. Following approval of the final FHCP, and subsequent implementation of the various compensation works proposed therein, no additional residual uncompensated losses of fish habitat are anticipated. All non-mitigable habitat losses resulting from development of the Kiggavik Project will be fully compensated.

The objectives of this conceptual FHCP are:

- to assess impacts to fish habitat associated with the Project;

- to describe plans to mitigate Project effects on fish habitat;
- to quantify surface area of habitat loss and habitat alteration;
- to develop habitat compensation options so that the NNL principle of DFO's fish habitat management policy can be achieved; and
- to describe plans to monitor fish habitat compensation during construction and to assess its effectiveness.

Relevant Project activities and associated environmental interactions with fish habitat for each Project phase are summarized in Table 1.1-1 for project-environment interactions that were ranked Category 1 or 2 in the "Tier 2 Environmental Assessment Report - Aquatic Environment" (Table 10.1-1 for fish habitat). Project activities that will affect fish habitat will occur at several locations in conjunction with in-water construction activities (e.g., relocation of downstream portion of Mushroom/End Grid Stream, construction of a berm and dewatering a portion of Andrew Lake, installing freshwater intake structures and treated effluent diffusers, and water removal for construction and maintenance of the winter access road during the construction phase) and on-land construction activities (e.g., filling portions of streams and ponds to allow construction of site infrastructure, and installing culverts at stream crossings for the haul road and various access roads) during the construction phase of the Project. Mining (e.g., blasting in the Main Zone open pit and Andrew Lake open pit), and water management (e.g., withdrawal of potable and mill process water supplies, and water removal for construction and maintenance of the winter access road) are activities that will affect fish habitat during the operations phase of the Project. In-water decommissioning activities (e.g., removal of freshwater diversions to re-establish natural drainage systems, refilling Andrew Lake pit with water from Judge Sissons Lake, and removal of freshwater intake structures and treated effluent diffusers) and on-land decommissioning activities (e.g., removal of stream crossing structures and re-establishment of natural drainage systems) will positively affect fish habitat during the final closure phase of the Project.

1.2 GENERAL SITE DESCRIPTION

The Project is located within the physiographic region of the Canadian Shield and, as such, the land contains features formed by glaciation, including eskers and boulder moraines (Environment Canada [EC] 2009, internet site). The topography is gently undulating, and is filled with hummocks and patterned ground resulting from permafrost. Vertical drainage is impeded by the permafrost layer, and wetlands, small ponds, and lakes are common over the landscape. The Project is also located in the Southern Arctic terrestrial ecozone, which is characterized by continuous permafrost that may be present just a few centimetres (cm) below the surface (EC 2009, internet site). Low precipitation and extremely low winter temperatures prevent tree growth in this ecozone (National Resources Canada [NRCAN] 2009, internet site). Summers in the Southern Arctic Ecozone are cool and about four months in length. This ecozone is bounded to the south by the treeline and the Taiga Shield Ecozone and to the north by the Northern Arctic Ecozone, which includes most of the islands off the northern shores of Nunavut and the Northwest Territories, as well as the northern-most portion of the Ungava Peninsula. Common types of vegetation that may be found here include low-lying shrubs such as willow, shrub birch and Labrador tea, and lichens and mosses (EC 2009, internet site).

Table 1.1-1
Summary of Project Environment Interactions and Effects on Fish Habitat

Project Phase	Project Activities/Physical Works	Change in Quality or Distribution of Fish Habitat
Construction:		
In-water construction	construct freshwater diversions and site drainage containment systems (dykes, berms, collection ponds)	2
	construct in-water/shoreline structures	2
	water transfers and discharge	2
	freshwater withdrawal	1
On-land construction	site clearing and pad construction (blasting, earth moving, loading, hauling, dumping, crushing)	2
Operations:		
Mining	mining ore (blasting)	0
Water management	freshwater withdrawal	1
Final Closure:		
In-water decommissioning	remove freshwater diversions; re-establish natural drainage	2
	remove surface drainage containment	2
	remove in-water/shoreline structures	2
	construct fish habitat as per FHCP	2
On-land decommissioning	remove site pads (earth moving, loading, hauling, dumping)	2

Source: Modified from Table 10.1-1 in TIER 2 DEIS report.
Category 1 activities are those having an interaction with the aquatic environment; however, based on past experience and professional judgment, the resulting effect can be managed to acceptable levels through standard operating practices and/or through the application of best management or codified practices.
Category 2 activities are those activities that do interact with the aquatic environment and the resulting effect may exceed acceptable levels without implementation of specified mitigation. Further assessment of the effects of these interactions on the aquatic environment is warranted and is presented in the environmental assessment report.

Climate and permafrost play an important role in the hydrological regime of this area. Peak stream flows in this region are a result of spring melt, which can account for the majority of the volume of total annual runoff. Throughout the summer and fall, the active layer of permafrost increases, thereby increasing the amount of storage available within the ground. Secondary peaks are common in the late summer or early fall of the annual hydrograph, due to precipitation later in the season. Smaller streams may freeze completely to their channel bottoms throughout the winter, and begin to flow again overtop the anchor ice when spring melt begins. Lake ice thickens over winter reaching a depth of approximately 2 metres (m). Thus, many shallow lakes freeze completely and a substantial portion of the volume of larger lakes is frozen by late winter.

In general terms, most lakes and ponds in the Mine Site Local Assessment Area (LAA) are shallow and provide only seasonal foraging and rearing habitat for fish. Overwintering habitat is found in a few deeper lakes (i.e., Cigar, Cirque, Judge Sissons, Mushroom, Ridge, and Siamese lakes, and Pointer Pond) in the area. All lakes less than 2.0 m deep, and all area streams and rivers (with the exception of the Thelon River) are thought to freeze to the bottom by late winter. It is uncertain whether five lakes with maximum depths between 2.0 and 3.0 m deep (i.e., Caribou, Crash, Fox, Pointer, and Willow lakes) are capable of supporting fish overwinter.

Many of the larger stream systems in the LAA support Arctic grayling spawning runs, as well as other fish species that move into the streams during the open water period to forage or to escape predatory fish in the over-wintering lakes. The diversity of fish species in streams is highest close to over-wintering lakes, and decreases as you move higher in the watershed (unless a deep, over-wintering lake exists in the headwaters of a stream system).

Baseline conditions for fish habitat in the Kiggavik Project area are described more thoroughly in the Aquatics Baseline - Appendix 5C (Section 10.0 Fish Habitat) and summarized in the Existing Environment Section of the TIER 2 DEIS (Section 5.5.5 Freshwater Habitats).

2 POTENTIAL AREAS OF IMPACT DUE TO THE KIGGAVIK PROJECT

Information was gathered from the environmental and engineering teams for the Kiggavik Project, through public engagement, and by NIRB to identify project activities that have potential to result in changes to the quality or distribution of fish habitat. Relevant project activities and the associated environmental interactions on fish habitat for each Project phase are summarized in Table 2.2-3 for proposed Project components, and in Table 2.4-1 for optional Project components. The surface area and stream length of disturbed areas were categorized separately to differentiate fish habitat losses from fish habitat alterations.

A number of Project development activities have the potential to alter, disrupt, or destroy fish habitat. These include diversion of streams away from their current locations, drainage of lakes or portions of lakes, and installation of stream crossing structures on the all-weather ore haul road and other roads related to Project infrastructure (e.g., roads to water intake and treated effluent discharge structures and the airstrip).

2.1 CONSTRUCTION PHASE

During the Project construction phase, land clearing and earth moving will be carried out to prepare areas for mine and mill site infrastructure development. Stream and watercourse crossings will be required as a component of developing mine infrastructure such as the ore haul road between the Kiggavik and Sissons Mine Sites, the access roads to the water intake locations and treated effluent discharge points, and the airstrip. As most medium- to large-sized streams support fish during the summer months, installation of stream crossing structures will result in the alteration, and potential loss of fish habitat. To reduce and mitigate these effects, best management practices will be incorporated into stream crossing design to minimize the amount of fish habitat lost or altered at each crossing. Crossing structures in fish bearing streams will also be designed to facilitate passage of large-bodied spawning fish species.

2.1.1 Construction of Freshwater Diversions and Site Drainage Containment Systems (Dykes, Berms, and Collection Ponds)

As part of developing the mine site and infrastructure at the Sissons site, about 475 m of the downstream portion of the stream between Mushroom Lake and End Grid Lake (Mushroom/End Grid Stream) will be diverted around the mine working area. The stream channel in this portion of the stream averages about 1.3 m wide, therefore the area of channel diverted would be about 0.062 ha (Table 2.2-3).

This portion of the stream had a maximum recorded depth of 0.2 m in the main channel. Wetted width ranged from 5.2 to 6.2 m; bankfull width ranged from 1.0 to 6.2 m. This portion of Mushroom/End Grid stream habitat consisted of shallow run habitat exclusively in braided channels. Shoreline slope was variable and ranged from moderate to high slopes. Instream substrate consisted primarily of silt with cobble, gravel, and boulder also being present. Instream cover consisted of interstitial spaces in the coarse substrate, and inundated terrestrial vegetation. During the time of assessment (spring freshet), areas of flooded tundra were present.

This stream has been documented to support spawning Arctic grayling (*Thymallus arcticus*) and foraging lake trout (*Salvelinus namaycush*) just downstream of the Mushroom Lake outlet during the spring spawning season. While this fish-bearing section of the stream will not be affected by the Sissons Mine Site development, the majority of the downstream portion of the stream will be diverted around the Sissons Mine Site and reconnected to End Grid Lake. The portion of stream that will be lost is used for seasonal fish passage between End Grid and Mushroom lakes. No spawning or rearing/foraging use was observed. The dewatered portion of stream channel connecting End Grid and Mushroom lakes will be filled in as part of developing mine infrastructure at the Sissons Mine Site. Mushroom and End Grid lakes will still be connected via the freshwater diversion channel S1 around the east side of the Sissons mine site.

2.1.2 Construction of In-Water/Shoreline Structures

During the mine development process, the north-east portion of Andrew Lake will be bermed off and dewatered in order to construct the Andrew Lake mine pit at the Sissons site. This work will result in the loss of 13.5 hectares of seasonal use fish habitat in the north-east end of Andrew Lake (Table 2.2-3). The 650 m long berm proposed for construction across the north-east end of Andrew Lake will require that 0.065 ha of rock-riprap be installed along the lakeward edge to protect it from wave and water erosion in Andrew Lake (Table 2.2-3). This rock riprap represents an alteration to the habitat type that was present on the natural shoreline of Andrew Lake.

In the summer of 2009, the surface area of Andrew Lake was 54 ha and the shoreline perimeter was 5,029 m. At the time of the assessment in 2009, the maximum water depth recorded at the sampling stations was 1.0 m. An assessment of overwintering conditions was undertaken in May 2009; ice thickness was about 1.0 m with the lake being frozen to the bottom. Andrew Lake shoreline substrate consisted primarily of sand and cobble, with some boulders. The shoreline slope was predominantly flat. Shoreline vegetation was primarily grasses and low shrubs. Shoreline cover consisted primarily of interstitial spaces in coarse substrate with some areas of inundated vegetation.

Andrew Lake provides seasonal rearing and foraging habitat for Arctic grayling, burbot (*Lota lota*), cisco (*Coregonus artedi*), and round whitefish (*Prosopium cylindraceum*). Andrew Lake is too shallow to support fish overwinter (i.e., maximum depth 1.0 m; mean depth 0.2 m), as winter ice depths in the region often reach 2.0 m.

2.1.3 Water Transfers and Discharge

Installation of water intake structures and connecting water intake lines in Mushroom and Siamese Lakes, and the treated effluent diffuser structures and treated effluent lines at two locations in Judge Sissons Lake are expected to result in the alteration or temporary loss of fish habitat.

2.1.3.1 Freshwater Intake Structure at Siamese Lake

The installation of the proposed freshwater intake structure in Siamese Lake will require installation of an intake pipeline about 125 m long to reach a water depth of 3 m which would be below predicted winter ice level (2.0 m), and below the proposed winter water removal level (see Section 2.2.2.1). As part of installing the water intake structure and connecting water intake line in Siamese Lake, about 0.063 ha of fish habitat (5 m wide) in Siamese Lake would be temporarily affected (Table 2.2-3).

In summer 2008, the surface area of Siamese Lake was 2,792 ha and the shoreline perimeter was 45,877 m. The maximum measured water depth was 12 m. In the area where the proposed freshwater intake structure may be installed, the Siamese Lake shoreline substrate consisted primarily of boulder and cobble. The shoreline slope was predominantly flat. Shoreline vegetation was dominated by grass with some patches of low shrubs. Shoreline cover consisted primarily of interstitial spaces in the coarse substrates and small areas of inundated terrestrial vegetation.

Lake trout is the only fish species which has been captured or observed in Siamese Lake between summer and fall 2008. Because this lake was not subjected to intensive fish surveys, the lack of other fish species in the record may reflect reduced sampling effort.

Rearing, feeding, and overwintering habitats are present in Siamese Lake. During the lake trout fall spawning survey of 2008, lake trout in spawning condition were captured in Siamese Lake. A desktop study was undertaken to identify the potential impact of water drawdown on lake trout spawning habitat, as eggs and larval fish of this fall spawning species will be the most susceptible to changes in water levels. Through this desktop study (described more fully in Section 2.2.2.1), locations of potential lake trout spawning habitat were identified between 2 m and 5 m deep throughout Siamese Lake, with the majority of the potential areas being identified in the east basin. None of the potentially suitable spawning areas were located near the proposed location of the water intake in the west basin of Siamese Lake.

