January 2018

HAMMOND REEF GOLD PROJECT

Aquatic Environment Technical Support Document

VERSION 3

Submitted to:
Canadian Malartic Corporation
2140 St Mathieu St.
Montreal, QC H3H 2J4

Project Number: 1656263

Distribution:
Sandra Pouliot, Environmental Project Leader

Note: This Version 3 Technical Supporting Document is identical to the Version 2 Technical Supporting Document as provided herein.

December 2013

HAMMOND REEF GOLD PROJECT
Aquatic Environment Technical Support Document

VERSION 2

Submitted to:
Osisko Hammond Reef Gold Ltd.
155 University Avenue, Suite 1440
Toronto, Ontario M5H 3B7

Project Number: 13-1118-0010
Document Number: DOC013
Distribution:

Alexandra Drapack, Director Sustainable Development
Cathryn Moffett, Project Manager Sustainable Development

Golder Associates

TABLE OF CONTENTS

Part A: Introduction

Part B: Supplemental Information Package

Part C: Aquatic Environment Technical Support Document, Version 1

Page left intentionally blank

AQUATIC ENVIRONMENT TECHNICAL SUPPORT DOCUMENT
VERSION 2

PART A

Introduction

AQUATIC ENVIRONMENT TECHNICAL SUPPORT DOCUMENT VERSION 2 PART A: INTRODUCTION

Version 1 of the Aquatic Environment Technical Support Document (TSD) was published on February 15, 2013 as part of Osisko Hammond Reef Gold's (OHRG) Draft Environmental Impact Statement/Environmental Assessment (EIS/EA) Report.

The Draft EIS/EA Report underwent a seven week public review comment period after which, on April 5, 2013 OHRG received comments from the public, Aboriginal groups and the Government Review Team (GRT) seeking clarification and requesting new information.

Approximately 40 comments regarding the Aquatic Environment TSD and the Aquatic component of the EIS/EA Report were received from the GRT. Written responses have been prepared for each comment and are provided in Appendix 1.IV of the EIS/EA Report.

The Aquatic Environment was a key concern identified by the public and Aboriginal communities. As outlined in Chapter 7 of the EIS/EA Report, two non-governmental organizations as well as the Seine River First Nation (SFRN) submitted comments on the Draft EIS/EA Report regarding fish and fish health. These comments were largely focused on the adequacy of fish tissue sampling undertaken during baseline studies. Notwithstanding the fact that OHRG believes that the fish tissue sampling undertaken for the EA was sufficient for EA purposes, as a result of these comments OHRG has committed to providing capacity support to SRFN to collect additional fish tissue and benthic samples in the Spring of 2014 in conjunction with an environmental study being undertaken with their community.

Version 1 of the Aquatic Environment TSD has not been revised (with the exception of Appendix 2.III described below). The methods used to define baseline aquatic conditions and predict potential changes to the aquatic environment are technically defensible and based on standard industry practices. The conclusions and results presented in the Aquatic Environment TSD are sound and have remained the same after consideration of comments received.

The EIS/EA Report has been revised and updated based on comments received. In addition, new work has been carried out to update the estimated pit flooding duration and to revise and update the Fish Habitat No-Net Loss / Habitat Offset Plan for the Project (Appendix 2.III of the Aquatic Environment TSD). Version 2 of the Aquatic Environment TSD is comprised of the following:

- Part A: Introduction
- Part B: Supplemental Information Package (attached) that provides additional detail on new work undertaken related to the Aquatic Environment component and the information presented in the Aquatic Environment TSD.
- Part C: Version 1 of the Aquatic Environment TSD. Part C was issued in February 2013, and is available online on OHRG's website; it has not been re-printed as part of this Version 2 of the Aquatic Environment TSD. The Version 1 document should be reviewed within the context of this Version 2 document, and associated updated information as presented in Part A or Part B should be considered as correct should it differ from the information presented in Version 1.

A summary of the information found in Part B is provided below. Throughout the EIS/EA Report, unless otherwise noted, all references made to the Aquatic Environment TSD are to Part C.

Revised Pit Flooding Duration

The pit flooding model was updated to better reflect planned water management activities at closure. The previous estimated flooding duration of 78 years was based on the assumption that runoff from the Waste Rock Management Facility (WRMF), Tailings Management Facility (TMF) and other project infrastructure would be diverted to the pits in perpetuity. However, as explained in the Conceptual Closure and Rehabilitation Plan TSD, runoff from these areas will be released to the environment when water quality is deemed to be suitable for discharge. The pit flooding model was updated based on this plan. The model update resulted in an increase in the predicted flooding duration to approximately 218 years. Although this change is not reflected in the Version 1 Aquatic Environment TSD a technical memorandum summarizing the revised pit flooding model results is provided in Part B of the Conceptual Closure and Rehabilitation Plan TSD.

Fish Habitat No-Net Loss / Habitat Offset Plan

Following submission of the Draft EIS/EA report, a series of meetings and workshops were held between OHRG and representatives from the Ministry of Natural Resources (MNR) and Fisheries and Oceans Canada (DFO) to discuss concerns raised by the GRT and to evaluate the proposed compensation projects. Through this collaborative effort, the Fish Habitat No-Net Loss / Habitat Offset Plan for the Project (Appendix 2.III of the Version 1 Aquatic Environment TSD) has been revised and the revision is provided in Part B of this TSD. The following summarizes the key changes:

- Habitat losses and compensation projects are categorized based on the applicable legislation or regulatory Act (i.e., the Metal Mining Effluent Regulations (MMER) and Subsection 35 of the *Fisheries Act*)
- The potential for development of aquatic habitat within the flooded pits at closure is evaluated and considered;
- Additional detail is provided on dissolved oxygen concentrations in the fishless lakes that are proposed to be stocked as part of the compensation plan;
- Additional detail is provided on the access road watercourse crossings and associated compensation projects; and,
- Additional detail is provided on the fish salvage and rescue plan for the fish bearing water bodies that will be impacted by the Project.

Other Supplemental Information

In response to information requests, additional information was prepared and has been provided in the attached Supplemental Information Package. The table below provides a summary of the additional information requested and the corresponding documents in the Supplemental Information Package in which the information is provided.

Additional Information Requested	Location of Information in the Supplemental Information Package
More detailed information on benthic and sediment sampling	Updated Figure 4 from the Aquatic Environment TSD Appendix 2.II

Additional Information Requested	Location of Information in the Supplemental Information Package
More detail on fish tissue sampling results	Response to MOE-Surface Water-4

Supplemental Information Provided in Part B

- Updated Figure 4 (from Response to Information Request EC-12)
- Response to Information Request MOE-Surface Water-4
- Revised No-Net Loss Plan (Rev 0, December 2013)
  - Appendix 2.III of the Aquatic Environment Version 1 TSD

AQUATIC ENVIRONMENT TECHNICAL SUPPORT DOCUMENT
VERSION 2

PART B

Supplemental Information Package

December 2013
Project No. 13-1118-0010
Hammond Reef Gold Project

610000 620000 630000

5430000 5420000

N

TAILINGS MANAGEMENT FACILITY ALTERNATIVE 1
TAILINGS MANAGEMENT FACILITY BASE CASE
TAILINGS MANAGEMENT FACILITY ALTERNATIVE 2
CONSTRUCTION CAMP
EXPLORATION CAMP
HELIPAD
HELIPAD 1
WATER RETENTION POND
TMF ROADWAY AREAS (PIPELINES TO FOLLOW)
OFFICE/ TRUCK SHOP/ FUEL BAY/ PARKING LOT
PROCESS FACILITY
SUBSTATION
MINE WATER SPILL EMERGENCY POND
OPEN PIT
WASTE ROCK STOCKPILE
STOCKPILE (UNKNOWN)
STOCKPILE (OVERBURDEN)
LOW GRADE STOCKPILE AREA
EXPLOSIVES PLANT AND AREA

Serpent Lake
Cornell Lake
Sawbill Bay
Mitta Lake
Lynxhead Bay
Marmion Reservoir
Light Lake
Upper Seine Bay
Hawk Bay

LEGEND

- Benthic Invertebrate Community Sampling Locations (Stream Mouths)
- Fish Tissue Sampling Location
- Raft Lake Cut Location
- Weather Station
- Helipad Location
- Trail
- Road
- Proposed Site Access Road
- Hardtack / Sawbill Access Road Alternative 1
- Raft Lake Access Road Alternative 2
- Proposed Raft Lake Powerline Alternative
- Proposed Hardtack Powerline Alternative
- River/Stream
- Lake
- Wetland
- Project Footprint
- Project Location

DRAFT

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
SCALE 1:80,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
BENTHIC INVERTEBRATE AND FISH TISSUE COLLECTION LOCATIONS (2010-2011)

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1118-0010			SCALE AS SHOWN	REV. 2.0
DESIGN	CGE	14 Nov. 2008	FIGURE: 4	
GIS	JO	25 Sep. 2013		
CHECK	SP	25 Sep. 2013		
REVIEW	RJ	25 Sep. 2013		

G:\Projects\2013\13-1118-0010_Osisko_Hammond_Reef\GIS\MXDs\Reporting\TerrestrialBenthicInvertebrate_FishTissueLocations_2010_2011.mxd

OSISKO HAMMOND REEF GOLD PROJECT EIS/EA
INFORMATION REQUEST RESPONSES

INFORMATION REQUEST ï ENVIRONMENT ï SURFACE WATER-4

Source: Ministry of Environment

Summary of Comment

It is encouraging that fish are being collected to establish baseline body burdens; however, further information is needed to better understand these existing conditions.

Potential Environmental Effects

Baseline body burdens have not been fully defined. In order to better understand the potential for the mine to impact on fish body burdens a more robust baseline should be developed. Some of the concentrations for walleye in Lizard Lake and Sawbill Bay are quite elevated.

Proposed Action

Future sampling should ensure that a minimum of 10 individuals per species is collected. To explain the variability in body burdens, other fish metrics need to be provided such as fish length, weight and age. A standardized size needs to be developed for each of the species of concern. For example, a standardized walleye is generally 40 cm.

Reference to EIS

Table 2-8. Total Mercury Levels in Fish

Response

There is no “guideline” for how to complete a baseline fish tissue collection and analysis program to establish a baseline for a mining EA. Typically, the baseline data collection (for all disciplines) is based on establishing what the current conditions are, with an emphasis on what the predicted impacts of the mine are anticipated to be, and in some cases, to better characterize existing impacts that may exist in the existing environment.

Fish tissue contaminant analyses are typically collected for an EA, when there is concern that impacts from the mine might result in release of contaminants that could bioaccumulate in fish tissue and subsequently pose either a human health or an environmental risk (for example result in mortality to fish eating birds) – in our case, mercury is really the only metal that could potentially bioaccumulate (most metals do not) **and the project is not predicted to cause an incremental increase in release of mercury to the environment.**

In terms of looking at potential impacts to fish (and other wildlife), water and sediment quality are typically collected and analysed because, in the case of metals, the main concern with metals is that they reach concentrations in water and sediment that may pose a threat (chronic or acute toxicity) to fish – we have sampled water and sediment quite extensively in our EA work.

Fish tissue samples were collected to identify whether there were existing concerns with fish tissue accumulation of contaminants, specifically mercury. The baseline data indicates that some fish have elevated concentrations that could be a concern for consumption by sensitive groups. Summary data for metals was presented in the EA and Table 2-8 of the Aquatic TSD (provided below) and data on individual fish was provided to those expressing interest (see attached Table 1 and Attachments A, B, C).

The water quality predictions indicated that mercury would not be a concern at the site due to low concentrations in the rock samples, negligible leaching of mercury in the geochemical tests, and no use of mercury anywhere in the production circuits. Similarly, the water quality predictions showed that there would be no measurable increase in other metals in the receiving waters. Therefore, there was no reason to continue fish tissue residue sampling.

Osisko and Golder believe sufficient information on fish contaminants has been collected (see the Table 2-8 from the Aquatic TSD below for the actual numbers) from both sport and non-sport fish to sufficiently characterize tissue contaminant levels. We believe that our fish tissue collection meets both the EIS guidelines and the ToR for the project. We have also collected extensive water and sediment quality data, which is equally, if not more important, in terms of predicting potential impacts of the project on the environment. Detailed measurements of individual fish were collected (except blacknose shiner) in order that more detailed analyses of this data could be completed if necessary, however this was not done as the project is not predicted to cause an incremental increase in release of mercury to the environment.

Notwithstanding the fact that OHRG believes that the fish tissue sampling undertaken for the EA was sufficient for EA purposes, as a result of these comments OHRG has committed to providing capacity support to SRFN to collect additional fish tissue and benthic samples in the Spring of 2014 in conjunction with an environmental study being undertaken with their community.

We are also aware that, in 2010, MNR submitted fish tissue samples from Upper Marmion Lake to be analysed in the MOE sportfish contaminant monitoring program and we are planning to obtain this additional data.

Table 2-8: Total Mercury Levels in Fish Tissue Samples (Õg/g wet weight; Detection Limit 0.050 Õg/g)

Water Body	Species	Average	Maximum	Minimum
Turtle Bay (Marmion)	Blacknose Shiner (n= 1)	0.083	0.083	0.083
	Lake Whitefish (n=8)	0.241	0.329	0.135
	Walleye (n=8)	0.461	0.935	0.267
	White Sucker (n= 5)	0.185	0.301	0.072
Sawbill Bay (Marmion)	Blacknose Shiner (n=1)	0.066	0.066	0.066
	Lake Whitefish (n=14)	0.214	0.335	0.102
	Walleye (n=18)	0.523	1.660	0.232
	White Sucker (n= 11)	0.244	0.374	0.124
Lizard Lake	Cisco (n=8)	0.155	0.178	0.140
	Walleye (n= 8)	1.210	1.730	0.796
	White Sucker (n= 6)	0.239	0.408	0.140

Once a decision is made to proceed with the project, an Environmental Effects Monitoring Program would be set up, which also collects baseline data; and establishes a reference location in order to monitor potential operations effects in a more quantitative way. The EEM program includes sampling of water, sediment, fish tissue and benthic invertebrates.

Attachments

Table 1 and Attachments A, B, C

OSISKO HAMMOND REEF GOLD PROJECT EIS/EA
INFORMATION REQUEST RESPONSES

Table 1: Fish Length and Weight Data Associated with Tissue Submitted For Metals Analysis - Osisko

Date sampled	Sample #	Location	Species	Fish Fork Length (mm)	Fish Weight (g)	Sex	Life stage
24-AUG-10	BHRI0UR6LKWH051	Turtle Bay	Lake Whitefish	520	2600	F	A
24-AUG-10	BHRI0UR6LKWH022	Turtle Bay	Lake Whitefish	545	2590	F	A
24-AUG-10	BHRI0UR6LKWH052	Turtle Bay	Lake Whitefish	493	1760	F	A
25-AUG-10	BHRI0UTBLKWH062	Turtle Bay	Lake Whitefish	547	2600	F	A
25-AUG-10	BHRI0UTBLKWH063	Turtle Bay	Lake Whitefish	545	2315	F	A
25-AUG-10	BHRI0UTBLKWH066	Turtle Bay	Lake Whitefish	515	2360	M	A
25-AUG-10	BHRI0UR6LKWH166	Turtle Bay	Lake Whitefish	510	2110	M	A
26-AUG-10	BHRI0UTBLKWH167	Turtle Bay	Lake Whitefish	500	1270	F	A
26-AUG-10	BHRI0UR6WALL021	Turtle Bay	Walleye	328	390	n/a	n/a
24-AUG-10	BHRI0UR6WALL023	Turtle Bay	Walleye	470	1245	M	A
24-AUG-10	BHRI0UR6WALL035	Turtle Bay	Walleye	258	185	F	J
25-AUG-10	BHRU0UR6WALL054	Turtle Bay	Walleye	318	325	F	J
25-AUG-10	BHRI0UTBWALL059	Turtle Bay	Walleye	332	395	M	J
26-AUG-10	BHRI0UTBWALL079	Turtle Bay	Walleye	286	250	M	J
26-AUG-10	BHRI0UTBWALL170	Turtle Bay	Walleye	434	860	M	A
26-AUG-10	BHRI0UTBWALL171	Turtle Bay	Walleye	371	510	M	-
22-AUG-10	BHRI0UTBWALL054	Turtle Bay	Walleye	476	n/a	n/a	n/a
26-AUG-10	BHRI0UTBWHSC169	Turtle Bay	White Sucker	493	1830	F	A
25-SEP-10	BHRIOUTBWHSC 001	Turtle Bay	White Sucker	483	1850	F	A
25-SEP-10	BHRIOUTBWHSC 006	Turtle Bay	White Sucker	474	1750	F	A
25-SEP-10	BHRIOUTBWHSC 007	Turtle Bay	White Sucker	464	1600	F	A
25-SEP-10	BHRIOUTBWHSC 009	Turtle Bay	White Sucker	365	650	F	J
25-AUG-10	BHRIOUR5BNSH118,R6BNSH183,BNSH	Turtle Bay	Blacknose Shiner	composite sample	n/a	n/a	n/a
22-AUG-10	BHRI0UR1WALL033	Lizard Lake	Walleye	539	975	F	A

OSISKO HAMMOND REEF GOLD PROJECT EIS/EA
INFORMATION REQUEST RESPONSES

Table 1: Fish Length and Weight Data Associated with Tissue Submitted For Metals Analysis ï Osisko (continued)

Date sampled	Sample #	Location	Species	Fish Fork Length (mm)	Fish Weight (g)	Sex	Life stage
22-AUG-10	BHRI0UR1WALL041	Lizard Lake	Walleye	653	3450	M	A
22-AUG-10	BHRI0UR1WALL042	Lizard Lake	Walleye	515	1550	M	A
22-AUG-10	BHRI0UR1WALL046	Lizard Lake	Walleye	530	1680	M	A
22-AUG-10	BHRI0UR1WALL047	Lizard Lake	Walleye	334	425	M	J
22-AUG-10	BHRI0UR1WALL055	Lizard Lake	Walleye	456	1025	M	A
22-AUG-10	BHRI0UR1WALL056	Lizard Lake	Walleye	542	2025	M	A
21-AUG-10	BHRI0UR1WHSC032	Lizard Lake	White Sucker	482	1650	F	A
22-AUG-10	BHRI0UR1WHSC034	Lizard Lake	White Sucker	440	1420	M	A
22-AUG-10	BHRI0UR1WHSC043	Lizard Lake	White Sucker	414	1200	M	A
22-AUG-10	BHRI0UR1WHSC044	Lizard Lake	White Sucker	462	1525	F	A
22-AUG-10	BHRI0UR1WHSC045	Lizard Lake	White Sucker	463	1450	F	A
22-AUG-10	BHRI0UR1WHSC051	Lizard Lake	White Sucker	505	1800	F	A
21-AUG-10	BHRI0URICISC031	Lizard Lake	Cisco	273	330	M	A
22-AUG-10	BHRI0URICISC035	Lizard Lake	Cisco	269	280	F	A
22-AUG-10	BHRI0URICISC036	Lizard Lake	Cisco	253	255	M	J
22-AUG-10	BHRI0URICISC037	Lizard Lake	Cisco	245	230	n/a	M
22-AUG-10	BHRI0URICISC038	Lizard Lake	Cisco	243	200	M	J
22-AUG-10	BHRI0URICISC048	Lizard Lake	Cisco	245	225	n/a	n/a
22-AUG-10	BHRI0URICISC049	Lizard Lake	Cisco	255	250	F	A
22-AUG-10	BHRI0URICISC050	Lizard Lake	Cisco	257	250	n/a	n/a
19-AUG-10	BHR10U13WALL009	Sawbill Bay	Walleye	389	610	M	A
19-AUG-10	BHR10U13WALL010	Sawbill Bay	Walleye	330	390	F	J
19-AUG-10	BHR10U13WALL012	Sawbill Bay	Walleye	306	330	M	J
19-AUG-10	BHR10U13WALL013	Sawbill Bay	Walleye	380	570	F	A
19-AUG-10	BHR10U13WALL014	Sawbill Bay	Walleye	343	450	F	A
19-AUG-10	BHR10U13WALL018	Sawbill Bay	Walleye	515	1600	F	A
20-AUG-10	BHR10U12WALL005	Sawbill Bay	Walleye	489	325	M	A
20-AUG-10	BHR10U12WALL006	Sawbill Bay	Walleye	430	845	M	A
19-AUG-10	BHR10U13WHSC016	Sawbill Bay	White Sucker	519	2350	F	A

OSISKO HAMMOND REEF GOLD PROJECT EIS/EA
INFORMATION REQUEST RESPONSES

Table 1: Fish Length and Weight Data Associated with Tissue Submitted For Metals Analysis ï Osisko (continued)

Date sampled	Sample #	Location	Species	Fish Fork Length (mm)	Fish Weight (g)	Sex	Life stage
19-AUG-10	BHR10U13WHSC017	Sawbill Bay	White Sucker	440	1300	F	A
19-AUG-10	BHR10U13WHSC020	Sawbill Bay	White Sucker	462	1640	M	A
19-AUG-10	BHR10U13WHSC021	Sawbill Bay	White Sucker	505	2225	F	A
20-AUG-10	BHR10U13WHSC030	Sawbill Bay	White Sucker	495	1840	F	A
27-AUG-10	BHR10U13WHSC038	Sawbill Bay	White Sucker	n/a	n/a	n/a	n/a
28-AUG-10	BHR10U13WHSC039	Sawbill Bay	White Sucker	n/a	n/a	n/a	n/a
28-AUG-10	BHR10U13WHSC040	Sawbill Bay	White Sucker	n/a	n/a	n/a	n/a
19-AUG-10	BHR10U13LKWH019	Sawbill Bay	Lake Whitefish	496	2250	M	A
28-AUG-10	BHR10U13LKWH041	Sawbill Bay	Lake Whitefish	n/a	n/a	n/a	n/a
28-AUG-10	BHR10U13LKWH042	Sawbill Bay	Lake Whitefish	n/a	n/a	n/a	n/a
28-AUG-10	BHR10U13LKWH043	Sawbill Bay	Lake Whitefish	n/a	n/a	n/a	n/a
18-AUG-10	BHR10U15BNSH005	Sawbill Bay	Blacknose Shiner	composite sample	n/a	n/a	n/a
21-SEP-11	OHR11FSBLKWH001	Sawbill Bay	Lake Whitefish	496	1550	F	A
21-SEP-11	OHR11FSBLKWH002	Sawbill Bay	Lake Whitefish	540	2350	F	A
21-SEP-11	OHR11FSBWALL003	Sawbill Bay	Walleye	387	650	M	A
21-SEP-11	OHR11FSBLKWH004	Sawbill Bay	Lake Whitefish	491	2025	F	A
21-SEP-11	OHR11FSBWALL005	Sawbill Bay	Walleye	405	800	M	A
21-SEP-11	OHR11FSBWALL006	Sawbill Bay	Walleye	346	450	M	A
21-SEP-11	OHR11FSBLKWH007	Sawbill Bay	Lake Whitefish	508	2450	M	A
21-SEP-11	OHR11FSBLKWH008	Sawbill Bay	Lake Whitefish	478	1900	M	A
21-SEP-11	OHR11FSBWALL009	Sawbill Bay	Walleye	346	400	M	A
21-SEP-11	OHR11FSBWALL010	Sawbill Bay	Walleye	389	615	M	A
21-SEP-11	OHR11FSBWHSC011	Sawbill Bay	White Sucker	505	2000	M	A

Table 1: Fish Length and Weight Data Associated with Tissue Submitted For Metals Analysis ï Osisko (continued)

Date sampled	Sample #	Location	Species	Fish Fork Length (mm)	Fish Weight (g)	Sex	Life stage
21-SEP-11	OHR11FSBLKWH012	Sawbill Bay	Lake Whitefish	432	1200	M	A
21-SEP-11	OHR11FSBWALL013	Sawbill Bay	Walleye	450	1025	F	A
23-SEP-11	OHR11FSBWALL014	Sawbill Bay	Walleye	270	210	M	J
23-SEP-11	OHR11FSBWHSC015	Sawbill Bay	White Sucker	490	1900	M	A
23-SEP-11	OHR11FSBLKWH016	Sawbill Bay	Lake Whitefish	470	1650	F	A
23-SEP-11	OHR11FSBLKWH017	Sawbill Bay	Lake Whitefish	465	1850	F	A
23-SEP-11	OHR11FSBWALL018	Sawbill Bay	Walleye	350	465	M	J
24-SEP-11	OHR11FSBLKWH019	Sawbill Bay	Lake Whitefish	n/a	n/a	F	A
24-SEP-11	OHR11FSBLKWH020	Sawbill Bay	Lake Whitefish	466	1600	F	A
24-SEP-11	OHR11FSBWALL021	Sawbill Bay	Walleye	561	2000	F	A
24-SEP-11	OHR11FSBWHSC022	Sawbill Bay	White Sucker	464	1600	M	A
24-SEP-11	OHR11FSBWALL023	Sawbill Bay	Walleye	330	420	M	J

ATTACHMENT A

GOLDER PASTE TECHNOLOGY
ATTN: JOHN SEYLER
1010 LORNE ST.
SUDBURY ON P3C 4R9

Date Received: 30-SEP-11
Report Date: 07-OCT-11 14:17 (MT)
Version: FINAL

Client Phone: 705-524-6861

Certificate of Analysis

Lab Work Order #: L1066235

Project P.O. #: NOT SUBMITTED
Job Reference: 10-1118-0020
C of C Numbers: L1066235
Legal Site Desc:

<Original signed by>

Karen Rutledge
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

Submitted as part of the Version 3 HRGP Amendment Application Documentation
January 2018 - 1656263

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID Description Sampled Date Sampled Time Client ID	L1066235-1 FISH TISSUE 21-SEP-11 OHR11FSBLKWH001	L1066235-2 FISH TISSUE 21-SEP-11 OHR11FSBLKWH002	L1066235-3 FISH TISSUE 21-SEP-11 OHR11FSBWALL003	L1066235-4 FISH TISSUE 21-SEP-11 OHR11FSBLKWH004	L1066235-5 FISH TISSUE 21-SEP-11 OHR11FSBWALL005
SOIL							
Physical Tests	% Moisture (%)		<0.10	<0.10	<0.10	<0.10	<0.10

Submitted as part of the Version 3 HRGP Amendment Application Documentation
January 2018 - 1656263

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1066235-6	L1066235-7	L1066235-8	L1066235-9	L1066235-10
Description	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE
Sampled Date	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11
Sampled Time					
Client ID	OHR11FSBWALL006	OHR11FSBLKWH007	OHR11FSBLKWH008	OHR11FSBWALL009	OHR11FSBWALL010
Grouping **Analyte**					
SOIL					
Physical Tests % Moisture (%)	<0.10	<0.10	<0.10	<0.10	<0.10

Submitted as part of the Version 3 HRGP Amendment Application Documentation
January 2018 - 1656263

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1066235-11	L1066235-12	L1066235-13	L1066235-14	L1066235-15
Description	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE
Sampled Date	21-SEP-11	21-SEP-11	21-SEP-11	23-SEP-11	23-SEP-11
Sampled Time					
Client ID	OHR11FSBWHSC011	OHR11FSBLKWH012	OHR11FSBWALL013	OHR11FSBWALL014	OHR11FSBWHSC015
Grouping **Analyte**					
SOIL					
Physical Tests % Moisture (%)	<0.10	<0.10	<0.10	<0.10	<0.10

Submitted as part of the Version 3 HRGP Amendment Application Documentation
January 2018 - 1656263

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1066235-16	L1066235-17	L1066235-18	L1066235-19	L1066235-20
Description	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE
Sampled Date	23-SEP-11	23-SEP-11	23-SEP-11	24-SEP-11	24-SEP-11
Sampled Time					
Client ID	OHR11FSBLKWH016	OHR11FSBLKWH017	OHR11FSBWALL018	OHR11FSBLKWH019	OHR11FSBLKWH020
Grouping **Analyte**					
SOIL					
Physical Tests % Moisture (%)	<0.10	<0.10	<0.10	<0.10	<0.10

Submitted as part of the Version 3 HRGP Amendment Application Documentation
January 2018 - 1656263

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1066235-21	L1066235-22	L1066235-23		
Description	FISH TISSUE	FISH TISSUE	FISH TISSUE		
Sampled Date	24-SEP-11	24-SEP-11	24-SEP-11		
Sampled Time					
Client ID	OHR11FSBWALL021	OHR11FSBWHSC022	OHR11FSBWALL023		
Grouping **Analyte**					
SOIL					
Physical Tests % Moisture (%)	<0.10	<0.10	<0.10		

Submitted as part of the Version 3 HRGP Amendment Application Documentation
January 2018 - 1656263

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1066235-1	L1066235-2	L1066235-3	L1066235-4	L1066235-5
	Description	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE
	Sampled Date	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11
	Sampled Time					
	Client ID	OHR11FSBLKWH001	OHR11FSBLKWH002	OHR11FSBWALL003	OHR11FSBLKWH004	OHR11FSBWALL005
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	8.8	7.7	7.4	12.5	18.5
	Antimony (Sb) (mg/kg wwt)	1.1	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	74	89	204	130	58
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	<10	<10	50	26
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)	183	266	293	330	314
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	0.197	0.235	0.402	0.113	0.317
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	1800	2300	2390	2840	2520
	Potassium (K) (mg/kg wwt)	3410	4390	4540	5200	5020
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	643	297	289	280	234
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	2.3	2.0	1.8	1.7	1.8
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)	1.2	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amendment Application January 2018 - 1656263

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1066235-6	L1066235-7	L1066235-8	L1066235-9	L1066235-10
	Description	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE
	Sampled Date	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11
	Sampled Time					
	Client ID	OHR11FSBWALL006	OHR11FSBLKWH007	OHR11FSBLKWH008	OHR11FSBWALL009	OHR11FSBWALL010
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	5.9	<5.0	6.5	9.9	55.6
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	1.6
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	91	71	85	81	1570
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	<10	<10	10	174
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	2.0
	Magnesium (Mg) (mg/kg wwt)	301	297	279	339	2270
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	0.393	0.229	0.147	0.362	0.469
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	2450	2820	2330	2390	18600
	Potassium (K) (mg/kg wwt)	4900	4700	4560	4600	37300
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	1.7
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	292	270	247	308	1610
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	1.8	1.5	1.7	1.7	12.2
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	12	37
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	1.0

Submitted as part of the Version 3 HRGP Amendment Application Documentation
January 2018 - 1656263

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1066235-11 FISH TISSUE 21-SEP-11 OHR11FSBWHSC011	L1066235-12 FISH TISSUE 21-SEP-11 OHR11FSBLKWH012	L1066235-13 FISH TISSUE 21-SEP-11 OHR11FSBWALL013	L1066235-14 FISH TISSUE 23-SEP-11 OHR11FSBWALL014	L1066235-15 FISH TISSUE 23-SEP-11 OHR11FSBWHSC015
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	10.3	<5.0	<5.0	<5.0	8.9
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	96	95	42	95	108
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	29	<10	<10	<10	<10
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)	303	254	310	311	262
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	0.356	0.102	0.446	0.273	0.374
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	2500	2370	2440	2230	2050
	Potassium (K) (mg/kg wwt)	4850	4330	5060	4600	3970
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	275	194	266	254	286
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	1.5	1.7	1.7	1.6	1.4
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amendment Application Documentation
January 2018 - 1656263

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1066235-16	L1066235-17	L1066235-18	L1066235-19	L1066235-20
	Description	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE
	Sampled Date	23-SEP-11	23-SEP-11	23-SEP-11	24-SEP-11	24-SEP-11
	Sampled Time					
	Client ID	OHR11FSBLKWH016	OHR11FSBLKWH017	OHR11FSBWALL018	OHR11FSBLKWH019	OHR11FSBLKWH020
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	8.1	6.6	6.3	5.8	<5.0
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	67	61	72	74	54
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	<10	<10	<10	<10
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)	266	255	284	270	245
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	0.119	0.176	0.342	0.324	0.264
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	2350	2340	2190	2510	2340
	Potassium (K) (mg/kg wwt)	4140	4160	4600	4610	4400
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	187	201	251	376	360
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	1.5	1.5	1.6	1.7	1.8
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amendment Application January 2018 - 1656263

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1066235-21	L1066235-22	L1066235-23		
	Description	FISH TISSUE	FISH TISSUE	FISH TISSUE		
	Sampled Date	24-SEP-11	24-SEP-11	24-SEP-11		
	Sampled Time					
	Client ID	OHR11FSBWALL021	OHR11FSBWHSC022	OHR11FSBWALL023		
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	<5.0	<5.0	6.4		
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0		
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0		
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0		
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20		
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0		
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0		
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20		
	Calcium (Ca) (mg/kg wwt)	79	65	61		
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0		
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0		
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0		
	Iron (Fe) (mg/kg wwt)	<10	<10	<10		
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0		
	Magnesium (Mg) (mg/kg wwt)	285	255	322		
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20		
	Mercury (Hg) (mg/kg wwt)	1.66	0.320	0.339		
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0		
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0		
	Phosphorus (P) (mg/kg wwt)	2350	2190	2520		
	Potassium (K) (mg/kg wwt)	4710	4570	5170		
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0		
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20		
	Sodium (Na) (mg/kg wwt)	278	248	255		
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20		
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0		
	Tin (Sn) (mg/kg wwt)	1.5	1.5	1.6		
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0		
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0		
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0		
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10		
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0		

Submitted as part of the Version 3 HRGP Amendment EIS Documentation
January 2018 1656263

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
AS,SB,SE-MS-WT	Tissue	As, Sb, Se in Tissue by ICP/MS	EPA 200.3/6020
HG-WT	Tissue	Mercury by CVAA	SW846 7470A
MET-ICP-WT	Tissue	Metals in Tissue by ICP	EPA 200.3/6020
MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

L1066235

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Submitted as part of the Version 3 submission documentation (Golder Ref. No. 10-1118-0020)

Chain of Custody / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1066235-COFC

COC # L1066235

Page 1 of 2

Report To

Company: Golder Associates Ltd

Contact: John Seyler

Address: 1010 Lorne St.
Sudbury ON

Phone: 705 524 6861 Fax:

Invoice To Same as Report? (Yes) No

THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (circle Yes or No)

Are any samples taken from a regulated DW System? Yes No

If yes, an authorized Drinking Water COC MUST be used for this submission.

