APPENDIX IX.12

FISH HABITAT ASSESSMENT – SUPPORTING INFORMATION

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1.0 STRUCTURE OF REPORT

This appendix provides detailed information on methods used to quantify changes or alterations to fish habitat within Snap Lake resulting from the construction of the water intake and mine water outflow structure and identifies the types of habitat associated with the various fish populations found in the lake. This appendix is a support document to the information presented in the environmental assessment (EA) (Section 9.5.2.3) and is not intended as a stand-alone document. The process used to identify and quantify changes or alteration to fish habitat have been explained in other documents relating to diamond developments in the Northwest Territories (NWT) and will be referenced in the text.

2.0 GENERAL METHODOLOGY – HABITAT ANALYSIS

A modified habitat evaluation procedure (HEP) (U.S. Fish and Wildlife Service 1980) was used to assess fish habitats being altered, lost, or created during the construction and operation of the Snap Lake Diamond Project. HEP analysis combines habitat quality, defined by the habitat suitability index (HSI), with habitat quantity to calculate habitat units (HUs), a measure that accounts for both the quantity and quality of habitat available for the life stages of a selected species. Multiplying the HSI value for each species and life stage by the area of each type of habitat affected provides the number of HUs available for each species and life stage during each project phase.

Comparing the number of HUs available under baseline conditions to those available during construction and operation allows the qualification of the overall number of HUs altered, lost, and created by the proposed project. This technique also facilitates the evaluation of mitigative options. Thus, the difference in habitat quantity, weighted by habitat quality, between the existing and future conditions enables an evaluation of the net effect of the proposed project on fish habitat.

Effects of the proposed project on fish habitat were evaluated for nearshore, deep-water and shoal areas of Snap Lake. Within these environments, four distinct classes of habitats were evaluated: spawning, nursery, rearing, and foraging.

Habitat classes are defined as follows.

- spawning habitat is used by fish for the specific act of spawning;
- nursery habitat is used by developing embryos and young-of-the-year (YOY);
- rearing habitat is used by sub-adult fish other than YOY for foraging and refuge from predators; and,
- foraging habitat is used by adult fish for feeding or periods between feeding events.

This assessment quantifies changes in habitat availability of the four different habitat classes (spawning, nursery, rearing, and foraging). Habitat changes account for the habitat altered or lost due to construction and the habitat gained through mitigation efforts.

3.0 NEARSHORE, DEEP WATER AND SHOAL HABITAT TYPE AND AREA

Golder Associates Ltd. (Golder Associates) conducted a bathymetric survey of Snap Lake in 1999. Survey data were used to produce a digital bathymetric map displaying contour lines at one-metre (m) intervals. The major physical attributes of Snap Lake were individually surveyed in the field during the environmental baseline study in the summer of 1999. Major physical attributes of the lake included nearshore types (0 to a depth of approximately 4 m), deep water (>4m), and shoals. As part of the baseline investigations for the Snap Lake Diamond Project, the physical attributes (*i.e.*, slope, substrate type, vegetation type) of shorelines and shoals were recorded. All procedures followed for habitat assessment are described in Golder Associates' Technical Procedures for Shoreline Habitat Mapping 8.19-0 (Appendix IX.9).

Methods used to delineate habitat are as follows:

- scanned, topographic maps of the proposed project site and surrounding area were overlaid with bathymetric information, and this composite image was transferred into geographic information systems (GIS);
- in the field, the maximum depth of the rocky substrate was determined for each section of nearshore in the area of the proposed project (local study area). Beyond this depth, the substratum was almost invariably composed of 100% organic matter and silt. In addition, a fall spawning survey was conducted and shoal areas were defined and categorised as primary or secondary spawning habitat for the dominant predator fish in the lake, lake trout; and,
- using the maximum depths, GIS was used to calculate the area (hectare [ha]) of available habitat along each uniform section of shoreline, shoals, and areas of deep water. The total area present for each habitat type (*e.g.*, boulders, and cobble) was then calculated for the shorelines of the entire lake as well as areas that may be altered by the proposed project activities.

The nearshore habitat of Snap Lake was defined to a depth of 4 m below which a predominantly homogeneous organic and silty substrate dominates. Seven distinct nearshore habitat types were defined in Snap Lake, typically combinations of bedrock, boulder, and cobble. Stretches of shoreline inundated vegetation occur sporadically around the lake (Table IX.12-1).

Deep-water habitat was identified using the Snap Lake bathymetric information. Deep-water habitat was defined as the area greater than 4 m deep, defined by the transition zone between clean bedrock, boulder, cobble substrate or combination thereof, and consistent silt or organics covered lake bottom (Table IX.12-1).

Table IX.12-1
Habitat Types Classified in Snap Lake

Habitat #	Habitat Type	Description
	Shorelines (<4 m)	
1	boulder/cobble (Bo/Co)	First 2-m steep gradient. Rocks relatively clean of algae and silt. Substrates 70% boulder/30% cobble on average. Gradient shallow after 2 m. Substrates 40% boulder, 40% silt or organic matter, 10% cobble. Rocky substrates covered in algae/silt and not more than one layer thick.
2	bedrock (Bd)	Flat or shallow gradient sheet of rock. Surface clean near shore but progressively covered with algae/silt with depth.
3	bedrock/boulder (Bd/Bo)	Flat or shallow gradient sheet of rock. Boulders scattered on surface of bedrock. No more than one layer thick of boulders at any location. Surface of all rocky substrates clean near shore but progressively covered with algae/silt with depth.
4	boulder (Bo)	First 2-m steep gradient. Rocks relatively clean of algae and silt. Substrates 100% boulder. Gradient shallow after 2 m. Substrates 50% boulder, 50% silt or organic matter. Rocky substrates covered in algae/silt and not more than one layer thick.
5	inundated vegetation/ boulder (IV/Bo)	Occurs only in sheltered bays or at the mouth of streams. Gradient flat or very shallow. Substrates a varying mixture of scattered boulders with silt substrates in between. Emergent vegetation found in between boulders. Boulders covered by thick layer of algae and silt.
6	bedrock/cobble (Bd/Co)	Flat or shallow gradient sheet of rock. Cobble scattered on surface of bedrock. No more than one layer thick of cobble at any location. Surface of all rocky substrates clean near shore but progressively covered with algae/silt with depth.
7	inundated vegetation (IV)	Occurs only in sheltered bays or at the mouth of streams. Gradient flat or very shallow. Substrates silt and organic matter. Emergent vegetation scattered throughout area.
	deep water (>4 m)	
8	deep water	Substrates in deep water dominated by thick layer of diatoms and other loose organic matter. Surface layer of diatoms alive but lower layers exhibit varying degrees of decay. Cover for forage fish or macroinvertebrates poor.
	shoals (0 – 6 m)	
9	primary	Mixture of boulder (60% - 70%) and cobble (40% - 30%) to a depth of 6 m. Gradient steep to moderate. Rocky substrates clean near surface but become progressively covered with silt and algae with depth. Boulder/cobble layer two to three rocks deep in most areas.
10	secondary	Mixture of boulder (80% - 90%) and cobble (20% - 10%) to a depth of 6 m. Gradient shallow to moderate. Rocky substrates clean near surface but become progressively covered with silt and algae with depth. Algae/silt cover heavy in areas with low gradient. Boulder/cobble layer one to two rocks deep in most areas.

Note: m = metre.

Shoals are shallow, submerged areas that are isolated from the shoreline of a lake. They can be composed of a variety of materials depending upon the regional geology. Shoals may be clean (free of fines) if they are in a shallow location that is affected by wave action. Shoals may have a significant potential to provide spawning habitat. Two types of shoal, both defined to a depth of 6 m, were identified in Snap Lake for use in the habitat analysis. Shoals that were identified could either provide primary spawning conditions (ideal) or secondary spawning conditions (good, but not ideal) for lake trout (Table IX.12-1).

Using the aforementioned criteria, ten habitat types were identified in Snap Lake: seven nearshore, two shoals, and one deep water. To facilitate comparison, a coding system was developed as a descriptive tool, using substrate as the primary variable (Table IX.12-1). Once the habitat types were defined and quantified, the total area (ha) of each habitat type in Snap Lake was calculated. The area of each habitat type along the northwest peninsula was also calculated to identify specific habitat immediately adjacent to the proposed project (Table IX.12-2).