2.1.3.2 Freshwater Intake Structure at Mushroom Lake

The installation of the proposed freshwater intake structure in Mushroom Lake will require installation of about 200 m of water intake piping to reach a water depth of 3 m which would be below predicted winter ice level (2.0 m), and below the proposed winter water removal level (see Section 2.2.2.1). As part of installing water intake structures and connecting water intake lines in Mushroom Lake, about 0.100 ha of fish habitat (5 m wide) in Mushroom Lake would be temporarily affected (Table 2.2-3).

In summer 2009, the surface area of Mushroom Lake was 32 ha, the shoreline perimeter was 3,416 m, and a maximum depth of 8.9 m was measured. Ice thickness in May 2009 was 2 m. In the area where the proposed freshwater intake structure may be installed, the Mushroom Lake shoreline substrate consisted primarily of sand and cobble. The shoreline slope was predominantly flat. Shoreline vegetation was dominated by grass with some patches of low shrubs. Cover habitat consisted primarily of interstitial spaces in coarse substrate.

Arctic grayling, lake trout, and round whitefish were captured in Mushroom Lake between fall 2007 and spring 2010, while cisco are also present according to the historical data. Arctic grayling may migrate between Mushroom Lake and Judge Sissons Lake during the spring freshet. Arctic grayling spawning was confirmed in two stream sections (Lunch/Andrew Stream and Andrew/Shack Stream) located about 2 km downstream of Mushroom Lake. Rearing and feeding habitats are available throughout the sub-basin and overwintering habitat is provided in Mushroom Lake. Cisco, lake trout, and round whitefish may also use Mushroom/End Grid Stream to migrate at times. Spawning and overwintering habitat for these species may be limited to two lakes in the Lower Lake sub-basin, including Mushroom Lake, while rearing and feeding activities may occur throughout the sub-basin during the open water period.

During the lake trout fall spawning survey of 2008, lake trout in spawning condition were captured in Mushroom Lake. A desktop study was undertaken to identify the potential impact of water drawdown on lake trout spawning habitat, as eggs and larval fish of this fall spawning species will be the most susceptible to changes in water levels. Through this desktop study (described more fully in Section 2.2.2.1), locations of potential lake trout spawning areas were identified between 2 m and 6 m deep on the north shore of Mushroom Lake. None of the potential suitable spawning areas were located near the proposed location of the water intake in Mushroom Lake.

2.1.3.3 Treated Effluent Diffusers at Judge Sissons Lake

The installation of the pipelines for the two proposed treated effluent diffusers (Kiggavik and Sissons mine sites) in Judge Sissons Lake will require the excavation of trenches from the shoreline to a depth of 3 m, followed by the laying of the pipe and diffuser structures on the bed of Judge Sissons Lake from the 3 m depth to their ends. For the proposed treated effluent diffuser for Kiggavik mine site, an estimated 264 m of pipe length will be excavated and 876 m of pipe and diffuser structure will be laid on the lake bottom (Table 2.1-1). The Kiggavik diffuser will be located at a depth greater than 7 m in segment JSL-2 (Table 2.1-1). For the proposed treated effluent diffuser for Sissons mine site, an estimated 254 m of pipe length will be excavated and 444 m of pipe and diffuser structure will be laid on the lake bottom (Table 2.1-1). As part of installing the treated effluent diffuser structures and connecting treated effluent diffuser lines in Judge Sissons Lake, about 0.919 ha of fish habitat (5 m wide) for both sites in Judge Sissons Lake (0.570 ha for Kiggavik diffuser and 0.349 ha for Sissons diffuser) would be temporarily affected (Table 2.2-3 and Table 2.1-1).

Table 2.1-1
Estimated Length of Treated Effluent Diffuser Pipeline in Judge Sissons Lake

Source of Pipeline	Receiving Segment of Lake	Estimated Pipe Length (m)			Estimated Area for Fish Habitat Compensation[a] (ha)
		to Excavate (0 to 3 m)	to Lay on Bottom Floor (> 3 m)	Total	
Kiggavik mine site	JSL-2	264	876	1,140	0.570
Sissons mine site[b]	JSL-8	254	444	698	0.349
Total		**518**	**1,320**	**1,838**	**0.919**

[a] Width of the treated effluent diffuser was assumed to be maximum 5 m wide.

[b] Values assume pipeline alignment which would avoid crossing of Boulder/Judge Sissons Stream and shorten the pipeline length in the water to get to required depth.

According to historical bathymetric data, the surface area of Judge Sissons Lake was 9,550 ha with a shoreline perimeter of 119,370 m, and a maximum depth of about 21 m. In the area where the proposed treated effluent diffuser from the Kiggavik site may be installed, the Judge Sissons Lake shoreline substrate consisted primarily of gravel mixed with coarse substrate, with several areas of cobble and boulder substrate. The shoreline slope was predominantly flat. Shoreline vegetation was grass with some patches of low shrubs, and several areas of exposed cobble or boulder. Shoreline cover habitat consisted primarily of interstitial spaces in coarse substrate, with small areas of emergent vegetation and inundated terrestrial vegetation. Habitat mapping has not been conducted in the area where the proposed treated effluent diffuser from the Sissons site may be installed. Habitat mapping of this area will be completed prior to any in-water construction work taking place.

Six fish species (i.e., Arctic grayling, burbot, cisco, lake trout, ninespine stickleback [*Pungitius pungitius*], and round whitefish) were captured or observed in Judge Sissons Lake between summer 2008 and fall 2009, while slimy sculpin (*Cottus cognatus*) were present according to historical data. The absence of slimy sculpin in the recent record likely reflects a bias in the sampling methods used, because of the focus on large-bodied fish species. Arctic char have not been captured or observed in Judge Sissons Lake. Judge Sissons Lake is a deep lake which provides overwintering habitat for all fish species. The variety of habitats in the lake would likely accommodate spawning preferences for all lake spawning species, and tributaries would provide habitat for stream spawning species. Rearing and feeding activities for all recorded fish species present may occur within Judge Sissons Lake, as well as in other surrounding lakes and streams.

During the fall 2008 lake trout spawning survey, lake trout in spawning condition were captured in Judge Sissons Lake. Although a desktop study was not completed to identify potential lake trout spawning areas in Judge Sissons Lake, no lake trout spawning habitat is expected in the area of the treated effluent diffuser sites, because of the lack of suitable areas with optimal underwater slope steepness.

2.1.4 Freshwater Withdrawal

During the construction and operational phases of the Project, about 75,000 cubic metres (m^3) of water will be withdrawn annually from lakes along the route of the proposed winter access road between Baker Lake and the Kiggavik site. Calculations show that expected water withdrawal volumes from the lakes along the route represent between 0.01% and 0.87% of the under-ice volume of these lakes (Table 2.1-2). These required volumes are all substantially less than the maximum water withdrawal volumes allowed under DFO's policy of a maximum of 10% of the under-ice volume (DFO 2010a).

Table 2.1-2
Estimated Maximum Annual Water Withdrawal Volumes for Winter Road Construction

Waterbody	Under-Ice Volume[a] (m^3)	Maximum Annual Water Withdrawal Volume		
		Maximum of 10% Allowed by DFO (m^3)	Required Volume[b] (m^3)	Required portion of Lake Under-Ice Volume (%)
Siamese Lake	65,821,284	6,582,128	7,275	0.01 (0.2 cm drawdown)
L2 / 20 km Lake	21,215,910	2,121,591	7,275	0.03 (0.2 cm drawdown)
Long Lake	1,573,164	157,316	8,850	0.56 (0.5 cm drawdown)
Audra Lake	30,409,439	3,040,944	27,450	0.09 (0.8 cm drawdown)
Four Unnamed Lakes	1,990,323	199,032	12,075	0.61 (0.5 cm drawdown)
Qinguq Bay	1,389,562	138,956	12,075	0.87 (0.5 cm drawdown)
Total	**122,399,682**	**12,239,968**	**75,000**	**0.06**

[a] Estimates based on EBA (2010) ground penetrating radar (GPR) data.
[b] Required volumes were allocated proportionally along the winter access road.
m^3 = cubic metres; % = percent; cm = centimetres.

2.1.5 Site Clearing and Pad Construction (Blasting, Earth Moving, Loading, Hauling, Dumping, Crushing)

During the mine development process, site clearing and pad construction will be required for both site facilities, the haul-road between the Kiggavik and Sissons facilities, both access roads to the water source lakes (Mushroom and Siamese lakes), and both access roads to the treated effluent discharges at Judge Sissons Lake (north and northwest). Most of these activities are expected to result in the alteration or temporary loss of fish habitat, while the balance of the activity is related to habitat alteration or loss of non-fish bearing streams.

2.1.5.1 Site Facilities

A number of streams and watercourse channels will be diverted and a number of small ponds will be filled to facilitate construction of the Kiggavik and Sissons mines and mill site, and associated infrastructure. None of the streams or ponds proposed for diversion or alteration contain any documented fish populations, or the diversions are located in the stream headwaters, upstream of known fish populations.

2.1.5.1.1 Kiggavik Site

Three streams and watercourse channels (i.e., middle section of the Northeast inflow of Pointer Lake, top section of the tributary of the Northeast inflow of Pointer Lake, and top section of the Northwest inflow of Pointer Lake) will be diverted to facilitate construction of the Kiggavik mine and mill site, and associated infrastructure. None of the streams proposed for diversion or alteration contain any documented fish populations, or the diversions are located in the stream headwaters, upstream of known fish populations.

During the mine development process, the middle section of the Northeast inflow of Pointer Lake (3,799 m x 2 m) will be filled and the water flowing from the upper section of the stream will be diverted around the site to reconnect to the lower section of the stream, which is fish bearing (ninespine stickleback) immediately upstream of Pointer Lake. The in-filling work will result in the loss of 0.760 ha of non-fish bearing stream (Table 2.2-3), including unused shallow run, flat, and riffle habitats.

As well, the top section of a tributary of the Northeast inflow of Pointer Lake (longer than 1,128 m x 1 m) will be filled and the water usually flowing in this section of the stream will also be diverted around the site to reconnect to the lower section of the Northeast inflow of Pointer Lake. The in-filling work will result in the loss of 0.113 ha of non-fish bearing stream (Table 2.2-3), including unused shallow run, flat, shallow pools, riffle, and several pond habitats.

The top section of the Northwest inflow of Pointer Lake (longer than 681 m x 2 m) will also be filled and the water usually flowing in this section of the stream will be diverted around the site to reconnect to the lower section of the Northwest inflow of Pointer Lake, which is fish bearing (slimy sculpin) immediately upstream of Pointer Pond. The in-filling work will result in the loss of 0.136 ha of non-fish bearing stream (Table 2.2-3), including unused flat, no visible channel (water flows underground), pond, shallow pool, and riffle habitats.

2.1.5.1.2 Sissons Site

Three shallow ponds (i.e., Pond 3, Pond 4, and Pond 8) will be filled in to facilitate construction of the Sissons mine and associated infrastructure. None of the ponds proposed to be in-filled contain any documented fish populations.

Pond 3 (surface area of 0.26 ha and maximum depth of 0.5 m) will be filled during the construction of the clean waste rock pile. The in-filling work will result in the loss of a non-fish bearing pond (Table 2.2-3). Substrate included silt deposed on ice (i.e., permafrost at 0.5 m deep) or mixed with sand. Cobble and boulder were also present near the shoreline. Open water substrate was a mixture of boulder and cobble with areas of sand and silt. There was no defined channel connecting this pond to the mainstem stream in the Lower Lake sub-basin. The shallow nature of the lake suggests that the pond freezes to the bottom each winter.