Is the water sampled intended to be potable for human consumption? Yes No

Report Format / Distribution

Standard Other (specify):

(PDF) Excel Digital Fax

Email 1: jseyler@golder.com

Email 2: jdickison@golder.com

Client / Project Information

Job #: 10-1118-0020

PO / AFE:

LSD:

Quote #:

Service Requested (Rush for routine analysis subject to availability)

(Regular) (Default)

Priority (Specify Date Required → →) Surcharges apply

Emergency (1 Business Day) - 100% Surcharge

For Emergency < 1 Day, ASAP or Weekend - Contact ALS

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Lab Work Order # (lab use only)

ALS Contact: K. Rutledge

Sampler: JD

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Metals incl. Hg	Number of Containers
1	OHR11FSBLKWH001	21/09/11		Fish tissue	✓	
2	OHR11FSBLKWH002				✓	
3	OHR11FSBWALL003				✓	
4	OHR11FSBLKWH004				✓	
5	OHR11FSBWALL005				✓	
6	OHR11FSBWALL006				✓	
7	OHR11FSBLKWH007				✓	
8	OHR11FSBLKWH008				✓	
9	OHR11FSBWALL009				✓	
10	OHR11FSBWALL010				✓	
11	OHR11FSBWHSC011				✓	
12	OHR11FSBLKWH012				✓	

Special Instructions / Regulations / Hazardous Details

Reg 153 Table 1 2 3 TCLP MISA PWQO OTHER (please specify):
Circle one - Note drinking water samples MUST USE DW Chain of Custody

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
<Original signed by>	30/09/11			30 Sept 11	13:45	4.5 °C				

1.6-7.3

TYFM014 26-Mar-10

Submitted as part of the Victoria 3 Mine Permanent Closure application 2018 1065663

ALS

* L 1 0 6 6 2 3 5 - C O F C *

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # _____

L1066235

Page 2 of 2

Report To	**Report Format / Distribution**
Company: Golder Associates Ltd.	Standard / Other (specify):
Contact: John Seyler	(PDF) / (Excel) / Digital / Fax
Address: 1010 Lorne St. Sudbury, ON	Email 1: jseyler@golder.com
Phone: 705 524-6861 Fax:	Email 2: jdickison@golder.com
Invoice To Same as Report ? (Yes) No	**Client / Project Information**
THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (circle Yes or No)	Job #: 10-1118-0020
Are any samples taken from a regulated DW System? Yes No	PO / AFE:
If yes, an authorized Drinking Water COC MUST be used for this submission.	LSD:
Is the water sampled intended to be potable for human consumption? Yes No	Quote #:
Lab Work Order # (lab use only)	ALS Contact: Karen Rutledge Sampler: JD

Service Requested (Rush for routine analysis subject to availability)

- (Regular (Default))
- Priority (Specify Date Required → →) — Surcharges apply
- Emergency (1 Business Day) - 100% Surcharge
- For Emergency < 1 Day, ASAP or Weekend - Contact ALS

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Metals incl. Hg	Number of Containers
13	OHR11FSBWALL013	21/SEP/11		Fish Tissue	✓	
14	OHR11FSBWALL014	23/SEP/11			✓	
15	OHR11FSBWHSC015				✓	
16	OHR11FSBLKWH016				✓	
17	OHR11FSBLKWH017				✓	
18	OHR11FSBWALL018				✓	
19	OHR11FSBLKWH019	24/SEP/11			✓	
20	OHR11FSBLKWH020				✓	
21	OHR11FSBWALL021				✓	
22	OHR11FSBWHSC022				✓	
23	OHR11FSBWALL023				✓	

Special Instructions / Regulations / Hazardous Details

Reg 153 Table 1 2 3 TCLP MISA PWQO OTHER (please specify):
Circle one - Note drinking water samples MUST USE DW Chain of Custody

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
<Original signed by>	30/SEP/11			30Sept11	13:45	4.5 °C				

TYFM014 26-Mar-10

ATTACHMENT B

GOLDER PASTE TECHNOLOGY
ATTN: JOHN SEYLER
1010 LORNE ST.
SUDBURY ON P3C 4R9
Phone: 705-524-6861

Date Received: 30-AUG-10
Report Date: 12-OCT-10 11:37 (MT)
Version: FINAL

Certificate of Analysis

Lab Work Order #: L925877
Project P.O. #: NOT SUBMITTED
Job Reference: 10-1118-0020
Legal Site Desc:
C of C Numbers: L925877

<Original signed by>

Karen Rutledge
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

Submitted as part of the Version 3 HRGP Amended Application Documentation
January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

		Sample ID	L925877-1	L925877-2	L925877-3	L925877-4	L925877-5
		Description	FILLET	FILLET	FILLET	FILLET	FILLET
		Sampled Date	24-AUG-10	24-AUG-10	24-AUG-10	25-AUG-10	25-AUG-10
		Sampled Time					
		Client ID	BHRI0UR6LKWH051	BHRI0UR6LKWH022	BHRI0UR6LKWH052	BHRI0UTBLKWH062	BHRI0UTBLKWH063
Grouping	**Analyte**						
TISSUE							
Metals	Aluminum (Al) (mg/kg wwt)		12.5	10.2	8.4	7.7	7.6
	Antimony (Sb) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)		<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)		<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)		<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)		148	2910	135	79	132
	Chromium (Cr) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)		<10	12	12	14	<10
	Lead (Pb) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)		254	274	237	222	261
	Manganese (Mn) (mg/kg wwt)		<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)		0.214	0.292	0.250	0.237	0.214
	Molybdenum (Mo) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)		2190	3350	2190	2230	2200
	Potassium (K) (mg/kg wwt)		3280	3260	3120	3420	3410
	Selenium (Se) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)		<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)		475	613	627	413	405
	Strontium (Sr) (mg/kg wwt)		<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)		<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Titanium (Ti) (mg/kg wwt)		<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)		<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)		<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amended Application January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L925877-6	L925877-7	L925877-8	L925877-9	L925877-10
	Description	FILLET	FILLET	FILLET	FILLET	FILLET
	Sampled Date	25-AUG-10	25-AUG-10	26-AUG-10	26-AUG-10	24-AUG-10
	Sampled Time					
	Client ID	BHRI0UTBLKWH066	BHRI0UR6LKWH166	BHRI0UTBLKWH167	BHRI0UR6WALL021	BHRI0UR6WALL023
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	25.3	20.7	<5.0	15.5	9.8
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	1.3	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	113	131	209	183	116
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	14	<10	<10	<10
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)	232	243	240	328	296
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	0.135	0.260	0.329	0.292	0.935
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	2010	2020	2050	2080	2200
	Potassium (K) (mg/kg wwt)	2860	3230	3120	3800	3930
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	305	384	566	452	298
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amended Application January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L925877-11	L925877-12	L925877-13	L925877-14	L925877-15
	Description	FILLET	FILLET	FILLET	FILLET	FILLET
	Sampled Date	24-AUG-10	25-AUG-10	25-AUG-10	26-AUG-10	26-AUG-10
	Sampled Time					
	Client ID	BHRI0UR6WALL035	BHRU0UR6WALL054	BHRI0UTBWALL059	BHRI0UTBWALL079	BHRI0UTBWALL170
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	6.5	19.7	30.1	9.3	19.7
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	121	373	208	508	135
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	<10	<10	<10	<10
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)	280	342	315	323	287
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	0.366	0.267	0.289	0.290	0.542
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	2240	2300	2220	2400	2060
	Potassium (K) (mg/kg wwt)	4010	4000	3860	3920	3610
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	329	360	404	350	360
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amended Application January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L925877-16	L925877-17	L925877-18	L925877-19	L925877-20
	Description	FILLET	FILLET	WHOLE	FILLET	FILLET
	Sampled Date	26-AUG-10	26-AUG-10	25-AUG-10	22-AUG-10	22-AUG-10
	Sampled Time					
	Client ID	BHRI0UTBWALL171	BHRI0UTBWHSC169	BHRIOUR5BNSH118,R6BNSH183,BNSH	BHRI0UR1WALL033	BHRI0UR1WALL041
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	17.5	17.8	33.7	14.6	14.0
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	281	623	5850	96	89
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	10	14	<10	<10
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)	302	187	271	247	244
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	0.432	0.193	0.083	1.30	1.73
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	2330	1950	4260	2000	2140
	Potassium (K) (mg/kg wwt)	3890	1800	1570	1950	3330
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	372	296	596	347	346
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	<1.0	1.5	1.3	1.0	<1.0
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	40	<10	<10
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amended Application January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	Sample ID / Description / Sampled Date / Sampled Time / Client ID				
		L925877-21 FILLET 22-AUG-10 BHRI0UR1WALL042	L925877-22 FILLET 22-AUG-10 BHRI0UR1WALL046	L925877-23 FILLET 22-AUG-10 BHRI0UR1WALL047	L925877-24 FILLET 22-AUG-10 BHRI0UTBWALL054	L925877-25 FILLET 22-AUG-10 BHRI0UR1WALL055
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	26.1	24.9	33.5	19.6	7.2
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	1.9	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	379	81	107	94	69
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	<10	<10	<10	<10
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)	304	206	233	230	227
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	1.20	1.51	0.921	0.736	0.796
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	2280	1900	1860	1780	1910
	Potassium (K) (mg/kg wwt)	3750	1990	2210	1910	1890
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	436	368	392	388	307
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	<1.0	1.4	1.6	1.1	<1.0
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amended Application Documentation
January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

		Sample ID	L925877-26	L925877-27	L925877-28	L925877-29	L925877-30
		Description	FILLET	FILLET	FILLET	FILLET	FILLET
		Sampled Date	22-AUG-10	21-AUG-10	22-AUG-10	22-AUG-10	22-AUG-10
		Sampled Time					
		Client ID	BHRI0UR1WALL056	BHRI0UR1WHSC032	BHRI0UR1WHSC034	BHRI0UR1WHSC043	BHRI0UR1WHSC044
Grouping	**Analyte**						
TISSUE							
Metals	Aluminum (Al) (mg/kg wwt)		17.4	29.0	30.2	10.0	49.1
	Antimony (Sb) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)		<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)		<5.0	<5.0	<5.0	<5.0	8.3
	Cadmium (Cd) (mg/kg wwt)		<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)		209	779	82	102	192
	Chromium (Cr) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)		<10	<10	21	<10	<10
	Lead (Pb) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)		215	319	214	288	251
	Manganese (Mn) (mg/kg wwt)		<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)		1.01	0.190	0.408	0.187	0.140
	Molybdenum (Mo) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)		1920	2590	1970	2140	2080
	Potassium (K) (mg/kg wwt)		1850	3940	2030	2300	2200
	Selenium (Se) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)		<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)		325	376	393	349	435
	Strontium (Sr) (mg/kg wwt)		<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)		<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)		1.2	<1.0	1.6	1.9	1.5
	Titanium (Ti) (mg/kg wwt)		<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)		<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)		<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)		<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amended Application January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	L925877-31 FILLET 22-AUG-10 BHRI0UR1WHSC045	L925877-32 FILLET 22-AUG-10 BHRI0UR1WHSC051	L925877-33 FILLET 21-AUG-10 BHRI0URICISC031	L925877-34 FILLET 22-AUG-10 BHRI0URICISC035	L925877-35 FILLET 22-AUG-10 BHRI0URICISC036
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	14.0	12.3	20.8	22.1	27.3
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	101	83	211	139	364
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	1.2	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	19	<10	<10	<10
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)	259	191	317	227	283
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	0.234	0.277	0.178	0.166	0.142
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	2060	2060	2500	2190	2240
	Potassium (K) (mg/kg wwt)	2240	2180	4040	2180	2210
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	352	565	344	482	436
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	1.5	2.0	<1.0	1.6	1.6
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amended Application January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	L925877-36 FILLET 22-AUG-10 BHRI0URICISC037	L925877-37 FILLET 22-AUG-10 BHRI0URICISC038	L925877-38 FILLET 22-AUG-10 BHRI0URICISC048	L925877-39 FILLET 22-AUG-10 BHRI0URICISC049	L925877-40 FILLET 22-AUG-10 BHRI0URICISC050
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	6.1	10.2	26.0	23.2	32.9
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	2.3	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	324	160	529	159	178
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	<10	<10	<10	<10
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)	264	311	338	265	311
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	0.155	0.146	0.166	0.149	0.140
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	2320	2640	2330	1910	2310
	Potassium (K) (mg/kg wwt)	2210	3970	3460	2060	3880
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	340	336	421	422	494
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	1.4	<1.0	<1.0	1.8	<1.0
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amended Application January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L925877-41	L925877-42	L925877-43	L925877-44	L925877-45
	Description	FILLET	FILLET	FILLET	FILLET	FILLET
	Sampled Date	19-AUG-10	19-AUG-10	19-AUG-10	19-AUG-10	19-AUG-10
	Sampled Time					
	Client ID	BHR10U13WALL009	BHR10U13WALL010	BHR10U13WALL012	BHR10U13WALL013	BHR10U13WALL014
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	23.5	18.6	10.9	33.0	18.7
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	128	153	290	488	129
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	<10	<10	<10	<10
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)	314	277	328	291	298
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	0.588	0.310	0.232	0.383	0.385
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	2210	2300	2460	2360	2170
	Potassium (K) (mg/kg wwt)	3920	3820	3990	3890	3690
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	368	500	379	428	470
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amended Application January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	L925877-46 FILLET 19-AUG-10 BHR10U13WALL018	L925877-47 FILLET 20-AUG-10 BHR10U12WALL005	L925877-48 FILLET 20-AUG-10 BHR10U12WALL006	L925877-49 FILLET 19-AUG-10 BHR10U13WHSC016	L925877-50 FILLET 19-AUG-10 BHR10U13WHSC017
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	14.4	<5.0	5.2	8.2	10.8
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	97	1900	603	3140	132
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	<10	<10	10	<10
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	1.8
	Magnesium (Mg) (mg/kg wwt)	281	285	311	293	286
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	1.35	0.354	0.810	0.208	0.124
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	2100	3160	2510	3290	2170
	Potassium (K) (mg/kg wwt)	3620	3680	3800	3360	3710
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	403	314	498	463	405
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amended Application January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	L925877-51 FILLET 19-AUG-10 BHR10U13WHSC020	L925877-52 FILLET 19-AUG-10 BHR10U13WHSC021	L925877-53 FILLET 20-AUG-10 BHR10U13WHSC030	L925877-54 FILLET 27-AUG-10 BHR10U13WHSC038	L925877-55 FILLET 28-AUG-10 BHR10U13WHSC039
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	7.0	28.4	10.2	<5.0	18.9
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	103	303	313	237	83
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	<10	<10	<10	<10
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)	298	251	251	257	229
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	0.231	0.217	0.286	0.161	0.255
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	2160	1930	2060	2120	2070
	Potassium (K) (mg/kg wwt)	3630	2030	2100	2010	1890
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	313	310	342	322	422
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	<1.0	1.7	1.4	1.1	1.3
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amended Application January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	L925877-56 FILLET 28-AUG-10 BHR10U13WHSC040	L925877-57 FILLET 19-AUG-10 BHR10U13LKWH019	L925877-58 FILLET 28-AUG-10 BHR10U13LKWH041	L925877-59 FILLET 28-AUG-10 BHR10U13LKWH042	L925877-60 FILLET 28-AUG-10 BHR10U13LKWH043
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	12.2	11.7	40.2	6.0	7.2
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Boron (B) (mg/kg wwt)	<5.0	<5.0	5.9	<5.0	<5.0
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Calcium (Ca) (mg/kg wwt)	281	83	131	81	113
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Iron (Fe) (mg/kg wwt)	<10	12	<10	<10	<10
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Magnesium (Mg) (mg/kg wwt)	238	215	240	236	250
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	<20
	Mercury (Hg) (mg/kg wwt)	0.156	0.335	0.257	0.185	0.312
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Phosphorus (P) (mg/kg wwt)	1960	2130	1850	2090	2190
	Potassium (K) (mg/kg wwt)	2020	1920	2110	3350	3200
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na) (mg/kg wwt)	267	404	450	517	529
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	<20
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tin (Sn) (mg/kg wwt)	1.3	1.4	1.7	<1.0	<1.0
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	<5.0
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	<10
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	<1.0

Submitted as part of the Version 3 HRGP Amended Application January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

		Sample ID	L925877-61				
		Description	WHOLE				
		Sampled Date	18-AUG-10				
		Sampled Time					
		Client ID	BHR10U15BNSH005				
Grouping	**Analyte**						
TISSUE							
Metals	Aluminum (Al) (mg/kg wwt)		14.7				
	Antimony (Sb) (mg/kg wwt)		<1.0				
	Arsenic (As) (mg/kg wwt)		<1.0				
	Barium (Ba) (mg/kg wwt)		1.3				
	Beryllium (Be) (mg/kg wwt)		<0.20				
	Bismuth (Bi) (mg/kg wwt)		<1.0				
	Boron (B) (mg/kg wwt)		<5.0				
	Cadmium (Cd) (mg/kg wwt)		<0.20				
	Calcium (Ca) (mg/kg wwt)		7970				
	Chromium (Cr) (mg/kg wwt)		<1.0				
	Cobalt (Co) (mg/kg wwt)		<1.0				
	Copper (Cu) (mg/kg wwt)		<1.0				
	Iron (Fe) (mg/kg wwt)		13				
	Lead (Pb) (mg/kg wwt)		<1.0				
	Magnesium (Mg) (mg/kg wwt)		285				
	Manganese (Mn) (mg/kg wwt)		<20				
	Mercury (Hg) (mg/kg wwt)		0.066				
	Molybdenum (Mo) (mg/kg wwt)		<1.0				
	Nickel (Ni) (mg/kg wwt)		<1.0				
	Phosphorus (P) (mg/kg wwt)		4800				
	Potassium (K) (mg/kg wwt)		1580				
	Selenium (Se) (mg/kg wwt)		<1.0				
	Silver (Ag) (mg/kg wwt)		<0.20				
	Sodium (Na) (mg/kg wwt)		532				
	Strontium (Sr) (mg/kg wwt)		<20				
	Thallium (Tl) (mg/kg wwt)		<5.0				
	Tin (Sn) (mg/kg wwt)		1.7				
	Titanium (Ti) (mg/kg wwt)		<5.0				
	Uranium (U) (mg/kg wwt)		<5.0				
	Vanadium (V) (mg/kg wwt)		<1.0				
	Zinc (Zn) (mg/kg wwt)		53				
	Zirconium (Zr) (mg/kg wwt)		<1.0				

Submitted as part of the Version 3 HRGP Amendment EA Documentation
January 2018 1656263

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
AS,SB,SE-MS-WT	Tissue	As, Sb, Se in Tissue by ICP/MS	EPA 200.3/6020
HG-WT	Tissue	Mercury by CVAA	SW846 7470A
MET-ICP-WT	Tissue	Metals in Tissue by ICP	EPA 200.3/6020

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS LABORATORY GROUP - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

L925877

GLOSSARY OF REPORT TERMS

Surrogate A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg milligrams per kilogram based on dry weight of sample.
mg/kg wwt milligrams per kilogram based on wet weight of sample.
mg/kg lwt milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L milligrams per litre.
< - Less than.
D.L. The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as receieved by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Submitted as part of the Vendor Qualification Program - January 2003

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # L925877
Page 1 of 6

Report To
Company: Golder Associates Ltd
Contact: John Seyler
Address: 1010 Lorne Street
Sudbury Ontario P3C 4R9
Phone: 705-524-6861 Fax: 705-524-1984

Report Format / Distribution
Standard: (PDF) Other (specify): (Excel) Digital Fax
Email 1: jseyler@golder.com
Email 2: tcalverley@golder.com

Service Requested (Rush for routine analysis subject to availability)
(Regular (Default))
Priority (Specify Date Required → →) Surcharges apply
Emergency (1 Business Day) - 100% Surcharge
For Emergency < 1 Day, ASAP or Weekend - Contact ALS

Invoice To Same as Report ? (Yes) No

THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (circle Yes or No)
Are any samples taken from a regulated DW System? Yes (No)
If yes, an authorized Drinking Water COC MUST be used for this submission.
Is the water sampled intended to be potable for human consumption? Yes (No)

Client / Project Information
Job #: 10-1118-0020
PO / AFE:
LSD:
Quote #:

Lab Work Order # (lab use only)

ALS Contact:

Sampler: TONY Calverley

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

See attached

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Number of Containers
1	BHR10UR6LKWH051	as per bag	—	Fillet	1
2	BHR10UR6LKWH022				1
3	BHR10UR6LKWH052				1
4	BHR10UR6LKWH062				1
5	BHR10UR6LKWH063				1
6	BHR10UR6LKWH066				1
7	BHR10UR6LKWH166				1
8	BHR10UTBLKWH167				1
9	BHR10UR6WALL021				1
10	BHR10UR6WALL023				1
11	BHR10UR6WALL035				1
12	BHR10UR6WALL054				1

Special Instructions / Regulations / Hazardous Details

Reg 153 Table 1 2 3 TCLP MISA PWQO OTHER (please specify):
Circle one - Note drinking water samples MUST USE DW Chain of Custody

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)			SHIPMENT VERIFICATION (lab use only)			
Released by: <Original signed by>	Date: Aug 30/10	Time: 15:30	Received by: <Original signed by>	Date: 30-Aug-10	Time: 15:10	Temperature: 1.2 °C	Verified by: RFD	Date: Aug 30/10	Time: 16:15	Observations: Yes / No ? If Yes add SIF

TYFM014 26-Mar-10

Submitted as part of the Version 3 Revision effective January 21, 2008

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # L925877

Report To	Report Format / Distribution	Service Requested (Rush for routine analysis subject to availability)
Company:	Standard Other (specify):	Regular (Default)
Contact:	PDF Excel Digital Fax	Priority (Specify Date Required → →) Surcharges apply
Address:	Email 1:	Emergency (1 Business Day) - 100% Surcharge
Phone: Fax:	Email 2:	For Emergency < 1 Day, ASAP or Weekend - Contact ALS
Invoice To Same as Report ? Yes No	**Client / Project Information**	**Analysis Request**
THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (circle Yes or No)	Job #:	Please indicate below Filtered, Preserved or both (F, P, F/P)
Are any samples taken from a regulated DW System? Yes (No)	PO / AFE:	
If yes, an authorized Drinking Water COC MUST be used for this submission.	LSD:	
Is the water sampled intended to be potable for human consumption? Yes (No)	Quote #:	
Lab Work Order # (lab use only)	**ALS Contact:** **Sampler:**	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Number of Containers
13 1	BHR10UR6WALL059	05-per bag	←	Fillet	
14 1	BHR10UR6WALL079				
15 1	BHR10UTBWALL170				
16 1	BHR10UTBWALL171				
17 1	BHR10UTBWHSC169				
1	BHR10UR6BNSH118 } combine				
18 1	BHR10UR6BNSH183 } into one			Whole	
1	BHR10UR6BNSH145 } sample				
19 1	BHR10UR1WALL033			Fillet	
20 1	BHR10UR1WALL041				
21 1	BHR10UR1WALL042				
22 1	BHR10UR1WALL046				

Special Instructions / Regulations / Hazardous Details

Reg 153 Table 1 2 3 TCLP MISA PWQO OTHER (please specify):
Circle one - Note drinking water samples MUST USE DW Chain of Custody

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)			SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
<Original signed by>	Aug 30/10	15:30	<Original signed by>	BG 06.10	15:10	-1.2°C	REB	Aug 30	16:15	

Submitted as part of the Version 3.8 GHG Emission Reporting Program (Jan 2010 - Dec 2010) 2010/06/23

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # L925877
Page 3 of 6

Report To
Company:
Contact:
Address:
Phone: Fax:

Report Format / Distribution
Standard Other (specify):
PDF Excel Digital Fax
Email 1:
Email 2:

Service Requested (Rush for routine analysis subject to availability)
Regular (Default)
Priority (Specify Date Required → →) Surcharges apply
Emergency (1 Business Day) - 100% Surcharge
For Emergency < 1 Day, ASAP or Weekend - Contact ALS

Invoice To Same as Report ? Yes No

THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (circle Yes or No)
Are any samples taken from a regulated DW System? Yes No
If yes, an authorized Drinking Water COC MUST be used for this submission.
Is the water sampled intended to be potable for human consumption? Yes No

Client / Project Information
Job #:
PO / AFE:
LSD:
Quote #:

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Lab Work Order # (lab use only)

ALS Contact: **Sampler:**

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Number of Containers
23	BHR10URIWALL047	as per bag	—	Fillet	1
24	BHR10URIWALL054				1
25	BHR10URIWALL055				1
26	BHR10URIWALL056				1
27	~~BHR10URIWALL057~~				1
28	BHR10URIWHSC032				1
28	BHR10URIWHSC034				1
29	BHR10URIWHSC093				1
30	BHR10URIWHSC044				1
31	BHR10URIWHSC045				1
32	BHR10URIWHSC051				1
33	BHR10URICISC031				1

Special Instructions / Regulations / Hazardous Details

Reg 153 Table 1 2 3 TCLP MISA PWQO OTHER (please specify):
Circle one - Note drinking water samples MUST USE DW Chain of Custody

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
<Original signed by>	Aug 30/10	15:30	<Original signed by>	30-Aug-10	13:10	1.2 °C	REB	Aug 30	16:15	

TYFM014 26-Mar-10

Submitted as part of the Voluntary Investigation
January 21, 2011

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # L925877

Report To	Report Format / Distribution	Service Requested (Rush for routine analysis subject to availability)
Company:	Standard Other (specify):	Regular (Default)
Contact:	PDF Excel Digital Fax	Priority (Specify Date Required → →) Surcharges apply
Address:	Email 1:	Emergency (1 Business Day) - 100% Surcharge
	Email 2:	For Emergency < 1 Day, ASAP or Weekend - Contact ALS
Phone: Fax:		
Invoice To Same as Report ? Yes No	Client / Project Information	Analysis Request
THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (circle Yes or No)	Job #:	Please indicate below Filtered, Preserved or both (F, P, F/P)
Are any samples taken from a regulated DW System? Yes No	PO / AFE:	
If yes, an authorized Drinking Water COC MUST be used for this submission.	LSD:	
Is the water sampled intended to be potable for human consumption? Yes No		
	Quote #:	
Lab Work Order # (lab use only)	ALS Contact: / Sampler:	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Number of Containers
34 1	BHR10uRIC15C035	as per bag	—	Fillet	
35 1	BHR10uRIC15C036				
36 1	BHR10uRIC15C037				
39 1	BHR10uRIC15C038				
38 1	BHR10uRIC15C048				
39 1	BHR10uRIC15C049				
40 1	BHR10uRIC15C050				
42 1	BHR10u13WALL009				
43 1	BHR10u13WALL010				
44 1	BHR10u13WALL012				
45 1	BHR10u13WALL013				
46 1	BHR10u13WALL014				

Special Instructions / Regulations / Hazardous Details

Reg 153 Table 1 2 3 TCLP MISA PWQO OTHER (please specify):
Circle one - Note drinking water samples MUST USE DW Chain of Custody

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
<Original signed by>	Aug 30/10	15:30	<Original signed by>	3-Sep-10	15:30	1.2 °C	Aug 30/10	16:15		

Submitted as part of the Version 3.0 Amendment to the E-Commerce Agreement effective January 1, 2010

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # L925877
Page 5 of 6

Report To	Report Format / Distribution	Service Requested (Rush for routine analysis subject to availability)
Company:	Standard Other (specify):	Regular (Default)
Contact:	PDF Excel Digital Fax	Priority (Specify Date Required → →) Surcharges apply
Address:	Email 1:	Emergency (1 Business Day) - 100% Surcharge
	Email 2:	For Emergency < 1 Day, ASAP or Weekend - Contact ALS
Phone: Fax:		
Invoice To Same as Report ? Yes No	**Client / Project Information**	**Analysis Request**
THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (circle Yes or No)	Job #:	Please indicate below Filtered, Preserved or both (F, P, F/P)
Are any samples taken from a regulated DW System? Yes No	PO / AFE:	
If yes, an authorized Drinking Water COC MUST be used for this submission.	LSD:	
Is the water sampled intended to be potable for human consumption? Yes No		
	Quote #:	
Lab Work Order # (lab use only)	**ALS Contact:** **Sampler:**	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Number of Containers
46	BHR10U13WALL018	as per bag	—	Fillet	
47	BHR10U12WALL005				
48	BHR10U12WALL006				
49	BHR10U13WHSC016				
50	BHR10U13WHSC017				
51	BHR10U13WHSC020				
52	BHR10U13WHSC021				
53	BHR10U13WHSC030				
54	BHR10U10WHSC038				
55	BHR10U13WHSC039				
56	BHR10U13WHSC040				
57	BHR10U13LKWH019				

Special Instructions / Regulations / Hazardous Details

Reg 153 Table 1 2 3 TCLP MISA PWQO OTHER (please specify):
Circle one - Note drinking water samples MUST USE DW Chain of Custody

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)			SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
<Original signed by>	30Aug10	15:30	<Original signed by>	30-AUG10	15:30	1.2 °C	RES	Aug 30/10	16:15	