Table IX.12-2
Summary of Major Aquatic Habitat Areas in Snap Lake

Habitat	Habitat #	Area of Major Habitat Types in Snap Lake (ha)	% of Total Area of each Habitat Type	Area of Major Habitat Types along the Northwest Peninsula (ha)	% of Total Area of Northwest Peninsula
Nearshore habitat (waters edge to 4-m contour)					
Bo/Co	1	290.48	76.6	52.40	89.3
Bd	2	28.96	7.6	0	0
Bd/Bo	3	27.20	7.2	3.79	6.5
Bo	4	23.85	6.3	2.16	3.7
IV/Bo	5	4.24	1.1	0.34	0.6
unknown	-	2.18	0.6	0	0
Bd/Co	6	1.25	0.3	0	0
IV	7	1.21	0.3	0	0
Total nearshore habitat		379.37	100	58.69	100
Shoal habitat (primary and secondary lake trout spawning areas to the 6 m contour)					
Primary	9	16.82	50	-	-
Secondary	10	16.34	50	-	-
Total shoal habitat		33.16	100	-	-
Deep water (>4 m in depth)					
Deep water	8	276.36	100	-	-
Open water (entire lake area)					
Open water	-	688.89	-	-	-

Note: m = metre; ha = hectare; dash line (-) = not applicable; unknown = not classified; Bd = Bedrock, Bo = boulder (>25 cm), C = cobble (>6.5 cm), R = rubble (>6.5 cm, angular), G = gravel (>0.2 cm), S = sand (>0.06 mm) and CS = clay/silt (<0.06 mm).

4.0 FISH SPECIES SELECTION

Fish were captured by a variety of means (*e.g.*, gill nets, minnow traps, and angling) in Snap Lake to identify species presence, relative abundance and to investigate habitat use. Electrofishing was not a feasible sampling method due to the very low conductivity of Snap Lake water (~10-20 microSiemens). The baseline-sampling program included an adult fish survey, fall spawning surveys, shoreline fish sampling. Detailed information on how and where fish were captured are presented in Appendix IX.9. The fish species captured during the baseline fieldwork are listed in Table IX.12-3. Potential habitat changes were quantified for all of the fish species observed.

Table IX.12-3
Fish Species Utilized for the Snap Lake Habitat Assessment

Common Name	Species Code	Latin Name
Lake trout	LKTR	*Salvelinus namaycush* Walbaum
Arctic grayling	ARGR	*Thymallus arcticus* Pallas
Round whitefish	RNWH	*Prosopium cylindraceum* Pallas
Longnose sucker	LNSC	*Catostomus catostomus* Forster
Burbot	BURB	*Lota lota* Linnaeus
Slimy sculpin	SLSC	*Cottus cognatus* Richardson
Lake chub	LKCH	*Couesius plumbeus* Agassiz

5.0 DEVELOPMENT OF HABITAT SUITABILITY MODELS

The habitat evaluation involved utilizing HSIs for each fish species and life stage. HSI values range from 0.0 to 1.0, with a rating of 1.0 being excellent and 0 being unsuitable (Table IX.12-4).

Table IX.12-4
Habitat Suitability Indices and Descriptions Used to Represent Habitat Quality

HSI Value	Habitat Description
1.00	excellent
0.75	above average
0.50	average
0.25	below average
0.00	unsuitable

Note: HSI = habitat suitability index.

The identification of gaps in published HSIs relating to northern fish species and the development of HSIs applicable for northern fish species have been fully described in previous northern diamond project environmental assessments (Diavik 1998a and 1998b). These reports addressed the need to modify or develop HSI values specific to Arctic species found in Snap Lake (Diavik 1998b), and will not be described here. In general, the existing HSIs for longnose sucker and Arctic grayling were modified to fit arctic conditions. The lack of published models necessitated the development of HSIs for lake trout, round whitefish, burbot, slimy sculpin, and lake chub (Table IX.12-5 a - f). Only minor modifications were made to the Diavik (1998b) HSI models for the Snap Lake habitat assessment.

Once HSIs were defined for all species and life stages, they were applied to the specific habitat types present in Snap Lake (Table IX.12-6). This allowed for a habitat-ranking specific to Snap Lake, and for each species and life stage to be considered in the habitat evaluation. For example, the same shoal or stretch of shoreline may receive a ranking of 'Excellent' (HSI=1.0) for spawning for one species and 'Average' (HSI=0.50) for another. For one habitat type, nearshore boulder/cobble habitat, 32 HSI values (eight fish species multiplied by four life stages) were assigned.

Table IX.12-5
Habitat Suitability Indices and Descriptions Developed to Describe Fish Habitat for Selected Species in Snap Lake

a) Lake trout

	SPAWNING					NURSERY				
Physical habitat	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**
HSI value	1.0	0.75	0.5	0.25	0	1.0	0.75	0.5	0.25	0
Substratum type	Bo dominant	Bo or C	Bo or C	Bo/C with G	Bd or CS	Bo dominant	Bo or C	Bo or C	Bo/C with G	Bd or CS
Substratum size	20-50 cm	10-50 cm	5 - 60 cm	>1 cm	<1 cm	20-50 cm	10-50 cm	5 - 60 cm	>1 cm	<1 cm
Minimum depth	2 m	2 m	1.5 m	<3 m	<3 m	2 m	2 m	1.5 m	<3 m	<3 m
Maximum depth	>4 m	>3 m	>1.5 m	>1.5 m	>1.5 m	>4 m	>3 m	>1.5 m	>1.5 m	>1.5 m
Slope of rock substratum	30 - 50º	30 - 50º	15 - 50º	>0º	>0º	30 - 50º	30 - 50º	15 - 50º	>0º	>0º
Substratum shape	angular/fractured	angular	angular or round	angular or round	-	angular/fractured	angular	angular or round	angular or round	-
Substratum cleanliness	clean	clean	some silt	silt/algae covered	-	clean	clean	some silt	silt/algae covered	-
Depth of interstitial spaces	>30 cm	>20 cm	>10 cm	>3 cm	-	>30 cm	>20 cm	>10 cm	>3 cm	-
Exposure to predominant wind and wave action	full exposure	full exposure	>180º exposure	<180º exposure	-	full exposure	full exposure	>180º exposure	<180º exposure	-
Proximity to deep water areas	directly adjacent	-	-	-	not adjacent	directly adjacent	-	-	-	not adjacent
	REARING					**FORAGING**				
Physical habitat	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**
HSI Value	1.0	0.75	0.5	0.25	-	1.0	0.75	0.5	0.25	0
Substratum type	Bo/C	C		S/CS	-	B/C	-	G/S and pelagic	CS/Bd	-
Substratum size	>6.5 cm	>6.5 cm	<6.5 cm	0	-	25 - 6.5 cm	-	-	-	-
Minimum depth	-	-	variable	variable	-	1 m	-	10 m	>30 m	-
Maximum depth	<10 m	<10 m	variable	variable	-	10 m	-	30 m	-	-
Slope of rock substratum	-	-	25º	0º	-	-	-	-	-	-
Substratum shape	round/angular	round/angular	round	100% fines	-	angular or round	-	-	-	-
Substratum cleanliness	-	-	-	-	-	-	-	-	-	-
Depth of interstitial spaces	-	-	-	-	-	-	-	-	-	-
Exposure to predominant wind and wave action	<180º exposure	<180º exposure	>180º exposure	full exposure	-	-	-	-	-	-
Proximity to deep water areas	directly adjacent	-	-	not adjacent	-	-	-	-	-	-

Notes: HSI = habitat suitability index; cm = centimetres; m = metres; Bd = Bedrock, Bo = boulder (>25 cm), C = cobble (>6.5 cm), R = rubble (>6.5 cm, angular), G = gravel (>0.2 cm), S = sand (>0.06 mm) and CS = clay/silt (<0.06 mm).

Table IX.12-5
Habitat Suitability Indices and Descriptions Developed to Describe Fish Habitat for Selected Fish Species in Snap Lake (Continued)

b) Round whitefish

	SPAWNING					NURSERY				
Physical habitat	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**
HSI Value	1.0	0.75	0.5	0.25	0	1.0	0.75	0.5	0.25	0
Substratum type	G and C	G or C	Bo or C/G	Bo or S	Bd or CS	G and C	G or C	Bo or C/G	Bo or S	Bd or CS
Substratum size	0.2 - 6.5 cm	0.2 - 6.5 cm	0.2 - 25 cm	>1 mm	<1 mm	0.2 - 6.5 cm	0.2 - 6.5 cm	0.2 - 25 cm	>1 mm	<1 mm
Minimum depth	4 m	<4 m	<4 m	<4 m	<4 m	4 m	<4 m	<4 m	<4 m	<4 m
Maximum depth	20 m	>20 m	>20 m	>20 m	>20 m	20 m	>20 m	>20 m	>20 m	>20 m
Slope of rock substratum	10 - 25º	10 - 40º	10 - >25º	>0º	>0º	10 - 25º	10 - 40º	10 - >25º	>0º	>0º
Substratum shape	angular or round	angular or round	angular or round	angular or round	-	angular or round	angular or round	angular or round	angular or round	-
Substratum cleanliness	clean	some silt	some silt	silt/algae covered	-	clean	some silt	some silt	silt/algae covered	-
Depth of interstitial spaces	>5 cm	>5 cm	>5 cm	>1 mm	-	>5 cm	>5 cm	>5 cm	>1 mm	-
Exposure to predominant wind and wave action	full exposure	full exposure	>180º exposure	<180º exposure	-	full exposure	full exposure	>180º exposure	<180º exposure	-
Proximity to deep water areas	directly adjacent	-	-	-	not adjacent	directly adjacent	-	-	-	not adjacent
	REARING					**FORAGING**				
Physical habitat	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**
HSI Value	1.0	-	0.5	0.25	-	1.0	0.75	0.5	0.25	0
Substratum type	G/S/SC	-	C/G/S/SC	Bo/C	-	Bo/C	-	G/S	CS/Bd	-
Substratum size	<0.2	-	<6.5	<25 m	-	25 - 6.5 cm	-	0.2 - >0.06 mm	<0.06 mm	-
Minimum depth	<1 m	-	<5 m	>10 m	-	0 m	-	6 m	20 m	<2 m
Maximum depth	3 m	-	<10 m	>10 m	-	6 m	-	20 m	50 m	>7 m
Slope of rock substratum	-	-	-	-	-	-	-	-	-	-
Substratum shape	-	-	-	-	-	angular or round	-	-	-	-
Substratum cleanliness	-	-	-	-	-	clean	-	moderately clean	heavily silted	heavily silted
Depth of interstitial spaces	-	-	-	-	-	-	-	-	-	-
Exposure to predominant wind and wave action	<180º exposure	-	>180º exposure	full exposure	-	-	-	-	-	-
Proximity to deep water areas	directly adjacent	-	-	not adjacent	-	-	-	-	-	not adjacent