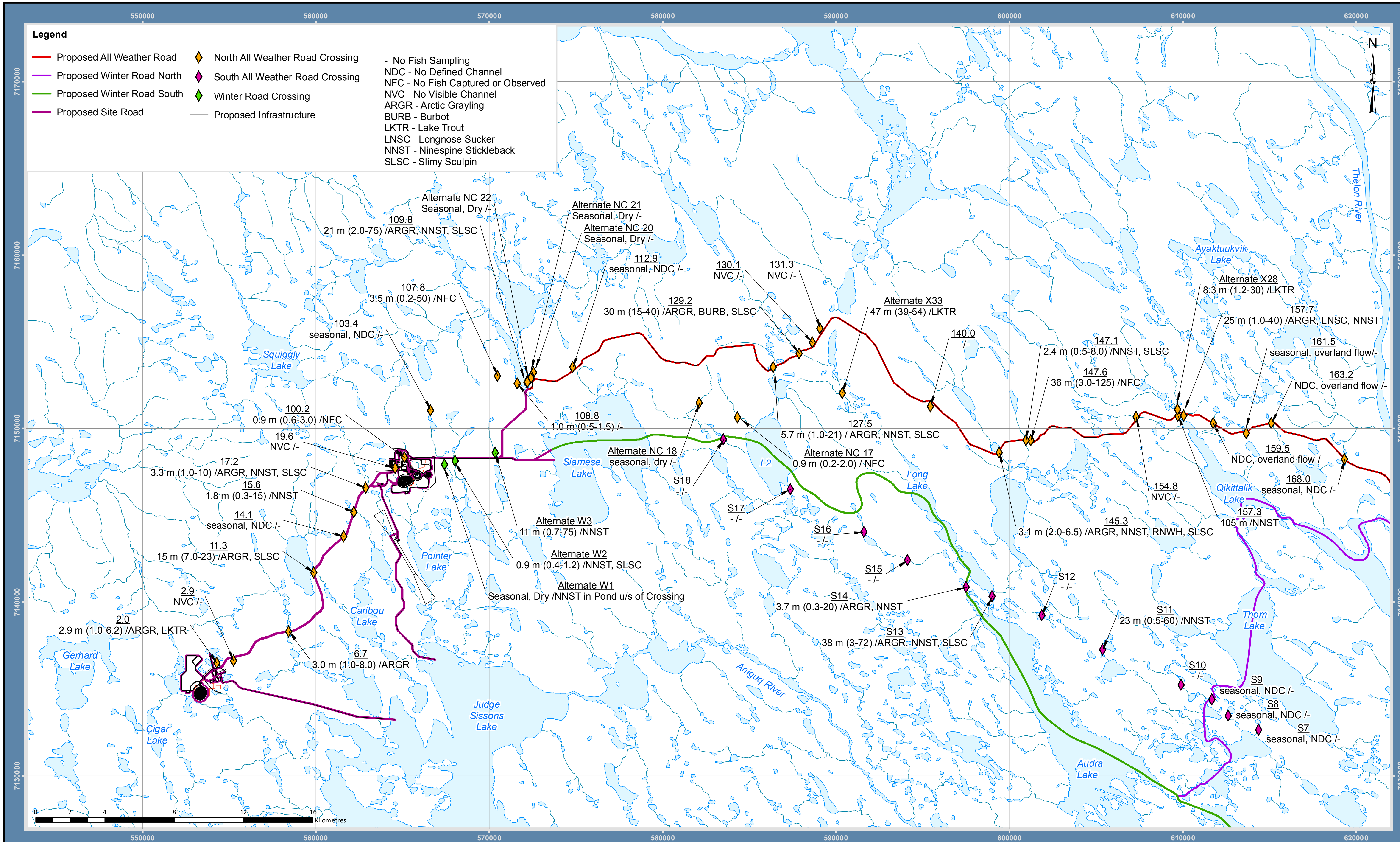
Pond 4 (surface area of 0.67 ha and maximum depth of 0.7 m) will be filled during the construction of the clean waste rock pile. The in-filling work will result in the loss of a non-fish bearing pond (Table 2.2-3). Substrate near the western shoreline consisted primarily of cobble, gravel and boulder, with patches of silt and sand. Near the eastern shoreline, substrate consisted primarily of silt and sand substrate with some boulder. Open water substrate consisted of a mixture of cobble, sand, gravel, and boulder. No defined channel connects this pond to the mainstem stream in the Lower Lake sub-basin. The shallow nature of the lake suggests that the pond freezes to the bottom each winter.

Pond 8 (surface area of 0.44 ha and maximum depth of 0.7 m) will be dug out during the construction of the Sissons open pit (Table 2.2-3). Substrate near the shoreline consisted primarily of organic material and silt, with patches of sand, gravel and clay occurring in isolated areas. Open water substrate consisted primarily of sand and silt with some patches of clay. No defined channel connects this pond to the mainstem stream in the Lower Lake sub-basin. The shallow nature of the lake suggests that the pond freezes to the bottom each winter.

Water collected in the watershed west of Mushroom Lake will be diverted through an artificial channel to flow between Pond 2, Pond 5, Pond 6, and Pond 7, finally connecting back to End Grid/Shack Stream. None of these ponds have been documented to support even seasonal fish populations. Because of the small drainage area involved and the intermittent nature of the expected flows, fish will be prevented from entering this artificial drainage channel in order to reduce the potential for stranding fish in the shallow ponds.

2.1.5.2 Roads

A number of rivers, streams, and watercourse channels may be altered by the installation of watercourse crossings during the construction of the Ore Haul Road connecting the Kiggavik site to the Sissons site, as well as other associated infrastructure roads to water intakes, treated effluent diffusers, and the airstrip (Figure 2.1-1a). Some of the watercourses are fish bearing, while others do not contain any documented fish populations, or the stream crossings are located in the stream headwaters upstream of known fish population.



Projection: NAD 1983 UTM Zone 14N
Creator: JRC
Date: 12/07/2011 Scale: 1:200,000
KIO8C354
Data Sources: NTS Mapsheet 56D, 66A, 66B, AREVA Resources Canada Inc.

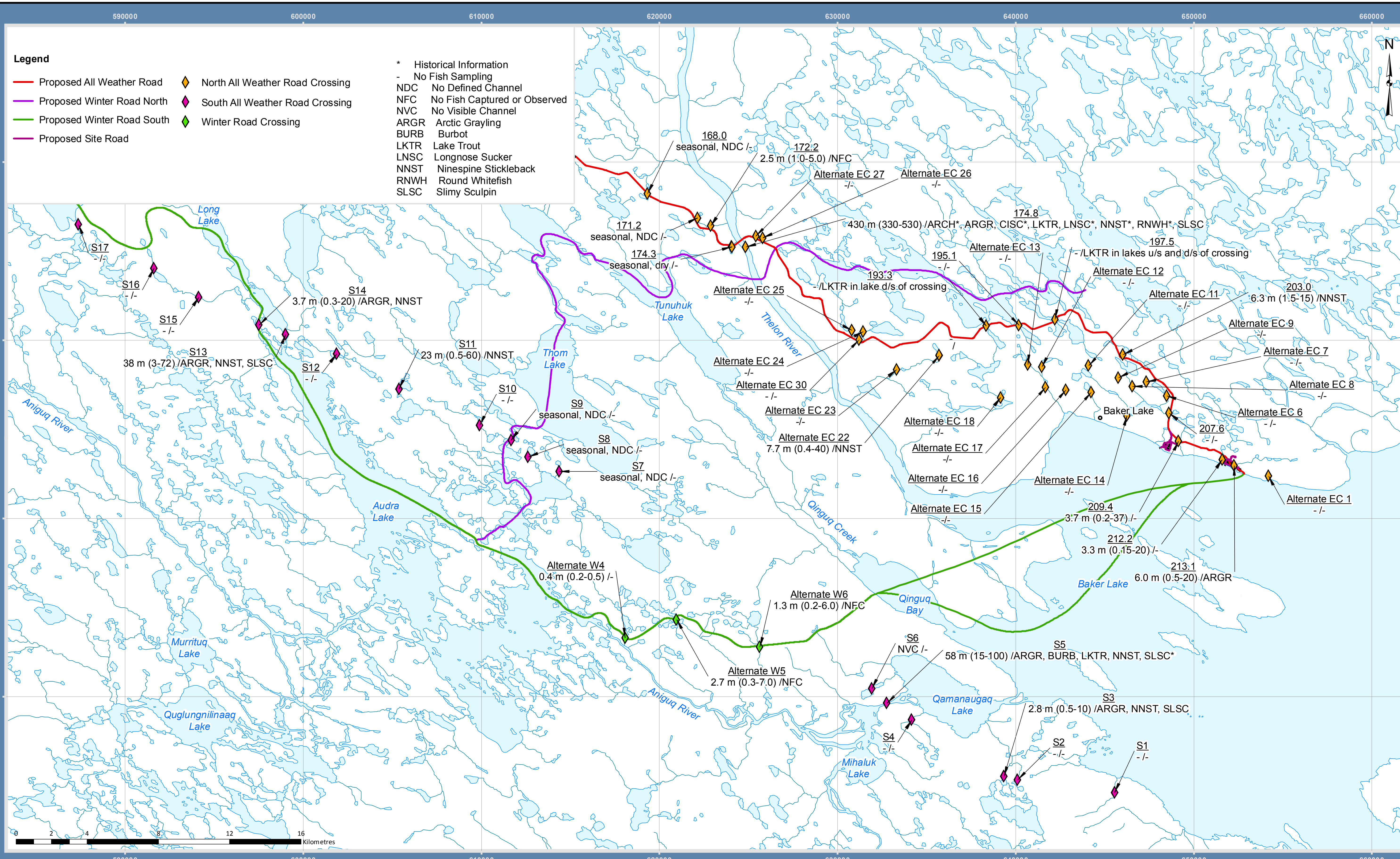
FIGURE 2.1-1A
SUMMARY OF AQUATIC HABITAT AND FISH DISTRIBUTION AT PROPOSED ROAD CROSSINGS

KIGGAVIK PROJECT - EIS

120.0	Stream Crossing ID (Kilometre Marker)
Bankfull Width — 2.5m(1.0 - 5.0)/NFC	Fish Species

Golder Associates
AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5



Projection: NAD 1983 UTM Zone 14N
Creator: JRC
Date: 12/07/2011 Scale: 1:200,000
KIO8C355
Data Sources: NTS Mapsheet 56D, 66A, 66B, AREVA Resources Canada Inc.

FIGURE 2.1-1B
SUMMARY OF AQUATIC HABITAT AND FISH DISTRIBUTION AT PROPOSED ROAD CROSSINGS

KIGGAVIK PROJECT - EIS

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2.1.5.2.1 Haul Road from Sissons to Kiggavik Sites

Eight streams and watercourse channels may be altered by the installation of watercourse crossings during the construction of the Ore Haul Road connecting the Kiggavik site to the Sissons site. Two wide fish bearing streams (i.e., Km 6.7 and Km 11.3) will be crossed using clear span bridges; fish habitat loss and alteration is not expected at these crossings. Three fish bearing streams (i.e., Fresh Water Diversion Channel S1, Km 15.6, and Km 17.2) will be crossed using one to three large diameter culverts (i.e., between 2,600 mm and 3,000 mm) (Figure 2.1-1a). Fish habitat alteration is expected at these crossings. Two dry stream channels (i.e., Km 14.1 and Km 19.6) will be crossed using one small culvert each (i.e., between 600 mm and 900 mm). These streams do not contain any documented fish populations. One watercourse (i.e., Km 2.9) including a pond, a snye, and no visible channel may be crossed without culverts or with a minimal size culvert to allow unimpeded drainage across the proposed Haul Road.

The Haul Road will cross Fresh Water Diversion Channel S1 at location 0+700. Diversion channel S1 re-connects the middle section of Mushroom/End Grid Stream to End Grid Lake. Around the 0+700 location, the diversion channel is expected to be 6.0 m wide at the base with slope of 3:1 for both channel sides, high enough to contain spring freshet flows and to reach the natural ground level. The newly created diversion channel will be altered with the construction of the haul road and culvert installation, which will cover a surface area of 0.018 ha (Table 2.2-3). A narrower (i.e., 1 m wide) sinuous channel may be constructed within the 6.0 m base channel to concentrate the water during periods of low flow, and to allow fish passage for as long as possible during the open water period. The diversion channel will be lined with rock rip rap to reduce flow velocities, and to provide a diversity of fish habitat, including resting areas during upstream migrations. Culvert would be installed to accommodate the spring freshet, and to allow fish passage for large-bodied fish species such as Arctic grayling and lake trout.

Watercourse crossing Km 2.9 has no visible channel associated with a pond and a snye, therefore the surface area lost or altered does not qualify as fish habitat (Table 2.2-3).

Stream crossing Km 6.7 has a bankful channel width of 1.5 m, a wetted width of 1.0 m, and a maximum depth of 0.4 m. The fish habitat present at this stream crossing is a shallow run. Dominant substrate consisted of gravel, followed by cobble; silt and sand were also present. Instream cover consisted of interstitial spaces in the coarse substrate and submergent and emergent vegetation. Arctic grayling were captured at this location. A clear span bridge is proposed at this location, so no fish habitat should be disturbed (Table 2.2-3).

Stream crossing Km 11.3 (downstream of Sleek Lake) has a bankful channel width of 15 m, a wetted width of 16 m, and a maximum depth of 0.2 m. Fish habitat present at the proposed stream crossing location is a flat. Dominant substrate consisted of cobble, followed by boulder; gravel and organic material were also present. Instream cover consisted of interstitial spaces in the coarse substrate and emergent vegetation. Arctic grayling and slimy sculpin were captured at this location. A clear span bridge is proposed at this location, so no fish habitat should be disturbed (Table 2.2-3).

Watercourse crossing Km 14.1 has no defined channel, therefore the surface area lost or altered does not qualify as fish habitat (Table 2.2-3).

Stream crossing Km 15.6 (upstream of Fox Lake) has a bankfull channel width of 1.5 m, therefore the fish habitat alteration would be about 0.005 ha in area (Table 2.2-3). The maximum recorded depth was 0.1 m in flat habitat. Dominant substrate consisted of organic material; boulders were also present. Instream cover consisted of emergent vegetation. Ninespine stickleback were captured in this stream. Two 3,000 mm culverts would be installed to accommodate the spring freshet and fish passage.

Stream crossing Km 17.2 (upstream of Fox Lake) has a bankfull channel width of 7.0 m, therefore the fish habitat alteration would be about 0.021 ha (Table 2.2-3). The maximum recorded depth was 0.4 m in riffle habitat. Dominant substrate consisted of cobble; gravel and boulders were also present. Instream cover consisted of interstitial spaces in the coarse substrate and emergent vegetation. Arctic grayling, ninespine stickleback, and slimy sculpin were captured in this stream. Three 3,000 mm culverts would be installed to accommodate the spring freshet and fish passage.

Watercourse crossing Km 19.6 has no visible channel, therefore the surface area lost or altered does not qualify as fish habitat (Table 2.2-3).

2.1.5.2.2 Water Intake Road from Kiggavik Site to Siamese Lake

Four streams and watercourse channels may be altered by the installation of watercourse crossings during the construction of the water intake access road between Kiggavik mine site and Siamese Lake (Figure 2.1-1a). Two fish bearing streams (i.e., W2 and W3) will be crossed using culverts. Culvert sizes will be determined following a hydrological channel assessment; fish habitat alteration is expected. One dry stream channel (i.e., W1) will be crossed using a culvert as well. Fish are present in the upstream pond; therefore fish habitat alteration is expected. One watercourse (i.e., Fresh Water Diversion Channel K1 - east section) will be crossed using a culvert large enough to allow cross drainage.