TYFM014 26-Mar-10

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # L925877
Page 6 of 6

Submitted as part of the Vessel SHRP Monitoring Program
Jan 1 2010 - Dec 31 2010

Report To	Report Format / Distribution	Service Requested (Rush for routine analysis subject to availability)
Company:	Standard Other (specify):	Regular (Default)
Contact:	PDF Excel Digital Fax	Priority (Specify Date Required → →) Surcharges apply
Address:	Email 1:	Emergency (1 Business Day) - 100% Surcharge
	Email 2:	For Emergency < 1 Day, ASAP or Weekend - Contact ALS
Phone: Fax:		
Invoice To Same as Report ? Yes No	**Client / Project Information**	**Analysis Request**
THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (circle Yes or No)	Job #:	Please indicate below Filtered, Preserved or both (F, P, F/P)
Are any samples taken from a regulated DW System? Yes No	PO / AFE:	
If yes, an authorized Drinking Water COC MUST be used for this submission.	LSD:	
Is the water sampled intended to be potable for human consumption? Yes No		
	Quote #:	
Lab Work Order # (lab use only)	**ALS Contact:** **Sampler:**	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Number of Containers
58 1	BHR10U13LKWH041	as per bag	—	Fillet	
59	BHR10U13LKWH042				
60	BHR10U13LKWH043				
61	BHR10U15BNSH005			Whole	

Special Instructions / Regulations / Hazardous Details

Reg 153 Table 1 2 3 TCLP MISA PWQO OTHER (please specify):
Circle one - Note drinking water samples MUST USE DW Chain of Custody

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: <Original signed by>	Date: Aug 30/10	Time: 15:30	Received by: <Original signed by>	Date: 30-Aug-10	Time: 15:30	Temperature: 1.2°C	Verified by:	Date: Aug 30/10	Time: 16:15	Observations: Yes / No ? If Yes add SIF

TYFM014 26-Mar-10

ATTACHMENT C

GOLDER PASTE TECHNOLOGY
ATTN: JOHN SEYLER
1010 LORNE ST.
SUDBURY ON P3C 4R9
Phone: 705-524-6861

Date Received: 01-OCT-10
Report Date: 13-OCT-10 14:26 (MT)
Version: FINAL

Certificate of Analysis

Lab Work Order #: L938749
Project P.O. #: NOT SUBMITTED
Job Reference: 10-1118-0020
Legal Site Desc:
C of C Numbers: L938749

<Original signed by>

Richard Clara
General Manager, Thunder Bay

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

Submitted as part of the Version 3 HRGP Amended Application January 2018 - 1656263

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L938749-1	L938749-2	L938749-3	L938749-4	
	Description	FISH TISSUE	FISH TISSUE	FISH TISSUE	FISH TISSUE	
	Sampled Date	25-SEP-10	25-SEP-10	25-SEP-10	25-SEP-10	
	Sampled Time					
	Client ID	BHRIOUTBWHSC 001	BHRIOUTBWHSC 006	BHRIOUTBWHSC 007	BHRIOUTBWHSC 009	
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al) (mg/kg wwt)	10.6	18.9	9.8	6.1	
	Antimony (Sb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	
	Arsenic (As) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	
	Barium (Ba) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	
	Beryllium (Be) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	
	Bismuth (Bi) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	
	Boron (B) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	
	Cadmium (Cd) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	
	Calcium (Ca) (mg/kg wwt)	115	148	90	552	
	Chromium (Cr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	
	Cobalt (Co) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	
	Copper (Cu) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	
	Iron (Fe) (mg/kg wwt)	<10	<10	<10	<10	
	Lead (Pb) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	
	Magnesium (Mg) (mg/kg wwt)	251	249	260	222	
	Manganese (Mn) (mg/kg wwt)	<20	<20	<20	<20	
	Mercury (Hg) (mg/kg wwt)	0.301	0.162	0.198	0.072	
	Molybdenum (Mo) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	
	Nickel (Ni) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	
	Phosphorus (P) (mg/kg wwt)	2010	1700	1850	1840	
	Potassium (K) (mg/kg wwt)	3690	3020	3320	2970	
	Selenium (Se) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	
	Silver (Ag) (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	
	Sodium (Na) (mg/kg wwt)	470	262	342	271	
	Strontium (Sr) (mg/kg wwt)	<20	<20	<20	<20	
	Thallium (Tl) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	
	Tin (Sn) (mg/kg wwt)	1.8	1.6	1.4	1.3	
	Titanium (Ti) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	
	Uranium (U) (mg/kg wwt)	<5.0	<5.0	<5.0	<5.0	
	Vanadium (V) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	
	Zinc (Zn) (mg/kg wwt)	<10	<10	<10	<10	
	Zirconium (Zr) (mg/kg wwt)	<1.0	<1.0	<1.0	<1.0	

Submitted as part of the Version 3 HRGP Amendment EIS Documentation
January 2018 - 1656263

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
AS,SB,SE-MS-WT	Tissue	As, Sb, Se in Tissue by ICP/MS	EPA 200.3/6020
HG-WT	Tissue	Mercury by CVAA	SW846 7470A
MET-ICP-WT	Tissue	Metals in Tissue by ICP	EPA 200.3/6020

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS LABORATORY GROUP - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

L938749

GLOSSARY OF REPORT TERMS

Surrogate A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg milligrams per kilogram based on dry weight of sample.
mg/kg wwt milligrams per kilogram based on wet weight of sample.
mg/kg lwt milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L milligrams per litre.
< - Less than.
D.L. The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as receieved by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Submitted as part of the Vendor SAR Information Package January 2011 1502763

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # L938749 Page 1 of 1

Report To	Golder Associates Ltd.
Company:	Golder Associates Ltd.
Contact:	John Seyler
Address:	1010 Lorne St. Sudbury ON
Phone:	705 524 6861 Fax: 705 524 1984
Invoice To	Same as Report ? (Yes) No

Report Format / Distribution
Standard Other (specify):
(PDF) (Excel) Digital Fax
Email 1: jseyler@golder.com
Email 2: jdickison@golder.com

Service Requested (Rush for routine analysis subject to availability)
(Regular) (Default)
Priority (Specify Date Required → →) Surcharges apply
Emergency (1 Business Day) - 100% Surcharge
For Emergency < 1 Day, ASAP or Weekend - Contact ALS

THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (circle Yes or No)
Are any samples taken from a regulated DW System? Yes No
If yes, an authorized Drinking Water COC MUST be used for this submission.
Is the water sampled intended to be potable for human consumption? Yes No

Client / Project Information
Job #: 10-1118-0020
PO / AFE:
LSD:
Quote #: Q25939
ALS Contact: Karen Rutledge Sampler: JD

Lab Work Order # (lab use only)

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	As per previous fish tissue samples under this Quote #	Number of Containers
1	BHR 10U TB WHSC 001	25 SEP 10	—	Fish tissue		1
2	BHR 10U TB WHSC 006	25 SEP 10	—	Fish tissue		1
3	BHR 10U TB WHSC 007	25 SEP 10	—	Fish tissue		1
4	BHR 10U TB WHSC 009	25 SEP 10	—	Fish tissue		1

Special Instructions / Regulations / Hazardous Details

Reg 153 Table 1 2 3 TCLP MISA PWQO OTHER (please specify):
Circle one - Note drinking water samples MUST USE DW Chain of Custody

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / (No ?) If Yes add SIF
<Original signed by>	01 OCT 10		<Original signed by>	OCT 1/10	3:25	4.9 °C	<Original signed by>	Oct. 4/10	10:45	

TYFM014 26-Mar-10

December 2013

OSISKO HAMMOND REEF GOLD LTD.

Fish Habitat No Net Loss / Habitat Offset Plan for the Hammond Reef Gold Project Rev. 0

Submitted to:
Alexandra Drapack
Osisko Hammond Reef Gold Ltd.
155 University Avenue
Suite 1440
Toronto, ON M5H 3B7

REPORT

Report Number: 13-1118-0010 (DOC028)

Distribution:

1 e-copy - Osisko Hammond Reef Gold Ltd.

1 copy - Golder Associates Ltd.

Golder Associates

Table of Contents

1.0 INTRODUCTION 1

2.0 OBJECTIVE 1

3.0 OVERVIEW OF APPROACH TO NO NET LOSS PLANNING 5

4.0 THE PROJECT AND POTENTIAL IMPACTS ON AQUATIC FEATURES 6

5.0 THE AQUATIC ENVIRONMENT AND BASELINE DATA COLLECTION 16

5.1 Habitat Mapping and Determination of Habitat Areas 16

5.2 Fish Species Presence and Species Weighting 27

5.2.1 Gear Selection and Sampling Methods 28

5.3 Species Guilds and Weighting 32

5.4 Ecotypes and Fish Community Composition 34

5.5 Species Associations by Ecotype 35

5.6 Habitat Classes and Habitat Sensitivity Weighting 40

5.7 Calculation of Weighted Useable Area Scores 41

5.7.1 Worked Example Calculation – Mitta Lake and Area of Potential Impact #2 44

6.0 SUMMARY OF HABITAT LOSSES 48

7.0 COMPENSATION APPROACHES 53

7.1 Compensation Calculations 63

7.1.1 Assessment of Habitat Potential of Fishless Lakes 64

7.1.2 Stream Crossings 69

7.2 Additional Mitigation and Compensation Measures 75

7.2.1 Northern Pike Spawning Habitat Creation 85

7.2.2 Fish Passage in Sawbill Creek for Walleye 88

7.2.3 Summary of Offsetting Compensation Measures 93

7.3 Open Pit Habitat Creation 93

7.4 Summary of MMER and Section 35 Habitat Offsets 94

7.4.1 MMER 98

7.4.2 Section 35 of the Fisheries Act 99

8.0 MONITORING PROGRAMS AND COMMITMENTS 100

8.1 Aquatic Monitoring Program 100

8.2 Final No Net Loss / Habitat Offset Plan 100

8.3 Scheduling of Waterbodies Under Metal Mining Effluent Regulation 101

8.4 Environmental Effects Monitoring under Metal Mining Effluent Regulation 102

8.5 Fish Rescue and Salvage Protocols – Mitta Lake and Other Waterbodies 102

8.6 Construction Monitoring 109

8.7 Blast Monitoring and Collection of Supplementary Fish Habitat Information (Sawbill Bay) 109

9.0 REFERENCES 110

10.0 CLOSURE 112

TABLES

Table 1: Aquatic Areas of Potential Impact Potentially Directly Affected by the Hammond Reef Gold Project (Preferred Option) 9

Table 2: Habitat Features and Variables Measured During Baseline Studies 16

Table 3: Fish Species Captured During Baseline Studies 28

Table 4: General Guide to Gear Selection by Ecotype and Major Habitat Type 31

Table 5: Fish Habitat Groupings 32

Table 6: Species Habitat Weights by Habitat Group 33

Table 7: Fish Community Composition by Ecotype 36

Table 8: Example of Weighted Useable Area Calculation of Two Areas of Potential Impact Showing Estimates of Habitat Losses 44

Table 9: Example of Habitat Suitability Index Scores for Two Fish Species 45

Table 10: Mitta Lake Species Weights and Habitat Suitability Index Scores 47

Table 11: Area of Potential Impact #2 Species Weights and Habitat Suitability Index Scores 48

Table 12: Percent of Habitat Units Represented by Valued Fisheries 48

Table 13: Aquatic Areas of Potential Impact affected by Project Footprint 49

Table 14: Weighted Useable Area Calculations of Proposed Habitat Creation Showing Estimates of Habitat Gains 63

Table 15: Summary of Habitat Compensation for 15 Stream Crossings 69

Table 16: Summary of MMER and Section 35 Habitat Losses 94

Table 17: Regulatory Agency Consultation for Aquatic Ecology Studies 95

FIGURES

Figure 1: Aquatic Environment Local Study Area 3
Figure 2: Site Layout 7
Figure 3: Project Footprint and Aquatic Areas of Potential Impact 13
Figure 4: Area of Potential Impact #12 (Stream) 19
Figure 5: Area of Potential Impact #12 (Mitta Lake) 21
Figure 6: Area of Potential Impact #12 (Mitta Lake) Bathymetry 23
Figure 7: Area of Potential Impact #12 (Mitta Lake) Interpreted Lake Bottom Substrate 25
Figure 8: Potential Fish Habitat Compensation Works 55
Figure 9: Potential Fish Habitat Compensation Area – Beaver Meadow 1 57
Figure 10: Potential Fish Habitat Compensation Area – Beaver Meadow 2 59
Figure 11: Potential Fish Habitat Compensation Area – Beaver Meadow 3 61
Figure 12: Location of Fishless Ponds 65
Figure 13 (a-f): Late Winter Dissolved Oxygen (blue) and Temperature (red) profiles of selected Ponds. 68
Figure 14: Water Crossing Locations 73
Figure 15: Minimum and Maximum Water Levels for Upper Marmion Reservoir (Hydrology TSD) 75
Figure 16: Sawbill Creek Mouth Pike Spawning Habitat 79
Figure 17: Hammond Embayment Pike Spawning Habitat 80
Figure 18: Snail Bay Pike Spawning Habitat 81
Figure 19: Area of Potential Impact #37 Pike Spawning Habitat 82
Figure 20: Hammond Peninsula Discharge Area Spawning Reef 83
Figure 21: Lynxhead Bay Spawning Reef Alternative 84
Figure 22: Concept of a Shallow Excavation with a Series of Deeper Channels for Access and/or Mounds to Provide Habitat Diversity (TRCA 2003) 86
Figure 23: Representative Shallow Water Vegetation Zones. 87
Figure 24: Example Illustrating a Typical Riffle Step. 92
Figure 25: Areas of Potential Impact Requiring Metal Mining Effluent Regulation in the Tailings Management Facility 105
Figure 26: Areas of Potential Impact Requiring Metal Mining Effluent Regulation in the Waste Rock Management Facility 107

PHOTOS

Photo 1: Exposed Shoreline of Sawbill Bay during Low Water, near the Mouth of API #33 (June 2010) 76
Photo 2: Exposed Shoreline of Snail Bay during Low Water Elevation (June 2010) 77
Photo 3: Upstream End of Existing Barrier to Walleye Movement (September 2010) 88

Photo 4: Middle Portion of Barrier to Walleye Movement (September 2010) 89

Photo 5: A Series of Step Pool Features Were Constructed to Improve Fish Passage in this Former Cascade Feature 90

Photo 6: Example of Natural Fish Passages (Wildman et. al. in press) 91

APPENDICES

APPENDIX A

Definitions for Habitat Variables

APPENDIX B

Fish Habitat Preference Tables

APPENDIX C

Habitat Accounting Model

APPENDIX D

Winter Dissolved Oxygen Measurements

APPENDIX E

Stream Crossings

1.0 INTRODUCTION

In Canada, the fish resources and the habitats that support them are protected by the *Fisheries Act,* federal legislation that is administered by Fisheries and Oceans Canada (DFO) and Environment Canada. The harmful alteration or disruption, or destruction (HADD) of fish habitat is prohibited by Subsection 35(1) of the *Fisheries Act* unless it is authorized pursuant to Subsection 35(2). In keeping with the guiding principal of No Net Loss outlined in DFO's Policy for the Management of Fish Habitat (DFO 1986), authorizations are issued on condition that the proponent implements measures to compensate or offset the HADD arising from their project. The measures that a proponent intends to implement to compensate for the HADD of fish habitat arising from their project are described in compensation plans, also referred to as a No Net Loss Plans (NNLPs). In addition to describing the compensation measures, NNLPs also provide quantification of fish habitat harmfully altered or disrupted, or destroyed, by the project as well as the habitat gained through the compensation.

2.0 OBJECTIVE

The following provides a description of how fish habitat losses and gains were calculated in this No Net Loss Plan (NNLP) developed to offset habitat altered by the Hammond Reef Gold Project (the Project). The proponent of the Project is Osisko Hammond Reef Gold Ltd. (OHRG). The methodology outlined in this report forms the basis of habitat compensation planning for the Project. The methodology is consistent with NNLPs developed and approved for other mining projects by Golder Associates Ltd. (Golder), notably the De Beers Snap Lake Diamond Project (Golder 2004), the Imperial Oil Kearl Oil Sands Project (Golder 2007) and the Agnico-Eagle Mines Meliadine Gold Project Conceptual Fish Habitat Compensation Plan (Golder 2011). Key guidance documents used to formulate the habitat accounting approach include the *Practitioners Guide to Compensation for Department of Fisheries and Oceans Habitat Staff* (DFO 2006), *Review of Approaches for Estimating Changes in Productive Capacity from Whole Lake/Stream Destruction and Related Compensation Projects* (Packman et. al. 2006) and *An Introductory Guide to Preparing and Assessing No Net Loss Plans* (Minns 2010).

Bill C-38, passed in June 2012, and implemented into policy in January 2013 (Phase 1) and November 2013 (Phase 2), amends the *Fisheries Act* to focus on the protection of fish that support commercial, recreational or Aboriginal fisheries and to more effectively manage activities that pose the greatest threat to these fisheries. The development of the habitat compensation approach was based upon DFOs current priority of focusing compensation activities on valued fisheries, namely commercial, recreational and Aboriginal (CRA) fisheries and the fish that support them. In addition, this priority also gives consideration to the hierarchy of compensation preferences as outlined in DFO Policy for Management of Fish Habitat (DFO 1986) and the *Practitioners Guide to Habitat Compensation* for DFO Habitat Management Staff (DFO 2006).

Within the aquatic environment Local Study Area (LSA) (Figure 1), the key CRA fisheries that may be affected by the Project are as follows:

- Receiving waterbodies: Upper Marmion Reservoir, including Sawbill and Lynxhead Bay and Lizard Lake.
- Streams and lakes within the Project footprint that may support fisheries within receiving waterbodies, that may provide seasonal habitats for CRA species, and that may provide potential baitfish opportunities.

In the context of the valued fisheries, the general preferences for habitat compensation can be summarized as follows, in order of priority:

- Creation of similar habitat at or near the Project footprint within the same ecological unit; that is, replace natural habitat with the same type of habitat at or near the Project.
- Create similar habitat in a different ecological unit that supports the same stock or species.
- Increase the productive capacity of existing habitat at or near the development site and within the same ecological unit.
- Increase the productive capacity of a different ecological unit that supports the same stock or species.
- Increase the productivity capacity of existing habitat for a different species of fish either on or off-site.

Potential compensation options assessed included the following:

- Impoundment of former beaver ponds that have reverted to meadows to create pond habitat.
- Potential to introduce large and small bodied fish species into ponds/small lakes that were determined to be fishless during baseline studies.
- Assessment of on-site Areas of Potential Impact (APIs) found to be fishless during baseline studies to determine their potential for fish introduction (an API is any waterbody that was deemed at the beginning of the Project to be potentially impacted by the Project).
- Examine existing water crossings to determine if fish passage or adjacent habitat can be enhanced/ created.
- Development and assessment of additional projects within Upper Marmion Lake and its major tributaries to enhance spawning and nursery habitat for target CRA fisheries, primarily northern pike, walleye and smallmouth bass.
- Consideration of other habitat creation opportunities considered to have merit, based on Ministry of Natural Resources (MNR)/DFO fish management priorities.

600000 610000 620000 630000

5430000 5420000 5410000

Serpent Lake
Cornell Lake
Sawbill Bay
Lynxhead Bay
Marmion Reservoir
Hawk Bay
Upper Seine Bay
Light Lake
Highway 622
Steep Rock Lake

N

LEGEND

- Small Community
- Provincial Highway
- Road
- Existing Railway
- Power Transmission Line
- River/Stream
- Lake
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities
- Aquatic Environment Local Study Area

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2.5 1.25 0 2.5 5 7.5
KILOMETRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AQUATIC ENVIRONMENT LOCAL STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	CGE	8 Jan. 2013		
GIS	JO	10 Apr. 2013		
CHECK	BH	10 Apr. 2013		
REVIEW	GA	10 Apr. 2013		

FIGURE: 1

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\AquaticsNoNetLossPlan\AquaticEnvironmentLSA.mxd

Page left intentionally blank

3.0 OVERVIEW OF APPROACH TO NO NET LOSS PLANNING

A number of steps were required to document how habitat losses and gains were calculated. These are as follows:

- Evaluate baseline habitat characteristics in the areas where habitat alteration will occur.
- Determine which fish species and life history stages will be affected by habitat alteration (species present).
- Determine the quantity and quality of habitat affected by the Project.
- Determine the quantity and quality of habitat gained/created by compensation measures.
- Estimate the net change in habitat quality and quantity.

The Habitat Evaluation Procedure (HEP) approach developed by the U.S. Fish and Wildlife Service (USFW 1980) was adopted to determine the quantity and quality of fish habitat affected by mine construction, operation and closure including the pit, the preferred tailings management and waste rock storage facilities and all other infrastructure (e.g., roads, transmission corridors, process facilities). While more recent methodologies have been developed, in particular Minns et al (2001) and Minns (2010), the HEP approach was preferred for the following reasons:

- DFO has agreed with the application of this method, also used in the Meliadine Gold Project (Golder 2011).
- Golder has successfully demonstrated the use of HEP in a number of approved NNLPs and was familiar with the Meliadine project.
- The HEP approach, though more subjective, offered greater flexibility in terms of the range of habitat variables that could be used.
- The HEP approach can be applied using baseline data collected by Golder for the Project.

HEP uses Habitat Units (HUs), a single dimensionless value that integrates habitat quantity and quality, where the HU is the product of habitat quantity measured as a unit area (typically square metres) (HA) and habitat quality expressed as a Habitat Suitability Index (i.e., HU = HSI x HA). Minns et al. (2001) use the term Weighted Useable Area (WUA) in place of HU, as it more accurately reflects the fact that although the value is dimensionless, it is weighted based on the habitat preferences of the fish species present in each habitat unit and inherently linked to HA. The number of WUAs lost, as a result of permanent alteration of, or destruction of, fish habitat, due to the construction, operations and post-closure phases of the Project were compared to the WUAs gained from habitat created or enhanced. For No Net Loss to be achieved:

$$\mathbf{WUA_{lost} - WUA_{compensation} = 0}$$

Not all habitat loss will be immediate. It is expected that some HADDs will take place over time through the construction and operations phases of the Project. Once detailed engineering is available, it will be possible to predict the timing of losses (i.e., scheduling for tailings dam construction and filling of the tailings management area). Similarly, not all compensation works will be completed immediately, and it is anticipated that it will take time to create functioning habitats and to detect the results of habitat enhancement. Where there is a lag between loss of habitat and creation of functioning compensation habitat, WUA_{lost} may need to be compensated using a replacement ratio of $WUA_{compensation}$:WUA_{lost} greater than 1.

HSI models are derived using a comparison of a set of habitat variables (e.g., depth, substrate). Suitability value is rated on a 5-point scale, from 0.0 to 1.0 with a rating of 1.0 representing optimal habitat, for each life stage of each species. The HSI relationships used to determine habitat suitability were based on published HSI models and life history studies, existing data collected as part of the Project, and upon professional judgement (e.g., expert opinion provided by northern Ontario fisheries managers and researchers).

4.0 THE PROJECT AND POTENTIAL IMPACTS ON AQUATIC FEATURES

The Project is situated on the Hammond Peninsula, which extends out into the Upper Flood Waters (Upper Marmion Reservoir). The eastern edge of the peninsula is bordered by Lizard Lake, which is physically connected to the Upper Flood Waters. The Project will consist of an open pit Mine, an Ore Processing Facility, a Waste Rock Management Facility (WRMF), and a Tailings Management Facility (TMF) as well as a road network and project transmission line to support operation of the Project facilities (Figure 2). Ancillary structures, such as an on-site accommodation camp, will also be part of the Project footprint. A number of sub-catchments drain the Project footprint.

Aquatic features may be potentially impacted by the following:

- Construction and permanent camp operation.
- Pit excavation including blasting.
- Construction of process facilities, including buildings, explosives plant, parking lots and a mine spill emergency pond.
- Storage of tailings, waste rock, overburden and low-grade ore.
- Construction of tailings dams, and diversion of natural watercourses around TMF and WRMF. Surface water management and discharge.
- Construction and maintenance of access roads (including aggregate extraction), electrical transmission and tailings pipeline corridors.
- Quality and quantity of mine effluent and sewage treatment effluent. Construction and operation of effluent discharge and water intakes.

A full assessment of impacts and quantification of residual direct and indirect impacts (i.e., after mitigation has been taken into account) was carried out and is described in the Environmental Impact Statement/ Environmental Assessment Report (EIS/EA Report) (Golder 2013b) and the Aquatic Environment Technical Support Document (TSD) (Golder 2013a).

610000 615000 620000

5430000 5425000 5420000

Serpent Lake
Cornell Lake
Long Hike Lake
Vista Lake
Lizard Lake
Light Lake
Sawbill Bay
Marmion Reservoir
Lynxhead Bay
Trap Bay
Turtle Bay
Upper Seine Bay

ACCOMMODATION CAMP
PUMPING STATION
TAILINGS MANAGEMENT FACILITY
PUMPING STATION
DETONATOR STORAGE
EMULSION PLANT
PEBBLE CRUSHING STATION
CONCENTRATOR
POWER SUBSTATION
PROPANE FARM
EFFLUENT TREATMENT PLANT
PROCESS PLANT COLLECTION POND
GYRATORY CRUSHER PAD
LIVE ORE STOCKPILE
PARKING LOT
SECURITY STATION
TRUCK SHOP / MINE OFFICE
PARKING LOT
FUEL BAY
EAST PIT
WEST PIT
WASTE ROCK STOCKPILE
LOW-GRADE ORE STOCKPILE
OVERBURDEN STOCKPILE

N

LEGEND

- Index Contour (5m interval)
- Ditch
- Marsh/Swamp
- River/Stream
- Road
- Trail
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Accommodation Camp
- Laydown Area
- Office and Truck Shop, Explosives Storage and Processing Plant
- Open Pits
- Low-Grade Ore Stockpile
- Overburden Stockpile
- Process Plant Collection Pond
- Pumping Station
- Tailings Management Facility
- Tailings Management Facility Reclaim Pond
- Waste Rock Stockpile

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd. under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

500 0 500 1,000 1,500 2,000 2,500
METERS

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
SITE LAYOUT

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	CGE	14 Nov. 2008	FIGURE: 2	
GIS	JO	10 Apr. 2013		
CHECK	BH	10 Apr. 2013		
REVIEW	GA	10 Apr. 2013		

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\NoNetLossPlan\SiteLayout.mxd

Page left intentionally blank

During the aquatic baseline program aquatic features were assessed within and adjacent to the Project footprint, including water crossings located along the corridors. The assessment included areas of alternative TMF and access road arrangements later eliminated during the EA process. These features have been termed APIs. APIs include a number of permanent streams and associated beaver (*Castor canadensis*) impoundments as well as several small lakes, the largest of which is Mitta Lake (Figure 3). Table 1 summarizes the aquatic features (APIs) impacted or altered by various Project components based upon the most recent site plan. Detailed fish community composition and habitat mapping information for most of the APIs listed in Table 1 can be found in the Aquatic Environment TSD.

Table 1: Aquatic Areas of Potential Impact Potentially Directly Affected by the Hammond Reef Gold Project (Preferred Option)

Infrastructure Feature	Aquatic Area of Potential Impact	Description	Description of Potential Effect
Open Pit	Mitta Lake (API #12) and its outlet stream	17.2737 ha Headwater lake; approximately 0.0449 ha of Lower Reach - stream; empties into Sawbill Bay; supports white sucker (*Catostomus commersoni)*, ninespine stickleback (*Pungitius pungitius)*, brook stickleback (*Culaea inconstans*), fathead minnow (*Pimephales promelas)*, Iowa darter (*Etheostoma exile)*, mottled sculpin (*Cottus bairdii*) and finescale dace (*Phoxinus neogaeus)*.	Mitta Lake forms the active pit. The destruction of Mitta Lake results in the loss of 494 HU of useable littoral habitat and 9,114 HU of useable open water habitat.
	API #14	Upper portions of approximately 0.1169 ha Lower Reach stream; empties into Sawbill Bay; supports, finescale dace, northern redbelly dace (*Phoxinus eos)*, fathead minnow; juvenile white sucker captured in lower reach.	API #14 will be removed for the construction of the Support and Ancillary Structures near the open pit. Destruction of API #14 results in a loss of 45 HU of useable low gradient stream habitat and 119 HU of useable high gradient stream habitat.
	API #69	0.9871 ha Headwater pond and 0.0165 ha of Headwater stream; pond supports white sucker, pearl dace, Iowa darter, , central mudminnow (*Umbra limi*), blacknose shiner, finescale dace and northern redbelly dace. No fish were found to exist within the outlet stream.	Headwater pond and upper reaches of API #69 will be destroyed through the construction of the open pit. Destruction of API #69 results in a loss of 224 HU of useable littoral habitat, 1080 HU of useable open water habitat.

Table 1: Aquatic Areas of Potential Impact Potentially Directly Affected by the Hammond Reef Gold Project (Preferred Option) (Continued)

Infrastructure Feature	Aquatic Area of Potential Impact	Description	Description of Potential Effect
Other Mine Facilities	Sawbill Bay	Localized filling within the drawdown zone along Hammond Reef peninsula to provide adequate space for mine buildings, parking, etc. approximately 0.8 ha of seasonal habitat within the drawdown zone will be destroyed. Area provides seasonal nursery/foraging habitat for baitfish species, northern pike, smallmouth bass	About 0.8 ha of the drawdown zone along the Hammond Reef peninsula Shoreline will be destroyed. Resulting loss of about 913 HU of useable habitat destroyed
Mine Water Spill Emergency Pond	API #13	1.9375 ha Headwater pond; approximately 0.0396 ha of Headwater stream and 0.0476 ha of Headwater beaver impoundments; both pond and stream are fishless. Empties into Sawbill Bay.	No useable habitat will be lost through the destruction of API #13 for purposes of Support and Ancillary Structure development.
Waste Rock Management Facility	API #11	2.7777 ha Headwater pond; approximately 0.0787 ha of Headwater stream including (several) 0.1030 ha of beaver impoundments; empties into Lynxhead Bay; supports finescale dace, northern redbelly dace, fathead minnow.	API#11 will be destroyed through the construction of the Waste Rock Stockpile. 32 HU of useable low gradient stream, 13 m of useable high gradient stream, 58 HU of useable pond, 173 HU of useable littoral and 1701 HU of useable open water habitat will be lost.
Tailings Management Facility	API #47	Approximately 0.0762 ha of Lower Reaches – Inlet stream and 2.9944 ha of beaver impoundments; supports finescale dace, pearl dace (*Margariscus margarita),* and northern redbelly dace.	The streams and beaver impoundments of API #47 will be impacted by the proposed Tailings Management Facility. This will result in a loss of 12 HU of useable low gradient habitat, 35HU of useable high gradient habitat and 1825 m^2 of useable pond habitat.

Table 1: Aquatic Areas of Potential Impact Potentially Directly Affected by the Hammond Reef Gold Project (Preferred Option) (Continued)

Infrastructure Feature	Aquatic Area of Potential Impact	Description	Description of Potential Effect
	API #48	Approximately 0.0123 ha of Headwater - ephemeral/seasonal stream, 0.0430 ha of Headwater - permanent stream and several Headwater beaver ponds (1.0198 ha total); approximately 0.2051 ha Headwater pond; no hydraulic connection to downstream aquatic features. Finescale dace captured in one of the beaver ponds.	The outlet stream and associated beaver impoundments will be impacted by the proposed TMF. This will result in the loss of 239 HU of useable pond habitat.
	API #1	Approximately 0.0894 ha of Lower Reaches – inlet stream, including 0.5836 ha of beaver impoundments; empties into Sawbill Bay; upper sections support pearl dace, finescale dace and fathead minnow; juvenile and young-of-the-year (YOY) white sucker captured in lower sections.	API #1 is entirely contained within the footprint of the TMF and, thus, will be destroyed. This will result in the loss of 266 HU of useable low gradient habitat, 22 HU of useable high gradient habitat, and 3,306 HU of useable pond habitat.
	API #7	1.0962 ha Headwater pond; partially in-filled; fishless; connected to API #6 by a series of small, Headwater beaver ponds (approximately 0.0721 ha).	Though API #7 will be destroyed by the proposed TMF, no useable habitat will be eliminated since the feature is fishless and isolated from API #6.
	API #6	0.5385 ha pond, 0.0437 ha of Lower Reahes – inlet stream, and 0.1004 ha of Lower Reaches - ephemeral stream; empties into Lizard Lake; pond and ephemeral stream are fishless; white sucker and Iowa dater captured in lower segment of stream.	API #6 is contained within the footprint of the proposed TMF. This will result in the loss of 21 HU of useable low gradient stream habitat.