Notes: HSI = habitat suitability index cm = centimetres; m = metres; Bd = Bedrock, Bo = boulder (>25 cm), C = cobble (>6.5 cm), R = rubble (>6.5 cm, angular), G = gravel (>0.2 cm), S = sand (>0.06 mm) and CS = clay/silt (<0.06 mm).

Table IX.12-5
Habitat Suitability Indices and Descriptions Developed to Describe Fish Habitat for Selected Fish Species in Snap Lake (Continued)

c) Arctic grayling

	SPAWNING (n/a - STREAM SPAWNER)					NURSERY (n/a STREAM SPAWNER)				
Physical habitat	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**
HSI Value	1.0	0.75	0.5	0.25	0	1.0	0.75	0.5	0.25	0
Substratum type	-	-	-	-	-	-	-	-	-	-
Substratum size	-	-	-	-	-	-	-	-	-	-
Minimum depth	-	-	-	-	-	-	-	-	-	-
Maximum depth	-	-	-	-	-	-	-	-	-	-
Slope of rock substratum	-	-	-	-	-	-	-	-	-	-
Substratum shape	-	-	-	-	-	-	-	-	-	-
Substratum cleanliness	-	-	-	-	-	-	-	-	-	-
Depth of interstitial spaces	-	-	-	-	-	-	-	-	-	-
Exposure to predominant wind and wave action	-	-	-	-	-	-	-	-	-	-
Proximity to deep water areas	-	-	-	-	-	-	-	-	-	-
	REARING					**FORAGING**				
Physical habitat	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**
HSI Value	1.0	0.75	0.5	0.25	-	1.0	0.75	0.5	0.25	0
Substratum type	large Bo / C	-	sparse Bo / C	sand/silt	-	variable	-	variable	variable	CS / S
Substratum size	>25 cm	-		<0.06 cm	-	-	-	-	-	
Minimum depth	50 cm	-		<50 cm	-	0 m	-	5 m	10 m	>20 m
Maximum depth	>50 cm	-		<50 cm	-	5 m	-	10 m	50 m	>20 m
Slope of rock substratum	-	-	-	-	-	-	-	-	-	-
Substratum shape	angular / round	-	angular only	fines	-	-	-	-	-	-
Substratum cleanliness	clean	-	moderately clean	heavily silted	-	clean	-	moderately clean	heavily silted	heavily silted
Depth of interstitial spaces	-	-	-	-	-	-	-	-	-	-
Exposure to predominant wind and wave action	-	-	-	-	-	-	-	-	-	-
Proximity to deep water areas	directly adjacent	-	-	not adjacent	-	directly adjacent	-	-	-	not adjacent

Notes: HSI = habitat suitability index; cm = centimetres; n/a = not available; Bd = Bedrock, Bo = boulder (>25 cm), C = cobble (>6.5 cm), R = rubble (>6.5 cm, angular), G = gravel (>0.2 cm), S = sand (>0.06 mm) and CS = clay/silt (<0.06 mm).

Table IX.12-5
Habitat Suitability Indices and Descriptions Developed to Describe Fish Habitat for Selected Fish Species in Snap Lake (Continued)

d) Burbot

	SPAWNING					NURSERY				
Physical habitat	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**
HSI Value	1.0	0.75	0.5	0.25	0	1.0	0.75	0.5	0.25	0
Substratum type	Bo/C	-	G/S	-	Bd/CS	Bo/Co	-	G/S	-	Bd/CS
Substratum size	6.5 - 25 cm	-	>0.2 cm	-	-	6.5 - 25 cm	-	>0.2 cm	-	-
Minimum depth	2 m	-	5 m	-	>20 m	2 m	-	5 m	-	>20 m
Maximum depth	10 m	-	20 m	-	>20 m	10 m	-	20 m	-	>20 m
Slope of rock substratum	10 - 20º	-	>5º	-	>0º	10 - 20º	-	>5º	-	>0º
Substratum shape	angular or round	-	angular or round	-		angular or round	-	angular or round	-	
Substratum cleanliness	clean	-	moderately clean	-		clean	-	moderately clean	-	
Depth of interstitial spaces	>1 mm	-	>0.2 m	-	>0.06 m	>1 mm	-	>0.2 m	-	>0.06 m
Exposure to predominant wind and wave action	full exposure	-	partial exposure	-	<180º exposure	full exposure	-	partial exposure	-	<180º exposure
Proximity to deep water areas	directly adjacent	-		-	not adjacent	directly adjacent	-		-	not adjacent
	REARING					**FORAGING**				
Physical habitat	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**
HSI Value	1.0	0.75	0.5	0.25	-	1.0	-	0.5	0.25	0
Substratum type	Bo/C	-	C/G	CS/S	-	variable	-	Bo / C	Bd	-
Substratum size	6.5 - >25 cm	-	>0.2 cm	0.06 - .2 cm	-	-	-	-	-	-
Minimum depth	0.25 m	-	1 m	>6 m	-	0 m	-	10 m	20 m	-
Maximum depth	3 m	-	6 m	>6 m	-	10 m	-	30 m	30 m	-
Slope of rock substratum	0 - 10º	-	0 - 20 m	>20º	-	-	-	-	-	-
Substratum shape	angled or round	-	angled or round	round	-	-	-	-	-	-
Substratum cleanliness	clean	-	moderately clean	silt/algae	-	-	-	-	-	-
Depth of interstitial spaces	>2 mm	-	>1 mm	<1 mm	-	-	-	-	-	-
Exposure to predominant wind and wave action	>180º exposure	-	>180º exposure	full exposure	-	-	-	-	-	-
Proximity to deep water areas	directly adjacent	-	-	not adjacent	-	-	-	-	-	not adjacent

Notes: HSI = habitat suitability index; cm = centimetres; m = metres; Bd = Bedrock, Bo = boulder (>25 cm), C = cobble (>6.5 cm), R = rubble (>6.5 cm, angular), G = gravel (>0.2 cm), S = sand (>0.06 mm) and CS = clay/silt (<0.06 mm).

Table IX.12-5
Habitat Suitability Indices and Descriptions Developed to Describe Fish Habitat for Selected Fish Species in Snap Lake (Continued)

e) Longnose sucker

	SPAWNING (n/a - STREAM SPAWNER)					NURSERY (n/a STREAM SPAWNER)				
Physical habitat	Excellent	Above Average	Average	Below Average	Unsuitable	Excellent	Above Average	Average	Below Average	Unsuitable
HSI Value	1.0	0.75	0.5	0.25	0	1.0	0.75	0.5	0.25	0
Substratum type	-	-	-	-	-	-	-	-	-	-
Substratum size	-	-	-	-	-	-	-	-	-	-
Minimum depth	-	-	-	-	-	-	-	-	-	-
Maximum depth	-	-	-	-	-	-	-	-	-	-
Slope of rock substratum	-	-	-	-	-	-	-	-	-	-
Substratum shape	-	-	-	-	-	-	-	-	-	-
Substratum cleanliness	-	-	-	-	-	-	-	-	-	-
Depth of interstitial spaces	-	-	-	-	-	-	-	-	-	-
Exposure to predominant wind and wave action	-	-	-	-	-	-	-	-	-	-
Proximity to deep water areas	-	-	-	-	-	-	-	-	-	-
	REARING					FORAGING				
Physical habitat	Excellent	Above Average	Average	Below Average	Unsuitable	Excellent	Above Average	Average	Below Average	Unsuitable
HSI Value	1	0.75	0.5	0.25	-	1	0.75	0.5	0.25	0
Substratum type	CS/S/vegetation	G/S	G/C	Bd/Bo	-	CS/S	-	C/Gr	Bo/Bd	
Substratum size	0.06	0.06 - 0.2 cm	0.2 - 6.5 cm	variable	-	0.2 -0.06 cm	-	0.2 - 6.5 cm	>25 cm	
Minimum depth	0.5 m	2.5 m	3 m	5 m	-	1 m	-	10 m	>30 m	
Maximum depth	3 m	5 m	10 m	>10 m	-	10 m	-	30 m	>30 m	
Slope of rock substratum	0 - 10º	0 - 20º	angled or round	angled or round	-	moderate slope	-	-	sheer	
Substratum shape	-	-	-	-	-	-	-	-	-	
Substratum cleanliness	-	-	-	-	-	-	-	-	-	
Depth of interstitial spaces	-	-	-	-	-	-	-	-	-	
Exposure to predominant wind and wave action	<180º exposure	>180º exposure	>180º exposure	full exposure	-	-	-	-	-	
Proximity to deep water areas	not adjacent	-	-	directly adjacent	-	-	-	-	-	not adjacent