The Road connecting the Kiggavik site to the water intake located at Siamese Lake will cross the Fresh Water Diversion Channel K1 (east section) at location 3+900. The diversion channel K1 (east section) is re-connecting the non-fish bearing upper sections of several tributaries (located downstream of the former North All-Weather Road crossing Km 100.2) to the Northeast inflow to Pointer Lake stream which is fish bearing at its extreme downstream end. Around the 3+900 location, the diversion channel is expected to be 5.0 m wide at the base with slope of 3:1 for both channel sides, high enough to contain spring freshet flows and to reach the natural ground level. The newly created diversion channel will be altered with the construction of the water intake road and culvert installation, which will cover a surface area of 0.015 ha (Table 2.2-3). A narrower (i.e., 1 m wide) sinuous channel may be constructed within the 5.0 m base channel to concentrate the water during periods of low flow. The diversion channel will be lined with rock rip rap to break the flow velocity.

Stream crossing W1 has a bankfull channel width of 2.0 m; therefore the fish habitat alteration would be about 0.006 ha in area (Table 2.2-3). Maximum depth was not recorded because the channel was dry at the time of survey. Ninespine stickleback were captured in the pond located immediately upstream of the stream crossing location. Stream crossing W1 will be crossed using culverts designed to accommodate the spring freshet and fish passage. Culvert sizes will be determined following a hydrological channel assessment.

Stream crossing W2 has a bankfull channel width of 0.5 m; therefore the fish habitat alteration would be about 0.002 ha (Table 2.2-3). The maximum recorded depths were 0.2 m in the shallow run habitat and 0.1 m in the flat habitat located further upstream. Dominant substrate consisted of organic material; cobble, boulder, and gravel were also present. Instream cover consisted of emergent vegetation. Ninespine stickleback and slimy sculpin were captured in this stream. Stream crossing W2 will consist of culverts designed to accommodate the spring freshet and fish passage. Culvert sizes will be determined following a hydrology assessment.

Stream crossing W3 has a bankfull channel width of 1.0 m in shallow run habitat; the fish habitat alteration would be about 0.003 ha (Table 2.2-3). The maximum recorded depth was 0.3 m. Dominant substrate consisted of cobble; gravel, boulder, and organic material were also present. Instream cover consisted of emergent vegetation. Ninespine stickleback were captured in this stream. Stream crossing W3 will utilize culverts to accommodate the spring freshet and fish passage. Culvert sizes will be determined following a hydrology assessment.

2.1.5.2.3 Water Intake Road from Sissons Site to Mushroom Lake

Only one stream may be altered by the installation of watercourse crossings during the construction of the water intake access road between the Sissons mine site and Mushroom Lake (Figure 2.1-1a). However, the watercourse (i.e., Pond 1/Mushroom Stream) has no visible channel, therefore the surface area lost or altered does not qualify as fish habitat (Table 2.2-3). A culvert may be required to accommodate the spring freshet. Culvert size will be determined following a hydrology assessment.

2.1.5.2.4 Treated Effluent Diffuser Road from Kiggavik Site to Judge Sissons Lake and Access Road to the Airstrip

Two watercourse channels may be altered by the installation of watercourse crossings during the construction of the treated effluent diffuser access road between Kiggavik mine site and Judge Sissons Lake, as well as the proposed airstrip (Figure 2.1-1a). Both watercourses (i.e., Fresh Water Diversion Channel K1 – west section, and a tributary to the Northwest inflow of Pointer Lake) will be crossed using culverts large enough to allow cross drainage and fish passage if required.

The road connecting the Kiggavik site to the treated effluent diffuser at Judge Sissons Lake will cross Fresh Water Diversion Channel K1 (west section) at location 0+100. The diversion channel K1 (west section) collects water drainages from west of the Kiggavik mine site (located near Haul Road crossing Km 19.6) to the Northwest inflow to Pointer Lake stream which is fish bearing. Located at about the 0+100 location, the diversion channel is expected to be 2.0 m wide at the base with 3:1 side slopes high enough to contain spring freshet flows and to reach the natural ground level. The newly created diversion channel will be altered with the construction of the treated effluent diffuser road and culvert installation, which will cover a surface area of 0.006 ha (Table 2.2-3). A narrower (i.e., 1 m wide) sinuous channel may be constructed within the 2.0 m base channel to concentrate flows during periods of low runoff. The diversion channel will be lined with rock rip rap to reduce flow velocity.

The tributary to the Northwest inflow of Pointer Lake has not been surveyed for fish habitat mapping (Table 2.2-3). Arctic grayling and lake trout are present downstream in the Northwest inflow of Pointer Lake. Habitat mapping and fish sampling would be required to determine fish presence in this tributary. This tributary will be crossed using culverts to accommodate the spring freshet, as well as fish passage if necessary. Culvert sizes will be determined following a hydrology assessment.

2.1.5.2.5 Treated Effluent Diffuser Road from Sissons Site to Judge Sissons Lake

Two stream channels may be altered by the installation of watercourse crossings during the construction of the treated effluent diffuser access road between the Sissons mine site and Judge Sissons Lake (Figure 2.1-1a). One fish bearing stream (i.e., End Grid/Shack Stream) will be crossed using culverts; fish habitat alteration is expected. Culvert sizes will be determined following a hydrology assessment; fish habitat alteration is expected. One additional stream (i.e., Boulder/Judge Sissons Stream) will also be crossed using a culvert. Culvert sizes for this crossing will be determined following a hydrology assessment; fish habitat alteration is expected because of the proximity of this crossing to Judge Sissons Lake.

According to LiDAR imagery, End Grid/Shack Stream consists of a pair of stream channels with a combined total bankful channel width of about 140 m; therefore the fish habitat alteration would be about 0.420 ha (Table 2.2-3). During spring freshet, when the stream was surveyed, wetted width was about 500 m and maximum depth was 0.5 m. Fish habitat at the proposed stream crossing location consists of flat habitat. Dominant substrate was organic material, with silt and cobble present. Instream cover consisted of submergent and emergent vegetation. Arctic grayling were captured at this location. End Grid/Shack Stream will be crossed using culverts or a bridge designed to accommodate the spring freshet and fish passage. Culvert or bridge size will be determined following a hydrology assessment.

According to LiDAR imagery, Boulder/Judge Sissons Stream has a bankfull channel width of about 13.3 m; therefore the fish habitat alteration would be about 0.040 ha (Table 2.2-3). Fish presence is assumed because of the proximity of the crossing location to Judge Sissons Lake. Habitat mapping will be required to determine the type of fish habitat present. The Boulder/Judge Sissons Stream crossing will be designed to accommodate spring freshet flows, as well as fish passage. The crossing structure size and type will be determined following a hydrology assessment.

2.2 OPERATIONS PHASE

During the Project operations phase, mining operations (including blasting) will occur in open pits located near two fish-bearing and one potentially fish-bearing waterbody. Andrew Lake and Andrew/Shack Stream may be affected when blasting occurs in the Sissons Site Andrew Lake open pit. As well, a small pond, located west of the current AREVA field camp and upstream of Pointer Pond, may be affected when blasting occurs in the Kiggavik Site Main Zone open pit.

Freshwater will be withdrawn from Siamese Lake for potable use and mine and mill process water, from Mushroom Lake for potable and mine use, and from a number of lakes for the winter water requirement for construction and maintenance of the winter access road. As most large lakes in the area are fish bearing, water withdrawal may result in the alteration and/or potential loss of fish habitat. To reduce and mitigate these effects, best management practices will be incorporated to conserve and reduce water usage on site.

2.2.1 Mining - Mining Ore (Blasting)

During the mine development process, the blasting program associated with mining the proposed Andrew Lake open pit at the Sissons Mine Site, and the Main Zone open pit at the Kiggavik Mine Site may have residual effects on the abundance and distribution of fish. The proposed blasting program has the potential to affect fish in streams and lakes near the mine pits through the generation of shock waves and vibrations as explosive charges are detonated. These shock waves and vibrations can result in physical injuries (e.g., damage to swim-bladder; death or injury to fish eggs and larvae) to fish at various life stages, and can disturb adult fish (e.g., changes in fish behavior) during spawning or migration activities.

The federal *Fisheries Act* includes provisions for the protection of fish and their habitats. Detonation of explosives in or adjacent to fish-bearing waters can disturb, injure, or kill fish, and/or result in the harmful alteration, disruption, or destruction of fish habitat.

At the Kiggavik Mine Site, a small pond is located to the west of the proposed Main Zone open pit and upstream of Pointer Pond. This potential fish habitat may be lost due to its proximity to blasting in the Main Zone open pit. At the Sissons mine site, Andrew Lake is adjacent to the Andrew Lake open pit. Arctic grayling spawning activity has been confirmed in the inlet (Lunch/Andrew Stream) and outlet (Andrew/Shack Stream) of Andrew Lake. Andrew Lake also supports foraging and possibly rearing activities for Arctic grayling, burbot, cisco, and round whitefish during the open water season.

2.2.1.1 Main Zone Open Pit at Kiggavik Mine Site

At the Kiggavik Mine Site, a small pond located upstream of Pointer Pond is situated close to the proposed rim of the Main Zone open pit. Due to its small size (about 1.28 ha), and known shallow depth, no baseline fisheries information was collected for this waterbody. This pond is located very close to the site of AREVA's current mining exploration camp.

No large- or small-bodied fish were caught in Pointer Pond, located downstream of the small pond adjacent to the Main Zone open pit, in spite of Pointer Pond having a maximum depth of 4.5 m. However, a single slimy sculpin was captured just at the stream inlet to Pointer Pond. It is assumed that Pointer Pond, with its reasonable over-wintering depth, likely supports at least limited large and small bodied fish populations. However, it is doubtful that the small, shallow pond located further upstream in the drainage system would be used for spawning or rearing by any large-bodied fish species due to its distance from Pointer Pond and the temporary nature of flows in the connecting stream. It is possible however, although not likely, that the small pond near the Main Zone open pit may be used seasonally by small-bodied species such as slimy sculpin.

Presence of fish and fish habitat needs to be determined for the shallow pond located near the proposed Main Zone open pit. If fish absence is confirmed, then blasting in the main zone pit can proceed without compensation. If fish presence is confirmed, then the entire pond (1.28 ha) would be considered as lost seasonal fish habitat which would require compensation.

2.2.1.2 Andrew Lake Pit at Sissons Mine Site

Andrew Lake is located in the Lower Lake watershed about 8 km upstream of Judge Sissons Lake. Andrew Lake has a surface area of 54.3 ha, however is very shallow with a maximum depth of 1.0 m, and a mean depth of 0.2 m. Four fish species (i.e., Arctic grayling, burbot, cisco, and round whitefish) have been documented as occurring in Andrew Lake. Andrew Lake lies over top of, and immediately adjacent to, the proposed Andrew Lake pit at the Sissons Mine Site. In addition to Andrew Lake, the inflow (Lunch/Andrew) and outflow (Andrew/Shack) streams are also located near the proposed Andrew Lake open pit.

Andrew Lake, and Lunch/Andrew and Andrew/Shack streams are all shallow and freeze to the bottom during the winter. As such, fish are only present in Andrew Lake and the connecting streams during the open-water season. However, Andrew Lake provides rearing and foraging habitat for several fish species during the open water season. Lunch/Andrew (inflow) and Andrew/Shack (outflow) streams are also used as seasonal migration streams by several fish species. More importantly however, both streams contain important Arctic grayling spawning areas.

Rationale for the following proposed mitigation measures to neutralize the effect of blasting near Andrew Lake are presented in the TIER 2 Volume 5 DEIS document (Section 11.2.1.4).

Potential mitigation measures available for blasting near Andrew Lake include:

- use of smaller charge sizes near Andrew Lake during the open water season to reduce the blasting setback distance to less than 50 m (the width of the dyke); and

- plan the blasting program so that all required blasting within the blasting set back distance from Andrew Lake is carried out during the frozen water period when Andrew Lake and the inflow and outflow streams do not support fish populations. This is approximately eight months of the year.

Potential mitigation measures available to deal with the blasting vibration issue can include:

- smaller charge sizes to be used near Andrew Lake outlet stream during the egg incubation period (about one month to 6 weeks long from early to mid-June to early to mid-July depending on when spawning begins in a particular year) in order to reduce the blasting setback distance to less than 160 metres; and
- modify the blasting program to complete the required blasting within the blasting vibration set back distance from the Andrew Lake outlet stream (the south side of the Andrew Lake open pit) during times of year when egg incubation is not occurring. This is approximately 10.5 to 11 months of the year.

No significant changes in fish population abundance or distribution are anticipated providing effective mitigation measures are enacted to ensure compliance with DFO’s blasting guidelines.

2.2.2 Water Management - Water Withdrawal

During the Project operation phase, freshwater will be withdrawn from two lakes to provide water for potable use and mill processes, and from a number of lakes for the winter water requirement for construction and maintenance of the winter access road. As most large lakes in the area are fish bearing, water withdrawal may result in the alteration and/or potential loss of fish habitat. To reduce and mitigate these effects, best management practices will be incorporated into water usage on site.

In most cases, the fish habitat alterations associated with water withdrawals will be in place for the life of the mine’s operation (i.e., 25 years). During Mine Closure, most habitat alterations will be reversed with the removal of the water intake structures, effluent diffusers, and stream crossing structures, and the altered habitats will be returned to pre-development conditions to the extent possible.