Table 1: Aquatic Areas of Potential Impact Potentially Directly Affected by the Hammond Reef Gold Project (Preferred Option) (Continued)

Infrastructure Feature	Aquatic Area of Potential Impact	Description	Description of Potential Effect
	API #2	12.4351 ha Headwater lake and 0.2217 ha of Headwater stream and 0.3808 ha of Headwater beaver impoundments; supports pumpkinseed (*Lepomis gibbosus)*, northern pike, yellow perch (*Perca flavescens)*, Iowa darter (*Etheostoma exile),* white sucker, blacknose shiner (*Notropis heterolepis)*.	The destruction of API #2 results in the loss of 881 HU of useable littoral habitat and 13,604 HU of useable open water habitat.
Corridors	Water crossing locations along the Hardtack, Sawbill access roads, and site access road (APIs #20 to #23 and #63 to #68)	14 Culvert locations; movement of fish between waterbodies located up/downstream of water crossings.	Impacts to surface water features contained within road crossing API include alteration of the stream channel at the location of the culvert. Potential for HADDs at each crossing will be assessed once culvert design specifications are developed

610000 620000 630000

5430000 5420000

N

Serpent Lake
Cornell Lake
Sawbill Bay
Mitta Lake
Lynxhead Bay
Marmion Reservoir
Light Lake
Upper Seine Bay
Hawk Bay

LEGEND

- Area of Potential Impact (API); Assessed 2010 - 2012
- Raft Lake Cut Location
- Trail
- Road
- River/Stream
- Lake
- Wetland
- Raft Lake Access Road Alternative
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities
- Tailings Management Facility Alternatives

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREAS OF POTENTIAL IMPACT

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	CGE	14 Nov. 2008		
GIS	JO	10 Apr. 2013		
CHECK	BH	10 Apr. 2013		
REVIEW	GA	10 Apr. 2013		

FIGURE: 3

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\NoNetLossPlan\fod_print_api.mxd

Page left intentionally blank

A detailed analysis of all Project-related effects was carried out as part of the EIS/EA Report and the Aquatic Environment TSD, and a comprehensive accounting of lost or altered habitats was based upon the results of this impact assessment.

Potential indirect effects may take place in the lower reaches of watercourses that drain the Project footprint due to alterations of natural hydrographs. Fish from downstream water bodies (including the Upper Marmion Reservoir) use the lower sections of some watercourses to reproduce, and as nursery habitats. The alteration of headwater ponds and streams may also impair downstream flow or movement of fish, other aquatic organisms (i.e., benthic invertebrates) and nutrients into receiving waters. Water quality and hydrologic modelling was used to determine the geographic extent and magnitude of downstream effects.

The assessment of potential indirect effects identified the following potential effects on valued fisheries that are not included within the direct effects in Table 1:

- The effect of lost drainage due to the Project footprint and minewater consumption will affect receiving waterbodies as follows:
  - A reduction in Upper Marmion Lake water levels in the order of 5 to 7 cm, which can be accommodated within the normally operating regime of the Raft Lake Dam
  - A reduction of less than 5 cm in Lizard Lake and API #8 as a result of upstream drainage diversion. This reduction is considered to be within the long term water level fluctuation on these waterbodies.
- Under rare events, there is potential for discharges from the minewater treatment facility to exceed stated water quality objectives. Resulting predicted concentrations are lower than both the PWQO and MISA criteria for most parameters with the exception of copper and free cyanide, which were predicted to increase above the CWQG and PWQO. Site-specific water quality objectives (SSWQOs) that would be protective of aquatic life but that take into account the characteristics of surface waters in Upper Marmion Reservoir and Lizard Lake were developed for these two substances. Based on these analyses, there is no predicted effect on aquatic organisms for these parameters.
- As the WRMF and the TMF are filled with material, there is potential for seepage of water through the groundwater system and into receivers including Sawbill Bay and Lizard Lake. A seepage collection system will be constructed and operated to manage seepage and ensure that seepage does not exit the Mine Site Area. Water quality predictions indicate that under average conditions there will be no seepage losses from the Tailings Management Facility. However, to be conservative, the effect of 10% of the seepage by-passing the collection system and migrating to Lizard Lake (Lake Water Quality TSD [Golder 2013f]) was assessed. Predicted worst case concentrations in Lizard Lake for free cyanide were 0.006 mg/L, which is slightly above the guideline of 0.005 mg/L and below the SSWQO of 0.01 mg/L. As a result there are no predicted effects on aquatic life due to free cyanide in Lizard Lake.

5.0 THE AQUATIC ENVIRONMENT AND BASELINE DATA COLLECTION

Baseline data collection for the Project involved two primary tasks:

- Habitat mapping to evaluate baseline habitat conditions.
- Fish species presence/absence sampling; determining which fish species will be affected by alterations to fish habitat, and their distributions.

5.1 Habitat Mapping and Determination of Habitat Areas

Golder has developed technical procedures for measuring and characterizing fish habitat in watercourses and waterbodies, provided and presented previously to DFO and Ontario Ministry of Natural Resources (MNR). Habitat is mapped to provide an inventory of the available habitats and to identify the locations of habitats that are of importance to fish, such as migration routes, spawning habitats and rearing habitats. During the 2010, 2011 and 2012 field seasons, these mapping protocols were applied to aquatic features potentially impacted by the Project. Table 2 contains a summary of data/variables measured during habitat mapping. These variables are defined in Appendix A. Some variables are further broken down to classes (e.g., size ranges of gravel or cobble substrate) within the technical procedures. Physical features, their locations and/or distribution were measured and recorded on data sheets and field maps by field crews. GPS referenced digital photos illustrating channel/shoreline characteristics also have been collected for each aquatic feature. This information was used to create maps of each API. Interpretation of completed maps, field data sheets, photos, aerial photography and fish capture data (e.g., where capture data can be associated with a specific habitat type) were used to characterize and quantify habitat features in relation to the requirements of fish species present and their life history stages.

Table 2: Habitat Features and Variables Measured During Baseline Studies

Habitat Features (waterbodies)	Channel Units (watercourses)	Habitat Features (watercourses)	Substrate Types
Littoral/limnetic zones	Falls	Shoal	organic material
Shelf	Cascade	Slough	clay/silt
Shoals	Chute	Log jam	Sand
Bottom slope	Rapids	Undercut banks	Gravel
Submerged vegetation	Riffle	Unstable banks	Cobble
Emergent vegetation	Run	Inundated vegetation	boulder
Depth	Flat	Beaver dam	bedrock
Water Quality Parameters	Pool	Exposed bar	**Channel Unit Measures**
	Impoundment pool	Islands	Wetted width
Dissolved oxygen	Backwater	Bank/riparian vegetation	Channel width
Water temperature	Snye	Bank slope	Channel unit length
pH	Boulder garden	Gradient	Channel profile (depth)
		Overhead cover	Velocity
		Instream cover	

Note: Definitions for habitat variables can be found in Appendix A.

Habitat maps for the Project have been created by overlaying Light Detection and Ranging (LiDAR) images of aquatic features with field data (Figure 4).

Stream segment lengths and widths measured for all watercourse segments in the field were used to determine stream area. Two types of stream width data were collected during the baseline study: wetted width and channel width. Wetted width or the width of the water present in the channel at the time of the survey varied with stream discharge, and measures were dependent upon when mapping took place (e.g., freshet vs. late summer, following rainfall events). Habitat areas within channel segments were calculated based upon segment length and measures of channel width, which is defined as the portion of the channel that contains stream bed substrate, whether wet or dry, and is bordered by rooted terrestrial vegetation (e.g., the width representative of the normal high water mark). Channel width is not dependent on stream discharge and does not vary as water level varies. This measurement of channel width is typically somewhat less than bankfull width; however, it approximates the width of channel that provides the majority of the more or less permanently inundated channel substrates, but may exclude the upper bank margins which would be inundated by the bankfull flow.

Littoral zone habitat was mapped on all lakes and ponds potentially impacted by the Project (Figure 5). Digital elevation (e.g., bathymetry) and substrate maps were produced for natural lakes potentially impacted by the Project using single beam, sidescan sonar (Figures 6 and 7). For small ponds, spot depths and bottom grabs were collected during habitat mapping to determine general bathymetric and substrate characteristics.

The resulting datasets are extensive, covering a broad range of habitat variables and allow for a detailed description of fish habitats in both stream and lake settings. For the purpose of calculating habitat losses/gains, two approaches may be used:

- The approach used by Minns (2010) and Minns et al. (2001), which is to reduce the number of habitat variables, based on literature relating use to a simple set of variables – depth, substrate, cover, discharge.
- The approach used in the HEP analysis, which is to utilize more of the collected habitat data but in a less objective, more descriptive manner.

Golder is using the latter method, but with more attention given to using more standardized descriptions of habitat preferences for individual species (or species guilds), life cycle stages and ecotypes as developed in the Minns' lake and stream models.

Minns et al. (2001) and Minns (2010) also completed analyses of key habitat preferences that considered grouping species according to trophic status, reproductive guild and thermal preference data, which was subsequently used in these documents as a means of grouping species into "habitat guilds" and assigning weights to the species habitat calculations. Golder has modified the selected approach by adopting these groupings (with a minor modification) to improve on the approach chosen for evaluation the Project habitat losses and gains as outlined in the following sections.

Page left intentionally blank

611800 612000

5421400 5421200 5421000

450 N Mitta Lake Flow

IP3(2) Si R3(3) Co/Gr FL(2) CF dry(2) CF FL(1) Si dry(1) CF R3(2) Si CF

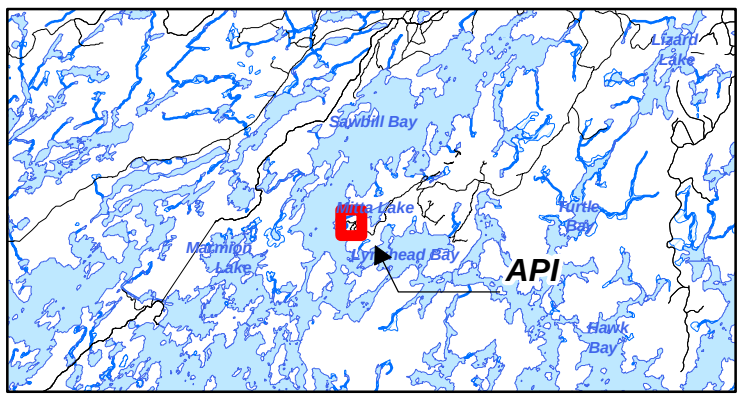
IP2(1) Si 17 CF 450 BD BD

IP2(1) Si 16 15 R3/CA Si BD R3(1) Si CF Sawbill Bay

100 0 100 METRES

SCALE 1:2,400

Segment	Length (m)	Channel Width Transect (m)	Max. Depth a transect (m)	Substrate Dominant	Substrate Sub-dominant	In stream Vegetation
R3	34.42	1.04	0.03	Si	Sa	0
R3/CA	31.9	0.74	0.05	Si	-	25
IP2	254.19	65	1.5	Si	-	5
R3	206.23	0.75	-	Si	-	20
dry	30.68	-	-	-	-	-
FL	84.99	-	-	Si	-	-
dry	82.58	-	-	-	-	-
FL	67.95	-	-	-	-	-
IP3(1)	33.48	-	-	Si	-	-
R3	23.97	-	-	Co	Gr	-



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- IV Instream Vegetation

Bank Slope
← Shallow Slope (0 to 5%)

Channel Unit Type
- FL - Flat, Low Gradient, Low Velocity
- CA - Cascade; Extremely high gradient and velocity
- R3 - Run Class 2; Moderate quality/Depth (0.75-11.0m)
- IP2 - Impoundment Pool: Class 2
- IP3 - Impoundment Pool: Class 3

Substrate Classification
- Co - Cobble
- Gr - Gravel
- Sa - Sand
- Si - Silt

Riparian Vegetation
- CF - Coniferous Forest

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 12 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	DM	21 Mar. 2012	FIGURE: 4	
GIS	DM	26 Mar. 2012		
CHECK	BH	Apr. 2013		
REVIEW	GA	Apr. 2013		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_12.mxd

Page left intentionally blank

612000 612250 612500 612750 613000

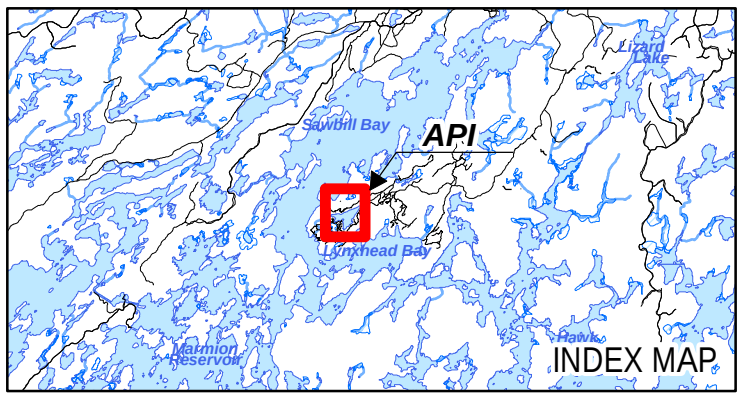
5422000 5421750 5421500 5421250 5421000

N

Be/Bo
14
13
Be
Be/Bo/Co
11
CF
Bo Be
Be/Bo
Co
Be
7
Bo
Be/Bo Be/Bo
Be/Bo Be/Bo
Be/Co/Gr
12
2
Be/Co
Flow
Be/Bo
Be/Bo
Be/Co
9
3
Be/Bo
Be
10
Be
8
Be
4
6
5
Bo
CF
Be/Bo/Co
Be/Bo
Be/Bo
SV
1
Be
Bo
Bo/Co
CF
Inlet
Stream

612000 612250 612500 612750 613000

110 0 110 220
SCALE 1:4,500 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- EV Emergent Vegetation
- SV Submergent Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)
- Steep Slope (31 to 70%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- SH - Shrubs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Gr -Gravel
- Sa -Sand
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

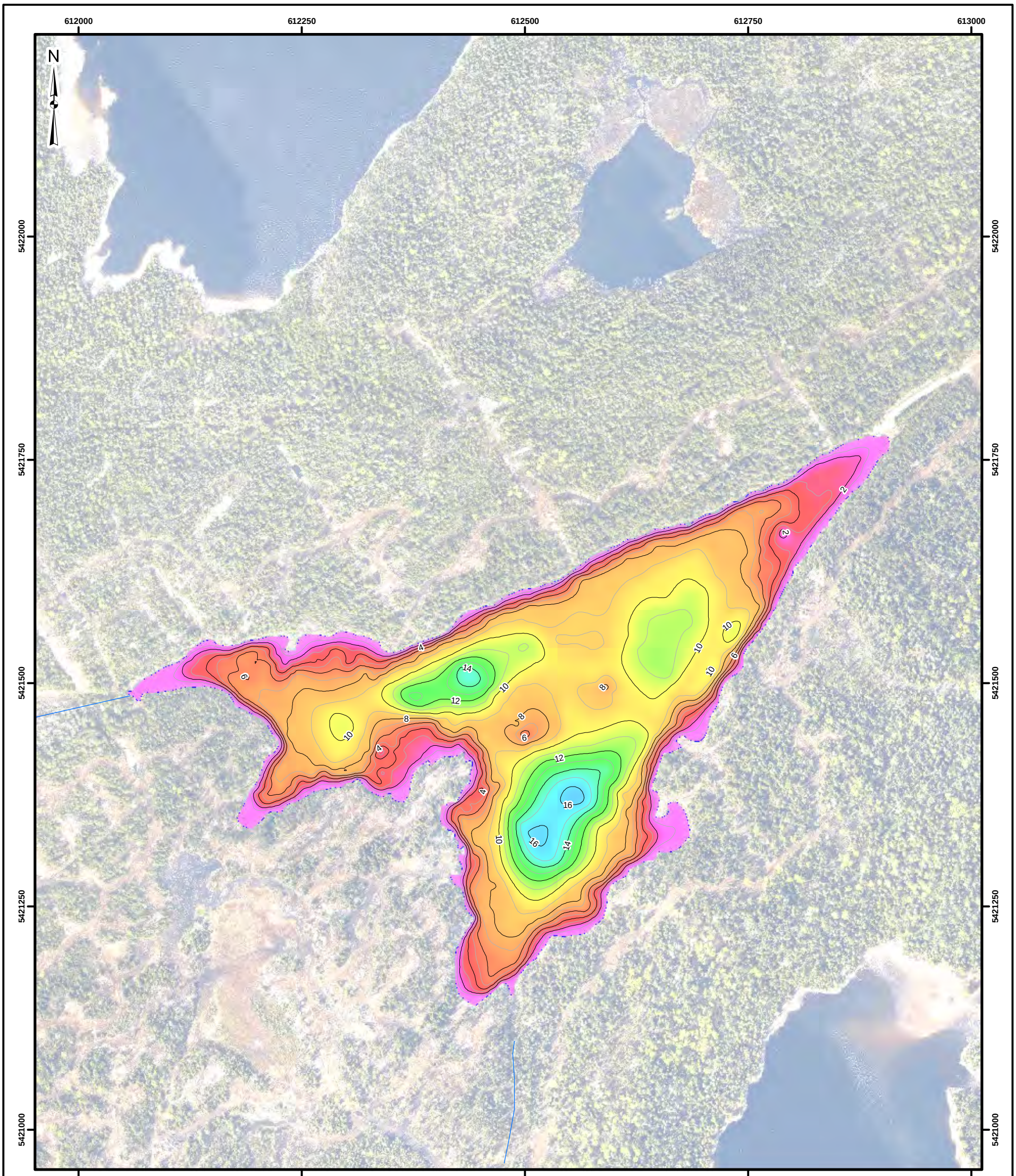
TITLE
AREA OF POTENTIAL IMPACT 12
(MITTA LAKE)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	RRD	06 Jan. 2012	FIGURE: 5	
GIS	DM	10 Apr. 2012		
CHECK	BH	Apr. 2013		
REVIEW	GA	Apr. 2013		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\PondAPI\API_12.mxd

Page left intentionally blank

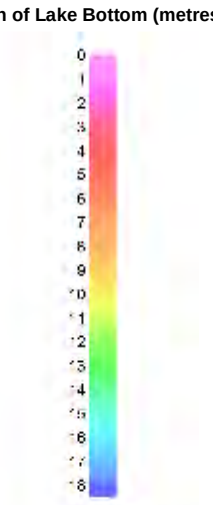


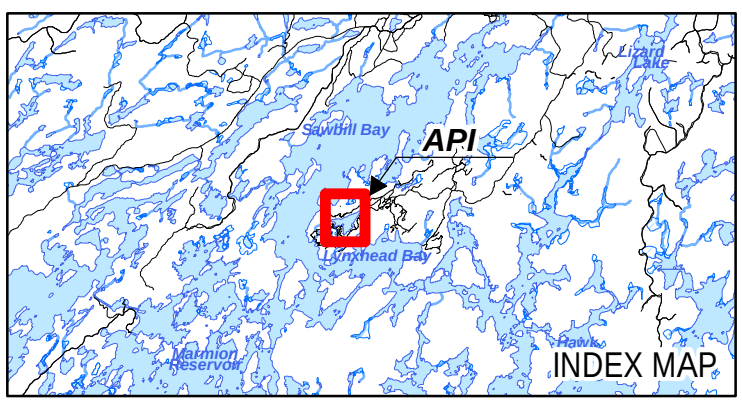
110 0 110 220
SCALE 1:4,500 METRES

LEGEND:

- Ditch
- River/Stream
- Road
- Lake Bottom Contours - 1 m interval
- Lake Bottom Contours - 2 m interval

Depth of Lake Bottom (metres)





REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 12
(MITTA LAKE) BATHYMETRY

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	RRD	06 Jan. 2012	FIGURE: 6	
GIS	DM	10 Apr. 2012		
CHECK	BH	Apr. 2013		
REVIEW	GA	Apr. 2013		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\PondAPI\API_12_Bathymetry.mxd

Page left intentionally blank

612000 612250 612500 612750 613000

5422000 5421750 5421500 5421250 5421000

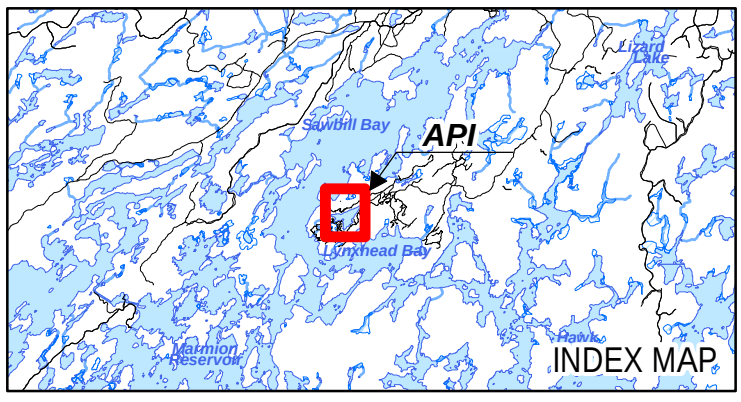
N

110 0 110 220

SCALE 1:4,500 METRES

LEGEND:

- Ditch
- River/Stream
- Road
- Boulders
- Shallow or Exposed Bedrock
- Fine Sediment
- Mixed Coarse and Fine Sediment



REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 12
(MITTA LAKE) INTERPRETED LAKE
BOTTOM SUBSTRATE

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	RRD	06 Jan. 2012	FIGURE: 7	
GIS	DM	10 Apr. 2012		
CHECK	BH	Apr. 2013		
REVIEW	GA	Apr. 2013		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\PondAPI\API_12_LakeBottomSubstrate.mxd

Page left intentionally blank

5.2 Fish Species Presence and Species Weighting

The objectives of the baseline fish sampling program were as follows:

- To establish what fish species and life history stages were present in each aquatic feature and catchment.
- Identify fish frequented waters and non-fish-bearing waters relative to Project footprint.

Each aquatic feature was visited by field crews on multiple occasions during several open water seasons. No fish sampling was undertaken during the winter. Where habitat mapping has identified features (e.g., pools) that provide conditions consistent with overwinter requirements of fish species present, those features will be characterized as overwinter habitat.

A variety of gears were used to confirm fish presence and fish community composition. Passive gears were set for 18- to 24-hour periods and at a variety of depths in ponds and small lakes. Fishing gears included the following:

- Nordic nets.
- Standard experimental gill net gangs.
- Large and small mesh broadscale monitoring nets.
- Minnow traps.
- Backpack electrofishing.
- Boat electrofishing.
- Observations in channels too narrow/shallow to effectively electrofish or set passive fishing gear.

Data recorded on catch records included location (GPS coordinates), time, date, gear type, depth, effort (metres shocked or hours fished), and the numbers and life history stage (fry, juvenile and adults) by species of all fish captured.

The 22 fish species listed in Table 3 were captured during aquatic baseline studies (plus three additional species identified by MNR as likely to be present). This list reflects sampling results from watercourses and waterbodies that may be altered by the Project during construction, operation or closure of the pit, waste rock storage and tailings management areas. Species listed in Table 3 include seven species captured only in the Upper Marmion Reservoir and Lizard Lake. It is most likely that the three species (trout-perch, logperch, mimic shiner) identified by MNR as likely to be present would also only occur in Upper Marmion Lake and Lizard Lake, based on their typical habitat preferences. Fish inhabiting these features use habitat within the Project footprint seasonally (e.g., lower reaches of watercourses to reproduce). Fish community composition varies between catchments potentially affected by the Project, and each catchment will be considered separately for the purposes of habitat accounting.

Table 3: Fish Species Captured During Baseline Studies

Family/Subfamily	Species Common Name	Species Scientific Name
Coregoninae	lake whitefish[(a)] cisco[(a)]	*Coregonus clupeaformis* *Coregonus artedi*
Umbridae	central mudminnow	*Umbra limi*
Esocidae	northern pike	*Esox lucius*
Cyprinidae	longnose dace[(a)] northern redbelly dace finescale dace pearl dace fathead minnow spottail shiner[(a)] blacknose shiner golden shiner[(a)] mimic shiner[(b)]	*Rhinichthys cataractae* *Phoxinus eos* *Phoxinus neogaeus* *Margariscus margarita* *Pimephales promelas* *Notropis hudsonius* *Notropis heterolepis* *Notemigonus crysoleucas* *Notropis volucellus*
Catostomidae	common white sucker	*Catostomus commersoni*
Gadidae	burbot	*Lota lota*
Gasterosteidae	ninespine stickleback brook stickleback	*Pungitius pungitius* *Culaea inconstans*
Centrarchidae	smallmouth bass[(a)] pumpkinseed	*Micropterus dolomieu* *Lepomis gibbosus*
Percidae	walleye[(a)] yellow perch Iowa darter trout-perch[(b)] logperch[(b)]	*Sander vitreus* *Perca flavescens* *Etheostoma exile* *Percopsis omiscomaycus* *Percina caprodes*
Cottidae	mottled sculpin	*Cottus bairdii*

Note:

(a) Captured only in Upper Marmion Reservoir and/or Lizard Lake.

(b) These species were reported as likely present by MNR, but not captured in the field program.

5.2.1 Gear Selection and Sampling Methods

A range of fish collection methods were employed, depending on physical characteristics of each aquatic feature (e.g., stream/pond depth). A backpack electrofisher was used in streams where wading was possible and the margins of small waterbodies such as beaver ponds. A portable, boat mounted electrofisher and netting gear was used in the vicinity of existing dams and near the mouths of small streams. Minnow traps, small mesh Nordic gill nets and experimental gill nets were deployed overnight in headwater lakes and ponds located within study areas, and to collect fish tissue samples for background contaminant analyses.

For each stream API, backpack electrofishing, minnow traps and expert observations were employed at a minimum. Where streams were impounded by beaver dams, the same sampling gear was used. If the beaver ponds were sufficiently large or deep, gillnets also were employed. In such cases, where the size and depth of beaver ponds and other small headwater ponds were conducive to gillnetting, experimental gangs or, where

fishable area was limited, single panels of experimental gangs (38 mm and 76 mm mesh) were deployed. Multiple gears were deployed during the assessment of each aquatic feature.

For larger ponds, small lakes and receiving waterbodies, backpack electrofisher or seine nets, broadscale gillnets and experimental gillnets, boat electrofisher and minnow traps were all utilized, depending on the physical characteristics of the waterbody, to effectively sample the range of habitats present in each waterbody.

All stationary gear (gillnets and minnow traps) were deployed overnight and fished for 15 to 20 hours.

The objectives of fish community assessment studies were to establish what fish species were present, verify the presence of various life history stages, identify fish frequented waters and non-fish-bearing waters relative to the MSA and collect samples to determine baseline concentrations of metals in fish muscle tissue. A variety of gears and techniques were utilized to confirm fish presence and fish community composition. Stationary fishing gears were set for 18 to 24-hour periods and at variety of depths in ponds and small lakes, and in a variety of habitats in watercourses. Because of the nature of gillnetting gear (e.g., tangling gear) and the duration of sets, a large proportion of fish captured in gillnets were mortalities. Fishing gears included the following:

- **Nordic Nets:** The Nordic net is an internationally adopted netting gear used to characterize fish assemblages and assess fish community diversity in a variety of Scandinavian countries and within the Province of Ontario (Morgan and Snucins 2005). Nordic nets consist of 30 m long, 1.5 m high gangs of 12 different 2.5 m-long panels of 10 mm to 55 mm nylon mesh. These nets are suited to smaller, shallower lakes and where there is potential to capture smaller fish.
- **Standard Experimental Gill Net Gangs:** The standard experimental gang was adopted by the MNR in the late 1970s as the standard gear used to determine fish community composition for the Province's lake and river assessment program (MNR 1979). Experimental gangs consist of eight, 1.5 m-high, 15.2 m-long panels of 38 mm, 51 mm, 64 mm, 76 mm, 89 mm, 102 mm, 114 mm and 127 mm stretched multifilament mesh. These nets are suited to a range of lake sizes, and are standardized to capture small and large-bodied fish.
- **Large and Small Mesh Broadscale Monitoring Nets:** The large mesh gillnet has been proposed by the American Fisheries Society as a North American standard for sampling angler harvested freshwater species. The small mesh gillnet is a new standard, developed in Ontario (Sandstrom et al. 2010). Jointly, the large and small mesh gillnets span a mesh size range that is similar to the Nordic gang. Large mesh broadscale nets are 49.6 m long and are comprised of eight, 3.1 m panels consisting of 38 mm, 51 mm, 64 mm, 76 mm, 102 mm, 114 mm and 127 mm stretched, monofilament mesh. Small mesh broadscale nets are 25 m long and are comprised of 1.8 m high panels of 13 mm, 19 mm, 25 mm, 32 mm and 38 mm stretched monofilament mesh. This nets have similar application to standard experimental gillnet gangs but they generally are more suited to short duration sets and can cover a wider depth range per net set than other gillnet types.
- **Minnow Traps:** A minnow trap is a small metal cylinder with narrow openings at either end that is typically used by anglers to collect baitfish. It can be baited with different baits, such as bread or meat scraps, to attract different small-bodied fish, and is usually used as a scientific apparatus to collect small fish or young-of-the-year (YOY) fish. These are best suited for shallow inshore waters of lakes, ponds and

wetlands, as well as streams and rivers and are effective at capturing small bodied fish and the juvenile stages of large-bodied fish.

- **Seine Netting:** A 15.2 m bag seine consisting of 6 mm nylon mesh was used to capture fish in shallow habitats where the bottom consisted of hard, near-flat substrates with minimal organic debris (e.g., sunken branches). Seining effort is presented as area seined in square metres (m^2). This technique is best suited to shallow inshore waters of lakes and ponds and rivers and streams and is effective at capturing a range of small and large bodied fish. Seining is not effective in waters over 1 m depth or where the substrate has numerous snags to catch the net or soft bottoms where wading is impractical. Seining also requires an open area on shore to pull the net out of the water, such as a beach.

- **Backpack Electrofishing:** A backpack electrofisher is a device that consists of an anode (usually designed as a dipnet) and cathode (usually designed as a trailing metal wire or "rat tail") that creates an electric field around the operator. The operator walks in wadable waters, such as small streams, and fish are momentarily rendered immobile by the electric field and can be captured on the anode or by a second person with a dipnet. Fish generally recover quickly and can be released. Backpack electrofishers are best suited to shallow water habitats, usually up to 1 m deep, and are effective in sampling streams and rivers and shallow nearshores of lakes, ponds and wetlands. They capture both small and large-bodied fish, but may miss benthic fish species that remain on the bottom.

- **Boat Electroshocking:** A boat electrofisher is a larger version of a backpack electrofisher that is set up on a boat. The cathode is generally a series of wires suspended from the sides of the boat and the anodes are on two booms that are placed off the front of the boat. One person operates the boat and one or two staff man dipnets in order to retrieve fish immobilized by the electric field. A boat electrofisher is designed to sample larger rivers or the littoral areas of lakes, and was used primarily in receiving bays of Upper Marmion Reservoir and Lizard Lake. Boat electrofishers are similar to backpack electrofishing, but is effective at depths of up to 2 m and for streams and waterbodies that are navigable. They capture both large and small-bodied fish.

- **Observations** in streams too narrow to electroshock or set other gears.

The selection of sampling gear used for sampling each aquatic feature was based on the limitations of each gear type relative to characteristics of each water body (e.g., depth, conductivity). However, every effort was made to sample each feature with several gears to identify all fish species present. Data recorded on catch records included location (Global Positioning System [GPS] coordinates) at each end of stationary gear, start and end locations for electrofishing, time, date, gear type, depth, effort (square metres seined, metres of stream electroshocked or hours fished), numbers and life history stage (young-of-the-year, juvenile and adults) of all fish captured by species. Each location where fishing effort was expended has been assigned a unique site-location number and these numbers appear in catch tables and on fish habitat maps created for each aquatic feature.