Notes: HSI = habitat suitability index; n/a = not available; cm = centimetres; m = metres; Bd = Bedrock, Bo = boulder (>25 cm), C = cobble (>6.5 cm), R = rubble (>6.5 cm, angular), G = gravel (>0.2 cm), S = sand (>0.06 mm) and CS = clay/silt (<0.06 mm)

Table IX.12-5
Habitat Suitability Indices and Descriptions Developed to Describe Fish Habitat for Selected Fish Species in Snap Lake (Continued)

f) Lake chub

	SPAWNING					NURSERY				
Physical habitat	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**
HSI Value	1.0	0.75	0.5	0.25	0	1.0	0.75	0.5	0.25	0
Substratum type	G and C	-	Bo, S, and C/S	-	-	Bo, C, and G	-	S and CS	-	-
Substratum size	0.2 - 6.5 cm	-	0.06 mm - >25 cm	-	-	-	-	-	-	-
Minimum depth	<1 m	-	>2 m	-	-	<1 m	-	>2 m	-	-
Maximum depth	2 m	-	-	-	-	2 m	-	-	V	-
Slope of rock substratum	-	-	-	-	-	-	-	-	-	-
Substratum shape	angular or round	-	-	-	-	angular or round	-	*in-situ* vegetation		-
Substratum cleanliness	-	-	-	-	-	-	-	-	-	-
Depth of interstitial spaces	-	-	-	-	-	-	-	-	-	-
Exposure to predominant wind and wave action	*in-situ* cover present	-	-	-	-	-	-	-	-	-
Proximity to deep water areas	-	-	-	-	-	-	-	-	-	-
	REARING					**FORAGING**				
Physical habitat	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**	**Excellent**	**Above Average**	**Average**	**Below Average**	**Unsuitable**
HSI Value	1.0	0.75	0.5	0.25	0	1.0	0.75	0.5	0.25	0
Substratum type	-	-	-	-	-	-	-	-	-	-
Substratum size	-	-	-	-	-	-	-	-	-	-
Minimum depth	<1 m	-	5	-	-	<1 m	-	5	-	-
Maximum depth	5 m	-	>10 m	-	-	5 m and >10 m	-	10 m	-	-
Slope of rock substratum	-	-	-	-	-	-	-	-	-	-
Substratum shape	-	-	-	-	-	-	-	*in-situ* cover	submergent vegetation	emergent vegetation
Substratum cleanliness	-	-	-	-	-	-	-	-	-	-
Depth of interstitial spaces	-	-	-	-	-	-	-	-	-	-
Exposure to predominant wind and wave action	-	-	-	-	-	-	-	-	-	-
Proximity to deep water areas	-	-	-	-	-	-	-	-	-	-

Notes: mm = millimetres; cm = centimetres; m = metres B HSI = habitat suitability index; Bd = Bedrock, Bo = boulder (>25 cm), C = cobble (>6.5 cm), R = rubble (>6.5 cm, angular), G = gravel (>0.2 cm), S = sand (>0.06 mm) and CS = clay/silt (<0.06 mm).

Table IX.12-5
Habitat Suitability Indices and Descriptions Developed to Describe Fish Habitat for Selected Fish Species in Snap Lake (Continued)

g) Slimy sculpin

	SPAWNING					NURSERY				
Physical habitat	Excellent	Above Average	Average	Below Average	Unsuitable	Excellent	Above Average	Average	Below Average	Unsuitable
HSI Value	1.0	0.75	0.5	0.25	0	1.0	0.75	0.5	0.25	0
Substratum type	Bo, C, and G	-	S	CS	detritus	Bo and C, and hard pan clay		S and CS	detritus	-
Substratum size	0.06 mm - >25 cm	-	0.06 mm	<0.06 mm	-	0.06 mm - >25 cm	-	<0.06 mm - 0.06 mm	-	-
Minimum depth	<1 m	-	2 m	-	5 m	<1 m	-	2 m	-	-
Maximum depth	2 m	-	5 m	-	>10 m	2 m	-	10 m	-	pelagic
Slope of rock substratum	-	-	-	-	-	-	-	-	-	-
Substratum shape	angular or round	-	-	-	-	angular or round	-	-	-	-
Substratum cleanliness	-	-	-	-	-	-	-	-	-	-
Depth of interstitial spaces	-	-	-	-	-	-	-	-	-	-
Exposure to predominant wind and wave action	*in-situ* cover	-	-	-	-	*in-situ* cover	-	-	-	-
Proximity to deep water areas	-	-	-	-	-	-	-	-	-	-
	REARING					FORAGING				
Physical habitat	Excellent	Above Average	Average	Below Average	Unsuitable	Excellent	Above Average	Average	Below Average	Unsuitable
HSI Value	1.0	0.75	0.5	0.25	0	1.0	0.75	0.5	0.25	0
Substratum type	Bo and C	-	R, G, and S	detritus	-	R, G, S and CS	-	Bd, Bo, and C	detritus	-
Substratum size	6.5 - >25 cm	-	0.06 mm - >6.5 cm	-	-	<0.06 mm - >6.5 cm	-	>6.5 cm	-	-
Minimum depth	<1 m	-	2 m	-	-	1	-	-	-	-
Maximum depth	2 m	-	10 m	>10 m	pelagic	>10 m	-	-	<1 m	pelagic
Slope of rock substratum	-	-	-	-	-	-	-	-	-	-
Substratum shape	-	-	-	-	-	angular	-	-	-	-
Substratum cleanliness	-	-	-	-	-	-	-	-	-	-
Depth of interstitial spaces	-	-	-	-	-	-	-	-	-	-
Exposure to predominant wind and wave action	*in-situ* cover	-	-	-	-	*in-situ* cover	-	-	-	-
Proximity to deep water areas	-	-	-	-	-	-	-	-	-	-

Notes: HSI = habitat suitability index; mm = millimetres; cm = centimetres; m = metres Bd = Bedrock, Bo = boulder (>25 cm), C = cobble (>6.5 cm), R = rubble (>6.5 cm, angular), G = gravel (>0.2 cm), S = sand (>0.06 mm) and CS = clay/silt (<0.06 mm).

Table IX.12-6
Habitat Suitability Indices by Habitat Type for Fish Species In Snap Lake

	Habitat #	Spawning	Rearing	Foraging	Nursery		Habitat #	Spawning	Rearing	Foraging	Nursery
Lake Trout	**1**	0.25	0.75	1	0.25	**Arctic Grayling**	**1**	-	0.75	0.5	-
	2	0	0.25	0.25	0		**2**	-	0.25	0.25	-
	3	0	0.5	0.25	0		**3**	-	0.25	0.5	-
	4	0.25	0.75	0.75	0.25		**4**	-	0.5	0.5	-
	5	0	0.25	0.25	0		**5**	-	0.25	0.25	-
	6	0	0.25	0.25	0		**6**	-	0.25	0.5	-
	7	0	0.25	0.25	0		**7**	-	0.25	0.25	-
	8	0	0.5	0.75	0		**8**	-	0.75	0.75	-
	9	0.75	0.25	0.5	0.75		**9**	-	1	1	-
	10	0.5	0.25	0.5	0		**10**	-	0.5	0.5	-
Round Whitefish	**1**	0.25	0.25	0.75	0.25	**Longnose Sucker**	**1**	-	0.5	0.5	-
	2	0	0.25	0.25	0		**2**	-	0.25	0.25	-
	3	0.25	0.25	0.25	0.25		**3**	-	0.25	0.25	-
	4	0.25	0.25	0.25	0.25		**4**	-	0.5	0.5	-
	5	0	0.75	0.25	0		**5**	-	1	1	-
	6	0.25	0.25	0.25	0.25		**6**	-	0.25	0.25	-
	7	0	1	0.25	0		**7**	-	1	1	-
	8	0	1	1	0		**8**	-	1	1	-
	9	0.5	0.25	1	0.5		**9**	-	0.25	0.25	-
	10	0.5	0.25	0.5	0.5		**10**	-	0.25	0.25	-
Burbot	**1**	0.5	0.75	1	0.5	**Slimy Sculpin**	**1**	1	1	0.5	1
	2	0	0.25	0.25	0		**2**	0	0.25	0.5	0
	3	0	0.5	0.5	0		**3**	0.25	0.75	0.5	0.25
	4	0.5	0.5	0.5	0.5		**4**	0.75	1	0.5	0.75
	5	0	0.25	0.25	0		**5**	0	0.25	0.25	0
	6	0	0.5	0.5	0		**6**	0.25	0.75	0.5	0.25
	7	0	0.25	0.25	0		**7**	0	0.25	0.25	0
	8	0.25	1	1	0.25		**8**	1	1	0.75	1
	9	1	0.5	0.5	1		**9**	0.75	1	0.5	0.75
	10	1	1	0.5	1		**10**	0.75	1	0.5	0.75
Lake Chub	**1**	1	1	1	1						
	2	0.25	1	1	0.25						
	3	0.5	1	1	0.5						
	4	0.5	1	1	0.5						
	5	0.25	0.25	0.25	0.25						
	6	0.5	1	1	0.5						
	7	0.25	0.25	0.25	0.25						
	8	0	0.5	0.5	0						
	9	0.5	0.75	0.75	0.5						
	10	0.5	0.75	0.75	0.5						