2.2.2.1 Proposed Potable and Mill Process Water Supplies

Water will be withdrawn from Siamese Lake for potable use and mine and mill process water, and from Mushroom Lake for potable use and mine process water. Water balance calculations have been completed for both lakes to ensure that they are capable of supplying the required water volumes with minimal lake level drawdowns during the winter ice-covered season. Water levels in both lakes will recover during the spring snowmelt freshet. Winter draw downs are expected to be about 34.2 cm for Mushroom Lake, and between 9.4 cm and 16.5 cm in Siamese Lake, depending on different water availability scenarios. Water volumes proposed for withdrawal during the winter ice-covered period represent 3.0% to 4.0% of the under-ice volume of Siamese Lake, and 8.8% of the under-ice volume of Mushroom Lake (Table 2.2-1). Both of these water withdrawals are less than the 10% of under-ice volume maximum acceptable withdrawal limit set by DFO for Arctic waters (DFO 2010a).

In order to evaluate the worst case scenario for under-ice water withdrawals, a desktop study was undertaken to identify the potential impact of water drawdown on lake trout spawning habitat. Eggs and larval fish of this fall spawning species will be the most susceptible to changes in water levels. Potential suitable spawning locations were determined theoretically by cross-matching available data (e.g., substrate type and size, depth and slope of cobbles, sedimentation rate, winter under-ice dissolved oxygen levels, presence of current and direction of predominant winds, presence of ice scour and cover, and water level fluctuations). Of the data available, the limiting factors for determination of potential lake trout spawning habitat included the presence of cobbles on moderate to high underwater slopes, high dissolved oxygen levels, and the occurrence of multiple layers of cobble. Through this desktop study, locations of potential lake trout spawning habitat were identified between 2 m and 5 m deep throughout Siamese Lake with the majority of the potential areas being identified in the east basin, and between 2 m and 6 m deep on the north shore of Mushroom Lake.

An under-ice water level drawdown between 9.4 cm and 16.5 cm in Siamese Lake will result in an alteration to potential lake trout spawning habitat area between 1.6% (0.12 ha) and 2.2% (0.16 ha), depending on different water availability scenarios. A drawdown of 34.2 cm in Mushroom Lake will result in an alteration to potential lake trout spawning habitat area of about 11.0% (0.05 ha) each winter during Sissons Mine Site operations (Table 2.2-2).

Table 2.2-1
Estimated Maximum Annual Water Withdrawal Volumes for Selected Waterbodies

Waterbody	Under-Ice Volume (m^3)	Maximum Annual Water Withdrawal Volume		
		Maximum of 10% Allowed by DFO (m^3)	Required Volume (m^3)	Required Portion of Lake Under-Ice Volume (%)
Siamese Lake: both basins together	65,800,000	6,580,000	1,960,000	3.0 (equivalent to 9.4 cm)
Siamese Lake: both basins (October-March) and West Basin only (April-May)	65,800,000 28,000,000	6,580,000 2,800,000	1,960,000	3.0 in the east basin (equivalent to 9.4 cm) 4.0 in the west basin (equivalent to 16.5 cm)
Mushroom Lake	284,000	28,400	25,125	8.8 (equivalent to 34.2 cm)

m^3 = cubic metres; % = percent; cm = centimetres.

Table 2.2-2
Potential Lake Trout Spawning Habitat Alteration for Siamese Lake and Mushroom Lake

Waterbody / Scenario	Potential Lake Trout Spawning Area Available (m^2)	Under Ice Water Level Drawdown (cm)	Potential Lake Trout Spawning Habitat Alteration		
			Surface Area (m^2)	Surface Area (ha)	Percent Change (%)
Siamese Lake – both basins together	74,241	9.4 in both basins	1,163	0.12	1.57
Siamese Lake (October-March) and West Basin only (April-May)	74,241	9.4 in east basin 16.5 in west basin	1,631	0.16	2.20
Mushroom Lake	4,132	34.2	455	0.05	11.01

m^2 = square metres; cm = centimetres; % = percent; ha = hectares.

2.2.2.2 Proposed Winter Access Road Construction and Maintenance Water Supplies

During the operations phase of the Project about 75,000 m^3 of water will be withdrawn annually from lakes along the route of the proposed winter access road between Baker Lake and the Kiggavik site, as specified in Section 2.1.4 and Table 2.1-2. However, the volume of water withdrawal for winter access road construction and maintenance from Siamese Lake is in addition to the winter water withdrawal volumes required for potable and mill process water supplies required at the Kiggavik Mine Site. Calculations show that expected water withdrawal volumes from Siamese Lake represent between 3.01% (9.6 cm drawdown in both basins, or in the east basin only if separation of the two lake basins occurs in April and May due to the formation of thick lake ice) and 4.01% (16.7 cm drawdown in the west basin if separation of the two basins occurs in April and May), of the under-ice volume depending on the different water availability scenarios (Tables 2.1-2 and 2.2-1). These estimated volumes are substantially less than the maximum 10% under-ice water withdrawal volume allowed under DFO's policy (DFO 2010a).

2.3 FINAL-CLOSURE PHASE

During the final-closure phase of the Project, freshwater diversions and site drainage containment systems will be removed to re-establish natural drainage; in-water/shoreline structures and site pads will also be removed. The removal of these structures and mitigation work to restore disturbed areas will address these temporary fish habitat alterations. The fish habitat compensation plan (Section 4.0) will address permanent fish habitat losses.

2.3.1 Removal of Freshwater Diversions to Re-Establish Natural Drainage

During the final closure phase of the Project, the objective, where possible will be to re-establish pre-development drainage areas and flow directions. In some cases where site infrastructure such as waste rock piles and open pits occur, the proposed operational freshwater diversion drainage would be maintained. As was the case during operations, interrupted flow pathways would be reconnected in the same drainage area but further downstream. Inter-basin transfer of water would be avoided so that pre-development flow volumes would report to the existing channels and waterbodies downstream.

2.3.2 Removal of Site Drainage Containment Systems (Dykes, Berms, and Collection Ponds)

During the final closure phase of the Project, the Sissons Mine Site Andrew Lake open pit would be filled with water by pumping from Judge Sissons Lake over a number of open water seasons. The extended period proposed to refill the pit is intended to limit effects to the aquatic ecosystem. Depending on the final quality of the water in the refilled Andrew Lake pit, the berm separating Andrew Lake from the open pit may be breached to allow fish access into the pit.

2.3.3 Removal of In-Water/Shoreline Structures

Removal of water intake structures and connecting water intake lines in Mushroom and Siamese Lakes, and effluent diffuser structures and effluent lines in Judge Sissons Lake, is also expected to result in alterations to fish habitat. However, the effect on fish habitat is expected to be positive, in that habitat that was disturbed during the initial structure construction/installation will be restored as much as possible to its pre-development condition.

2.3.4 Construction of Fish Habitat as per FHCP

Options for fish habitat compensation are discussed in Section 4.0. Most of the options presented can be built during the construction phase of the Project. The estimated area of fish habitat compensation for the options chosen will need to be equal to, or greater than, the total lake surface area and stream length that will be lost or altered during the construction and operations phases of the Project.

2.3.5 Removal of Site Pads

All stream crossing structures will be removed during the final closure phase, and stream substrate restored to conditions similar to those found in the pre-development streams.

Table 2.2-3
Predicted Project Environment Effects on Fish Habitat

Project Phase / Activity	Project Activities/Physical Works	Surface Area (ha)		
		Non-Fish Bearing Habitat Losses or Alterations	Fish Bearing Habitat	
			Losses	Alterations
Construction:				
In-water construction	**construct freshwater diversions and site drainage containment systems (dykes, berms, collection ponds)**			
	site infrastructure at Sissons facilities • relocate downstream portion of Mushroom/End-Grid Stream (fish bearing - 475 m x 1.3 m)	-	0.062 ha	-
	construct in-water/shoreline structures			
	drain north-east portion of Andrew Lake (fish bearing) • pit and berm • face of berm (650 m x 1 m)	-	13.5 ha -	- 0.065 ha
	water transfers and discharge			
	footprint of freshwater intake structures installed in fish bearing lakes • Siamese Lake – Kiggavik site (125 m x 5 m) • Mushroom Lake – Sissons site (200 m x 5 m)	-	-	0.063 ha 0.100 ha
	footprint of treated effluent diffusers installed in fish bearing lakes • Judge Sissons Lake – Kiggavik site (1,140 m x 5 m) • Judge Sissons Lake – Sissons site (698 m x 5 m)	-	-	0.570 ha 0.349 ha
	freshwater withdrawal			
	Baker Lake to Kiggavik site winter access road – water withdrawal for construction and maintenance of winter road (all lakes are expected to be fish bearing) • Siamese Lake (0.01% under-ice volume)[a] • L2 / 20 km Lake (0.03% under-ice volume)[a] • Long Lake (0.56% under-ice volume)[a] • Audra Lake (0.09% under-ice volume)[a] • four unnamed ponds (0.61% under-ice volume)[a] • Qinguq Bay of Baker Lake (0.87% under-ice volume)[a]	-	-	0.2 cm drawdown 0.2 cm drawdown 0.5 cm drawdown 0.8 cm drawdown 0.5 cm drawdown 0.5 cm drawdown
On-land construction	**site clearing and pad construction (blasting, earth moving, loading, hauling, dumping, crushing)**			
	construct site infrastructure at Kiggavik facilities • fill in middle section of the Northeast inflow of Pointer Lake (no fish this far up) (3,799 m x 2 m) • fill in top section of the tributary of the Northeast inflow of Pointer Lake (no fish this far up) (>1,128 m x 1 m) • fill in top section of the Northwest inflow of Pointer Lake (no fish this far up) (>681 m x 2 m)	0.760 ha > 0.113 ha > 0.136 ha	-	-
	construct site infrastructure at Sissons facilities • fill in Pond 3 (no fish) • fill in Pond 4 (no fish) • fill in Pond 8 (no fish) • link Ponds 2, 5, 6, to Pond 7 (no visible channel)	0.26 ha 0.67 ha 0.44 ha 0 ha	-	-
	construct stream crossings for haul road between the Kiggavik and Sissons facilities • Fresh Water Diversion Channel S1 (0+700) (fish bearing - 30 m x 6.0 m - TBD)[b] • Km 2.9 (pond, snye, no visible channel - 30 m x 0.2 m) • Km 6.7 (fish bearing - 0 m - clear span bridge) • Km 11.3 (fish bearing - 0 m - clear span bridge) • Km 14.1 (no defined channel - 30 m x 0.2 m - 1-900 mm culvert) • Km 15.6 (fish bearing - 30 m x 1.5 m - 2-3,000 mm culvert) • Km 17.2 (fish bearing - 30 m x 7.0 m - 3-3,000 mm culvert) • Km 19.6 (no visible channel - 30 m x 0.2 m - 1-600 mm culvert)	- 0.001 ha[d] - - 0.001 ha[d] - - 0.001 ha[d]	-	0.018 ha[c] - 0 ha 0 ha - 0.005 ha[e] 0.021 ha[e] -
	construct stream crossings for the access road between the Kiggavik facilities and the site water source (Siamese Lake) • Fresh Water Diversion Channel K1 (east section: 3+900) (no fish this far up - 30 m x 5.0 m - TBD)[b] • alternate W1 (fish bearing in upstream pond, dry at stream crossing - 30 m x 2.0 m - TBD)[b] • alternate W2 (fish bearing - 30 m x 0.5 m - TBD)[b] • alternate W3 (fish bearing - 30 m x 1.0 m - TBD)[b]	0.015 ha[c] - - -	-	- 0.006 ha[f] 0.002 ha[f] 0.003 ha[f]
	construct stream crossings for the access road between the Sissons facilities and the site water source (Mushroom Lake) • Pond 1/Mushroom Stream (no visible channel - 30 m x 0.2 m - TBD)[b]	0.001 ha[g]	-	-
	construct stream crossings for the access road between the Kiggavik facilities and the treated effluent discharge in Judge Sissons Lake – Kiggavik site • Fresh Water Diversion Channel K1 (west section: 0+100) (no fish this far up - 30 m x 2.0 m - TBD)[b] • tributary to the Northwest inflow of Pointer Lake (not sampled – 30 m x 0.2 m - TBD)[b]	0.006 ha[c] -	-	- 0.001 ha[g]
	construct stream crossings for the access road between the Sissons facilities and the treated effluent discharge in Judge Sissons Lake – Sissons site • End Grid/Shack Stream (fish bearing - 30 m x 140 m - TBD)[b] • Boulder/Judge Sissons Stream (not sampled but expected to be fish bearing - 30 m x 13.3 m - TBD)[b]	-	-	0.420 ha[g] 0.040 ha[g]

Table 2.2-3
Predicted Project Environment Effects on Fish Habitat (continued)