With this in mind, fishing effort was planned to cover all major habitat types present. If one habitat type was much more prevalent than another, it typically received more gear types and effort. If there were obvious changes in substrate, macrophyte growth and depth within a major habitat type, this variability was sampled to the extent practical. Net placement was not based on any type of predetermined stratification methodology.

Netting in lentic waters initially began with a combination of Nordic nets and experimental gill nets. This was based on past experience and success that demonstrated that these nets are very effective in capturing a variety of fish species and sizes. When practical, both Nordic nets and experimental nets were used on a given waterbody. In some cases, waterbodies were too small to effectively use the experimental gill nets and only Nordic nets were applied (or a portion of a Nordic or experimental gillnet). Most gillnetting efforts also were complemented with minnow traps in shallow nearshore habitats, generally targeting available cover (weed growth, beaver lodges, woody debris). In some cases other gear was used (seine netting, electrofishing along shorelines, visual observation) to add to netting efforts.

During the baseline collection program, it was suggested by DFO and MNR that the use of MNR broad-scale nets would be useful; thus, many of the waterbodies were also fished with some combination of all of these nets (Nordic, experimental and broad-scale).

It is should be noted that on many of the beaver ponds and small headwater lakes and ponds, some of these nets would span across the entire waterbody through all available depth zones and habitats (so strategic placement was irrelevant). The approach was to fish most of these locations on several occasions, with sufficient gear to cover all available habitats. Table 4 provides a general guide to gear selection by Ecotype and major habitat unit.

Table 4: General Guide to Gear Selection by Ecotype and Major Habitat Type

Major Habitats	Receiver	Headwater Lake	Headwater Pond	Inlet Stream	Warmwater Stream	Intermittent Stream
Open Water / Deep Water Habitats	B, EG, N	B, EG, N	N/A	N/A	N/A	N/A
Nearshore / Littoral Habitats	B, EG, N, M, BEF	B, EG, N, M, EF	EG, N, M, EF, S	N/A	N/A	N/A
Marsh / Wetland Habitats	N, S, M. BEF	N, M, EF, S	N, M, EF, S	N/A	N/A	N/A
Inlet / Outlet Habitats	B, EG, N, EF, S, M	B, EG, N, EF, S, M	N/A	N/A	N/A	N/A
Beaver Impoundments	N/A	N/A	N/A	N, EF, M, S, D	N, EF, M, S, D	N/A
Fastwater – Cascades, Riffles, Runs	N/A	N/A	N/A	EF, D	EF, D	N/A
Slackwater – ponds, pools, flats	N/A	N/A	N/A	EF, M. D	EF, M. D	EF, M. D

Note:

Gillnets: B – Broadscale, EG – Experimental, N – Nordic. Other Nets: M – Minnow Trap, D – Dipnet, S - Seine.
Electrofishers: EF - Backpack Electrofisher, BEF – Boat Electrofisher, N/A – habitat not typically present in the Ecotype.

5.3 Species Guilds and Weighting

The assumption in designating guilds for the purpose of habitat accounting is that all member species share the same habitat requirements, vulnerabilities to habitat alteration and will benefit equally from proposed compensation measures.

To develop Species Habitat Weights (SHW), Minns et al. (2001) grouped fish into "habitat groups" using thermal preference and feeding ecology (i.e., piscivorous and non-piscivorous species). Using a more rigorous statistical approach, Minns (2010) undertook a similar analyses and grouped fish into habitat groups using thermal preference and spawning habitat preference. A key rule of this weighting procedure is that the sum of the individual weightings for all species recorded for the area must sum to 1.0. For the purpose of weighting/grouping fish, Golder has adapted the latter approach and grouped the species present into a number of these guilds (Table 5)

Table 5: Fish Habitat Groupings

Habitat Group	Description	Piscivore	Non-Piscivore
Cold + A1 (lake)[(a)]	lake stenotherms		**Group 1**: lake whitefish, cisco, trout-perch[(b)],
Cold + A1 (stream)[(a)]	stream stenotherms	**Group 3**: burbot	**Group 2**: pearl dace
Cold +A2	stream salmon, lamprey	N/A	N/A
Cold + B	sculpins, sticklebacks		**Group 4**: brook stickleback, ninespine stickleback, mottled sculpin
Cool + A1	percids, redhorses, darters, dace	**Group 6**: northern pike, walleye	**Group 5**: longnose dace, finescale dace, northern redbelly dace, golden shiner, Iowa darter, yellow perch, white sucker
Cool + A2	nonguarding darters, chubs, lamprey	N/A	N/A
Cool + B	guarding darters, pomoxids	N/A	N/A
Warm + A	shiners,moronids, gars, suckers		**Group 7**: blacknose shiner, central mudminnow, emerald shiner, spottail shiner, mimic shiner[(b)], logperch[(b)]
Warm + B	centrarchids, minnows, bullhead	**Group 9**: smallmouth bass	**Group 8**: fathead minnow, pumpkinseed

Note:

(a) This was one category in Minns (2010); however, it has been split into a lake versus stream grouping here.

(b) These species were reported as likely present by MNR, but not captured in the field program.

N/A = No representatives in the study area for the habitat group.

This classification or grouping of fish resulted in nine categories, which were assigned weights as follows:

- Piscivores (three categories): 0.5 (combined score).
- Non-piscivores (six categories): 0.5 (combined score).

In this way, piscivores are given the same proportional weighting as non-piscivores. In addition, this approach also gives some consideration to relative abundance and biomass by assigning more weighting to generally larger, though less abundant piscivores and less to non-piscivores. Minns (2010) also considered giving more weighting to species considered to have "fishery potential" and well as "species richness." The former included species that were considered important as sportfish or commercial fish, which is also consistent with DFO's habitat priorities. Some adjustment in the weightings for individual fish species also was made to recognize their values to recreational and commercial fisheries. For example, baitfish were given a higher weighting (0.03) compared to other small-bodied fish (0.013) and lake cisco and whitefish were also given a higher weighting (0.04). Burbot were given the same weighting as baitfish, since in this location they were not considered as a sportfish. Final SHW's for each species are shown in Table 6.

From a CRA fishery perspective, the weights can be summarized as follows:

- Primary CRA species – Walleye, northern pike, smallmouth bass 0.49
- Secondary CRA species – baitfish (8 species) 0.24
- Secondary CRA species – lake whitefish, burbot, cisco, yellow perch 0.11
- Remaining species (8 species) 0.16
- **Total** **1.00**

Table 6: Species Habitat Weights by Habitat Group

Group	Species	Weighting
Group 1: Cold+A1-Lake: Non-Piscivore	lake whitefish	0.04
	cisco	0.04
Group 2: Cold+A1-Stream: Non-Piscivore	pearl dace	0.03
Group 3: Cold+A1-Stream: Piscivore	burbot	0.03
Group 4: Cold+B: Non-Piscivore	ninespine stickleback	0.013
	brook stickleback	0.013
	mottled sculpin	0.013
	finescale dace	0.03
	redbelly dace	0.03
	golden shiner	0.03
	longnose dace	0.013
	white sucker	0.03
	Iowa darter	0.013
	yellow perch	0.04

Table 6: Species Habitat Weights by Habitat Group (Continued)

Group	Species	Weighting
Group 6: Cool+A1: Piscivore	walleye	0.17
	northern pike	0.17
Group 7: Warm+B: Non-Piscivore	blacknose shiner	0.013
	emerald shiner	0.03
	spottail shiner	0.03
	central mudminnow	0.013
Group 8: Warm+B: Non-Piscivore	fathead minnow	0.03
	pumpkinseed	0.013
Group 9: Warm+B: Piscivore	smallmouth bass	0.17
Total		**1.00**

These SHWs were used as multipliers to adjust the final calculation of WUA totals for each API in each Ecotype. Within each ecotype, streams and lakes were tallied separately. The overall habitat value of each Ecotype is dependent on the same list of fish species and will be inherently sensitive to the hierarchy of fisheries identified in the *Fisheries Act*, (i.e., sports and commercial species, species important to Aboriginal groups, baitfish, etc). With this weighting, Ecotypes supporting piscivores generally will receive a higher ranking. For example, the habitat scores for Receivers would get a higher HU score because of the presence of walleye and smallmouth bass, compared to Lakes and Warm Water Streams. Only fish that were captured within each Ecoptype were ranked in terms of the existing habitat; as such, fish that were not present did not contribute to the total weighted useable area.

5.4 Ecotypes and Fish Community Composition

Aquatic APIs in the study area can be classified into distinct ecological types (Ecotypes). These are as follows:

- Lake Ecotype (e.g., Mitta Lake and API #2): surrounded by natural shoreline features, diverse substrates and habitats (i.e., deeper than 5 m and may include several basins); generally support diverse fish communities relative to other eco-types.
- Headwater Ponds Ecotype: including their inflows and outflows (e.g., APIs #6, #7, #11, #13 #69); generally shallow (i.e., less than 2 m deep) with outflows/water elevation controlled by beaver dams, substrate consists of silt, organic material, may be partially infilled and/or contain flooded terrestrial vegetation. Many of the headwater ponds assessed during baseline studies were found to be fishless.
- Warm Water Stream Ecotype: shallow to steep gradient channels with interspersed beaver impoundments (e.g., APIs #1, #14, #47, #48), excluding lower reaches.
- Seasonal or Intermittent Stream Ecotype: portions of some streams have no defined channels. In these locations flows are conveyed periodically through flooded forest areas in response to precipitation events. Some streams have been characterized as seasonal (i.e., have defined channels but are dry for extended periods), because stream flow is largely dependent on precipitation generated runoff.

- Inflows to Receiving Waters Ecotype: the lower reaches of warm water streams, some of which are used by fish in the receiving waterbodies as spawning and/or nursery habitat. Juvenile white suckers, northern pike and yellow perch were captured in the lower segments of some streams flowing into the Upper Floodwaters and Lizard Lake. The lower reaches of the streams in which these species were documented tend to be flat and are likely accessible to fish from receiving waters during periods of high flow/water elevation. Some of these inflows are not accessible to fish from downstream receivers due to steep cascades located at their mouths.
- Receiving Waters Ecotype: Upper Flood Waters (including Sawbill Bay, Lynxhead Bay and Turtle Bay), Lizard Lake and API #8.

Table 7 summarizes fish species assemblages, by ecotype, in all APIs assessed during baseline studies.

The potentially impacted portion of each API will be partitioned into homogenous habitat patches. For lakes, headwater ponds and receiving waters, these will be defined as littoral area (extending from the high water mark to 3 m depth), and the open water/metalimnion (the area inside the 3 m contour). For permanent, seasonal and intermittent streams, habitat patches will be defined as ponds (permanently impounded areas), shallow gradient, pool/riffle channel and high gradient (i.e., cascade) channel segments.

A productive capacity index (PCI) (Minns 2010) was applied to each habitat patch within each ecotype to factor in differences in productivity of each, and their contributions to downstream aquatic features. PCI designations are 1.0 for lakes, headwater ponds and receiving waters, 2.5 for warm water streams and inflows to receiving waters and 0.75 to seasonal and intermittent streams. The value 0.75 was chosen for intermittent features to recognise, not so much that their productive capacity is lower than permanent streams, but rather to recognize that they only provide direct habitat for fish during a portion of the year (roughly one third of the year).

Once the WUA for each Ecotype is determined for each API, it is multiplied by the PCI to give an Ecotype Weighted Useable Area (EWUA). This value provides a means of more directly comparing Ecotypes, recognizing the differences in productive capacity and can be used to assist in determining compensation where “like for like” compensation cannot be achieved.

5.5 Species Associations by Ecotype

A summary table was prepared (Table 7) that lists all of the species found within each ecotype. In general, this shows that species such as walleye, smallmouth bass, lake whitefish and cisco are restricted to Receivers, and that there are a number of fishless waterbodies, both streams and lakes.

Table 7: Fish Community Composition by Ecotype

Area of Potential Impact	Fish Species Present																					
	lake whitefish	cisco	central mudminnow	northern pike	longnose dace	northern redbelly dace	finescale dace	pearl dace	fathead minnow	spottail shiner	blacknose shiner	golden shiner	white sucker	burbot	ninespine stickleback	brook stickleback	smallmouth bass	pumpkinseed	walleye	yellow perch	lowa darter	mottled sculpin
Ecotype: Lakes																						
Mitta Lake						X	X		X				X		X	X					X	X
#2				X									X		X			X		X		
#46[(a)]							X		X													
#45[(a)]				X									X					X		X		
#47[(a)]							X	X														
Ecotype: Headwater Ponds																						
#6	Fishless																					
#7	Fishless																					
#4[(a)]						X	X															
#5[(a)]						X	X															
#11						X	X		X													
#13	Fishless																					
#10[(a)]	Fishless																					
#15[(a)]	Fishless																					
#16[(a)]	Fishless																					

Table 7: Fish Community Composition by Ecotype (Continued)

Area of Potential Impact	Fish Species Present																					
	lake whitefish	cisco	central mudminnow	northern pike	longnose dace	northern redbelly dace	finescale dace	pearl dace	fathead minnow	spottail shiner	blacknose shiner	golden shiner	white sucker	burbot	ninespine stickleback	brook stickleback	smallmouth bass	pumpkinseed	walleye	yellow perch	Iowa darter	mottled sculpin
Ecotype: Headwater Ponds (Continued)																						
#17						X	X		X													
#43[(a)]	Fishless																					
#44[(a)]	Fishless																					
#48	Fishless																					
#69						X	X															
Ecotype: Warm Water Streams																						
#1							X		X													
#2			X																			
#3[(a)]				X		X	X															
#4[(a)]						X	X															
#5[(a)]						X	X															
#9[(a)]			X						X													
#6	Fishless																					
#7	Fishless																					
#10	Fishless																					
#11						X	X															
#14						X	X		X													

Table 7: Fish Community Composition by Ecotype (Continued)

Area of Potential Impact	Fish Species Present																					
	lake whitefish	cisco	central mudminnow	northern pike	longnose dace	northern redbelly dace	finescale dace	pearl dace	fathead minnow	spottail shiner	blacknose shiner	golden shiner	white sucker	burbot	ninespine stickleback	brook stickleback	smallmouth bass	pumpkinseed	walleye	yellow perch	lowa darter	mottled sculpin
Ecotype: Warm Water Streams (Continued)																						
#15[(a)]	Fishless																					
#16[(a)]	Fishless																					
#40[(a)]				X									X									
#47							X	X														
#44[(a)]							X						X									
#46[(a)]							X	X														
#43[(a)]	Fishless																					
#69	Fishless																					
Ecotype: Seasonal and Intermittent Streams																						
API #48							X															
Ecotype: Inflows to Receiving Waters																						
#1							X		X				X	X								
#6				X									X								X	
#8				X									X									
#10				X									X							X		
#11						X	X															
#12						X	X		X				X									

Table 7: Fish Community Composition by Ecotype (Continued)

Area of Potential Impact	Fish Species Present																					
	lake whitefish	cisco	central mudminnow	northern pike	longnose dace	northern redbelly dace	finescale dace	pearl dace	fathead minnow	spottail shiner	blacknose shiner	golden shiner	white sucker	burbot	ninespine stickleback	brook stickleback	smallmouth bass	pumpkinseed	walleye	yellow perch	lowa darter	mottled sculpin
Ecotype: Inflows to Receiving Waters (Continued)																						
#13	Fishless																					
#14						X	X		X				X									
#40[(a)]				X									X									
#41[(a)]				X																		
#44																				X	X	
#49[(a)]				X							X		X							X	X	
#50[(a)]				X									X									
#69	Fishless																					
Ecotype: Receiving Waters																						
Upper Marmion Lake	X	X		X						X	X	X	X	X			X		X	X	X	
Lizard Lake		X		X	X					X	X		X	X			X	X	X	X	X	X
#8				X									X	X			X					

Note:

(a) Assessed, will not be affected by the Project.

5.6 Habitat Classes and Habitat Sensitivity Weighting

The guidelines for the preparation of the Project's EIS/EA Report requires that habitats for each potentially affected species be characterized as spawning, rearing/nursery, feeding, migratory corridor and overwintering/ summer refuge habitats (Canadian Environmental Assessment Agency 2011). These habitat classes have been adopted for NNL Planning and are defined as follows:

- Spawning habitat is used by fish for the specific act of reproduction.
- Nursery/rearing habitat is used by developing embryos and YOY and sub-adult fish for foraging and refuge from predators.
- Feeding habitat is used by adult fish for feeding or periods between feeding events.
- Overwintering/summer refugia are used by YOY, sub-adult and adult fish to survive periods of hostile conditions (e.g., flows and water temperature extremes).
- Migratory corridors are used by fish to access important habitats described above.

A conservative approach to classifying specific habitats was used. No specific studies to document spawning activity or overwintering locations were undertaken during baseline studies. For the purpose of habitat classification, it was assumed that stream or lake habitat segments possessing characteristics consistent with habitat requirements of fish species or guilds of fish are spawning or overwintering habitats. Habitats identified as one of the five types listed above were rated equally (i.e., no type(s) of habitat were valued higher than others). The Habitat Unit Score (HU score) is the unweighted average of the life stage specific HSI scores.

While it may be argued that there is merit in assigning greater weights to some habitats that are considered more important than others, for example spawning habitat is often considered to be more important or critical to the species survival than other life stage habitats, an equal weighting is considered appropriate in assessment the losses and gains within the context of the compensation plan. This same approach was also used in the recently submitted No Net Loss Plan for the Meliadine Project (Golder 2011). Generally, there is not sufficient justification, based on the field studies, to conclude that the habitat for any one life stage is "limiting" for the species. For a number of the habitat compensation projects for the Project where spawning and rearing habitat is the focus, only these life cycle stages are scored, which automatically weights these specific projects. These include the northern pike spawning habitat projects, the lake whitefish spawning shoal projects and the walleye fish passage projects presented in Section 7.2. Other species that may use these features were also scored as part of determining the overall WUA for the Project.

Appendix B provides descriptive summaries of life stage habitat requirements for all species. In addition to assigning an HSI score for each life stage for each species, the weightings based on the fish grouping adapted from Minns et al. (1991) and Minns (2010), because they are linked to some common habitat features in common, i.e., thermal preference, feeding strategy, reproductive strategy, will also serve to strengthen the habitat linkages.

5.7 Calculation of Weighted Useable Area Scores

Habitat loss and gain was calculated based on a HEP type of approach (U.S. FWS 1980; 1981). The premise of the HEP approach is that an area of aquatic habitat can be composed of a variety of habitat types (e.g., deep pools, shallow riffles) and that these habitat types will have differing levels of suitability for species that may occur in that habitat area. Recommended steps to perform a HEP analysis include identification of impacted areas, delineation of cover types, selection of evaluation species, calculation of total area of available habitat, and the calculation of a habitat suitability index for available habitat.

Habitat suitability relationships (Appendix B) describing spawning, rearing/nursery, feeding, migratory corridor and overwintering/summer refuge habitats for each of the species listed in Table 2 have been derived using published HSI models, technical papers and other environmental impact assessments completed by Golder. References consulted for the development of habitat suitability relationships include the following:

- Life History Characteristics of Freshwater Fishes Occurring in Newfoundland and Labrador, with Major Emphasis on Lake Habitat Requirements (Bradbury et al. 1999).
- Synopsis of biological data on the walleye (Colby et al. 1979).
- Habitat suitability information: Smallmouth bass (Edwards et al. 1983).
- Fish Species Habitat Suitability Index Models for the Alberta Oil Sands Region (Golder 2008).
- Fish use of wetlands in northwestern Ontario: A literature review and bibliography (Hall-Armstrong et al. 1996).
- Habitat suitability index models: Northern pike (Inskip 1982).
- Literature review on fishes interactions with aquatic macrophytes with special reference to the Upper Mississippi River system (Janacek 1988).
- Walleye Habitat: A Synthesis of Current Knowledge with Guidelines for Conservation Ontario. Ministry of Natural Resources (Kerr et. al. 1997).
- Life History Characteristics of freshwater Fishes Occurring in Manitoba, Saskatchewan and Alberta, with Major Emphasis on Lake Habitat Requirements (Langhorne et al. 2001).
- Ecological significance of vegetation to northern pike, *Esox lucius*, spawning (McCarragher et al. 1972).
- Habitat suitability information: walleye (McMahon et al. 1984).
- Riverine Habitat Characteristics of Fishes of the Great Lakes Watershed (Portt et al. 1999).

For the purpose of habitat accounting, an ordinal ranking system was used to rank the quality of spawning, rearing/nursery, feeding, migratory corridor and overwintering/summer refuge habitats based on field data, as “optimal” (two categories), “sub-optimal” (one category) or “unsuitable” (two categories). These rank categories correspond with SI values of 1.0, 0.75, 0.5, 0.25 and 0.0, for each habitat type, respectively.

The assignment of HSI scores for each species and for each life stage is based on an assessment of the habitat in each feature based on the species habitat preference table and the descriptive summary (including maps and

descriptive information) provided in the factsheets for each API in the Interim Baseline Report (Golder 2012). Scoring of the HSI for each life stage takes into consideration the following:

- Within the habitat type, for example littoral zone and open water zone for lake ecotypes, the approximate area of suitable habitat. For example, in the case of spawning habitat for white sucker, the amount of suitable spawning habitat may only be a portion of the total littoral zone.
- For the suitable habitat present, the quality of this habitat for the species' life stage, for example, there may be suitable nursery habitat present for white sucker, but it may be rated as poor because of the lack of cover in the form of macrophyte growth or coarse substrates that provide refuge. Other factors affecting the quality of the habitat could include inadequate depth, cover, flow or substrate conditions.
- For the suitable habitat present, there may be a number of other constraints that would lower the suitability/availability of the habitat, for example:
  - The presence of predator species or competition may be considered as a factor that reduces the suitability or availability of the habitat.
  - The potential for mid-summer or winter anoxia to exist, which would limit access to the habitat or result in mortality to fish using the habitat.
  - Seasonality of the habitat: access to the habitat may be limited by the seasonality/permanence of stream flows or by seasonal water level fluctuations in ponds or lakes (for example the fluctuations on Upper Marmion Reservoir imposed by the operating regime of the Raft Lake dam).
  - Barriers to fish movement or isolation of habitat: In some cases, this aspect of habitat may be addressed under the Migration SI component of a species' HSI score, which refers to species that undertake long, specific, directed migrations, for example, walleye. However, a number of species do not undertake such migrations and all species undertake smaller migrations during their life for feeding, overwintering, seeking refuge from predators, etc. For example, a stream may be partitioned into a number of segments by complete or partial fish barriers (beaver dams, falls, rapids, cascades, debris jams), which at least partially isolate fish populations. The suitability of a stream with barriers would score lower than one without, even if the fish species was not a typical "migrating species," for example, fathead minnow, finescale dace or Iowa darter.
  - Other thermal or chemical limitations: the presence of a thermocline or portions of habitat that are in waters with a thermal regime outside of that of the species may reduce habitat suitability, for example, smallmouth bass may be limited to shallow waters if deep, offshore waters are too cold. There may also be conditions where contaminants in water/sediment render them unsuitable for fish.

For each of the watercourse segments and waterbodies that will be affected by the Project, habitat suitability was assigned using species-specific habitat suitability relationships for fish species present. In addition to the descriptive information for each species and life stage described in Appendix B, consideration was given to the key habitat criteria in the lake model described by Minns et al. (2001) and the stream model described by Minns (2010). These methodologies emphasize substrate, depth, cover and discharge (stream model only). The quantification of WUAs takes into account the following:

- Fish habitat mapping data.
- A general description of habitat conditions, the qualitative assessment of habitat use potential and the documented fish use.
- Fish species presence and distribution data.
- Species guild associations.

The following is the general formula for calculating WUA and EWUA:

$$WUA = (HA * (SUM_{1-24} (SHW_1 * HU_1) + (SHW_2 * HU_2) + ... + (SHW_{24} * HU_{24}))$$

$$EWUA = WUA * EPCI$$

Where:

- WUA = Weighted Useable Area
- HA = Available Habitat Area
- SHW = Species Habitat Weighting
- HU = Average Habitat Suitability score
- EWUA = Ecotype Weighted Useable Area
- EPCI = Ecotype Productive Capacity Index

The calculation of WUAs for each aquatic feature affected by the Project follows these steps:

- The quantification of habitat areas (m^2) for each aquatic feature (API) in each Ecotype affected by the Project.
- Characterization of affected habitat within each ecotype into homogenous habitat patches.
- The application of species valuation (HSI and species weightings) to each habitat patch and calculation of total Useable Weighted Area for each API and each ecotype.
- The determination of each habitat class in each aquatic feature, based on species guilds and life cycle stages.
- The assignment of HSI values for each of the species or guilds present.
- The calculation of the Weighted Useable Area for each Ecotype Habitat unit.

- The application of productive capacity index (CPI) to each API within each Ecotype.
- Sum all WUA values of aquatic features affected by the Project by Ecotype and sum these to determine total habitat losses (HADD) due to the Project.

For each affected watercourse segment and waterbody, multiplication of the habitat area (surface area in m^2) by the habitat quality (as represented by the HSI assignments) results in the derivation of WUAs. Based on the applied methods, the derived WUAs represent the overall value of the habitat for fish species that are present or could reasonably be expected to be present.

It is important to note that the resultant WUAs and EWUAs, while linked to the total areas of the habitat units within each ecotype, represent a species weighted score that will always be less than the absolute area of the habitat unit being evaluated. However, since the same approach is applied to both the habitat losses and the habitat gains, the model provides an effective method of applying DFO habitat principles. This is also consistent with Minns (2010) and Minns et al. (2001).

Fish habitats within the Upper Marmion Reservoir and along corridors were included in habitat loss accounting. The normal, summer water elevation of 415.2 m above sea level[1] was used to establish the location of the boundary between the Upper Reservoir and inflowing streams.

5.7.1 Worked Example Calculation – Mitta Lake and Area of Potential Impact #2

Habitat areas, HSI values and calculated HUs for each of the relevant fish species within the affected watercourse segments and waterbodies were presented in habitat accounting spreadsheets (Appendix C). Table 8 summarizes the results of an example of a WUA spreadsheet used to calculate habitat loss for two APIs in the lake Ecotype, and Appendix C contains the full spreadsheet. Appendix B summarizes the habitat preferences for all species found in the study area according to life stage that was used to rank the habitat for each species. An identical procedure was used to calculate habitat gains associated with planned habitat compensation works.

Table 8: Example of Weighted Useable Area Calculation of Two Areas of Potential Impact Showing Estimates of Habitat Losses

Total Area	Available Habitat Area (HA)	Number of Species Present	Total Weighted Useable Area (WUA)	Ecotype Weighted Useable Area (EWUA)
API # 12 (Mitta Lake) 172,737 m^2				
Littoral	8,891 m^2	8	494 HU	494 HU
Open Water	163,846 m^2	8	9,114 HU	9,114 HU

[1] Normal high water elevation provided by MNR (Jackson 2012, pers. comm.)

Table 8: Example of Weighted Useable Area Calculation of Two Areas of Potential Impact Showing Estimates of Habitat Losses (Continued)

Total Area	Available Habitat Area (HA)	Number of Species Present	Total Weighted Useable Area (WUA)	Ecotype Weighted Useable Area (EWUA)
API # 2 124,351 m^2				
Littoral	5990 m^2	6	881 HU	881 HU
Open Water	118,361 m^2	5	13,604 HU	13,604 HU
Total			**24,093 HU**	

The key differences between API #12 and API #2 that contribute to the habitat scores are as follows:

- API #12 has a similar Littoral Habitat Unit as API #2 and a much smaller Open Water Habitat Unit.
- API #2 has fewer species, but has more predators and sportfish present than API #12.
- The productive capacity index for lake ecotypes is 1; therefore, there is no difference between the WUA and the EWUA.
- The destruction of Mitta Lake results in the loss of 494 HU of littoral habitat and 9,114 HU of open water habitat, compared to the loss of 881 HU of littoral habitat and 13,604 HU of open water habitat for API #2.
- Although Mitta Lake is the larger of the two lakes, there are more HUs in API#2, because the fishery has more CRA species present. In the context of the valued fisheries as defined under the *Fisheries Act*, API #2 ranks as a more valued fishery than Mitta Lake, based on species composition and habitat.

Example calculation and rationale for scoring is provided for Mitta Lake and API #2.

Table 9 provides an example of the rationale and HSI scoring for two fish species in Mitta Lake and API #2. In both cases, the resultant combined scoring for white sucker and northern pike is greater than the scoring for individual scores for either spawning or nursery habitat.

Table 9: Example of Habitat Suitability Index Scores for Two Fish Species

Area of Potential Impact/Species	Life Stage	Habitat Sustainability Index Score	Rationale
Mitta Lake – White Sucker	Spawning	0.25	Habitat exists in both littoral and open water habitat units. There is limited suitable habitat area for the life stage in the habitat unit. Habitat quality is poor.
	Nursery	0.25	Habitat exists in both littoral and open water habitat units. There is limited suitable habitat area for the life stage in the habitat unit. Habitat quality is poor due to lack of cover and sparce macrophytes. Habitat productivity is generally low.

Table 9: Example of Habitat Suitability Index Scores for Two Fish Species (Continued)

Area of Potential Impact/Species	Life Stage	Habitat Sustainability Index Score	Rationale
	Feeding	0.5	Habitat exists in both littoral and open water habitat units. There is moderately abundant suitable habitat area for the life stage in the habitat unit. Habitat quality is moderate due to limited littoral areas, thermocline effects and sparce macrophytes. Habitat productivity is generally low.
	Over-wintering	0.5	Habitat exists in both littoral and open water habitat units. There is moderately abundant suitable habitat area for the life stage in the habitat unit. Habitat quality is moderate due to limited littoral areas, probable winter oxygen limitations and sparce macrophytes. Habitat productivity is generally low.
	Migration	N/A	
Total HSI score		**0.35**	
API #2 – northern pike	Spawning	0.5	Habitat exists in both littoral and open water habitat units. There is moderate amount of suitable habitat area for the life stage in the habitat unit. Habitat quality is good, but macrophytes are sparce.
	Nursery	0.5	Habitat exists in both littoral and open water habitat units. There is moderate amount of suitable habitat area for the life stage in the habitat unit. Habitat quality is poor to moderate due to lack of cover and sparce macrophytes. Habitat productivity is generally low.
	Feeding	0.75	Habitat exists in both littoral and open water habitat units. There is moderately abundant suitable habitat area for the life stage in the habitat unit. Habitat quality is good due to abundance of prey, but some limitations in terms of possible thermocline effects and sparce macrophytes. Habitat productivity is generally low.
	Over-wintering	0.5	Habitat exists in both littoral and open water habitat units. There is moderately abundant suitable habitat area for the life stage in the habitat unit. Habitat quality is good due to abundance of prey, but some limitations; probable winter oxygen limitations and sparce macrophytes. Habitat productivity is generally low.
	Migration	N/A	
Total HSI score		**0.60**	

Note:

N/A = Not applicable for the species.

Tables 10 and 11 show the individual HSI scores for all species in Mitta Lake and API #2, respectively. The following points provide examples of the rationale for the scoring:

- Overall scores tend to be sub-optimal since these are smaller waterbodies that would generally be considered as low productivity waters for most species present.
- In some cases, for example blacknose shiner in API #2, zero scores occur in the open water/profundal habitat because the species is considered not to use that habitat type. This is also the case for northern pike spawning habitat in the open water/profundal habitat type.
- In general, these waterbodies have sparce marcophyte growth, often limited to the inlet and outlet stream resulting in poor to suboptimal nursery habitat for many species.
- The availability of coarse grained material, for example gravel – cobble sized material is scarce, as fine grained and soft sediments predominate on the lake bed, resulting in sub-optimal spawning/nursery habitat for species requiring these substrates, for example, mottled sculpin and iowa darter.
- Migration scores for northern pike and white sucker were zero because access to tributaries or outlet streams for spawning is very limited by seasonal stream flows and beaver dams.