6.0 DETERMINATION OF HABITAT UNITS

To calculate HUs, each type of habitat was assigned a numerical ranking of suitability for each species based on the HSIs (Table IX.12-6). The area (ha) of each habitat type was multiplied by the appropriate HSI values to obtain HUs. The HUs were then used to predict potential habitat losses and gains for each species caused by the development of instream structures in support of the proposed project.

The steps used to quantify habitat change included:

- determine habitat area and HSI rating;
- calculate HUs by multiplying the habitat area by the HSI rating for the baseline conditions in the local study area for the proposed project;
- quantify the potential habitat losses and gains from the proposed project;
- apply weighting factors to HU calculations, based on exploitation and abundance of each species found in Snap Lake (following the Defensible Methods Approach, Minns [1995] and the approach used in Diavik [1999]). By applying the mean of the exploitation and abundance weighting factors, the calculated HUs are more reflective of the actual habitat usage and the relative importance of each habitat type to fish species in Snap Lake;
- determine mitigation options and calculate habitat gains from each option;
- determine and adopt the mitigative options that meet the objectives set out in the Fisheries and Oceans Canada (DFO) *Policy for the Management of Fish Habitat* (DFO 1986). The policy's primary objective is a net gain on the productive capacity of fish habitat in Canada. The guiding principle that is applied to achieve this goal is of **no net loss**. Under this principle all fish habitat in Canada is protected while alteration of existing habitats are balanced by the development of new habitat. The legislative authority provided by the *Fisheries Act* is used to achieve **no net loss**; and,
- classify the potential effects.

The following tables (Tables IX.12-7a to f) summarize the calculation used to determine the HUs available in Snap Lake.

Table IX.12-7
Habitat Suitability and Habitat Units Calculated for Selected Fish Species in Snap Lake

a) **Lake trout**

Habitat #	Habitat Area (ha)	Spawning	HU	Rearing	HU	Foraging	HU	Nursery	HU	TOTAL HUs
1	290.48	0.25	72.62	0.75	217.86	1.00	290.48	0.25	72.62	653.58
2	28.96	0	0	0.25	7.24	0.25	7.24	0	0	14.48
3	27.20	0	0	0.50	13.60	0.25	6.80	0	0	20.40
4	23.85	0.25	5.96	0.75	17.89	0.75	17.89	0.25	5.96	47.70
5	4.24	0	0	0.25	1.06	0.25	1.06	0	0	2.12
6	1.25	0	0	0.25	0.31	0.25	0.31	0	0	0.63
7	1.21	0	0	0.25	0.30	0.25	0.30	0	0	0.61
8	276.36	0	0.0	0.50	138.2	0.75	207.3	0	0.0	345.5
9	16.82	0.75	12.6	0.25	4.2	0.50	8.4	0.75	12.6	37.8
10	16.34	0.50	8.2	0.25	4.1	0.50	8.2	0	0.0	20.4
Total	686.71		99.37		404.73		547.93		91.2	1143.23

Note: ha = hectares; HU = habitat unit.

b) **Arctic grayling**

Habitat #	Habitat Area (ha)	Spawning	HU	Rearing	HU	Foraging	HU	Nursery	HU	TOTAL HUs
1	290.48	0	0	0.75	217.86	0.50	145.24	0	0	363.10
2	28.96	0	0	0.25	7.24	0.25	7.24	0	0	14.48
3	27.20	0	0	0.25	6.80	0.50	13.60	0	0	20.40
4	23.85	0	0	0.50	11.93	0.50	11.93	0	0	23.85
5	4.24	0	0	0.25	1.06	0.25	1.06	0	0	2.12
6	1.25	0	0	0.25	0.31	0.50	0.63	0	0	0.94
7	1.21	0	0	0.25	0.30	0.25	0.30	0	0	0.61
8	276.36	0	0	0.75	207.3	0.75	207.3	0	0	414.5
9	16.82	0	0	1.00	16.8	1.00	16.8	0	0	33.6
10	16.34	0	0	0.50	8.2	0.50	8.2	0	0	16.3
Total	686.71		0		477.76		412.25		0	890.01

Note: ha = hectares; HU = habitat unit.

Table IX.12-7
Habitat Suitability and Habitat Units Calculated for Selected Fish Species in Snap Lake (Continued)

c) **Round whitefish**

Habitat #	Habitat Area (ha)	Spawning	HU	Rearing	HU	Foraging	HU	Nursery	HU	TOTAL HUs
1	290.48	0.25	72.62	0.25	72.62	0.75	217.86	0.25	72.62	435.72
2	28.96	0	0	0.25	7.24	0.25	7.24	0	0	14.48
3	27.20	0.25	6.80	0.25	6.80	0.25	6.80	0.25	6.80	27.20
4	23.85	0.25	5.96	0.25	5.96	0.25	5.96	0.25	5.96	23.85
5	4.24	0	0	0.75	3.18	0.25	1.06	0.00	0.00	4.24
6	1.25	0.25	0.31	0.25	0.31	0.25	0.31	0.25	0.31	1.25
7	1.21	0	0.00	1.00	1.21	0.25	0.30	0.00	0.00	1.51
8	276.36	0	0	1.00	276.4	1.00	276.4	0.00	0	552.7
9	16.82	0.50	8.4	0.25	4.2	1.00	16.8	0.50	8.4	37.8
10	16.34	0.50	8.2	0.25	4.1	0.50	8.2	0.50	8.2	28.6
Total	686.71		102.28		381.98		540.89		102.28	508.25

Note: ha = hectares; HU = habitat unit.

d) **Longnose sucker**

Habitat #	Habitat Area (ha)	Spawning	HU	Rearing	HU	Foraging	HU	Nursery	HU	TOTAL HUs
1	290.48	0	0	0.50	145.24	0.50	145.24	0	0	290.48
2	28.96	0	0	0.25	7.24	0.25	7.24	0	0	14.48
3	27.20	0	0	0.25	6.80	0.25	6.80	0	0	13.60
4	23.85	0	0	0.50	11.93	0.50	11.93	0	0	23.85
5	4.24	0	0	1.00	4.24	1.00	4.24	0	0	8.48
6	1.25	0	0	0.25	0.31	0.25	0.31	0	0	0.63
7	1.21	0	0	1.00	1.21	1.00	1.21	0	0	2.42
8	276.36	0	0	1.00	276.4	1.00	276.4	0	0	552.7
9	16.82	0	0	0.25	4.2	0.25	4.2	0	0	8.4
10	16.34	0	0	0.25	4.1	0.25	4.1	0	0	8.2
Total	686.71		0.00		461.6		461.62		0.00	923.24

Note: ha = hectares; HU = habitat unit.