Project Phase / Activity	Project Activities/Physical Works	Surface Area (ha): Non-Fish Bearing Habitat Losses or Alterations	Surface Area (ha): Fish Bearing Habitat: Losses	Surface Area (ha): Fish Bearing Habitat: Alterations
Operations:				
Mining	**mining ore (blasting)**			
	blasting in Main Zone open pit at the Kiggavik site • small pond west to the proposed Main Zone open pit (not sampled but may have small-bodied fish such as slimy sculpin)	1.28 ha (tentative)	1.28 ha (tentative)	-
	blasting in Andrew Lake pit at the Sissons site • physical damage to fish rearing and feeding in Andrew Lake • change of fish behavior during spawning or migration activities in Andrew/Shack Stream • physical damage to fish eggs and larvae located in Andrew/Shack Stream	-	-	follow proposed mitigation measures to neutralize these effects
Water management	**freshwater withdrawal**			
	withdrawal of potable and mill process water supplies (value in cm = under ice water level drawdown) • Siamese Lake : o both basins, no disconnect during late winter: 9.4 cm in both basins o both basins (October-March), west basin (April-May): 9.4 cm in east basin 16.5 cm in west basin • Mushroom Lake: 34.2 cm	-	less than 10% under ice water volume: 3.0% both basins 3.0% east basin 4.0% west basin 8.8%	total area of potential lake trout spawning habitat that could be lost: 0.12 ha 0.16 ha both basins together 0.05 ha
	Baker Lake to Kiggavik site winter access road – water withdrawal for construction and maintenance of winter road (all lakes are expected to be fish bearing) • Siamese Lake (0.01% under-ice volume)[a] • L2 / 20 km Lake (0.03% under-ice volume)[a] • Long Lake (0.56% under-ice volume)[a] • Audra Lake (0.09% under-ice volume)[a] • four unnamed ponds (0.61% under-ice volume)[a] • Qinguq Bay of Baker Lake (0.87% under-ice volume)[a]	-	-	0.2 cm drawdown 0.2 cm drawdown 0.5 cm drawdown 0.8 cm drawdown 0.5 cm drawdown 0.5 cm drawdown
Final Closure:				
In-water decommissioning	remove freshwater diversions; re-establish natural drainage	-	-	positive
	remove surface drainage containment	-	-	positive
	remove in-water/shoreline structures	-	-	positive
	construct fish habitat as per Fish Habitat Compensation Plan	-	gain	-
On-land decommissioning	remove site pads	-	-	positive
Total			**14.842**	**between 1.833 and 1.873**

(a) Estimated percent of under-ice water volume withdraws to construct and maintain the Baker Lake to Kiggavik winter access road.
(b) Culvert still to be designed.
(c) Based on culvert length of 30 m and proposed diversion channel width at the crossing location.
(d) Applied minimum width of 0.2 m for culvert of 30 m long to calculate surface area.
(e) Based on culvert length of 30 m and average stream channel width at the crossing location.
(f) Based on culvert length of 30 m and average stream channel width estimated from habitat map.
(g) Based on culvert length of 30 m and average stream channel width estimated from LiDAR image.
- = not applicable; ha = hectare; m = metre; % = percent; cm = centimetre; > greater than; TBD = to be determined; mm = millimetre; km = kilometre.

2.4 OPTIONAL COMPONENTS

One optional component of the Project includes the proposed North All-Weather Access Road, as well as the ferry crossing on the Thelon River associated with it (Table 2.4-1, Figure 2.1-1a, and Figure 2.1-1b). A second Project option concerns the construction of an alternate north route to the proposed Baker Lake to Kiggavik site winter road. This route would require an ice-bridge crossing of the Thelon River.

The field assessed portion of the Thelon River included the proposed ferry crossing at Km 174.8 on the North All-Weather Access Road, and the Nuna ice bridge.

2.4.1 Proposed North All-Weather Access Road

This optional component of the Project includes the proposed North All-Weather Access Road, as well as the ferry crossing on the Thelon River associated with it (Table 2.4-1, Figure 2.1-1a, and Figure 2.1-1b). Stream and watercourse crossings will be required as a component of developing the all-weather access road between the Kiggavik mine site and Baker Lake. As most medium- to large-sized streams support fish during the summer months, installation of stream crossing structures will result in the alteration, and potential loss of fish habitat. To reduce and mitigate these effects, best management practices will be incorporated into stream crossing design to minimize the amount of fish habitat lost or altered at each crossing. Crossing structures in fish bearing streams will also be designed to facilitate passage of large-bodied fish species.

2.4.1.1 Existing Environment

Fish habitat was assessed on about 3.8 km of the Thelon River; bathymetry was conducted on a 4.5 km section of the river. The maximum depth encountered was 7.5 m. Wetted and bankfull channel widths ranged from 300 to 520 m and 330 to 550 m, respectively. The portion of the Thelon River in the site access LAA is generally fast flowing, with run sections being most common; a rapid section is located further upstream. The Thelon River is a fish-bearing stream with good overwintering habitat, and year round cover and spawning habitats in the assessed river section. Interstitial spaces in the coarse substrate, depth, and turbulence of the water provide good cover habitat for all sizes of fish.

The Thelon River near the proposed cable ferry crossing is characterized as run habitat. Shoreline slopes ranged from moderate to very steep. The slope was predominantly moderate near the water and very steep further away from the water on the west shore (right downstream bank), and predominantly moderate slopes on the east shore (left downstream bank) with several steep sections. Shoreline vegetation was open tundra. Shoreline substrate ranged from sand to bedrock; instream substrate consisted primarily of cobble, boulder and gravel, with sand, bedrock and silt also present. Instream cover consisted of interstitial spaces in the substrate, depth, and turbulence. Overhead cover was not present.

2.4.1.2 Construction - Road

As part of constructing the proposed North All-Weather Access Road, about 18 stream crossings west of the Thelon River and 12 stream crossings east of the Thelon River are required (Table 2.4-1). Streams crossed by the proposed road alignment generally fell into three categories:

1. small drainages or watercourses that had no defined channel or no visible channel. The distinction between the two is that watercourses with no defined channel exhibited wet areas or evidence of overland flow. The no visible channel watercourses did not exhibit any signs of overland flow. These types of watercourses are seasonal flow paths that appear to convey snow melt only;
2. small to intermediate sized streams with channel widths of 1 to 5 m; and
3. large streams or rivers (i.e., greater than 5 m in width).

Many watercourse channels were undefined, seasonal or dry. Small streams were generally characterized by organic substrate and low habitat diversity (i.e., few habitat types present). Large streams or rivers contained more instream and overhead cover, and had a greater diversity of substrates and habitat types present.

Eight watercourses crossed along the North All-Weather Access Road (west of the Thelon River) were first category streams (i.e., no defined or no visible channel). Five were classified as large streams or rivers (e.g., crossings Km 127.5 and Km 147.6), or required a bridge structure (e.g., crossings Km 129.2, Km 145.3, and Km 157.3). The remainder of the streams (n = 5) were small to intermediate in size with channel widths less than 5 m. About 0.062 ha of substrate alterations would occur on non-fish bearing streams. It is expected that about 0.023 ha of fish habitat will be altered (Table 2.4-1).

Four watercourses to be crossed by the portion of North All-Weather Access Road located east of the Thelon River are considered to be first category streams or require additional information for proper classification. Six streams were in the small to intermediate size category (e.g., crossings alternate EC 30, Km 193.3, Km 195.1, Km 197.5, Km 209.4, and Km 212.2). The remaining large watercourses had average channel widths (near the proposed crossing locations) ranging from 8.7 m (crossing Km 203.0) to 12.3 m (crossing Km 213.1). Detailed habitat assessments were only completed on these larger streams. About 0.009 ha of substrate alterations would occur in non-fish bearing streams. It is expected that about 0.093 ha of fish habitat may be altered (Table 2.4-1).

2.4.1.3 Construction - Ferry Crossing

If construction of the optional North All-Weather Access Road connecting the Kiggavik mine site to Baker Lake proceeds, a cable ferry crossing will be required to cross the Thelon River.

Two ferry approach aprons will be required for operation of the proposed ferry, one on each bank. The estimated size of each apron is 30 m along the shoreline by 10 m towards deeper water, for a surface area of 0.030 ha each. On each bank, half of this surface area will be considered fish habitat loss (0.015 ha) due to construction, while the other half will be considered fish habitat alteration (0.015 ha) due to the rock rip rap that will replace the original fish habitat (Table 2.4-1).

2.4.1.4 Final Closure

During the final-closure phase of the Project, in-water/shoreline structures (i.e., ferry crossing approach aprons) and site pads (i.e., culverts) will be removed to re-establish natural drainage. The removal of these structures and mitigation work to restore disturbed areas will address these temporary fish habitat alterations (Figure 2.1-1a and Figure 2.1-1b).

All stream crossing structures will be removed during the final closure phase, and stream substrates restored to conditions similar to those found in the pre-development streams.

Removal of the ferry crossing approach aprons located on both shores of the Thelon River is expected to result in alterations to fish habitat. However, the effect on fish habitat is expected to be positive, in that habitat that was disturbed during the initial structure construction/installation will be restored as much as possible to its pre-development condition.

2.4.2 Proposed North Route of Winter Access Road

A second Project option concerns the construction of an alternate north route to the proposed Baker Lake to Kiggavik site winter road. This route would require an ice-bridge crossing of the Thelon River.

2.4.2.1 Existing Environment

A 560 m long section of the Thelon River was assessed near the proposed Nuna ice bridge location. This area is about 700 m downstream of the habitat assessed for the proposed Thelon River ferry crossing location. Maximum depth observed during the bathymetric survey was 4.7 m. Wetted and bankfull channel widths were 460 m and 520 m, respectively.

The Thelon River near the proposed Nuna ice bridge is characterized as a deep run. Shoreline slope ranged from moderate to steep. The slope was predominantly steep on the west shore (right downstream bank) and predominantly moderate on the east shore (left downstream bank). Shoreline vegetation was open tundra. Shoreline substrate ranged from sand to bedrock; instream substrate consisted primarily of cobble and gravel, with boulder also present. Instream cover consisted of interstitial spaces in the substrate, depth, and turbulence. Overhead cover was not present.

2.4.2.2 Construction and Removal

If the proposed north winter road is selected, the Nuna ice bridge will be required to cross the Thelon River during winter months. If necessary, in order to build up adequate ice thickness on the Thelon River to support the loaded trucks, water may be pumped onto the ice surface. Pump intakes will be screened to prevent entrainment of fish. It is anticipated that the approaches to the ice crossing will be constructed of snow and ice only. No alteration or loss of fish habitat is expected from the annual installation of this temporary ice-bridge.

Table 2.4-1
Predicted Project Environment Effects on Fish Habitat for Optional Components

Project Phase	Project Activities/Physical Works	Surface Area (ha)		
		Non-Fish Bearing Habitat Losses or Alterations	Fish Bearing Habitat	
			Losses	Alterations
Construction:				
In-water construction	**construct in-water/shoreline structures**			
	Km 174.8 - Thelon River ferry approach aprons			
	• west bank (30 m x 10 m)	-	0.015 ha	0.015 ha
	• east bank (30 m x 10 m)		0.015 ha	0.015 ha
On-land construction	**site clearing and pad construction (blasting, earth moving, loading, hauling, dumping, crushing)**			
	construct stream crossings located along the North All-Weather Road west of the Thelon River			
	• Km 112.9 (no defined channel – 30 m x 0.2 m - 1-600 mm culvert)	0.001 ha[a]		-
	• Km 127.5 (fish bearing - 30 m x 6.1 m -4-3,000 mm culvert)	-		0.018 ha[b]
	• Km 129.2 (fish bearing - 0 m - clear span bridge)	-		0 ha
	• Km 130.1 (no visible channel - 30 m x 0.2 m - TBD)[c]	0.001 ha[a]		-
	• Km 131.3 (no visible channel - 30 m x 0.2 m - 1-1,400 mm culvert)	0.001 ha[a]		-
	• Km 140.0 (expected to be non fish bearing - 30 m x 1.2 m - 1-1,200 mm culvert)	0.004 ha[b]		-
	• Km 145.3 (fish bearing - 0 m - clean span bridge)	-		0 ha
	• Km 147.1 (fish bearing - 30 m x 0.8 m - 3-2,400 mm culvert)	-	-	0.002 ha[b]
	• Km 147.6 (no fish - 30 m x 12 m - TBD)[c]	0.036 ha[d]		-
	• Km 154.8 (no visible channel - 30 m x 0.2 m - 1-1,800 mm culvert)	0.001 ha[a]		-
	• Km 157.3 (fish bearing - 0 m - clear span bridge)	-		0 ha
	• Km 157.7 (fish bearing - 30 m x 1.0 m - 3-3,000 mm culvert)	-		0.003 ha[b]
	• Km 159.5 (no defined channel - 30 m x 0.2 m - 1-800 mm culvert)	0.001 ha[a]		-
	• Km 161.5 (seasonal - 30 m x 1.3 m - 1-1,000 mm culvert)	0.004 ha[b]		-
	• Km 163.2 (no defined channel - 30 m x 0.2 m - 1-800 mm culvert)	0.001 ha[a]		-
	• Km 168.0 (no defined channel - 30 m x 0.2 m - 1-1,200 mm culvert)	0.001 ha[a]		-
	• Km 172.2 (no fish - 30 m x 3.3 m - 1-1,200 mm culvert)	0.010 ha[b]		-
	• Km 174.3 (no visible channel - 30 m x 0.2 m - 1-800 mm culvert)	0.001 ha[a]		-
	construct stream crossings located along the North All-Weather Road east of the Thelon River			
	• alternate EC 27 (expected to be non fish bearing - 30 m x 0.2 m - TBD)[c]	0.001 ha[a]		-
	• alternate EC 26 (expected to be non fish bearing - 30 m x 0.2 m - TBD)[c]	0.001 ha[a]		-
	• alternate EC 30 (expected to be fish bearing - 30 m x 3.3 m - 2-3,000 mm culvert)	-		0.010 ha[b]
	• Km 193.3 (fish bearing - 30 m x 2.7 m - 3-3,200 mm culvert)	-		0.008 ha[b]
	• Km 195.1 (expected to be fish bearing - 30 m x 1.2 m - 2-1,800 mm culvert)	-		0.004 ha[b]
	• Km 197.5 (fish bearing - 30 m x 1.1 m - 2-2,800 mm culvert)	-	-	0.003 ha[b]
	• Km between 197.5-203.0 (expected to be fish-bearing for small-bodied fish - 30 m x 1.0 m - TBD)[c]	-		0.003 ha[e]
	• Km 203.0 (fish bearing - 30 m x 8.7 m - 2-2,200 mm culvert)	-		0.026 ha[b]
	• Km 207.6 (expected to be non fish bearing - 30 m x 0.2 m - 1-800 mm culvert)	0.001 ha[a]		-
	• Km 209.4 (expected to be fish bearing - 30 m x 0.6 m - 2-2,200 mm culvert)	-		0.002 ha[b]
	• Km 212.2 (expected to be non fish bearing - 30 m x 1.9 m - 1-900 mm culvert)	0.006 ha[b]		-
	• Km 213.1 (fish bearing - 30 m x 12.3 m - 2-3,000 mm culvert)	-		0.037 ha[b]
Final Closure:				
In-water decommissioning	rehabilitation of ferry crossing site	-	-	positive
On-land decommissioning	remove culvert; re-establish natural drainage	-	-	positive
Total			**0.030**	**0.146**

[a] Applied minimum width of 0.2 m for culvert of 30 m long to calculate surface area.
[b] Based on culvert length of 30 m and average stream channel width at the crossing location.
[c] Culvert still to be designed.
[d] Based on culvert length of 30 m and average stream channel width estimated from habitat map.
[e] Based on culvert length of 30 m and average stream channel width estimated from Google Earth image.
km = kilometres; - = not applicable; ha = hectares; m = metres; mm = millimetres; TBD = to be determined.