Table 10: Mitta Lake Species Weights and Habitat Suitability Index Scores

Species	Habitat Type	Species Weight	Spawning	Nursery	Feeding	Over-wintering	Migration	Mean HSI
nine spine stickleback	Littoral[(a)]	0.013	0.5	0.5	0.25	0.5	N/A	0.438
	Op/prof.[(a)]	0.013	0.5	0.5	0.25	0.5	N/A	0.438
brook stickleback	Littoral	0.013	0.5	0.5	0.25	0.5	N/A	0.438
	Op/prof.	0.013	0.5	0.5	0.25	0.5	N/A	0.438
mottled sculpin	Littoral	0.013	0.5	0.5	0.25	0.5	N/A	0.438
	Op/prof.	0.013	0.5	0.5	0.25	0.5	N/A	0.438
finescale dace	Littoral	0.03	0.25	0.25	0.25	0.25	N/A	0.25
	Op/prof.	0.03	0.25	0.25	0.25	0.25	N/A	0.25
redbelly dace	Littoral	0.03	0.25	0.25	0.25	0.25	0.5	0.3
	Op/prof.	0.03	0.25	0.25	0.25	0.25	0.5	0.3
white sucker	Littoral	0.03	0.05	0.25	0.5	0.5	0	0.35
	Op/prof.	0.03	0.05	0.25	0.5	0.5	0	0.35
iowa darter	Littoral	0.013	0.25	0.25	0.5	0.25	N/A	0.313
	Op/prof.	0.013	0.25	0.25	0.5	0.25	N/A	0.313
fathead minnow	Littoral	0.03	0.25	0.25	0.25	0.25	N/A	0.25
	Op/prof.	0.03	0.25	0.25	0.25	0.25	N/A	0.25

Note:

(a) Littoral habitat occurs at depths from 0 to 3 m around the lake perimeter; open water/profundal habitat occurs at depths greater than 3 m.

N/A = Not applicable for the species.

Table 11: Area of Potential Impact #2 Species Weights and Habitat Suitability Index Scores

Species	Habitat Type	Species Weight	Spawning	Nursery	Feeding	Over-wintering	Migration	Mean HSI
white sucker	Littoral[(a)]	0.03	0.5	0.25	0.5	0.5	0	0.35
	Op/prof.[(a)]	0.03	0.5	0.5	0.5	0.5	0	0.4
Iowa darter	Littoral	0.013	0.25	0.25	0.5	0.25	N/A	0.313
	Op/prof.	0.013	0.25	0.25	0.5	0.25	N/A	0.313
yellow perch	Littoral	0.04	0.5	0.25	0.5	0.5	N/A	0.438
	Op/prof.	0.04	0.5	0.25	0.5	0.5	N/A	0.438
northern pike	Littoral	0.17	0.5	0.75	0.75	0.5	0.5	0.6
	Op/prof.	0.17	0	0.5	0.75	0.5	0.5	0.45
blacknose shiner	Littoral	0.013	0.5	0.5	0.5	0.5	N/A	0.5
	Op/prof.	0.013	0	0	0	0	N/A	0
pumpkinseed	Littoral	0.013	0.5	0.5	0.5	0.5	N/A	0.5
	Op/prof.	0.13	0	0	0	0	N/A	0

Note:

(a) Littoral habitat occurs at depths from 0 to 3 m around the lake perimeter; open water/profundal habitat occurs at depths greater than 3 m.

N/A = Not applicable for the species.

Table 12 summarizes the percent that each of the valued fisheries (as defined in Section 5.3) represents out of the total HU for each lake. This illustrates that the model places substantial weighting on valued fisheries as defined under the *Fisheries Act*.

Table 12: Percent of Habitat Units Represented by Valued Fisheries

Valued Fishery	Mitta Lake	Area of Potential Impact #2
Primary CRA fishery[(a)]	0% (0 species)	69.4% (1 species)
Secondary CRA fishery[(a)]	62.2% (4 species)	22.5% (2 species)
Other species[(a)]	37.8% (4 species)	8.1% (3 species)

Note:

(a) See definitions in Section 5.3.

All APIs and habitat types were scored based on the species present following the same process; detailed spreadsheets are in Appendix C.

6.0 SUMMARY OF HABITAT LOSSES

Using this model, and reviewing the APIs affected by the mine footprint, Table 13 shows the area of each API affected and the corresponding HU (WUA) values.

Table 13: Aquatic Areas of Potential Impact affected by Project Footprint

Infrastructure Feature	Aquatic Area of Potential Impact	Description	Description of Potential Impact
Open Pit	Mitta Lake (API #12) and its outlet stream	17.2737 ha Headwater lake; approximately 0.0449 ha of Lower Reach - stream; empties into Sawbill Bay; supports white sucker (*Catostomus commersoni)*, ninespine stickleback (*Pungitius pungitius)*, brook stickleback (*Culaea inconstans*), fathead minnow (*Pimephales promelas)*, Iowa darter (*Etheostoma exile)*, mottled sculpin (*Cottus bairdii*) and finescale dace (*Phoxinus neogaeus)*.	Mitta Lake forms the active pit. The destruction of Mitta Lake results in the loss of 494 HU of useable littoral habitat and 9,114 HU of useable open water habitat.
	API #14	Upper portions of approximately 0.1169 ha Lower Reach stream; empties into Sawbill Bay; supports (*Hybognathus hankinsoni),* finescale dace, northern redbelly dace (*Phoxinus eos)*, fathead minnow; juvenile white sucker captured in lower reach.	API #14 will be removed for the construction of the Support and Ancillary Structures near the open pit. Destruction of API #14 results in a loss of 45 HU of useable low gradient stream habitat and 119 HU of useable high gradient stream habitat.
	API #69	0.9871 ha Headwater pond and 0.0165 ha of Headwater stream; pond supports white sucker, pearl dace, Iowa darter, , central mudminnow (*Umbra limi*), blacknose shiner, finescale dace and northern redbelly dace. No fish were found to exist within the outlet stream.	Headwater pond and upper reaches of API #69 will be destroyed through the construction of the open pit. Destruction of API #69 results in a loss of 224 HU of useable littoral habitat, 1080 HU of useable open water habitat.

Table 13: Aquatic Areas of Potential Impact affected by Project Footprint (Continued)

Infrastructure Feature	Aquatic Area of Potential Impact	Description	Description of Potential Impact
Other Mine Facilities	Sawbill Bay	Localized filling within the drawdown zone along Hammond Reef peninsula to provide adequate space for mine buildings, parking, etc.; approximately 0.8 ha of seasonal habitat within the drawdown zone will be destroyed. Area provides seasonal nursery/foraging habitat for baitfish species, northern pike, smallmouth bass	About 0.8 ha of the drawdown zone along the Hammond Reef peninsula Shoreline will be destroyed. Resulting loss of about 913 HU of useable habitat destroyed
Mine Water Spill Emergency Pond	API #13	1.9375 ha Headwater pond; approximately 0.0396 ha of Headwater stream and 0.0476 ha of Headwater beaver impoundments; both pond and stream are fishless. Empties into Sawbill Bay.	No useable habitat will be lost through the destruction of API #13 for purposes of Support and Ancillary Structure development.
Waste Rock Management Facility	API #11	2.7777 ha Headwater pond; approximately 0.0787 ha of Headwater stream including (several) 0.1030 ha of beaver impoundments; empties into Lynxhead Bay; supports finescale dace, northern redbelly dace, fathead minnow.	API#11 will be destroyed through the construction of the Waste Rock Stockpile. 32 HU of useable low gradient stream, 13 HU of useable high gradient stream, 58 HU of useable pond, 173 HU of useable littoral and 1701 HU of useable open water habitat will be lost.

Table 13: Aquatic Areas of Potential Impact affected by Project Footprint (Continued)

Infrastructure Feature	Aquatic Area of Potential Impact	Description	Description of Potential Impact
Tailings Management Facility	API #47	Approximately 0.0762 ha of Lower Reaches – Inlet stream and 2.9944 ha of beaver impoundments; supports finescale dace, pearl dace (*Margariscus margarita),* and northern redbelly dace.	The streams and beaver impoundments of API #47 will be impacted by the proposed Tailings Management Facility. This will result in a loss of 12 HU of useable low gradient habitat, 35HU of useable high gradient habitat and 1825 m^2 of useable pond habitat.
	API #48	Approximately 0.0123 ha of Headwater - ephemeral/seasonal stream, 0.0430 ha of Headwater - permanent stream and several Headwater beaver ponds (1.0198 ha total); approximately 0.2051 ha Headwater pond; no hydraulic connection to downstream aquatic features. Finescale dace captured in one of the beaver ponds.	The outlet stream and associated beaver impoundments will be impacted by the proposed TMF. This will result in the loss of 239 HU of useable pond habitat.
	API #1	Approximately 0.0894 ha of Lower Reaches – inlet stream, including 0.5836 ha of beaver impoundments; empties into Sawbill Bay; upper sections support pearl dace, finescale dace and fathead minnow; juvenile and young-of-the-year (YOY) white sucker captured in lower sections.	API #1 is entirely contained within the footprint of the TMF and, thus, will be destroyed. This will result in the loss of 266 HU of useable low gradient habitat, 22 HU of useable high gradient habitat, and 3,306 HU of useable pond habitat.
	API #7	1.0962 ha Headwater pond; partially in-filled; fishless; connected to API #6 by a series of small, Headwater beaver ponds (approximately 0.0721 ha).	Though API #7 will be destroyed by the proposed TMF, no useable habitat will be eliminated since the feature is fishless and isolated from API #6.

Table 13: Aquatic Areas of Potential Impact affected by Project Footprint (Continued)

Infrastructure Feature	Aquatic Area of Potential Impact	Description	Description of Potential Impact
	API #6	0.5385 ha pond, 0.0437 ha of Lower Reahes – inlet stream, and 0.1004 ha of Lower Reaches - ephemeral stream; empties into Lizard Lake; pond and ephemeral stream are fishless; white sucker and Iowa dater captured in lower segment of stream.	API #6 is contained within the footprint of the proposed TMF. This will result in the loss of 21 HU of useable low gradient stream habitat.
	API #2	12.4351 ha Headwater lake and 0.2217 ha of Headwater stream and 0.3808 ha of Headwater beaver impoundments; supports pumpkinseed (*Lepomis gibbosus)*, northern pike, yellow perch (*Perca flavescens)*, Iowa darter (*Etheostoma exile),* white sucker, blacknose shiner (*Notropis heterolepis)*.	The destruction of API #2 results in the loss of 881 HU of useable littoral habitat and 13,604 HU of useable open water habitat.
Corridors	Water crossing locations along the Hardtack, Sawbill access roads, and site access road (APIs #20 to #23 and #63 to #68)	14 Culvert locations; movement of fish between waterbodies located up/downstream of water crossings.	Impacts to surface water features contained within road crossing API include alteration of the stream channel at the location of the culvert. Potential for HADDs at each crossing will be assessed once culvert design specifications are developed

Note: HU here refers to Weighted Useable Area (WUA) as calculated by the Habitat Accounting Model.

Table 9 presents the primary effects on aquatic habitat of the Project. In summary, the following habitat losses result for each of the habitat VECs:

- Receivers: There is 0.8 ha of seasonal habitat within the drawdown zone of Sawbill Bay lost, representing about 913 HUs of seasonal habitat for baitfish, northern pike and smallmouth bass.
- Lower Reaches: There are 3.9491 ha of inlet streams, 0 ha of lakes and 0.5385 ha of ponds that provide habitat for baitfish.
- Headwaters: there are 1.8635 ha of headwater streams, 29.7088 ha of lakes (API #12 and #2), and 3.7648 ha of ponds that provide habitat for baitfish and northern pike.
- There is a total of 34,177 HUs of habitat lost.
- There are 14 stream crossings or crossing upgrades on the proposed access road that will result in the loss of habitat within the footprint of the culvert/bridge structure. This represents habitat for baitfish and northern pike. These losses will be considered self-compensating as at-site measures will be implemented to offset losses.
- There are also several ephemeral streams and a number of fishless headwater ponds and Headwater streams.

A fish Habitat NNLP was prepared to offset the effects of these habitat losses. The NNLP habitat offsets are presented in Section 7.0.

7.0 COMPENSATION APPROACHES

The selection of the habitat compensation approach was based upon the hierarchy of compensation preferences as outlined in DFO Policy for Management of Fish Habitat (DFO 1986) and the *Practitioners Guide to Habitat Compensation* for DFO Habitat Management Staff (DFO 2006).

The Project NNLP is consistent with management direction provided in various existing management planning documents. The Hammond Peninsula and Marmion Lake watershed lie within MNRs current Fisheries Management Zone (FMZ) 5, which supports important Aboriginal, recreational, commercial and tourism-based fisheries. The MNR and the FMZ 5 Fisheries Advisory Council are currently developing a Fisheries Management Plan (FMP) that will include fisheries objectives to ensure resource sustainability and optimize angling opportunities. This document is currently available in draft form and is posted on the EBR for comment. While the direction provided is very broad, given the size of FMZ 5, walleye, northern pike and smallmouth bass are the most important recreational fisheries identified in the plan. MNR indicates strong support for any stewardship practices that would focus on improving the sustainability of these fisheries in the waters in which they are currently found.

The Atikokan District FMP, 1988 to 2000, provided management direction for sport fisheries within the former MNR Atikokan Administrative District (MNR 1989). Although this plan has expired and fisheries management objectives have not been updated, it continues to provide MNR fisheries management guidance to address

issues and mitigate impacts until a new Fisheries Management Zone 5 plan is prepared. Habitat compensation options adopted in the Project NNLP will be consistent with the direction provided by this plan.

Fish community objectives for the Seine River system have been developed by the MNR to identify objectives for known and potential fish species that may be affected by current and future development on the Seine River, including the Project (MNR 2012). The broad objective for the Seine River system is ***to maintain or enhance a healthy aquatic ecosystem structure and function that supports a diverse and sustainable fish community in the Seine River, thereby providing for optimum contribution of fish, fishing opportunities and associated cultural, social and economic benefits to society.***

The fish community objective is ***to protect, maintain or enhance genetic, species, and aquatic ecosystem diversity in the Seine River characterized by healthy, sustainable, naturally-reproducing native fish populations and viable fisheries.*** This fish community objective is consistent with existing goals and concepts outlined in both Ontario's Crown Land Use Policy Atlas (MNR 2007), the Atikokan District FMP (MNR 1989) and the Fort Frances District FMP (MNR 1987),which are relevant until replaced by management planning in FMZ 5.

Assessment of potential onsite and near-site locations for compensation projects was completed in 2012. The anticipated HUs gained through habitat compensation were calculated using the methods described above.

Assessment of compensation options included the following (Figure 8):

- **Pond Creation:** Potential for impoundment of former beaver ponds that have reverted to meadows to create pond habitat and the potential to introduce large and small bodied fish species into ponds that were determined to be fishless, during baseline studies. Several options for these forms of habitat enhancement have been identified on and offsite (Figures 9, 10 and 11).
- **Fish Introduction:** Assessment of onsite APIs found to be fishless during baseline studies to determine their potential for fish introduction.
- **Watercourse Crossings:** Examination of existing water crossings to determine if fish passage or adjacent habitat can be enhanced/created to make these crossings self-compensating (Figure 3).

Within the LSA, the key Commercial, Recreational and Aboriginal fisheries that may be affected by the Project are as follows:

- Receiving waterbodies: Upper Marmion Reservoir, including Sawbill Bay, Lynxhead Bay and Lizard Lake.
- Streams and lakes within the Project footprint that may support fisheries within receiving waterbodies, provide seasonal habitats for species important for Commercial, Recreational and Aboriginal fishing and that may provide potential baitfish opportunities.

610000 620000 630000

5430000

5420000

N

Serpent Lake

Cornell Lake

Sawbill Bay

Mitta Lake

Lynxhead Bay

Marmion Reservoir

Light Lake

Upper Seine Bay

Hawk Bay

1 2 3 4 5 6 7

LEGEND

- Additional Habitat Compensation Projects
- Pond Creation
- Fish Introduction
- Watercrossing Enhancement
- Trail
- Road
- River/Stream
- Raft Lake Cut Location
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
POTENTIAL FISH HABITAT COMPENSATION WORKS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	CGE	14 Nov. 2008		
GIS	JO	10 Apr. 2013		
CHECK	BH	10 Apr. 2013		
REVIEW	GA	10 Apr. 2013		

FIGURE: 8

G:\Projects\2010\10-1118-0020_BrettResources_HammondReefGIS\MXDs\Draft\Aquatics\NoNetLossPlan\Potential_Fish_Habitat_Compensation_Works.mxd

Page left intentionally blank

610200 610400 610600 610800 611000 611200

5426000 5425800 5425600 5425400 5425200

N

T1 T2 T3 T4 T5 T6

Water Level Control Structure

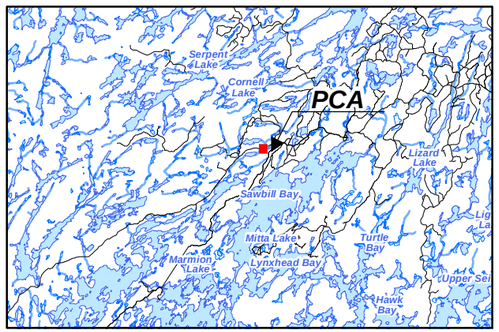
LEGEND

- Photo Location/Direction
- Water Level Control Structure
- Transects
- Current Wetted Area = 13128 m^2
- Proposed Wetted Area= 61304 m^2

Potential Gain = 48,176 m^2

Current Fish Community: Northern Pike, Yellow Perch, and Common White Sucker

Note: Transect data included wetted widths, bankfull widths, water depth, substrate type, and instream cover estimates.



REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

100 0 100
SCALE 1:4,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
Potential Fish Habitat Compensation Area
Beaver Meadow 1

Golder Associates
Sudbury, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	AL	Sept. 2012	FIGURE: 9	
GIS	AL	Sept. 2012		
CHECK	BH	Apr. 2013		
REVIEW	GA	Apr. 2013		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Field\JayAug_20_2012\Beaver_Meadow_1_PCA.mxd

Page left intentionally blank

611000 611200 611400 611600

5425400 5425200 5425000

T1 T2 T3 T4 T5 T6 T7

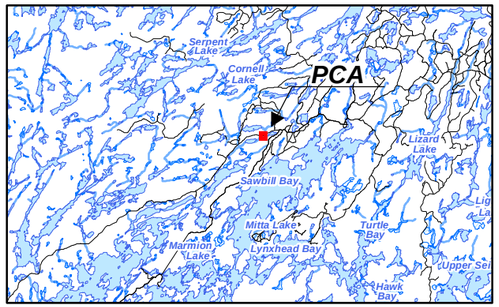
Water Level Control Structure

N

LEGEND

- Photo Location/Direction
- Water Level Control Structure
- Transects
- Current Wetted Area = 9582m^2
- Proposed Wetted Area = 84719m^2

Note: Transect data included wetted widths, bankfull widths, water depth, substrate type, and instream cover estimates. This data will be provided in the compensation plan.



REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

60 0 60
SCALE 1:2,500 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
Potential Fish Habitat Compensation Area
Beaver Meadow 2 (API)

Golder Associates
Sudbury, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	AL	Sept. 2012	FIGURE: 10	
GIS	AL	Sept. 2012		
CHECK	BH	Apr. 2013		
REVIEW	GA	Apr. 2013		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Field\JayAug_20_2012\Beaver_Meadow_2_PCA_a.mxd

Page left intentionally blank

614000 614200 614400

5422600 5422400 5422200

N

August 2012

Water Level Control Structure

T1 T2 T3 T4 T5 T6

August 2012

August 2012

Water Level Control Structure

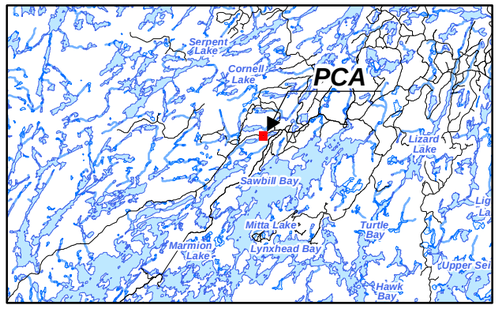
LEGEND

- Photo Location/Direction
- Water Level Control Structure
- Transects
- Current Wetted Area = 939 m^2
- Proposed Wetted Area = 33163 m^2

Potential Gain = 32,225 m^2

Current Fish Community: Common White Sucker, Northern Redbelly Dace, Finescale Dace, and Brassy Minnow

Note: Transect data included wetted widths, bankfull widths, water depth, substrate type, and instream cover estimates.



REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

60 0 60
SCALE 1:2,351 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
Potential Fish Habitat Compensation Area
Beaver Meadow 3 (API 14)

Golder Associates
Sudbury, Ontario

PROJECT No. 10-1118-0020		SCALE AS SHOWN	REV. A
DESIGN	AL	Sept. 2012	FIGURE: 11
GIS	AL	Sept. 2012	
CHECK	BH	Apr. 2013	
REVIEW	GA	Apr. 2013	

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\FieldJayAug_20_2012\Beaver_Meadow_3_PCA.mxd

Page left intentionally blank

7.1 Compensation Calculations

Habitat losses were accounted for based on the species present, habitat unit types present within each API and their areas. Losses were calculated using the same weight for each characteristic (Table 14).

The fishless ponds were considered to be able to support fish because they have sufficient depths to avoid winter anoxic conditions from occurring. Winter dissolved oxygen monitoring confirmed that for the ponds selected for stocking, conditions were suitable for the species proposed to be stocked, since these ponds have depth characteristics and dissolved oxygen concentrations similar to others studied that sustained fish populations.

In the case of fishless lakes, it was assumed that the following species could successfully be stocked to establish self-sustaining populations: finescale dace, northern redbelly dace, white sucker, fathead minnow and pumpkinseed. This is consistent with the species supported in the catchments and in similar aquatic features where these fishless lakes are located and also consistent with the fish communities occupying features that were proposed for flooding to create additional habitat. In the case of features that may be impounded, the habitat areas calculated in Table 14 and shown in Figure 8 represent the net increase in habitat area (e.g., existing habitat in these features has been subtracted and is not accounted for in the overall compensation value).

Table 14: Weighted Useable Area Calculations of Proposed Habitat Creation Showing Estimates of Habitat Gains

Total Area	Available Habitat Area (HA)	Number of Species Present	Total Weighted Useable Area (WUA)	Ecotype Weighted Useable Area (EWUA)
API #10 13,881 m^2				
Littoral	6763 m^2	7	419 HU	419 HU
Open Water	7118 m^2	7	120 HU	120 HU
API #16 6,142 m^2				
Littoral	5032 m^2	7	312 HU	312 HU
Open Water	1109 m^2	7	19 HU	19 HU
API #43 28,954 m^2				
Littoral	13826 m^2	7	857 HU	857 HU
Open Water	15125 m^2	7	255 HU	255 HU
BM #2 75,125 m^2				
Littoral	38,120 m^2	7	2,363 HU	2,363 HU
Open Water	37,000 m^2	7	624 HU	624 HU

Table 14: Weighted Useable Area Calculations of Proposed Habitat Creation Showing Estimates of Habitat Gains (Continued)

Total Area	Available Habitat Area (HA)	Number of Species Present	Total Weighted Useable Area (WUA)	Ecotype Weighted Useable Area (EWUA)
BM #1 48,176 m^2				
Littoral	24,176 m^2	7	1,499 HU	1,499 HU
Open Water	24,000 m^2	7	405 HU	405 HU
Total			**6,873 HU**	

Additional terrestrial studies (i.e., species at risk assessments) may be required where proposed compensation works entail the alteration of terrestrial habitats.

The habitat compensation measures identified in Table 14 represent about 18 ha of surface water area and 6,873 HUs of like for like fish habitat.

7.1.1 Assessment of Habitat Potential of Fishless Lakes

Osisko environmental staff recently completed a series of late winter water quality and temperature profiles to evaluate dissolved oxygen levels in several small fishless ponds and lakes within the Mine Study Area that are being considered for fish introductions. For comparative purposes several nearby similar sized waterbodies, including Mitta Lake and API 2, that contain fish were also monitored. The objective of the monitoring is to help determine the suitability of the fishless waterbodies for possible fish introductions. This work was completed at the request of DFO/MNR as part of assessing the suitability of these ponds as compensation. It was felt that if the ponds contained similar dissolved oxygen concentrations as other ponds that supported the same fish populations proposed for introduction, then fish stocking would be considered a viable compensation option.

Water quality profiles were completed during ice covered conditions between the dates of April 18 and April 25, 2013. A Yellow Springs Instruments (YSI) model 556 multi-meter was used to measure water temperature, dissolved oxygen, pH and conductivity at approximately 1m intervals from just below the ice to just above bottom.

Monitoring locations are provided in Figure 12. Selected results of the water quality profiles are provided in Figure 13 (a – f). Complete results are available in Appendix D.

610000 620000 630000

5430000

5420000

N

Serpent Lake

Cornell Lake

Sawbill Bay

Mitta Lake

Lynxhead Bay

Marmion Reservoir

Light Lake

Upper Seine Bay

Hawk Bay

1 2 3 4 5 6 7

16 10 44 43

LEGEND

- Additional Habitat Compensation Projects
- Pond Creation
- Fish Introduction
- Watercrossing Enhancement
- Trail
- Road
- River/Stream
- Raft Lake Cut Location
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
LOCATION OF FISHLESS PONDS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	CGE	14 Nov. 2008		
GIS	JO	10 Apr. 2013		
CHECK	BH	10 Apr. 2013		
REVIEW	GA	10 Apr. 2013		

FIGURE: 12

G:\Projects\2010\10-1118-0020_BrettResources_HammondReefGIS\MXDs\Draft\Aquatics\NoNetLossPlan\Potential_Fish_Habitat_Compensation_Works.mxd

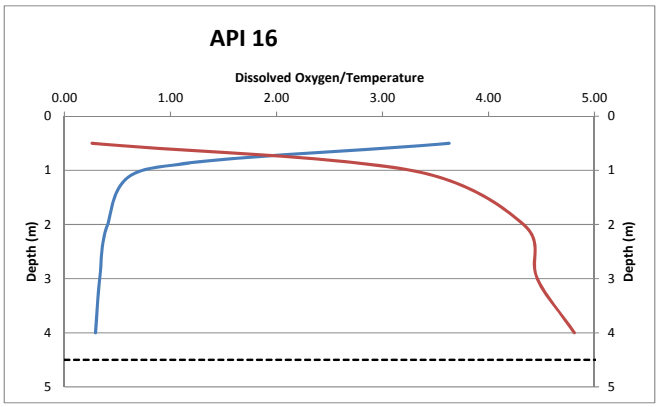
Page left intentionally blank

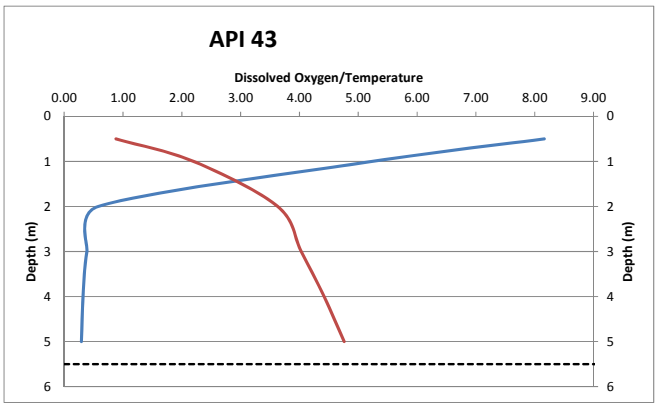
Six representative profiles are presented in Figure 13 (a – f):

- Fishless Ponds (API#16 and #43): both ponds showed near zero temperatures immediately beneath the ice, increasing to about 4 C at the bottom. Dissolved Oxygen levels were low dropping from around 4 mg/L at surface to less than 1 mg/L below 1 m. In one fishless pond, API#44 conditions were virtually anoxic immediately beneath the ice and this pond was dropped from consideration as a viable stocking location.
- Northern Pike Ponds (API #2, #8): API #2 showed a very similar dissolved oxygen/temperature profile as the fishless lakes, while API #8 had a similar temperature profile, however dissolved oxygen concentrations remained above 4 mg/L to a depth of about 3 m.
- Dace Ponds (API #47, #46): these also had similar dissolved oxygen/temperature profiles as the fishless ponds although API #47 had higher dissolved oxygen concentrations within 1 m of the surface.

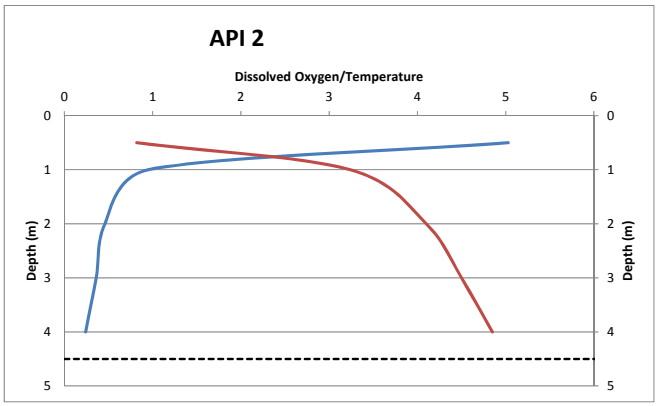
In conclusion, it was felt that these measurements support the use of the following fishless ponds as candidates for stocking: API #10, 16, 43, BM #1 and BM #2.

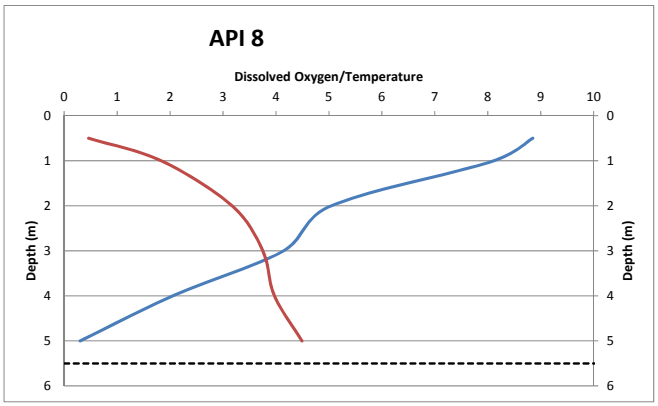
(a, b) Fishless Ponds (API #16, #43)



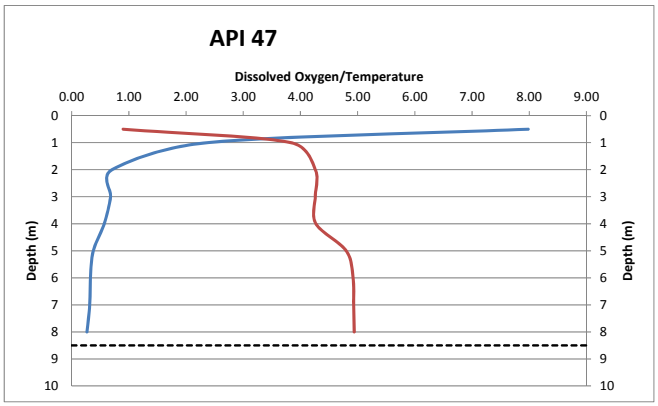


(c, d) Northern Pike Ponds (API #2, #8)





(e, f) Dace Ponds (API #47, #46)



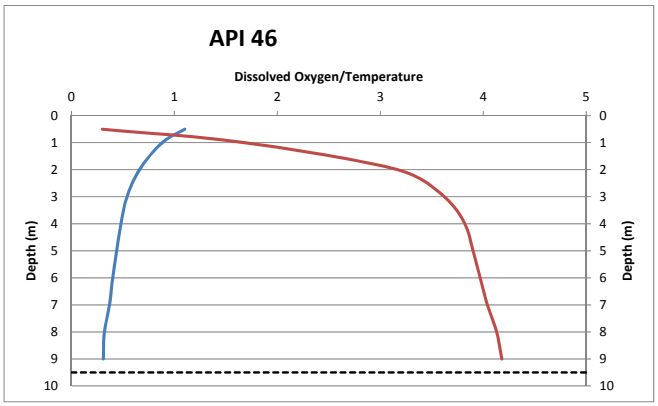


Figure 13 (a-f): Late Winter Dissolved Oxygen (blue) and Temperature (red) profiles of selected Ponds.