Table IX.12-7
Habitat Suitability and Habitat Units Calculated for Selected Fish Species in Snap Lake (Continued)

e) **Burbot**

Habitat #	Habitat Area (ha)	Spawning	HU	Rearing	HU	Foraging	HU	Nursery	HU	TOTAL HUs
1	290.48	0.50	145.24	0.75	217.86	1.00	290.48	0.50	145.24	798.82
2	28.96	0	0	0.25	7.24	0.25	7.24	0	0	14.48
3	27.20	0	0	0.50	13.60	0.50	13.60	0	0	27.20
4	23.85	0.50	11.93	0.50	11.93	0.50	11.93	0.50	11.93	47.70
5	4.24	0	0	0.25	1.06	0.25	1.06	0	0	2.12
6	1.25	0	0	0.50	0.63	0.50	0.63	0	0	1.25
7	1.21	0	0	0.25	0.30	0.25	0.30	0	0	0.61
8	276.36	0.25	69.1	1.00	276.4	1.00	276.4	0.25	69.1	690.9
9	16.82	1.00	16.8	0.50	8.4	0.50	8.4	1.00	16.8	50.5
10	16.34	1.00	16.3	1.00	16.3	0.50	8.2	1.00	16.3	57.2
Total	686.71		259.42		553.7		618.17		259.42	1690.7

Note: ha = hectares; HU = habitat unit.

f) **Slimy sculpin**

Habitat #	Habitat Area (ha)	Spawning	HU	Rearing	HU	Foraging	HU	Nursery	HU	TOTAL HUs
1	290.48	1.00	290.48	1.00	290.48	0.50	145.24	1.00	290.48	1016.68
2	28.96	0	0	0.25	7.24	0.50	14.48	0	0.00	21.72
3	27.20	0.25	6.80	0.75	20.40	0.50	13.60	0.25	6.80	47.60
4	23.85	0.75	17.89	1.00	23.85	0.50	11.93	0.75	17.89	71.55
5	4.24	0	0	0.25	1.06	0.25	1.06	0.00	0.00	2.12
6	1.25	0.25	0.31	0.75	0.94	0.50	0.63	0.25	0.31	2.19
7	1.21	0	0	0.25	0.30	0.25	0.30	0.00	0	0.61
8	276.36	1.00	276.4	1.00	276.4	0.75	207.3	1.00	276.4	1036.4
9	16.82	0.75	12.6	1.00	16.8	0.50	8.4	0.75	12.6	50.5
10	16.34	0.75	12.3	1.00	16.3	0.50	8.2	0.75	12.3	49.0
Total	686.71		616.7		653.79		411.1		616.7	2298.3

Note: ha = hectares; HU = habitat unit.

Table IX.12-7
Habitat Suitability and Habitat Units Calculated for Selected Fish Species in Snap Lake (Continued)

f) **Lake chub**

Habitat #	Habitat Area (ha)	Spawning	HU	Rearing	HU	Foraging	HU	Nursery	HU	TOTAL HUs
1	290.48	1.00	290.48	1.00	290.48	1.00	290.48	1.00	290.48	1161.92
2	28.96	0.25	7.24	1.00	28.96	1.00	28.96	0.25	7.24	72.40
3	27.20	0.50	13.60	1.00	27.20	1.00	27.20	0.50	13.60	81.60
4	23.85	0.50	11.93	1.00	23.85	1.00	23.85	0.50	11.93	71.55
5	4.24	0.25	1.06	0.25	1.06	0.25	1.06	0.25	1.06	4.24
6	1.25	0.50	0.63	1.00	1.25	1.00	1.25	0.50	0.63	3.75
7	1.21	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30	1.21
8	276.36	0	0	0.50	138.2	0.50	138.2	0	0	276.4
9	16.82	0.50	8.4	0.75	12.6	0.75	12.6	0.50	8.4	42.1
10	16.34	0.50	8.2	0.75	12.3	0.75	12.3	0.50	8.2	40.9
Total	686.71		341.8		536.2		536.2		341.8	1755.9

Note: ha = hectares; HU = habitat unit.

Following the same methodology, the HUs for the northwest peninsula (*i.e.,* ha available immediately adjacent to the project footprint only) were calculated and compared to Snap Lake as a whole. Table IX.12-8 summarizes HUs calculated along the northwest peninsula for each fish species found in Snap Lake. The HUs for the northwest peninsula are presented only as a comparison of HU abundance in proximity to the project footprint (northwest peninsula).

Table IX.12-8
Summary of Habitat Units available for Fish Species along the Northwest Peninsula (nearshore habitat only)

Species	Total Northwest Peninsula Habitat Area (ha)[1]	Spawning HUs	Rearing HUs	Foraging HUs	Nursery HUs	TOTAL Northwest Peninsula HUs
LKTR	58.69	13.64	42.9	55.05	13.64	125.2
ARGR		-	41.41	29.26	-	70.67
RNWH		14.59	14.84	40.87	14.59	84.89
LNSC		-	28.57	28.57	-	57.14
BURB		27.28	42.36	55.46	27.28	152.4
SLSC		54.97	57.49	29.26	54.97	196.7
LKCH		55.46	58.44	58.44	55.46	227.8

Notes: ha = hectares; LKTR = lake trout; ARGR = Arctic grayling; RNWH = round whitefish; LNSC = longnose sucker; BURB = burbot; SLSC = slimy sculpin; LKCH = lake chub; HUs = habitat units.
[1] Habitat areas found along the northwest peninsula in the nearshore habitat type include Bo/Co (52.40 ha), Bd/Bo (3.79 ha), Bo (2.16 ha) and IV/Bo (0.34 ha).

7.0 SUMMARY OF HABITAT LOST

Using the project description and GIS, the areas affected by the construction of the water intake and the mine water outlet were defined, and the habitat that would be affected was identified. The water intake structure will consist of a rock-filled embankment constructed out from shore to access water at a depth of 7 m. The pad will cover 0.0042 ha (42 square meters [m^2]) of lake bottom on the north side of the northwest peninsula affecting boulder cobble and 0.0787 ha (787 m^2) of deep-water habitat. The mine water outlet structure includes three main components. The construction of a rock filled embankment is proposed at the shoreline to ensure the pipeline is protected from ice and wind and wave action. There will also be an insulated pipeline, anchored to the lake bottom, extending approximately 125 m out from shore to a depth of 12 m. At the end of the pipeline, there will be 70-m long diffuser structure with seven evenly spaced outlet ports. Combined, this structure will affect approximately 760 m^2 (0.0760 ha) of lake bottom and alter 160 m^2 (0.016 ha) of deep water habitat (Table IX.12-9).

Table IX.12-9
Habitat Lost as a Result of Construction of the Water Intake and the Mine Water Outlet Structure in Snap Lake

	Water Intake		Mine Water Outlet	
Habitat #	**Habitat Area (ha)**	**% of Habitat Type in Snap Lake**	**Habitat Area (ha)**	**% of Habitat Type in Snap Lake**
Nearshore Habitat (waters edge to 4 m contour)				
1	0.0042	0.0014	0.0760	0.0262
Deep Water (>4 m in depth)				
8	0.0787	0.0285	0.0160	0.0058
Total	0.0829	0.0121	0.0920	0.0134

Note: ha = hectares; m = metres.

Table IX.12-10 provides a comparison of habitat affected by the instream structures in relation to the similar habitat available along the northwest peninsula and Snap Lake.

Table IX.12-10
Summary of Habitat Areas Lost to the Water Intake and Mine Water Outlet Structure in Relation to Snap Lake and the Northwest Peninsula

Habitat Type[1]	Habitat #	Habitat Area (ha) Water Intake (% of available)	Habitat Area (ha) Mine Water Outlet (% of available)	Total Habitat Type Lost (% of available)	Total Habitat Area (ha) Snap Lake	Habitat Area (ha) Northwest Peninsula (% of available)
Nearshore Habitat (waters edge to 4 m contour)						
(Bo/Co)	1	0.0042 (0.0014)	0.0760 (0.0262)	0.0802 (0.0276)	290.48	52.40 (18.03)
Deep Water (>4 m in depth)						
Deep Water	8	0.0787 (0.0285)	0.0160 (0.0058)	0.0947 (0.0343)	276.36	-[2]

Note: [1] Bd, Bd/Bo, Bo, IV/Bo, Bd/Co, IV, primary and secondary shoal habitat are not affected by the construction of the instream structures; ha = hectares; % = percent; m = metres.
[2] not applicable.

Using the method for calculating HUs described above (*i.e.*, multiplication of area and HSI values), the number of HUs associated with the two structures were calculated. The results of the HU calculations for each structure and each species observed in Snap Lake are summarized in Tables IX.12-11 and IX.12-12.

Table IX.12-11
Summary of Habitat Units Lost for the Observed Fish Species as a Result of the Water Intake Structure

Species	Total Water Intake Structure Area (ha)[1]	Spawning HUs	Rearing HUs	Foraging HUs	Nursery HUs	Total HUs
LKTR	0.083	0.001	0.043	0.063	0.001	0.108
ARGR		0	0.062	0.061	0	0.123
RNWH		0.001	0.08	0.082	0.001	0.164
LNSC		0	0.081	0.081	0	0.162
BURB		0.022	0.082	0.083	0.022	0.208
SLSC		0.083	0.083	0.061	0.083	0.310
LKCH		0.004	0.044	0.044	0.004	0.096

Notes: ha = hectares; LKTR = lake trout; ARGR = Arctic grayling; RNWH = round whitefish; LNSC = longnose sucker; BURB = burbot; SLSC = slimy sculpin; LKCH = lake chub; HUs = habitat units.
[1]HUs for water intake structure calculated for Bo/Co (0.0042 ha) and deep water (0.0787 ha).