3 MITIGATION MEASURES FOR FISH HABITAT

Mitigation measures have been incorporated into the Project design, and will be incorporated into various project construction activities to limit changes to fish habitat quantity and quality:

- Diversion channels will be designed to keep runoff and water flows within natural drainage pathways.
- In-water construction will follow standard protocols and best management practices.
- Andrew Lake open pit will be dewatered during the construction phase, and refilled during the closure phase at rates such that effects to water quality are minimized.
- Installation of the lake water intake structures and effluent diffuser structures will follow best management practices, including the installation of turbidity barriers prior to constructing the berm in Andrew Lake.
- Fish rescue will be carried out prior to dewatering the north-east portion of Andrew Lake in order to minimize the potential for fish losses due to stranding.
- Water systems will be designed to recycle water where applicable, and water use will be minimized to limit withdrawal requirements and discharge quantities.
- Site footprint will be minimized and situated such that natural drainage areas and watershed boundaries are maintained.
- Road construction and installation of stream crossings will follow best management practices and erosion control measures will be incorporated into the design of stream and watercourse diversions.
- Crossing structures on all fish-bearing streams will be designed and installed in a manner to facilitate fish passage under all flow conditions up to, and including, the 1 in 10 year flood.
- DFO procedures for water withdrawal from ice-covered waterbodies in the Northwest Territories and Nunavut will be followed. Specifically, no more than 10% of the under-ice volume will be withdrawn from a lake during one ice covered season.
- During decommissioning, the ground surface will be recontoured and natural flow patterns will be restored.

The above proposed measures describe the general approaches that will be used to mitigate effects to fish habitat. The detailed information regarding the compensation for fish habitat losses or alterations is presented in Section 4.0. The FHCP will be submitted to NIRB and DFO for review. Only after the FHCP receives approval, and the Project receives DFO's Authorization can any Project work begin that may result in the loss or harmful alteration of fish habitat.

4 FISH HABITAT COMPENSATION OPTIONS

In order to meet the requirements of DFO's "No Net Loss" policy, fish habitat compensation will be required to offset fish habitat lost and/or altered by Project development. The principle of "No Net Loss" strives to "balance unavoidable habitat losses with habitat replacement on a project-by-project basis so that further reductions to Canada's fisheries resources due to habitat loss or damage may be prevented" (DFO 1986). Although mitigation measures related to various Project development/construction activities will reduce the amount of fish habitat altered or lost (Section 3.0), some alteration and losses are unavoidable, therefore fish habitat compensation will be required.

According to DFO (2010b) where compensation is required, there is a preferred hierarchy of compensation options that should be followed. Additionally, it is preferred that the compensation be completed on site before moving off-site. DFO's preferred hierarchy for compensation includes:

- create or increase the productive capacity of like-for-like habitat in the same ecological unit;
- create or increase the productive capacity of unlike habitat in the same ecological unit;
- create or increase the productive capacity of habitat in a different ecological unit; and
- as a last resort, use artificial production techniques to maintain a stock of fish, deferred compensation, or restoration of chemically contaminated sites.

Once this Fish Habitat Compensation Plan is approved and works are constructed, a compliance and effectiveness monitoring program will be carried out to show that the compensation works have been built as specified and approved, and that they are functioning effectively as designed. In this way it will be shown that the compensation works have met DFO's requirement that the Project does not result in "net-loss" of fish habitat.

4.1 FISH HABITAT LOSSES

Fish habitat losses resulting from the Project are mainly associated with in-water construction activities during the construction phase. These losses include the relocation of the downstream portion of Mushroom/End Grid Stream (0.062 ha), the draining of the north-east portion of Andrew Lake (13.5 ha), and potentially the blasting near the small pond west of the proposed Main Zone open pit (1.28 ha - tentative). Fish habitat losses total 14.842 ha of seasonal-use stream and lake habitats (Table 2.2-3 and Table 4.1-1). Optional fish habitat losses include the construction of the Thelon River ferry approach aprons on both sides of the river. These losses are estimated to total 0.030 ha of fish-bearing stream habitat (Table 2.4-1 and Table 4.1-1).

Table 4.1-1
Summary of Predicted Fish Bearing Habitat Losses and Alterations

Project Phase / Activity	Habitat Losses (ha)	Habitat Alterations (ha)
Proposed Phase / Activity		
In-water construction	13.562	1.147
On-land construction	0	0.516
Mining operation	1.28 (tentative)	0
Water management	0	between 0.17 and 0.21[(a)]
subtotal	*14.842*	between 1.833 and 1.873[(a)]
Optional Phase / Activity		
In-water construction	0.030	0.030
On-land construction	0	0.116
subtotal	0.030	0.146
Total	**14.872**	**between 1.979 and 2.019*[(a)]***

[(a)] Surface area variable depending on different water availability scenarios.
ha = hectares.

4.2 FISH HABITAT ALTERATIONS

Fish habitat alterations will occur most frequently (1.147 ha) during in-water construction activities. These alterations include the rock rip-rap face of the berm separating the Andrew Lake open pit from Andrew Lake, the footprint of both freshwater intake structures (Siamese and Mushroom lakes), and the footprint of both treated effluent diffusers in Judge Sissons Lake (Table 2.2-3 and Table 4.1-1).

Land-based construction activities are predicted to result in 0.516 ha of fish habitat alterations during the construction phase of the Project development. These alterations include construction of crossing structures on fish bearing streams located on the haul road between the Kiggavik and Sissons mine sites, on the access road from Kiggavik mine site to the Siamese Lake water intake, and on the effluent diffuser access road from the Sissons mine site to Judge Sissons Lake (Table 2.2-3 and Table 4.1-1).

Proposed water withdrawals from both proposed water source lakes (Siamese and Mushroom lakes) are below the 10% maximum under-ice volume withdrawal limits specified by DFO (2010a). However, in order to confirm that the effect of these water withdrawals on potential lake trout spawning habitat would be minor, the effect was evaluated. The habitat analysis for Siamese Lake suggests that the alteration of potential lake trout spawning habitat could be 0.12 ha if both basins of Siamese Lake stay connected in April and May, or 0.16 ha if the west basin of Siamese Lake becomes separated from the east basin at the end of the winter

(Table 2.2-3 and Table 2.2-2). This small area represents a small alteration of potential lake trout spawning habitat in Siamese Lake (between 1.6% and 2.2% of total predicted available spawning habitat) (Table 2.2-2). This slight reduction in potential spawning area is expected to have a negligible effect on overall lake trout spawning success, recruitment, and population levels in Siamese Lake.

The habitat analysis for Mushroom Lake suggests that the alteration of potential lake trout spawning habitat could be 0.05 ha (Table 2.2-3 and Table 2.2-2). This represents a minor alteration of potential lake trout spawning habitat in Mushroom Lake of 11% (Table 2.2-2). However, this somewhat higher predicted alteration of potential lake trout spawning habitat is not expected to meaningfully affect lake trout populations or recruitment in Mushroom Lake. Lake trout spawning habitat is not considered to be a limiting population factor in Mushroom Lake. According to the desktop evaluation, the area of optimal lake trout spawning habitat with optimal egg survival requirements represents about 1.29% of the total lake surface area (or 4.21% of the under-ice water area). This is a high proportion of the lake area suitable for lake trout spawning. In comparison, the desktop evaluation for Siamese Lake shows that optimal lake trout spawning habitat represents only 0.27% of the total lake surface area (or 0.34% of under-ice water area).

Optional fish habitat alterations include the construction of the Thelon River ferry approach aprons on both sides of the river (0.030 ha); the construction of crossing structures on fish bearing streams located on the North All-Weather Access Road west of the Thelon River (0.023 ha) and east of the Thelon River (0.093 ha). These alterations total 0.146 ha of fish-bearing stream habitat (Table 2.4-1 and Table 4.1-1).

4.3 FISH HABITAT COMPENSATION

The majority of fish habitat lost or altered will be seasonal-use lake or pond habitat with a total area of 14.845 ha. Only 0.578 ha of seasonal-use stream habitat will be lost or altered. A total between 1.252 ha and 1.292 ha (depending on different water availability scenarios) of year-round fish habitat will be altered. Fish habitat losses or alterations associated with construction of the optional North All-Weather Access Road total 0.176 ha (Table 2.4-1).

Following consultation with DFO staff on the issue of determining appropriate compensation options, this FHCP proposes to replace the areas of lost seasonal-use fish habitat with equivalent areas of similar shallow, seasonal-use habitat. Remote sensing surveys were undertaken to locate a number of shallow, landlocked, potentially fishless waterbodies in the Kiggavik region, that might be connected to nearby fish-bearing stream systems to make them productive fish habitat. Previous baseline surveys in the Kiggavik area show that a number of such fishless waterbodies do exist. Ground-based fish and engineering surveys will be required to confirm that the selected waterbodies are currently fishless, and that connection with adjacent stream systems is possible in terms of elevation differences and other engineering considerations.

Fish habitat compensation for the construction of culvert stream crossings along the ore haul road and other infrastructure support roads will be determined on a crossing specific basis. Limiting fish habitat types will be identified for each affected stream through field surveys, and improvements to instream fish habitat will be made that would most benefit each individual stream.

Locations identified as having potential for fish habitat compensation are presented in Table 4.3-1 and Figure 4.3-1. Each compensation option will be discussed in the following section.

Table 4.3-1
Total Compensation Areas

Site Number	Pond Surface Area (m^2)	Channel Length and Width (m)	Channel Surface Area (m^2)
Site 1: downstream of Sleek Lake	12,958	223 x 1	223
Site 2: upstream of Sleek Lake	7,465	208 x 1	208
Site 3: upstream of Fox Lake	29,990	310 x 1	310
Site 4: upstream of Pointer Lake	13,221	135 x 1	135
Site 5: upstream of Pointer Lake	6,658	219 x 1	219
Site 6: upstream of L2/Km 20 Lake	112,485	795 x 1	795
Site 7: Sik Sik / Rock Stream	193,190	128 x 1	128
Site 8: New Mushroom / End Grid Stream[(a)]	-	900 x 6	5,400
Total	**375,967 (37.6 ha)**	**2,918**	**7,418 (0.7 ha)**

(a) Site 8 is located at the Sissons Mine Site and is not shown in Figure 4.3-1.
m^2 = square metres; m = metres; ha = hectares; - = not applicable.

4.3.1 Potential Compensation Site 1: Downstream of Sleek Lake

A pond located off the main channel downstream of Sleek Lake and the ore haul road stream crossing, appears to be unconnected to the main stream channel (Figure 4.3-1). This orphaned pond is about 1.3 ha in area. Construction of a channel 223 m in length would be required to connect the orphaned pond to the main channel (Table 4.3-1).

Arctic grayling and slimy sculpin were captured at proposed road crossing location Km 11.3. Other fish species are likely to reside in Sleek Lake and may migrate downstream during the open water period. Additional pond area downstream of Sleek Lake would increase the potential for foraging and rearing for various species. The channel would need to be constructed with fish passage and low flow availability in mind.

Projection: NAD 1983 UTM Zone 14N
Creator: TAH
Date: 01/12/11 Scale: 1:75,000
File: KI08C341
Data Sources: *Site layout provided by AREVA, June 3, 2011*
2006 Spot Imagery

FIGURE 4.3-1
POTENTIAL FISH HABITAT COMPENSATION OPTIONS

KIGGAVIK PROJECT

Golder Associates
AREVA
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4.3.2 Potential Compensation Site 2: Upstream of Sleek Lake

A pond located off the main channel upstream of Sleek Lake and between two larger ponds appears to be unconnected to the main channel (Figure 4.3-1). This orphaned pond is about 0.7 ha in area. Construction of an inflow channel 88 m in length and an outflow channel 120 m in length would be required to connect the orphaned pond to the main channel (Table 4.3-1).

Arctic grayling and slimy sculpin were captured at road crossing location Km 11.3 downstream of Sleek Lake. Other fish species are likely to reside in Sleek Lake and may migrate upstream. The addition of pond area upstream of Sleek Lake would increase the potential for feeding and rearing for various species. The channel would need to be constructed with fish passage and low flow availability in mind.