7.1.2 Stream Crossings

A total of 15 stream crossings for the proposed access road will be required, of which 14 are considered to impact fish habitat. For each of these, compensation for the lost habitat associated with culvert installation will be provided, using one of the following approaches:

- Installation of an open bottomed culvert, to replace existing closed culverts to preserve aquatic habitat.
- Remediate existing barriers in the stream being crossed to provide access by fish to more habitat area (equal to or greater than the area of habitat occupied by the culvert).
- Undertake a channel restoration associated with the culvert installation to increase stream area (by increasing channel length and/or width) and offset the habitat lost to the culvert.

By implementing these measures onsite to offset the habitat losses within the culverts, these crossings are considered to be self-compensating.

Table 15 provides a summary of the 15 crossings and the general proposed habitat compensation measures. Crossing locations are provided in Figure 14 and additional details on each crossing are included in Appendix E.

Table 15: Summary of Habitat Compensation for 15 Stream Crossings

Location	Fish Community	Barrier Remediation	Culvert Replacement	Habitat Compensation
API#1	Finescale dace, fathead minnow, white sucker, burbot	X	X	■ Reports to Sawbill Bay ■ Walleye/sucker spawning/nursery habitat ■ Riparian habitat plantings
API#20	White sucker, burbot, central mudminnow, blacknose shiner, northern pike, yellow perch, smallmouth bass	X	X	■ Reports to Sawbill Bay ■ Walleye/sucker spawning occurs at mouth ■ Remediate natural barrier to allow access to new habitat ■ Enhance instream habitat for spawning/nursery
API#21	Finescale dace,northern redbelly dace, iowa darter	X		■ Create backwater pools with channel connections upstream/downstream of culvert
API#22	Finescale dace, fathead minnow, blacknose dace, yellow perch, white sucker	X	X	■ Lengthen channel ■ Realign stream away for road

Table 15: Summary of Habitat Compensation for 15 Stream Crossings (Continued)

Location	Fish Community	Barrier Remediation	Culvert Replacement	Habitat Compensation
API#23	Finescale dace, northern redbelly dace, pearl dace, fathead minnow, white sucker			■ Widen downstream channel ■ Create backwater pools
API#60	Finescale dace, fathead minnow	X	X	■ Widen downstream/upstream channel and pond
API#61	Longnose dace, iowa darter, white sucker	X	X	■ Reports to Finlayson Lake ■ Existing span bridge to be widened
API#62	Finescale dace		X	■ widen upstream channel and pond
API#63	White sucker, finescale dace	X	X	■ reports to Finlayson Lake ■ Enhance spawning and nursery habitat for white sucker/walleye
API#64	Finescale dace, fathead minnow, yellow perch, lake whitefish (in lake), northern pike			■ Reports to Finlayson Lake ■ Enhance channel characteristics as spawning/nursery habitat for walleye/white sucker
API#65	Longnose dace, white sucker	X	X	■ Reports to Detach Lake (Finlayson Lake) ■ Enhance instream habitat to create deep refuge pools ■ Riparian plantings
API#66	Longnose dace, white sucker, northern pike	X	X	■ Reports to Detach Lake (Finlayson Lake) ■ Create pool habitat ■ Remediate natural barrier ■ Enhance spawning habitat for white sucker
API#56	Iowa darter, central mudminnow, walleye, northern pike, white sucker, yellow perch	X	X	■ Remediate natural barrier to provide upstream access to habitat
API#58	Finescale dace, pearl dace		X	■ Gradient too steep to benefit from natural fish barrier remediation
API#70	Central mudminnow, finescale dace, pearl dace, blacknose shiner, fathead minnow, white sucker			■ Increase size of existing pool and backwater pool habitat

Further details for each stream crossing compensation project will be detailed in the Section 35 Fisheries Act application.

Page left intentionally blank

600000 610000 620000

5430000 5420000

N

Serpent Lake
Coakell
Sawbill Bay
Mitta Lake
Marmion Lake
Lynxhead Bay
Hawk Bay

1 20 21 22 23 66 65 64 63 62 61 60 58 56 70

LEGEND

- Water Crossing Location (by API#)
- Hardtack Road
- Hammond Reef Road
- Sawbill Road
- River/Stream
- Lake
- Wetland

DRAFT

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
SCALE 1:80,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
Water Crossing Locations

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 2.0
DESIGN	CGE	14 Nov. 2008	FIGURE: 14	
GIS	RRD	Nov. 2011		
CHECK	JD	Mar 2012		
REVIEW	JS	Mar 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\5200_5210\WaterCrossingLocations.mxd

Page left intentionally blank

7.2 Additional Mitigation and Compensation Measures

The compensation measures described in Section 7.1 summarize the opportunities for "like for like" compensation for the lost habitat; however, these are insufficient in themselves to provide full compensation. MNR indicated that they would be interested in habitat enhancements for northern pike and lake whitefish in Upper Marmion Reservoir, should additional onsite compensation be required. The following measures represent additional onsite compensation that contributes directly to the valued fishery of Upper Marmion Lake.

Fluctuating reservoir levels in Upper Marmion Lake have the potential to impact spawning habitat for northern pike, which require high early spring water levels, and lake whitefish, which require near constant late fall and overwinter water levels. The water management regime for Upper Marmion Lake is shown in Figure 15.

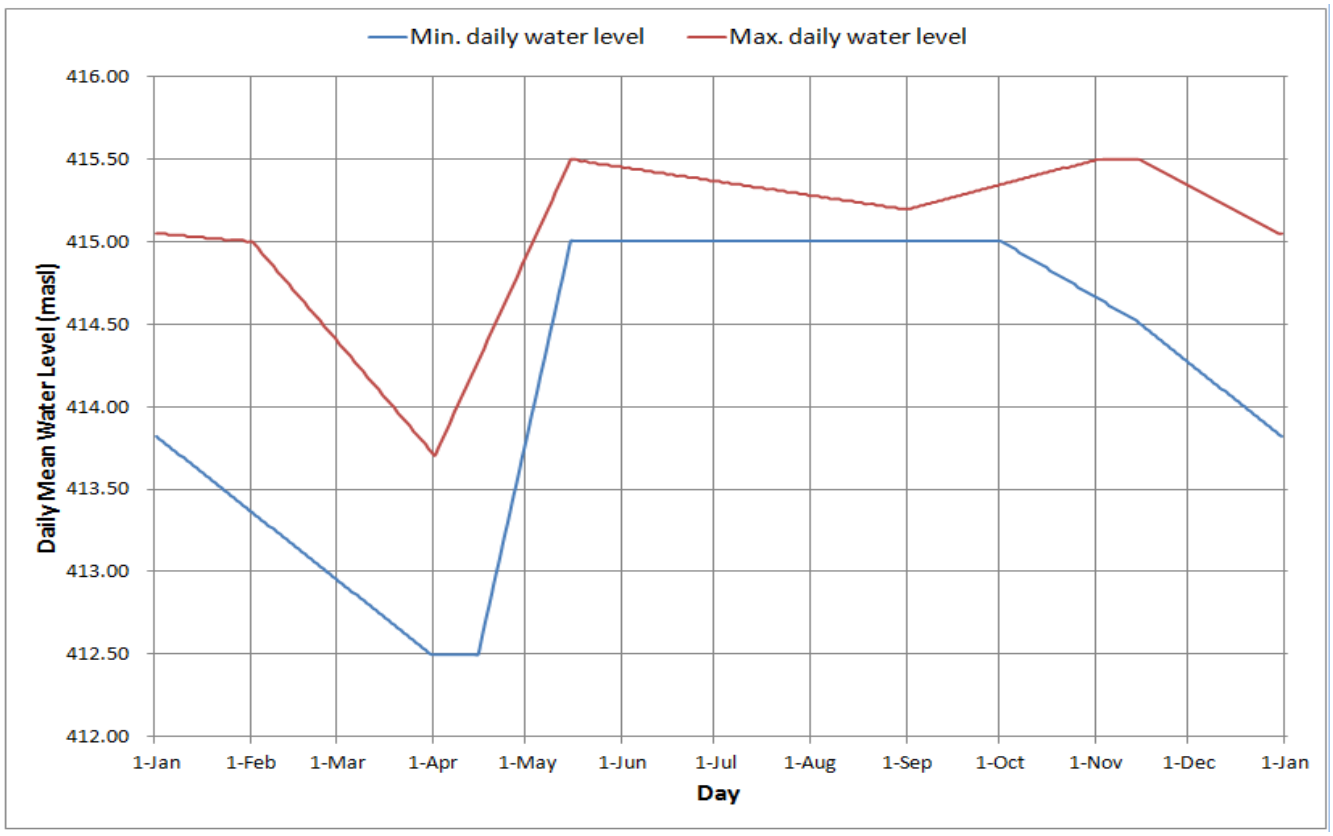


Figure 15: Minimum and Maximum Water Levels for Upper Marmion Reservoir (Hydrology TSD)

Declining water levels through the winter may expose lake whitefish eggs or result in freezing of eggs in the ice. Low or declining early spring levels may prevent northern pike from gaining access to flooded vegetation or limit the amount of available spawning habitat. This is also illustrated in Photos 1 and 2. While the lower limit of the drawdown may extend to elevation 412.5 masl, typical levels are about 413.2 masl.

Photo 1: Exposed Shoreline of Sawbill Bay during Low Water, near the Mouth of API #33 (June 2010)

Photo 2: Exposed Shoreline of Snail Bay during Low Water Elevation (June 2010).

A number of additional on-site compensation measures have been developed as follows (locations shown in Figure 8):

- **Creation of northern pike spawning habitat:** to enhance northern pike spawning habitat, which is currently impacted by water level fluctuations in the Upper Marmion Reservoir, several areas can be excavated to create the appropriate depths within or adjacent to the zone of water level fluctuations. The following areas have been identified:
  - Sawbill Creek Mouth Pike Spawning Habitat Creation (Location 2, Figure 16): An area of low-lying shore near the proposed Helipad to the east side of the shallow embayment at the mouth of Sawbill Creek. This area would be excavated to a depth equal to the lower limit of the water level fluctuation to create about 1.5 ha of spawning and nursery habitat. These habitats would also be used to some extent by other species in Upper Marmion Lake, including baitfish, smallmouth bass and other species. It is estimated that this habitat would create about 4,000 HUs.

- Hammond Embayment and Snail Bay Northern Pike Spawning Habitat Creation (Locations 4 and 3, Figures 17 and 18): Two additional shallow excavations and shallow channel excavations to create northern pike spawning habitat would be established along the shoreline of Snail Bay and Hammond Peninsula equivalent to an area of about 3.0 ha of spawning and nursery habitat. These habitats would also be used to some extent by other species in Upper Marmion Lake, including baitfish, smallmouth bass and other species. It is estimated that this habitat would create about 8,000 HUs.
- API#37 Northern Pike Spawning Habitat Creation (Location 1, Figure 19): API #37 is at the mouth of a small tributary to Sawbill Bay, just east of the mouth of Sawbill Creek. In this location, two areas can be enhanced for northern pike spawning: one in the shallow embayment, constructed in a similar way as the previous two projects described above; and, the other as a flooded marsh connected to the inlet stream itself. This would result in about 1.5 ha of habitat. These habitats would also likely be used by other species in Upper Marmion Lake, including baitfish, smallmouth bass and other species. It is estimated that this habitat would create about 4,000 HUs.

- **Creation of Walleye Spawning Habitat or Access to Spawning Habitat:** Spawning habitat exists in Sawbill Creek (the creek adjacent to the mine camp Helipad); however, fish passage is an issue. Removal of barriers and improvement of spawning habitat (Inflow 1 and 2, Figure 8) will improve existing spawning areas for walleye and improve access by Upper Marmion Reservoir walleye into Sawbill Creek. This would provide access to a substantial length of stream/floodplain habitat with suitable spawning, nursery and adult habitat. Spawning habitat exists in Lumby Creek between the mouth (in Lynxhead Bay) at the outlet of Lizard Lake; currently fish passage is limited for walleye in the Upper Marmion Reservoir. Removal of barriers and improvement of spawning habitat will improve existing spawning areas for walleye and improve access by Upper Marmion Reservoir walleye into Sawbill Creek. This would provide access to a substantial length of stream/floodplain habitat with suitable spawning, nursery and adult habitat. It is estimated that this improvement in fish passage would create about 1,000 HUs.

Additional terrestrial studies (i.e., species at risk assessments) may be required where proposed compensation works entail the alteration of existing terrestrial habitats.

A quantitative monitoring program will be established for all compensation works, based upon baseline conditions. The timing of monitoring activities will be linked to the rate of habitat change resulting from each compensation work. Monitoring events will measure compliance with the design of compensation works (i.e., the number of habitat units created) and physical and biological indicators of success (i.e., species utilization). For costing purposes, it has been assumed that all compensation works would be completed during the construction phase of the Project, and that five bi-annual surveys (a 10 year monitoring program) would be implemented to evaluate the success of the compensation.

LEGEND

- Access Road (Hardtack / Sawbill)
- Project Facilities
- Areas of Habitat Creation

100 50 0 100 200 300

SCALE 1:6,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
SAWBILL CREEK MOUTH
PIKE SPAWNING HABITAT

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020		SCALE AS SHOWN	REV. A
DESIGN	JO	8 Apr. 2013	FIGURE: 16
GIS	JO	10 Apr. 2013	
CHECK	BH	10 Apr. 2013	
REVIEW	GA	10 Apr. 2013	

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\NoNetLossPlan\Sawbill_Creek_Mouth.mxd

LEGEND

- Mine Site Road
- Project Facilities
- Areas of Habitat Creation

100 50 0 100 200 300

SCALE 1:6,000 METRES

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
HAMMOND EMBAYMENT
PIKE SPAWNING HABITAT

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020		SCALE AS SHOWN	REV. A
DESIGN	JO	8 Apr. 2013	FIGURE: 17
GIS	JO	10 Apr. 2013	
CHECK	BH	10 Apr. 2013	
REVIEW	GA	10 Apr. 2013	

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\NoNetLossPlan\Hammond_Embayment_Pike_Spawning_Habitat.mxd

LEGEND

- Mine Site Road
- Project Facilities
- Areas of Habitat Creation

100 50 0 100 200 300

SCALE 1:6,000 METRES

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

SNAIL BAY
PIKE SPAWNING HABITAT

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020		SCALE AS SHOWN	REV. A
DESIGN	JO	8 Apr. 2013	
GIS	JO	10 Apr. 2013	
CHECK	BH	10 Apr. 2013	
REVIEW	GA	10 Apr. 2013	

FIGURE: 18

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\NoNetLossPlan\Snails_Bay_Pike_Spawning_Habitat.mxd

LEGEND

- Mine Site Road
- Project Facilities
- Areas of Habitat Creation

100 50 0 100 200 300

SCALE 1:6,000 METRES

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
API #37
PIKE SPAWNING HABITAT

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020		SCALE AS SHOWN	REV. A
DESIGN	JO	8 Apr. 2013	
GIS	JO	10 Apr. 2013	
CHECK	BH	10 Apr. 2013	
REVIEW	GA	10 Apr. 2013	

FIGURE: 19

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\NoNetLossPlan\API37_Pike_Spawning_Habitat.mxd

LEGEND

- Project Facilities
- Areas of Habitat Creation

100 50 0 100 200 300

SCALE 1:6,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
HAMMOND PENINSULA DISCHARGE AREA
SPAWNING REEF

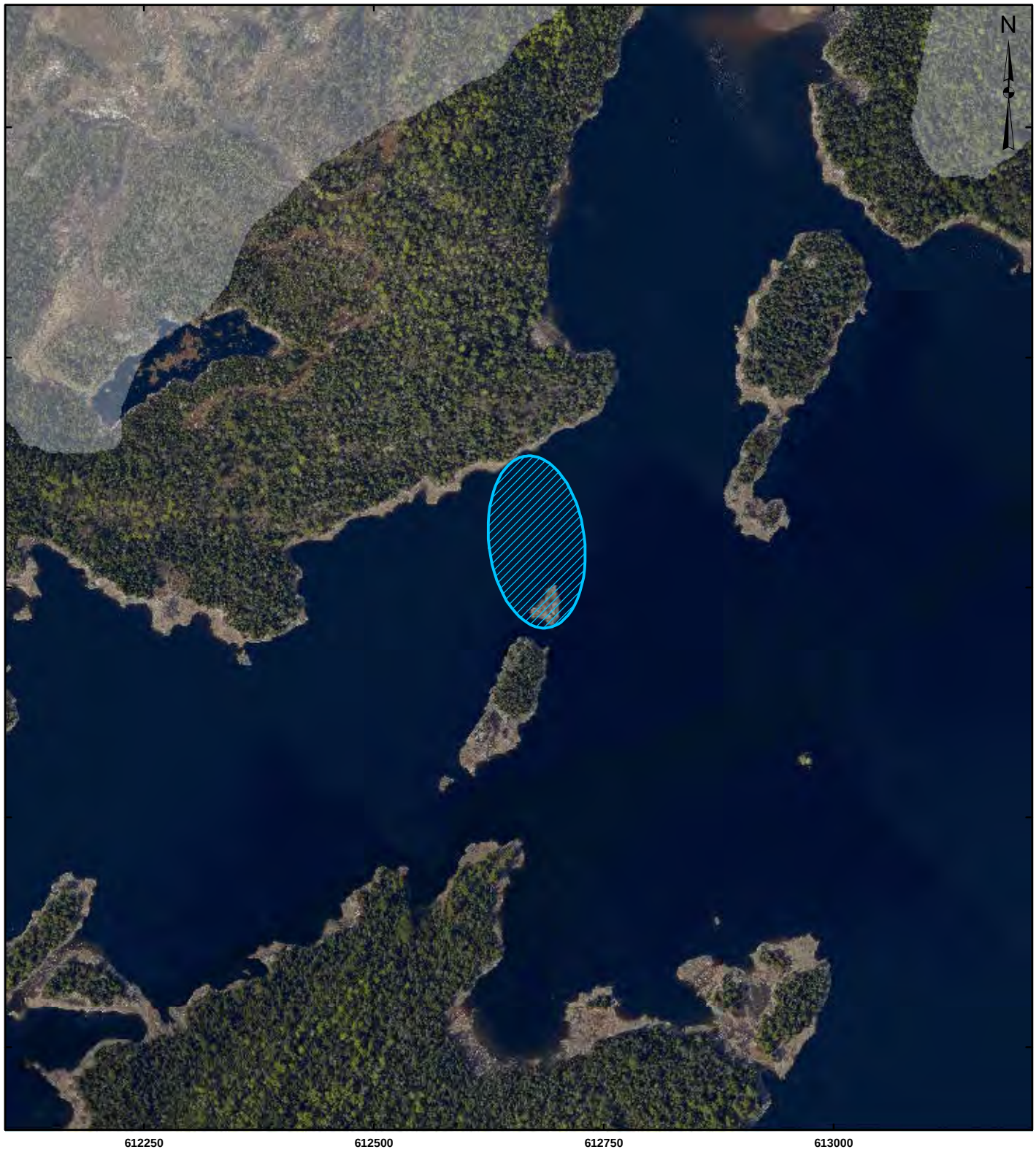
REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020		SCALE AS SHOWN	REV. 0.0
DESIGN	JO	8 Apr. 2013	FIGURE: 20
GIS	JO	10 Apr. 2013	
CHECK	BH	10 Apr. 2013	
REVIEW	GA	10 Apr. 2013	

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\NoNetLossPlan\Hammond_Penninsula_Discharge_Area.mxd



LEGEND

- Project Facilities
- Areas of Habitat Creation

100 50 0 100 200 300

SCALE 1:6,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

LYNXHEAD BAY
SPAWNING REEF ALTERNATIVE

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020		SCALE AS SHOWN	REV. A
DESIGN	JO	8 Apr. 2013	FIGURE: 21
GIS	JO	10 Apr. 2013	
CHECK	BH	10 Apr. 2013	
REVIEW	GA	10 Apr. 2013	

G:\Projects\2010\10-1118-0020_BrettResources_HammondReefGIS\MXDs\Draft\AquaticsNoNetLossPlan\LynxheadBay_Spawning_Habitat.mxd

7.2.1 Northern Pike Spawning Habitat Creation

The objective of habitat creation is to excavate some existing shallow shoreline/floodplain areas to an elevation that will be flooded in early spring when northern pike spawn. Based on the water level management regime, the habitat to be created should be approximately 25 to 50 cm below elevation 413 masl. In addition, a series of slightly deeper channels would also be created through the excavated area to improve access by adult fish. The excavated material would be spread in the backshore behind the proposed excavation and allowed to naturally revegetate. A series of mounds, using excavated material, would be scattered throughout the excavated area to diversify the habitat and provide a seed source for wetland vegetation. Figures 22 and 23 illustrate this habitat conceptually (TRCA 2003).

The mounds of excavated material provide seed sources for many aquatic and floodplain species. Should additional seed sources be required, these may be obtained from some of the wetland features that will be removed as part of the construction of mine facilities.

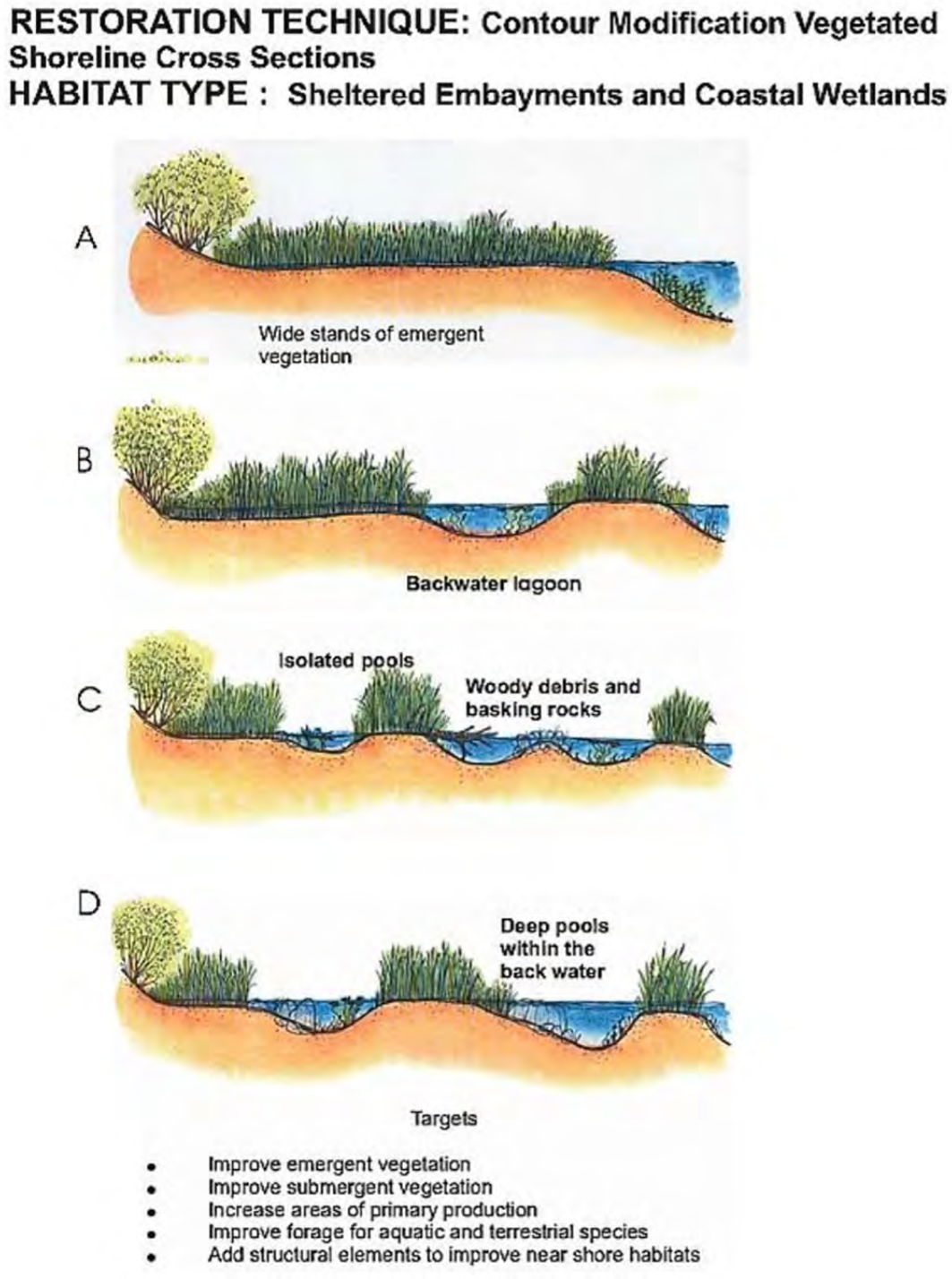


Figure 22: Concept of a Shallow Excavation with a Series of Deeper Channels for Access and/or Mounds to Provide Habitat Diversity (TRCA 2003)

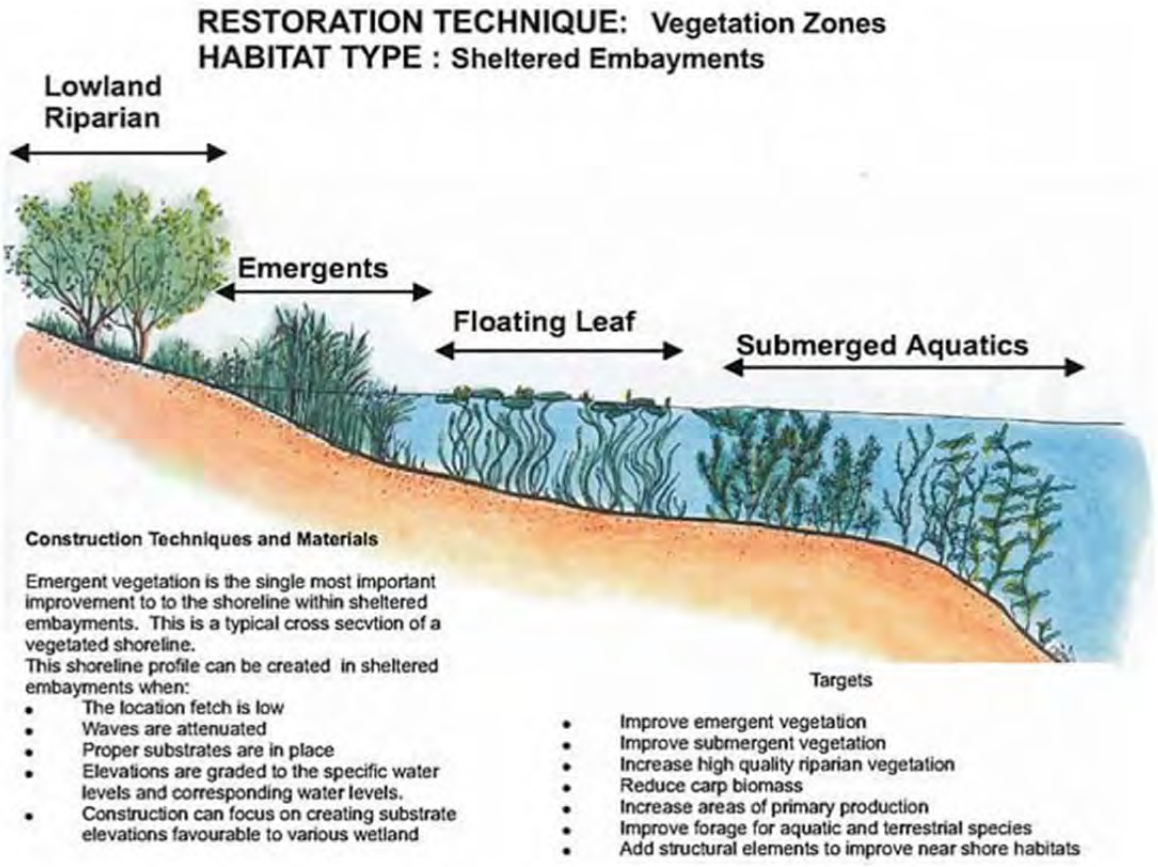


Figure 23: Representative Shallow Water Vegetation Zones.

Note: The "lowland riparian" zone may also be partially flooded in spring and provide spawning habitat for northern pike (TRCA 2003).

7.2.2 Fish Passage in Sawbill Creek for Walleye

Sawbill Creek has several natural and artificial barriers to fish movement. These barriers limit or constrain the upstream movement of walleye to spring spawning habitats. The objective of the Project is to modify the creek at these locations to allow fish to pass through/around these barriers. This would be accomplished by replacing the existing feature with a lower gradient stream segment that the fish could move through. In addition, the materials used for the construction would be cobble-sized stone that is also suitable as spawning habitat for this species. Photos 3 and 4 show an example of a barrier in Sawbill Creek and Photos 5 and 6 show examples of constructed fish passage features.

Photo 3: Upstream End of Existing Barrier to Walleye Movement (September 2010)

Photo 4: Middle Portion of Barrier to Walleye Movement (September 2010)

Photo 5: A Series of Step Pool Features Were Constructed to Improve Fish Passage in this Former Cascade Feature.

Source: Alluvium (http://www.alluvium.com.au/Home.aspx) 2013.

Location: Rapid City, Manatoba, Canada
River: Little Saskatchewan
Type: step-pool bypass channel
Fish Passed: walleye, northern pike
white sucker, shorthead redhorse sucker
Picture Source: Chris Katopodis

Photo 6: Example of Natural Fish Passages (Wildman et. al. in press)

The design shown in Photo 6 illustrates a step – pool type of stream section that could be used to replace the steep natural cascade feature that is shown in Photos 3 and 4. The fish passage structure would typically be a modified stream segment with an increased length and reduced gradient. A series of gradient drops would be designed and built into the modified stream section using a steep riffle section, often referred to as a "Newbury riffle" after its designer, Robert Newbury. An illustration of one of these features is shown in Figure 24.