Table IX.12-12
Summary of Habitat Units Lost for Observed Fish Species as a Result of the Mine Water Outlet

Species	Total Mine Water Outlet Area (ha)[1]	Spawning HUs	Rearing HUs	Foraging HUs	Nursery HUs	Total HUs
LKTR	0.092	0.019	0.065	0.088	0.019	0.191
ARGR		0	0.069	0.050	0	0.119
RNWH		0.019	0.035	0.073	0.019	0.146
LNSC		0	0.054	0.054	0	0.108
BURB		0.042	0.073	0.092	0.042	0.249
SLSC		0.092	0.092	0.050	0.092	0.326
LKCH		0.076	0.084	0.084	0.08	0.324

Notes: ha = hectares; LKTR = lake trout; ARGR = Arctic grayling; RNWH = round whitefish; LNSC = longnose sucker; BURB = burbot; SLSC = slimy sculpin; LKCH = lake chub; HUs = habitat units.
[1]HUs for mine water outlet structure calculated for Bo/Co (0.0760 ha) and deep water (0.0160 ha).

8.0 HABITAT GAINED/CREATED THROUGH MITIGATION AND RECLAMATION

Using the project description and GIS, the areas of various habitat types created by the construction of the water intake and the mine water outlet structure were calculated based on the size and materials used in the construction. The outer surface of the water intake structure will be constructed of rock that will simulate boulder-cobble habitat and will result in the creation of 0.0392 ha of new habitat up to the 4-m contour. The water intake structure will extend below 4 m, the extent of nearshore habitat. The structure will create boulder-cobble habitat from 4- to 7-m contours. The habitat at the 4 to 7 m depth range is a new habitat type (Type 11) that will be 0.0705 ha in size. The reason for the new habitat classification is based on the creation of clean rock (boulder/cobble) substrates between a depth of 4 and 7 m with different habitat suitability for various species (Table IX.12-13). The outlet structure will be constructed out of rock that will simulate boulder-cobble habitat and result in the creation of 0.0471 ha of habitat. Incorporation of boulder-cobble material into the construction design of these structures (mitigation) will create 0.1568 ha of habitat.

After the new habitat areas were defined, the number of HUs created were calculated. Table IX.12-14 summarizes the HUs available based on the total habitat created by both structures.

Table IX.12-13
Habitat Suitability Indices and Habitat Units Calculated for Newly Created Habitat Type 11

Habitat # 11 (Area 0.0705 ha)									
Species	**HSI**	**HU**	**HSI**	**HU**	**HSI**	**HU**	**HSI**	**HU**	**TOTAL**
	Spawning	**Spawning**	**Rearing**	**Rearing**	**Foraging**	**Foraging**	**Nursery**	**Nursery**	**HUs**
LKTR	0.25	0.0176	0.50	0.0353	1.00	0.0705	0.25	0.0176	0.141
ARGR	-	-	0.50	0.0353	0.50	0.0353	-	-	0.071
RNWH	0.25	0.0176	0.25	0.0176	0.50	0.0353	0.25	0.0176	0.088
LNSC	-	-	0.50	0.0353	0.50	0.0353	-	-	0.071
BURB	0.25	0.0176	0.25	0.0176	0.50	0.0353	0.25	0.0176	0.088
SLSC	0.00	0.0000	0.25	0.0176	0.50	0.0353	0.00	0.0000	0.053
LKCH	0.50	0.0353	0.50	0.0353	1.00	0.0705	0.50	0.0353	0.176

Note: HSI = habitat suitability index; HU = habitat unit.

Table IX.12-14
Habitat Units calculated for Habitat Created by Water Intake and Mine Water Outlet Structure for Observed Fish Species

Species #	Habitat Area Created through mitigation (ha)[1, 2 3]	Spawning HUs	Rearing HUs	Foraging HUs	Nursery HUs	Total HUs
LKTR	0.1568	0.039	0.100	0.157	0.039	0.335
ARGR		0.000	0.100	0.078	0.000	0.178
RNWH		0.039	0.039	0.100	0.039	0.218
LNSC		0.000	0.078	0.078	0.000	0.157
BURB		0.061	0.082	0.122	0.061	0.326
SLSC		0.086	0.104	0.078	0.086	0.355
LKCH		0.122	0.122	0.157	0.122	0.522

Notes: ha = hectares; LKTR = lake trout; ARGR = Arctic grayling; RNWH = round whitefish; LNSC = longnose sucker; BURB = burbot; SLSC = slimy sculpin; LKCH = lake chub; HUs = habitat units.
[1]HUs for habitat created were calculated for Habitat Types 1 and 11.
[2] Habitat # 1 includes 0.0392 ha Bo/Co along edges of the water intake structure to 4-m deep and 0.0471 ha - Bo/Co along edges of the outlet (rock protection cover) to 4 m deep (cover stops at 4-m deep).
[3] Habitat #11 - new habitat type of BO/CO to >4 m at the water intake site. Habitat #11(0.0705 ha) - Bo/Co along edges of the water intake structure for area >4 m deep.

In addition to creation of new habitat, some habitat, which will be altered as a result of installation the mine water outlet pipeline and diffuser will be reclaimed at closure. These two components of the outlet structure will only be utilized during the construction/operations phase and will be removed from the lake at closure. Because these structures will only be anchored to the lake bottom instead of permanently entrenched, very little disturbance to habitat is anticipated either during installation or removal. Table IX.12-15 summarizes the habitat reclaimed by this activity.

Table IX.12-15
Habitat Units Calculated for Habitat Reclaimed by Removal of Mine Water Outlet Components for Selected Fish Species

Species #	Habitat Area Reclaimed (ha)[1]	Spawning HUs	Rearing HUs	Foraging HUs	Nursery HUs	Total HUs
LKTR	0.0160	0	0.008	0.012	0	0.020
ARGR		0	0.012	0.012	0	0.024
RNWH		0	0.016	0.016	0	0.032
LNSC		0	0.016	0.016	0	0.032
BURB		0.004	0.016	0.016	0.004	0.040
SLSC		0.016	0.016	0.012	0.016	0.060
LKCH		0	0.008	0.008	0	0.016

Notes: ha = hectares; LKTR = lake trout; ARGR = Arctic grayling; RNWH = round whitefish; LNSC = longnose sucker; BURB = burbot; SLSC = slimy sculpin; LKCH = lake chub; HUs = habitat units.
[1]HUs for mine water outlet pipeline and diffuser removal in deep-water habitat (0.0160 ha).

9.0 FISH SPECIES WEIGHTINGS

DFO's Defensible Methods Approach was applied to Snap Lake to assist in calculating the net change of productivity of fish habitats (Minns 1995). This method was also applied in the fish habitat evaluation of the Diavik Diamonds Project Environmental Assessment (Diavik 1999).

The protocol that was followed in the development of species weightings for Snap Lake included consideration of the relative importance of the fauna in terms of fish exploitation activities in the NWT. As a group, domestic/commercial species were given a weighting of exploitation importance of 0.4, sport species were given a weighting of 0.4, and forage species were given a weighting of 0.2. Three domestic/commercial species are present in Snap Lake, which results in an individual weighting of 0.13 for each such species. Two species are considered to be sport species, which results in a weighting of 0.2 for each of these species. The three forage species in Snap Lake were each given a weighting of 0.07. The weights that were assigned on the basis of exploitation importance are shown in Table IX.12-16.

Because weightings on the basis of exploitation alone do not account for ecological relationships, weightings were also developed to reflect the relative abundance of fish species in Snap Lake. The catch-per-unit-effort results from sampling in 1999 were normalized and were used to incorporate abundance information in the weighting scheme. This resulted in the species abundance weightings presented in Table IX.12-16.

The final weightings for the fish of Snap Lake were calculated as the mean of the exploitation and abundance weightings. The final weightings for fish in Snap Lake are presented in Table IX.12-16.

Table IX.12-16
Exploitation and Abundance Weightings for Selected Fish Species in Snap Lake

Species	Exploitation Weighting	Abundance Weighting	Final Weighting
LKTR	0.33	0.31	0.32
ARGR	0.2	0.03	0.11
RNWH	0.13	0.12	0.12
LNSC	0.07	0.05	0.06
BURB	0.13	0.00	0.07
SLSC	0.07	0.00	0.04
LKCH	0.07	0.50	0.28

Notes: LKTR = lake trout; ARGR = Arctic grayling; RNWH = round whitefish; LNSC = longnose sucker; BURB = burbot; SLSC = slimy sculpin; LKCH = lake chub.

10.0 NET CHANGE IN FISH HABITAT

10.1 Construction and Operation

Table IX.12-17 summarizes habitat calculations with the weightings applied for each life stage. Calculations were made using baseline (pre-construction/operations Table IX.12-7) and construction/operation period HUs. Construction/operation period HUs were calculated by adding the number of HUs lost due to the construction of the water intake and the mine water outlet (Tables IX.12-11 and IX.12-12) and subtracting the number of HUs created after mitigation only for both structures (Tables IX.12-14). This net change in HUs represents the HUs either lost or gained during operations for the project.