4.3.3 Potential Compensation Site 3: Upstream of Fox Lake

Two ponds located off the main channel upstream of Fox Lake, and on both sides of a connected pond, appear to be unconnected to the main channel (Figure 4.3-1). These orphaned ponds are about 3.0 ha in area. Construction of two channels to the middle pond (168 m and 142 m in length) would be required to connect the orphaned ponds to the main channel (Table 4.3-1).

Arctic grayling, cisco, lake trout, and ninespine stickleback are present in Fox Lake located downstream of these ponds. These fish species may migrate upstream. The addition of pond area upstream of Fox Lake would increase the potential for foraging and rearing of various species. The connecting channels would need to be constructed with fish passage and low flow availability in mind.

4.3.4 Potential Compensation Site 4: Upstream of Pointer Lake

A pond located upstream of a larger pond connected to the main channel above Pointer Lake appears to be unconnected to the larger connected pond (Figure 4.3-1). This orphaned pond is about 1.3 ha in size. Construction of a channel 135 m in length would be required to connect the orphaned pond to the larger connected pond (Table 4.3-1).

Arctic grayling, cisco, lake trout, and ninespine stickleback are present in Pointer Lake. These fish species may migrate upstream. Additional pond area upstream of Pointer Lake would increase the potential for feeding and rearing for various species. The channel would need to be constructed with fish passage and low flow availability in mind.

4.3.5 Potential Compensation Site 5: Upstream of Pointer Lake

A pond located off the main stream channel upstream of Pointer Lake, and between two larger ponds appears to be unconnected to the main channel (Figure 4.3-1). This orphaned pond is about 0.7 ha in area. Construction of an inflow channel 85 m in length, and an outflow channel 134 m in length, would be required to connect the orphaned pond to the main stream channel (Table 4.3-1).

Arctic grayling, cisco, lake trout, and ninespine stickleback are present in Pointer Lake. These fish species may migrate upstream. Additional pond area upstream of Pointer Lake would increase the potential for foraging and rearing by various species. The channel would need to be constructed with fish passage and low flow availability in mind.

4.3.6 Potential Compensation Site 6: Upstream of L2/20 Km Lake

Three ponds located off the main channel upstream of L2/20 Km Lake appear to be unconnected to the main channel (Figure 4.3-1). These orphaned ponds are about 11.2 ha in total area, comprised of about 4.3 ha in the upstream pond, about 0.5 ha in the middle pond, and about 6.4 ha in the downstream pond. Construction of four channels for a total length of 795 m would be required to connect the orphaned ponds to the main stream channel (Table 4.3-1). This channel would be separated in sections of 252 m in length upstream, followed by 123 m, 51 m, and 369 m in length at the downstream end.

Based on fish species present at the proposed stream crossing near L2/Km 20 Lake, Arctic grayling and lake trout are expected in this lake. These fish species often migrate upstream to forage, and in the case of Arctic grayling, to spawn. Additional pond area upstream of L2/Km 20 Lake would increase the potential for foraging and rearing for a number of species. The channel would need to be constructed with fish passage and low flow availability in mind.

4.3.7 Potential Compensation Site 7: Sik Sik / Rock Stream

During spring freshet, water flows from Sik Sik Lake to Rock Lake. At the end of the spring freshet, water remains in three ponds and short stream sections. The two downstream ponds are connected together and to Rock Lake. The upstream pond is connected to Sik Sik Lake only. A section of stream about 128 m in length has no visible channel; in the spring water simply flows over the tundra (Figure 4.3-1). Connecting the upstream pond (1.3 ha in surface area) to the downstream ponds would allow large-bodied fish to migrate upstream to Sik Sik Lake (18.0 ha in surface area), and add 19.3 ha of fish rearing and feeding habitats (Table 4.3-1).

Ninespine stickleback are present in Sik Sik Lake and at the downstream end of Sik Sik/Rock Stream. Arctic grayling and lake trout are present in Rock Lake. These two large-bodied fish species may migrate upstream once an improved channel is created. This would increase the potential for fish foraging and rearing in Sik Sik Lake. The channel would need to be constructed with fish passage and low flow availability in mind.

4.3.8 Potential Compensation Site 8: Freshwater Diversion Channel S1 – New Mushroom / End Grid Stream

The downstream section of Mushroom/End Grid Stream will be filled in to allow for construction of the Sissons Mine Site facilities. Water will be diverted around the site through Freshwater Diversion Channel S1, from location 0+900 to 0+000. Within this length of 900 m, the base of the diversion channel is expected to be 6.0 m wide with side slopes of 3:1 for both channel sides. These sides are high enough to contain spring freshet flows as well as to reach the natural ground level where cuts are required. A narrower (i.e., 1 m wide) sinuous channel will be constructed within the 6.0 m base channel to concentrate the water during periods of low flow, and to allow large-bodied fish passage for as long as possible during the open water period. The diversion channel will be lined with rock rip rap to reduce flow velocities, and to provide a diversity of fish habitat including resting areas during upstream migrations.

Arctic grayling, cisco, lake trout, and round whitefish are present in Mushroom Lake, and Arctic grayling have been captured in End Grid Lake. These large-bodied fish species may potentially migrate between Mushroom Lake and End Grid Lake during the open water season when flows are sufficient.

4.4 FISH HABITAT SUMMARY

Losses and alterations of seasonal-use fish habitat resulting from the Project account for 15.423 ha. Alteration of year-round fish habitat will affect between 0.17 ha and 0.21 ha of potential lake trout spawning habitat in Mushroom and Siamese lakes, and 1.082 ha of Mushroom (0.100 ha), Siamese (0.063 ha) and Judge Sissons (0.919 ha) lake bottom. No losses of year-around fish habitat are anticipated to result from the Project. If the optional construction of the North All-Weather Access Road proceeds, additional fish habitat losses (0.030 ha) and alterations (0.146 ha) will occur (Table 4.1-1).

Potential compensation options include: six sites which involve connecting fishless ponds to fish-bearing streams by constructing access channels; one site that involves constructing an improved channel for large-bodied fish to access Sik Sik Lake as seasonal foraging habitat, and one site involves replacing a section of fish-bearing stream (Mushroom/End Grid Stream) with a diversion channel allowing fish passage under high and low flow conditions. These eight sites account for 37.6 ha of shallow pond area, and 0.7 ha of stream channel, all of which are seasonal fish habitat (Table 4.3-1).

The total surface area of the eight proposed fish habitat compensation options (38.3 ha) exceeds the total predicted fish habitat losses (14.842 ha). However, field evaluation of the proposed compensation options is required to confirm that fish are absent in the ponds selected. The field evaluations may eliminate a number of the proposed compensation options. Depending on the field evaluation results, other more suitable compensation sites may have to be located for the habitat compensation to cover the predicted losses.

5 COMPLIANCE AND EFFECTIVENESS MONITORING

Once the approved Fish Habitat Compensation works are constructed, a compliance and effectiveness monitoring program will be carried out in order to demonstrate that the compensation works have been built as specified and approved, and that they are functioning effectively, and as designed. The monitoring program is intended to show that the compensation works have met the DFO requirement that the Project result in “no-net-loss” of fish habitat. Monitoring will be carried out during the construction of the FHCP components, as well as after completion in order to evaluate the success of the fish habitat compensation works. DFO will be informed of the results of the fish habitat compensation construction and monitoring program.

5.1 MONITORING FOR COMPLIANCE DURING CONSTRUCTION OF FISH HABITAT COMPENSATION WORKS

Fish habitat compensation presented in this FHC Plan is of two main types: construction of new stream or diversion channels, and provision of new/improved access to shallow, seasonal-use lakes and deeper, over-wintering lakes. For both types of compensation works the following mitigation measures will be incorporated into the construction activities to limit changes to fish habitat quantity and quality present downstream of the working area:

- New stream and diversion channels will be designed to keep water flows within natural drainage paths, and to maintain existing surface water elevations in affected waterbodies.
- New stream and diversion channels will be designed and constructed in a manner to facilitate fish passage under high and low flow conditions, with the inclusion of a narrower and deeper sinuous channel at the bottom of the main channel, to allow large-bodied fish passage as long as possible during low flow conditions.
- New stream and diversion channels will be designed and constructed with a variety of shapes (e.g., sinuous bottom channel within a straight diversion channel), substrates (e.g., sand, gravel, cobble, and boulder), fish covers (e.g., interstitial spaces between coarse substrate and deeper pools), and habitat types (e.g., shallow pools, shallow runs, riffle, and flats) to allow fish passage and resting areas during migration, and/or to allow resting and feeding areas for fish rearing in the channel.
- When only a small quantity of water is diverted from the main channel to link some ponds together, the elevation of the upstream section of the new channel will be designed and constructed in a manner to assure the majority of the water continues to flow in the natural stream channel.

- Installation of diversion structures will follow best management practices, including the installation of sand bags, or similar techniques. To isolate the area, and the completion of fish rescue programs prior to dewatering the downstream section of Mushroom/End Grid Stream to minimize the potential for fish losses due to stranding.
- Stream channel construction will follow best management practices, and erosion control measures will be incorporated into the design of stream and watercourse diversions.
- All construction related to the FHCP will need to be completed during the appropriate DFO recommended timing windows to prevent mortality of Arctic grayling eggs potentially present downstream of the working area.

An environmental monitor will be present during fish habitat compensation construction activities, including during the construction of the Freshwater Diversion Channel S1, from location 0+900 to 0+000. This requirement is linked to the fish passage requirement of this diversion channel.

5.2 MONITORING THE EFFECTIVENESS OF FISH HABITAT COMPENSATION WORKS

Once the new stream and diversion channels have been constructed and water is flowing in them, fish sampling will be carried out to assess fish presence/absence during spring, summer, and fall flows for the first year, and then once per year during early summer for the two following years, or until fish are captured in the newly created and/or newly accessible habitat. The success of the FHCP would be based on the capture/observation of previously unreported fish species for Sik Sik Lake, or simply the presence of any fish species utilizing the ponds where no fish had been previously reported.

6 SUMMARY

Habitat compensation will be required to offset fish habitats lost and/or altered by development activities associated with the Kiggavik Project in order to meet the requirements of DFO's No Net Loss Policy. The No Net Loss Policy strives to "balance unavoidable habitat losses with habitat replacement on a project-by-project basis so that further reductions to Canada's fisheries resources due to habitat loss or damage may be prevented" (DFO 1986). Although implementation of best management practices and mitigation measures during Project construction and operation will reduce the amount of fish habitat altered or lost (Section 3.0), some habitat loss and alteration is unavoidable. Thus, a fish habitat compensation program is necessary.

Fish habitat losses are mainly associated with in-water construction activities during the construction phase of the Project, and generally involve the loss of seasonal-use fish habitat. These losses include the relocation of the downstream portion of Mushroom/End Grid Stream (0.062 ha), and the de-watering of the north-east portion of Andrew Lake (13.5 ha), and potentially the small pond located west of the proposed Main Zone open pit (1.28 ha - tentative). Permanent fish habitat losses total 14.842 ha of seasonal-use stream and lake habitats.

Most fish habitat alterations will occur during the in-water construction component of Project construction (1.147 ha) and during the water management component of Project operations (between 0.17 ha and 0.21 ha). These fish habitat alterations include the rock rip-rap face of the berm separating the Andrew Lake open pit from the rest of Andrew Lake, the footprint of both freshwater intake structures (Siamese and Mushroom lakes), the footprint of both treated effluent diffusers in Judge Sissons Lake, and potential fish habitat alterations associated with water level drawdowns in Siamese and Mushroom lakes.

Proposed water withdrawals from both proposed water source lakes (Siamese and Mushroom lakes) are below the 10% maximum under-ice volume withdrawal limits specified by DFO (2010a). Although some potential lake trout spawning habitat may be altered due to Project water withdrawals during the winter ice-covered season, this is not expected to result in negative effects on maintenance of lake trout populations in either Siamese or Mushroom lakes. Because proposed water withdrawals are in line with DFO's under-ice water withdrawal protocol, and no significant fish population effects are expected, no Fish Habitat Compensation is proposed for this Project activity.

Additional land-based fish habitat alterations (about 0.516 ha) include crossings of fish bearing streams by the haul road between the Kiggavik and Sissons mine facilities, on the access road from Kiggavik site to Siamese Lake, and on the access road from the Sissons mine site to Judge Sissons Lake.

Seven areas potentially suitable for habitat compensation were identified in the Kiggavik area for a total lake/pond surface area of 37.6 ha, and a total stream channel surface area of 0.2 ha. The eighth potential compensation area identified is the section of freshwater diversion channel S1 that will be constructed to replace the mid to downstream section of the fish-bearing stream channel originating in Mushroom Lake and flowing into End Grid Lake; this channel surface area represents 0.5 ha.

The total surface area (38.3 ha) of the eight proposed fish habitat compensation options exceeds the total predicted fish habitat losses (14.842 ha). However, field evaluation of the proposed compensation options is required to confirm that the ponds selected are fishless. The field evaluation may eliminate a number of the proposed options. If necessary, additional potential compensation sites will be identified until proposed habitat compensation is sufficient to cover predicted habitat losses.

In considering the optional construction components, 0.060 ha of stream fish habitat losses or alterations have been identified resulting from construction of the Thelon River ferry approach aprons to be installed on each side of the Thelon River. Construction of the proposed North All-Weather Access Road will result in the alteration of about 0.116 ha of stream fish habitat due to culvert installations.

7 REFERENCES

7.1 LITERATURE CITED

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