Table IX.12-17
Net change in Habitat Units Between Baseline and Construction/Operations Time Periods With Weightings Applied to Observed Fish Species

Life Stage	Species	Weight	Pre (2003) - before weighting	Habitat Units (HUs) Pre (2003) - after weighting	Construction and Operation (Yr.2005 - 2028) - before weighting	Construction and Operation (Yr. 2005 - 2028) - after weighting	Net Change (HUs) (weighted)
Spawning	LKTR	0.32	99.3675	31.5939	99.3867	31.6000	0.0061
	ARGR	0.11	0.0000	0.0000	0.0000	0.0000	0.0000
	RNWH	0.12	102.2750	12.6974	102.2942	12.6998	0.0024
	LNSC	0.06	0.0000	0.0000	0.0000	0.0000	0.0000
	BURB	0.07	259.4150	17.1992	259.4120	17.1990	-0.0002
	SLSC	0.04	616.7100	22.3866	616.6214	22.3834	-0.0032
	LKCH	0.28	341.8125	96.7500	341.8539	96.7617	0.0117
Rearing	LKTR	0.32	404.7325	128.6847	404.7250	128.6823	-0.0024
	ARGR	0.11	477.7600	53.9152	477.7288	53.9117	-0.0035
	RNWH	0.12	381.9750	47.4222	381.8995	47.4128	-0.0094
	LNSC	0.06	461.6175	27.4201	461.5611	27.4167	-0.0034
	BURB	0.07	553.7225	36.7118	553.6500	36.7070	-0.0048
	SLSC	0.04	653.7900	23.7326	653.7190	23.7300	-0.0026
	LKCH	0.28	536.1525	151.7580	536.1465	151.7563	-0.0017
Foraging	LKTR	0.32	547.9325	174.2151	547.9381	174.2169	0.0018
	ARGR	0.11	412.2525	46.5227	412.2198	46.5190	-0.0037
	RNWH	0.12	540.8875	67.1512	540.8326	67.1444	-0.0068
	LNSC	0.06	461.6175	27.4201	461.5611	27.4167	-0.0034
	BURB	0.07	618.1725	40.9848	618.1192	40.9813	-0.0035
	SLSC	0.04	411.0825	14.9223	411.0498	14.9211	-0.0012
	LKCH	0.28	536.1525	151.7580	536.1818	151.7662	0.0083
Nursery	LKTR	0.32	91.1975	28.9962	91.2167	29.0023	0.0061
	ARGR	0.11	0.0000	0.0000	0.0000	0.0000	0.0000
	RNWH	0.12	102.2750	12.6974	102.2942	12.6998	0.0024
	LNSC	0.06	0.0000	0.0000	0.0000	0.0000	0.0000
	BURB	0.07	259.4150	17.1992	259.4758	17.2032	0.0040
	SLSC	0.04	616.7100	22.3866	616.6214	22.3834	-0.0032
	LKCH	0.28	341.8125	96.7500	341.8539	96.7617	0.0117
Total				**1351.2754**		**1351.2769**	**0.0015**

Notes: LKTR = lake trout; ARGR = Arctic grayling; RNWH = round whitefish; LNSC = longnose sucker; BURB = burbot; SLSC = slimy sculpin; LKCH = lake chub; HUs = habitat units.

10.2 Post-closure

Table IX.12-18 summarizes habitat calculations with the weightings applied for each life stage. Calculations were made using baseline (pre-construction/operations Table IX.12-7) and post-closure HUs. Post-closure HUs were calculated by adding the number of HUs lost due to the construction of the water intake and the mine water outlet (Tables IX.12-11 and IX.12-12) and subtracting the number of HUs created after mitigation and reclamation for both structures (Tables IX.12-14 and IX.12-15). This net change in HUs takes into account HUs gained through mitigation and closure (*i.e.*, removal of the pipeline and diffuser) and represents the HUs either lost or gained at the completion of the project.

Table IX.12-18
Net Change in Habitat Units between Baseline and Post Closure Periods with Weightings Applied for Observed Fish Species

			Habitat Units (HUs)				
Life Stage	**Species**	**Weight**	**Pre (2003) - before weighting**	**Pre (2003) - after weighting**	**Post-closure (Post- Yr.2028) - before weighting**	**[2]Post-closure (Post Yr.2028) - after weighting**	**Net Change (HUs) (weighted)**
Spawning	LKTR	0.318	99.3675	31.5939	99.3867	31.6000	0.0061
	ARGR	0.1129	0.0000	0.0000	0.0000	0.0000	0.0000
	RNWH	0.1242	102.2750	12.6974	102.2942	12.6998	0.0024
	LNSC	0.0594	0.0000	0.0000	0.0000	0.0000	0.0000
	BURB	0.0663	259.4150	17.1992	259.4160	17.1993	0.0001
	SLSC	0.0363	616.7100	22.3866	616.6374	22.3839	-0.0026
	LKCH	0.2831	341.8125	96.7500	341.8539	96.7617	0.0117
Rearing	LKTR	0.318	404.7325	128.6847	404.7330	128.6848	0.0002
	ARGR	0.1129	477.7600	53.9152	477.7408	53.9130	-0.0022
	RNWH	0.1242	381.9750	47.4222	381.9155	47.4148	-0.0074
	LNSC	0.0594	461.6175	27.4201	461.5771	27.4177	-0.0024
	BURB	0.0663	553.7225	36.7118	553.6660	36.7081	-0.0037
	SLSC	0.0363	653.7900	23.7326	653.7350	23.7306	-0.0020
	LKCH	0.2831	536.1525	151.7580	536.1545	151.7585	0.0006
Foraging	LKTR	0.318	547.9325	174.2151	547.9501	174.2207	0.0056
	ARGR	0.1129	412.2525	46.5227	412.2318	46.5204	-0.0023
	RNWH	0.1242	540.8875	67.1512	540.8486	67.1464	-0.0048
	LNSC	0.0594	461.6175	27.4201	461.5771	27.4177	-0.0024
	BURB	0.0663	618.1725	40.9848	618.1352	40.9824	-0.0025
	SLSC	0.0363	411.0825	14.9223	411.0618	14.9215	-0.0008
	LKCH	0.2831	536.1525	151.7580	536.1898	151.7685	0.0105
Nursery	LKTR	0.318	91.1975	28.9962	91.2167	29.0023	0.0061
	ARGR	0.1129	0.0000	0.0000	0.0000	0.0000	0.0000
	RNWH	0.1242	102.2750	12.6974	102.2942	12.6998	0.0024
	LNSC	0.0594	0.0000	0.0000	0.0000	0.0000	0.0000
	BURB	0.0663	259.4150	17.1992	259.4798	17.2035	0.0043
	SLSC	0.0363	616.7100	22.3866	616.6374	22.3839	-0.0026
	LKCH	0.2831	341.8125	96.7500	341.8539	96.7617	0.0117
Total				**1351.2754**		**1351.3012**	**0.0258**

Notes: LKTR = lake trout; ARGR = Arctic grayling; RNWH = round whitefish; LNSC = longnose sucker; BURB = burbot; SLSC = slimy sculpin; LKCH = lake chub; HUs = habitat units.

After the net changes in HUs for each species and lifestage were calculated, the total HUs lost or gained over all phases of the project were tabulated (Table IX.12-19). The results indicated that there would be a net gain of 0.0015 HUs after construction and operations

and a 0.0258 ha gain of habitat after final reclamation. This gain may be further augmented at closure if portions of the water intake rock pad are removed in conjunction with the mine water outlet (*i.e.,* the removal of portions of the water intake pad and resultant re-contouring of the new shoreline may create more habitat area).

Table IX.12-19
Total Habitat Units Lost or Created during Construction/Operations and Post-Closure Periods in Snap Lake for each Fish Species

Species	Total HUs lost or gained, Construction/Operations	Total HUs lost or gained, Post Closure
LKTR	0.0116	0.0179
ARGR	-0.0072	-0.0045
RNWH	-0.0114	-0.0075
LNSC	-0.0067	-0.0048
BURB	-0.0045	-0.0019
SLSC	-0.0102	-0.008
LKCH	0.0300	0.0345
Total	0.0015	0.0258

Notes: LKTR = lake trout; ARGR = Arctic grayling; RNWH = round whitefish; LNSC = longnose sucker; BURB = burbot; SLSC = slimy sculpin; LKCH = lake chub; HUs = habitat units.

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12.0 UNITS AND ACRONYMS

UNITS

cm	centimetre
ha	hectare
m	metre
mm	millimetre
m^2	square meters
yr.	year

ACRONYMS

Bd	bedrock
Bo	boulder
Co	cobble
CS	clay/silt
DFO	Fisheries and Oceans Canada
EA	environmental assessment
G	gravel
GIS	geographic information systems
Golder Associates	Golder Associates Ltd.
HEP	habitat evaluation procedure
HSI	habitat suitability index
HU	habitat unit
IV	inundated vegetation
N/A	not available
NWT	Northwest Territories

R	rubble
S	sand
YOY	young-of-the-year