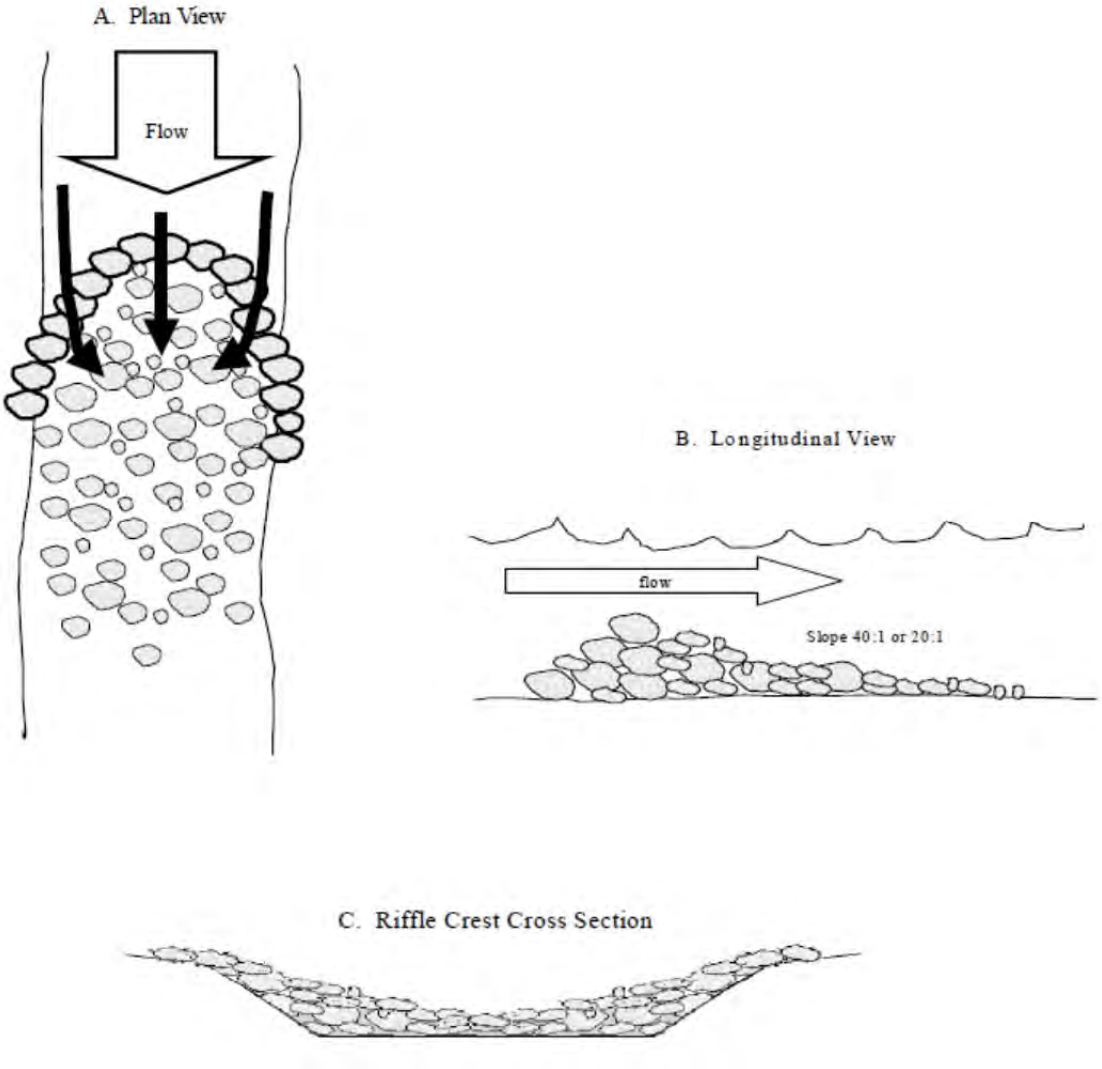


Figure 24: Example Illustrating a Typical Riffle Step.

7.2.3 Summary of Offsetting Compensation Measures

The habitat compensation measures identified in Table 8 represent about 18 ha of surface water area and 6,800 HUs of like for like fish habitat. At this time, the conceptual NNLP would consist of the measures in Table 8, plus the following:

- Stream crossings habitat enhancements.
- Northern pike spawning habitat creation at the mouth of Sawbill Bay, API#37 Bay, Snail Bay and Hammond Peninsula bay: 32,000 HUs.
- Walleye spawning habitat enhancements in Sawbill Creek and Lumby Creek: 2,000 HUs.
- The fish salvage and rescue operations.

The other measures outlined above are possible alternatives to these measures that would be discussed with DFO/MNR as the NNLP is finalized.

These measures, considered together, represent more than a 1:1 ratio of habitat losses and gains. However, since the majority of the habitat gains are focused on valued fisheries, walleye, northern pike, lake whitefish and baitfish, the value of the habitat gain is considered greater than the habitat lost, which is predominantly baitfish and other species.

These habitat compensation measures would be constructed during the construction phase of the Project and, therefore, there would be no lag between habitat removal and creation.

7.3 Open Pit Habitat Creation

Additional discussions occurred with DFO/MNR regarding the potential to utilize the open pits as part of the habitat compensation plan. After additional review, it was felt that this was not a viable habitat offset project for the reasons outlined below, and accordingly this alternative is not considered as part of the habitat offset plan.

For the post-closure period of the project, the pits will gradually fill with surface runoff from the MSA, groundwater and direct precipitation over a period of approximately 218 years. In the short term, it is anticipated that the quality of the runoff (which includes runoff from the TMF and WRMF) will not meet SSWQOs. During this early phase of filling, the pits will not be considered as aquatic habitat, as they continue to serve as part of the mine closure and rehabilitation process. Over time, the quality of the runoff from the TMF and WRMF is predicted to improve to the point where it will meet SSWQOs, at which time, it will be allowed to discharge directly to the environment. The pits will continue to fill with precipitation, groundwater and some local runoff. As the pits continue to fill, permanent stratification will occur and the deeper waters will become isolated from the upper waters. It is predicted that by the time that the pits overflow into Sawbill Bay (in approximately 218 years), water quality in the pits will meet SSWQOs. If in the long term pit water quality does not meet SSQWOs, further treatment of the discharge from the pit lakes will be required (after the 218 year filling period).

The filling strategy for the pits over a 218 year period is a conservative approach to ensuring that final quality of runoff from the closed site will meet SSWQOs, and during this time, the pits would not be considered aquatic habitat.

Post closure, the vertical faces of the cliffs represent a potential hazard to wildlife and humans, because of the risk of falling into the pits and also because the area adjacent to the pit walls may be unstable. Accordingly, the closure plan identifies a setback from the perimeter of the pit walls where efforts will be made to secure the site from intrusion by wildlife and people. This potential for mechanical instability of the bedrock around the perimeter of the pits also limits the potential to either blast or fill any nearshore areas to create shallow water littoral habitat for fish.

For the current mining plan, the area of appropriate depth would be about 1,250 m2 (which is the approximate area of the proposed connecting channel between the flooded pits). It is anticipated that this shallow area would naturally develop into wetland habitat over the long term, through colonization by emergent/submergent aquatic plants, facilitated by dispersion of seed/plant sources into the flooded pits by wind, surface runoff, avifauna, etc.

There exists the potential to modify the elevations of selected benches (during operations), and widen excavated channels to increase the area of wetland habitat (with a water depth of 2 – 3 m). Doing so would result in a total littoral bench area of about 21,000 m^2 that would have the potential to naturally develop into wetland habitat. However, changing the pit design to accommodate benching at this level may have significant ramifications with respect to mine planning and costs. Additionally, undertaking works and encouraging recreational fishing within the post-closure flooded pits may be contrary to safety considerations as indicated in the closure and reclamation guidelines (O.Reg. 240/00). For these reasons, modification to the pit design to increase fish habitat potential is currently not planned or reflected in the habitat offset plan.

7.4 Summary of MMER and Section 35 Habitat Offsets

Using the Habitat Accounting Model developed for the project, habitat losses were as follows:

- Total Habitat losses: approximately 34,000 Habitat Units
- Habitat Losses requiring MMER listing (approximately 22 000 HUs):
  - Losses associated with the Waste Rock Management Facility: 5 features representing 1,977 HUs
  - Losses associated with the Tailings Management Facility: 10 features representing 20,211 HUs
- Habitat Losses requiring Section 35 Fisheries Act Authorization: 7 features representing 11,989 HUs

Table 16 summarizes these habitat losses in more detail.

Table 16: Summary of MMER and Section 35 Habitat Losses

Habitat Loss	Area (ha)	Habitat Units	Species Present
MMER (TMF)			
API#2	12.4351	14,485	Pike, Suckers, small bodied fish
Other (9 features)	0.5016	5,726	Small bodied fish

Table 16: Summary of MMER and Section 35 Habitat Losses (Continued)

Habitat Loss	Area (ha)	Habitat Units	Species Present
MMER (WRMF)			
API#11	2.7777	1,874	Small bodied fish
Other (4 features)	0.0154	103	Small bodied fish
Section 35			
Mitta Lake	17.2737	9,608	Suckers, small bodied fish
Other (6 features)	3.146	2,381	Small bodied fish

The following sections summarize the habitat offset projects proposed to address habitat losses associated with the MMER and Section 35 habitat losses. Based on discussions with DFO in May and June 2013, these projects are considered by DFO to satisfy DFO requirements subject to additional detail being provided at the permitting stage.

Table 17 shows a chronology of agency consultation for aquatic ecology studies for the Project. Additional meetings will be organized as part of the development and finalization of the NNLP.

Table 17: Regulatory Agency Consultation for Aquatic Ecology Studies

Date	Agency/Staff Invited/*Attended*	Consultation
April 13, 2011 (Thunder Bay)	*DFO/T. Kleinboeck*, DFO/N. Ward, *MNR/B. Jackson, MNR/A. Godwin*, MNR/K. Armstrong, MNR/ Sobchuk, *CEAA/A. Lui*, ENE/M. Whitmore, ENE, T. Kondrat, MOE/J. Sutton, MNDM/M. O'Brien	■ Overview of 2010 baseline work ■ Summary of key results ■ Presentation of 2011 field program
July 12, 2011 (Atikokan)	*DFO/T. Kleinboeck*, DFO/N. Ward, *MNR/B. Jackson, MNR/A. Godwin*, MNR/K. Armstrong, MNR/ Sobchek, CEAA/A. Lui, ENE/M. Whitmore, ENE, T. Kondrat, MOE/J. Sutton, MNDM/M. O'Brien	■ Overview of 2011 baseline work ■ Review of data collection methods ■ Initiate discussion on compensation ■ Discuss potential compensation opportunities
September 14, 2011 (Atikokan)	*DFO/T. Kleinboeck*, DFO/N. Ward, *MNR/B. Jackson, MNR/A. Godwin*, MNR/K. Armstrong, MNR/ Sobchek, CEAA/A. Lui, ENE/M. Whitmore, ENE, T. Kondrat, MOE/J. Sutton, MNDM/M. O'Brien	■ Discussion on sampling effort and treatment of wetlands ■ Review of approach to habitat accounting ■ Discuss collection of additional data to fill gaps ■ Helicopter tour of APIs/project site

Table 17: Regulatory Agency Consultation for Aquatic Ecology Studies (Continued)

Date	Agency/Staff Invited/*Attended*	Consultation
February 29, 2012 (Thunder Bay)	*DFO/T. Kleinboeck, DFO/N. Ward, MNR/B. Jackson, MNR/A. Godwin, MNR/K. Armstrong, MNR/Sobchuk*, *CEAA/A. Lui*, ENE/M. Whitmore, ENE, T. Kondrat, MOE/J. Sutton, *MNDM/M.* O'Brien*/P. Barnes*	■ Present habitat preference tables ■ Discussion of compensation opportunities ■ Discussion of alternative habitat accounting methods – HATT/HEP/Meliadine ■ Discussion of baseline results and 2012 field program suggestions
June 4, 2012 (Thunder Bay)	DFO/T. Kleinboeck, DFO/N. Ward, MNR/B. Jackson, MNR/A. Godwin, MNR/K. Armstrong, MNR/S. Bobrowicz, CEAA/A. Lui, ENE/M. Whitmore, ENE, T. Kondrat, MOE/J. Sutton, MNDM/M. O'Brien	■ Presentation and discussion of Interim Baseline Report ■ Discussion of potential data gaps and 2012 field sampling program ■ Presentation and discussion of Baseline Report conclusions
June 19, 2012 (Atikokan)	MNR/B. Jackson, MNR/A. Godwin, MNR Steep Rock Project Staff	■ Tour and discussion of Steep Rock Site and Project
October 22, 2012 (Thunder Bay)	*DFO/T. Kleinboeck, DFO/N. Ward, MNR/B. Jackson, MNR/A. Godwin,* MNR/K. Armstrong, MNR/S. *Bobrowicz, CEAA/A. Lui, ENE/M.* Whitmore, ENE, T. Kondrat, *MOE/J. Sutton, MNDM/M. O'Brien*	■ Presentation of fish habitat accounting procedure and NNLP approach ■ Discussion of preliminary calculations of habitat losses and gains ■ Review proposed Fisheries Act changes ■ Presentation of fish salvage and rescue plan
October 31, 2012 (Toronto)	*DFO/L. Fowler, CEAA/A. Lui,*	■ Presentation on overview of the Project ■ Presentation of fish habitat accounting procedure and NNLP approach ■ Discussion of preliminary calculations of habitat losses and gains ■ Review proposed Fisheries Act changes ■ Presentation of fish salvage and rescue plan
November 20, 2012 (Toronto)	*CEAA/A. Blajchman, MOE/S. Hysenaj, MOE/D. Laverdiere, NCR/C. Dumaresq, NCR/P. Billau, EC/F.Beaudet, NRC/A. Magee, EC/R. Dobos, DFO/N.Ward, DFO/L. Fowler*, DFO/T. Kleinboeck, MNDM/P. *Barnes, CEAA/A. Lui*, ENE/M. Whitmore	■ Presented and discussed approach to evaluating TMF alternatives ■ Reviewed "dry land" TMF alternative ■ Discussion of Detour Lake Project Agency review letters ■ Preliminary discussion of MMER Schedule 2 requirements and listed waterbodies

Table 17: Regulatory Agency Consultation for Aquatic Ecology Studies (Continued)

Date	Agency/Staff Invited/*Attended*	Consultation
March 19, 2013	*DFO/N.Ward, DFO*, MNR/B. Jackson,	■ Discussion on Steep Rock as alternative compensation ■ Indications are that community support is not good for looking at Steep Rock options ■ MNR interest in Open Pits as possible compensation ■ Osisko to monitor winter DO in selected APIs
April 16, 2013	*DFO/N.Ward, DFO*, MNR/B. Jackson, MNDM/P. *Barnes, CEAA/A. Lui*, ENE/M. Whitmore,	■ Update/changes to Habitat Accounting Model ■ Allocate compensation between MMER & Section 35 ■ Discussion of compensation projects ■ Discussion of compensation ratio ■ Discussion of timing of approvals under Fisheries Act and MMER ■ Preliminary discussion of MNR/DFO comments on EA
May 9, 2013	*DFO/N.Ward, DFO*, MNR/B. Jackson,	■ Reviewed and finalized list of compensation projects ■ MNR requested further assessment of Pit Lakes as compensation ■ Golder identified that Pit Lakes cannot be part of compensation package ■ Fish stocking and pond creation remain compensation options ■ Continued discussion of apportioning compensation projects between MMER and Section 35
May 27, 2013	*DFO/N.Ward, DFO*, MNR/B. Jackson,	■ Finalized compensation plan in principle with DFO and MNR concurrence
June 20, 2013	*Sara Eddy (DFO), Rick Kiriluk (DFO),* ***CEAA (teleconference):*** *Amy Liu (CEAA), and Jill Aitken (CEAA)*	■ Eddy and Kiriluk assigned to continue as DFO contact on Osisko Habitat Offset plan ■ DFO staff were brought up to speed on the project and the concurrence in principle by DFO (N. Ward) on the plan

7.4.1 MMER

The fish-bearing waterbodies that would require listing under the MMER are as follows:

- MMER – Tailings Management Facility
  - API#2 is largest waterbody (12.4 ha), 72% of the area of Mitta Lake, but with 150% more habitat (14,400 HUs), because it has potential as a bait fishery and a recreational fishery (northern pike)
  - Remaining waterbodies are small headwater drainage features and beaver ponds with no valued fisheries (under new Act)
- MMER – Waste Rock Management Facility
  - API#11 is largest waterbody (2.8 ha), 16% of the area of Mitta Lake, and with 19.5% less habitat (1870 HUs), possibly with limited potential as a bait fishery
  - Remaining waterbodies are small headwater drainage features and beaver ponds with no valued fisheries (under new Act)

The following habitat offset projects are proposed to address these MMER Listed losses (totaling 24,000 HUs):

- A floodplain area at the mouth of Sawbill Creek
- An area at the mouth of API#1
- Snail Bay

Each of these projects will involve a shallow excavation of an area of about 1.5 ha to establish littoral habitat within the current drawdown zone of Upper Marmion Lake. The existing area will be excavated to an elevation of about 413.2 masl which will ensure that the substrates are flooded in early spring, prior to reservoir filling. A series of shallow, branching trenches will be cut into the excavation to provide additional access to the area for fish and wetland materials will be placed in “mounds” throughout the excavated area to promote wetland development. These areas will provide spawning and nursery habitat for a variety of species including important recreational fisheries of Upper Marmion Lake.

While some initial discussion regarding the proposed NNLP/Habitat Offset Plan occurred concerning the recent changes to the Fisheries Act, an additional review of how these changes may affect the current estimate of habitat losses and the proposed habitat offsetting projects needs to be completed to ensure consistency with the new Fisheries Act. More specifically this should include:

- A review of the new information and reporting requirements for projects submitted for Fisheries Act and MMER permits as Habitat Offset projects;
- A review of the fish habitat losses identified with the project under the new terms of the Act related to CRA fisheries, support fish and marginal habitats
- A review to determine whether some of the identified habitat losses can be addressed under the self assessment/reporting requirements of the new Act

7.4.2 Section 35 of the Fisheries Act

The Section 35 fish habitat losses can be summarized as follows:

- Mitta Lake is the largest waterbody (17 ha), representing the second largest habitat loss (9600 HUs). Has potential as a bait fishery, therefore a "valued" fishery
- Remaining waterbodies are small headwater drainage features and beaver ponds with no valued fisheries (under new Act)

The following habitat offset projects are proposed to address these Section 35 listed losses (totaling approximately 12,000 HUs):

- Stocking of several headwater waterbodies that are currently fishless
- The upper part of Trap Bay
- An area at the mouth of Lumby Creek
- Microhabitat features adjacent to an area of filling of a portion of the drawdown zone of Upper Marmion Lake
- Microhabitat features associated with the construction of the minewater discharge

Several fishless ponds will be stocked with fish from Mitta Lake and API#2 to create a potential baitfish resource and also to preserve a remnant fish community representative of Mitta Lake, which will preserve an opportunity to restock these fish in the flooded pits post closure. The Trap Bay and Lumby Creek projects will involve a shallow excavation of an area of about 1.5 ha to establish littoral habitat within the current drawdown zone of Upper Marmion Lake. The existing area will be excavated to an elevation of about 413.2 masl which will ensure that the substrates are flooded in early spring, prior to reservoir filling. A series of shallow, branching trenches will be cut into the excavation to provide additional access to the area for fish and wetland materials will be placed in "mounds" throughout the excavated area to promote wetland development. These areas will provide spawning and nursery habitat for a variety of species including important recreational fisheries of Upper Marmion Lake. The Microhabitat features will include installation of partially submerged logs and felled cedar trees, rocky shoals and other features that will provide shallow water cover for fish species in Upper Marmion Lake.

While some initial discussion regarding the proposed NNLP/Habitat Offset Plan occurred concerning the recent changes to the Fisheries Act, an additional review of how these changes may affect the current estimate of habitat losses and the proposed habitat offsetting projects needs to be completed to ensure consistency with the new Fisheries Act. More specifically this should include:

- A review of the new information and reporting requirements for projects submitted for Fisheries Act and MMER permits as Habitat Offset projects;
- A review of the fish habitat losses identified with the project under the new terms of the Act related to CRA fisheries, support fish and marginal habitats
- A review to determine whether some of the identified habitat losses can be addressed under the self assessment/reporting requirements of the new Act

8.0 MONITORING PROGRAMS AND COMMITMENTS

8.1 Aquatic Monitoring Program

A monitoring program will be designed and implemented to confirm water quality, flow and water level alteration predictions generated during surface water modelling. If this program establishes that Project-related effects on the aquatic environment are greater than predicted, fish habitat suitability and utilization studies will be triggered on aquatic features (APIs) and/or specific VECs.

Details of water quality, hydrology and aquatic sediment monitoring are provided in the Hydrology TSD (Golder 2013c), Lake Water Quality TSD (Golder 2013d), Site Water Quality TSD (Golder 2013e), and Water and Sediment Quality TSD (Golder 2013f).

The environmental monitoring program will include the EEM program during operations through to include post closure, details of which will follow EC/MOE requirements, as identified below.

In addition to the regular monitoring required under the EEM program, MNR has identified an opportunity to incorporate long term fisheries monitoring of Lizard Lake and Sawbill/Lynxhead Bay into their District Fisheries Assessment program. This program has recently been initiated, and MNR has indicated a willingness to work in partnership with OHRG on collection and sharing of methodologies and data for the life cycle of the Project.

8.2 Final No Net Loss / Habitat Offset Plan

A final NNLP plan to offset habitat losses attributed to the Project will be completed and submitted along with the *Fisheries Act* Authorization Request. It will include adequate compensation (e.g., creation of new habitat units) to fully offset all direct and indirect effects to habitat. It is expected that the final NNLP will be considered a living document, as it may require amendment periodically. New HADDs may be added to lists already generated in the conceptual NNLP, which will subsequently require compensation (e.g., if effects of a particular stream crossing cannot be completely mitigated). The final NNLP will include details of the timing and location of construction of compensation works, and a monitoring schedule for each form of compensation. Where monitoring determines that habitat gain objectives have not been met as planned, additional compensation measures will be designed and implemented. It is anticipated that a single final NNLP will be submitted to regulatory agencies to address requirements of Metal Mining Effluent Regulations (MMER) scheduling for API#2 and the other features within the Tailings Management Facility and the Waste Rock Management Facility that are natural, fish-bearing waterbodies and all non-MMER related HADDs.

Bill C-38, passed in June 2012 and November 2013, amends the *Fisheries Act* to focus on the protection of fish that support commercial, recreational or Aboriginal fisheries and to more effectively manage activities that pose the greatest threat to these fisheries. It is unclear if/how amendments to the *Fisheries Act* may affect current DFO policy. Habitat policy, including 'no net loss', is currently under review to ensure consistency with the focus of the *Fisheries Act* on managing threats to recreational, commercial and Aboriginal fisheries. When new direction regarding habitat management policy becomes available, it may require the final NNLP be amended. While some initial discussion regarding the proposed NNLP/Habitat Offset Plan occurred concerning the recent changes to the Fisheries Act, an additional review of how these changes may affect the current estimate of habitat losses and the proposed habitat offsetting projects needs to be completed to ensure consistency with the new Fisheries Act. More specifically this should include:

- A review of the new information and reporting requirements for projects submitted for Fisheries Act and MMER permits as Habitat Offset projects;
- A review of the fish habitat losses identified with the project under the new terms of the Act related to CRA fisheries, support fish and marginal habitats
- A review to determine whether some of the identified habitat losses can be addressed under the self assessment/reporting requirements of the new Act

At this time, the conceptual NNLP includes the habitat compensation measures identified in Table 14 representing about 18 ha of surface water area and 6,800 HUs of like for like fish habitat. The conceptual NNLP would consist of the measures in Table 14, plus the following:

- Stream crossings habitat enhancements (self-compensating)
- Northern pike spawning habitat creation at the mouth of Sawbill Bay, API#37 Bay, Snail Bay and Hammond Peninsula bay: 32,000 HUs.
- Walleye spawning habitat enhancements in Sawbill Creek and Lumby Creek: 2,000 HUs.
- The fish salvage and rescue operations

The other measures outlined above are possible alternatives to these measures that would be discussed with DFO/MNR as the NNLP is finalized.

These measures, considered together, represent more than a 1:1 ratio of habitat losses and gains. However, since the majority of the habitat gains are focused on valued fisheries, walleye, northern pike, lake whitefish and baitfish, the value of the habitat gain is considered greater than the habitat lost, which is predominantly baitfish and other species.

These habitat compensation measures would be constructed during the construction phase of the Project and therefore there would be no lag between habitat removal and creation.

8.3 Scheduling of Waterbodies Under Metal Mining Effluent Regulation

Using a natural water body frequented by fish for tailings disposal requires an amendment to the MMER, which is a federal legislative action. The MMER, enacted in 2002, were developed under subsections 34(2), 36(5) and 38(9) of the *Fisheries Act* to regulate the deposit of mine effluent, waste rock and tailings into natural waters frequented by fish. These regulations, administered by Environment Canada, apply to the TMF and the WRMF components of the Project. Environment Canada (2011) outlines a specific process that is required to utilize a natural water body for metal mine waste disposal. This process requires preparation of an assessment of alternatives for mine waste disposal for consideration (Revised and updated as a stand alone document and re-submitted with the final EIS/EA report submission.), the preparation of a fish habitat compensation plan for consideration as part of the EA, and public and aboriginal consultations on the EA, including on possible amendments to the MMER. OHRG will be required to submit all required documentation to Environment Canada and may be asked to provide additional background information necessary in the preparation of the regulatory amendment package. Within the TMF, APIs #1, #2, #6, #47 and #48 will likely require scheduling

under the Regulations, as shown in Figure 25. API #11, within the WRMF will also require scheduling, as shown in Figure 26.

8.4 Environmental Effects Monitoring under Metal Mining Effluent Regulation

The MMER under the *Fisheries Act* directs metal mines to conduct Environment Effects Monitoring (EEM) as a condition governing the authority to deposit effluent. EEM is a science-based performance measurement tool used to assess the adequacy of the regulations. EEM studies are designed to detect and measure changes in aquatic ecosystems (i.e., receiving environments). The metal mining EEM program is an iterative system of monitoring and interpretation phases that is used to assess the effectiveness of environmental management measures, by evaluating the effects of effluents on fish, fish habitat and the use of fisheries resources by humans. Long-term effects are assessed using regular cyclical monitoring and interpretation phases designed to investigate the impacts on the same parameters and locations. In this way, both a spatial and temporal characterization of potential effects to assess changes in receiving environments are obtained. Study elements include fish population and fish habitat assessments, benthic invertebrate surveys, fish tissue analyses, effluent characterization, sub-lethal toxicity and water quality monitoring.

The first EEM study design must be submitted not later than 12 months after the day on which the mine becomes subject to the Regulations. The first interpretative report must be submitted not later than 30 months after the date on which the mine becomes subject to the Regulations or not later than 42 months after the date on which it becomes subject to the Regulations, if the mine has submitted a report utilizing historical biological monitoring information. Subsequent interpretative reports are submitted 36 or 72 months after the day on which the most recent interpretative report was required to be submitted, depending on the results of the previous interpretative report.

8.5 Fish Rescue and Salvage Protocols – Mitta Lake and Other Waterbodies

During the construction phase, equipment will be transported to the site and site preparation activities will be undertaken. Clearing, grubbing and site grading will be undertaken where infrastructure is to be placed. Site drainage will be constructed in the initial stages, including the draining of Mitta Lake. The ore deposit is located directly under Mitta Lake.

The Project will include draining the water from Mitta Lake into the adjacent Marmion Reservoir. A fish salvage and relocation plan will be developed according to DFO guidelines, MNR permitting requirements and OHRG's No Net Loss Plan (NNLP) and will incorporate consultation with Aboriginal communities. Detailed planning and logistics for this activity has not been undertaken to date; but will be finalized with Aboriginal input prior to the Construction Phase of the Project. A preliminary outline of the planning considerations for the draining of Mitta Lake is provided below.

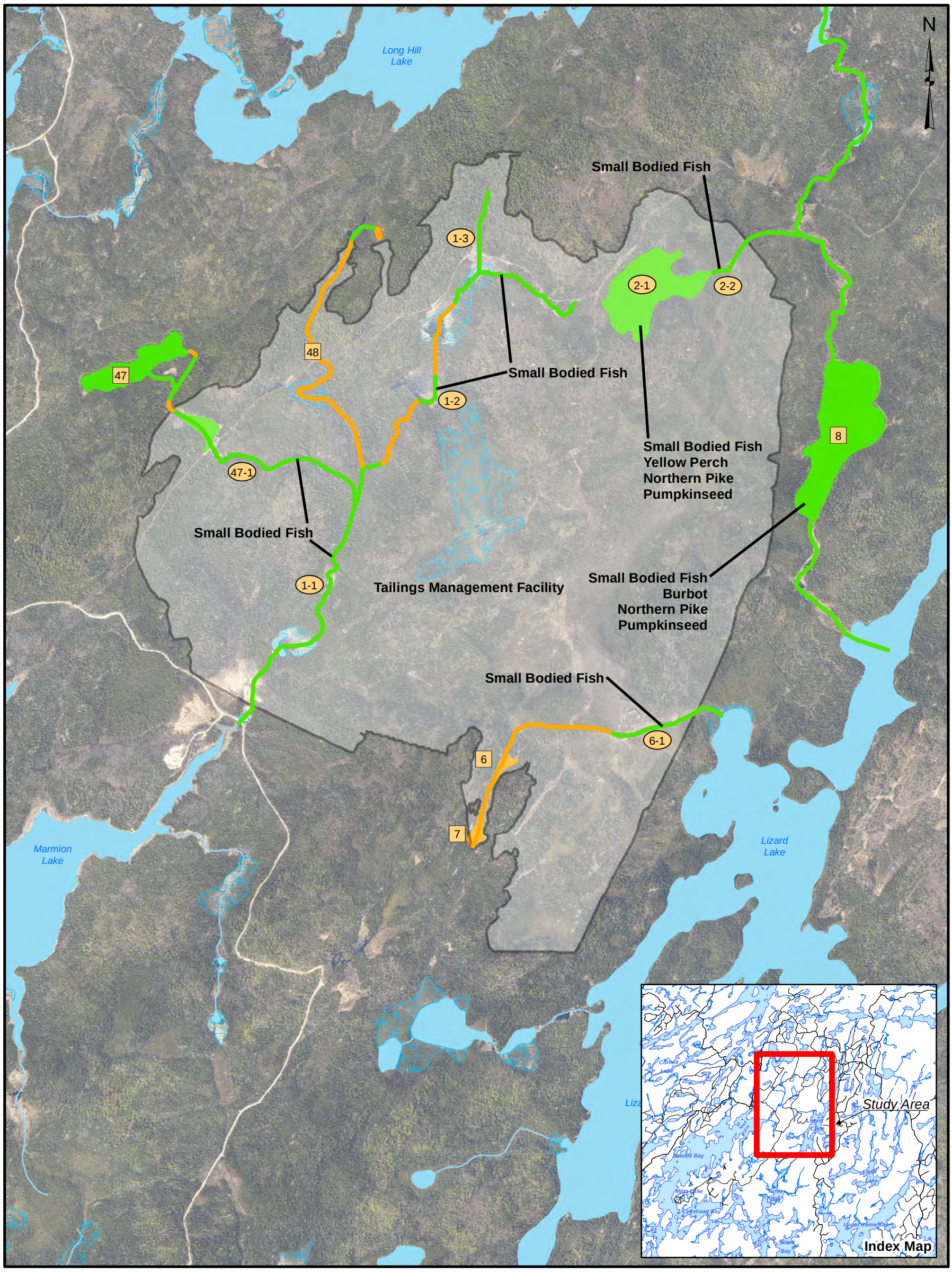
Water will be used as part of mine commissioning/operation where possible. Water will be pumped to the PPCP and allowed to settle until the TSS is suitable for discharge to the Marmion Reservoir. Lake sediment collection

and disposal methods will be identified. Removal of sediment and shallow overburden may be required as part of the pre-treatment preparation of the open pit. Sediment will be disposed of in the overburden stockpile.

Alternative locations for fish relocation will be examined through an assessment of logistics and compensation opportunities. The NNLP considers stocking of four fishless headwater lakes/ponds as part of the offset projects. Sawbill Bay will also be considered as an alternative location. Discussion with local bait fishers will take place to determine interest in using some of the fish within Mitta Lake as a baitfish source for sale to the public.

Methods of fish capture will be described including planned sampling, handling, transport and release. Depending on the identified site of relocation, fish may be transported from Mitta Lake to their new location by ATV or helicopter. Acclimation needs will be considered and a protocol for fish handling and treatment will be developed. Some mortality of fish is expected and plans for disposal of dead fish will be developed in consideration of potential wildlife issues. Discussions with Aboriginal groups through the RSA committees and the Métis consultation committee will ensure appropriate cultural and spiritual protocols are followed.

Page left intentionally blank



LEGEND

- API Reach
- Area of Potential Impact
- Fish Bearing Waters
- Non Fish Bearing Waters
- Waterbody
- Wetland
- Water Segment
- Tailings Management Facility

REFERENCE

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15

490 0 490
SCALE 1:20,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

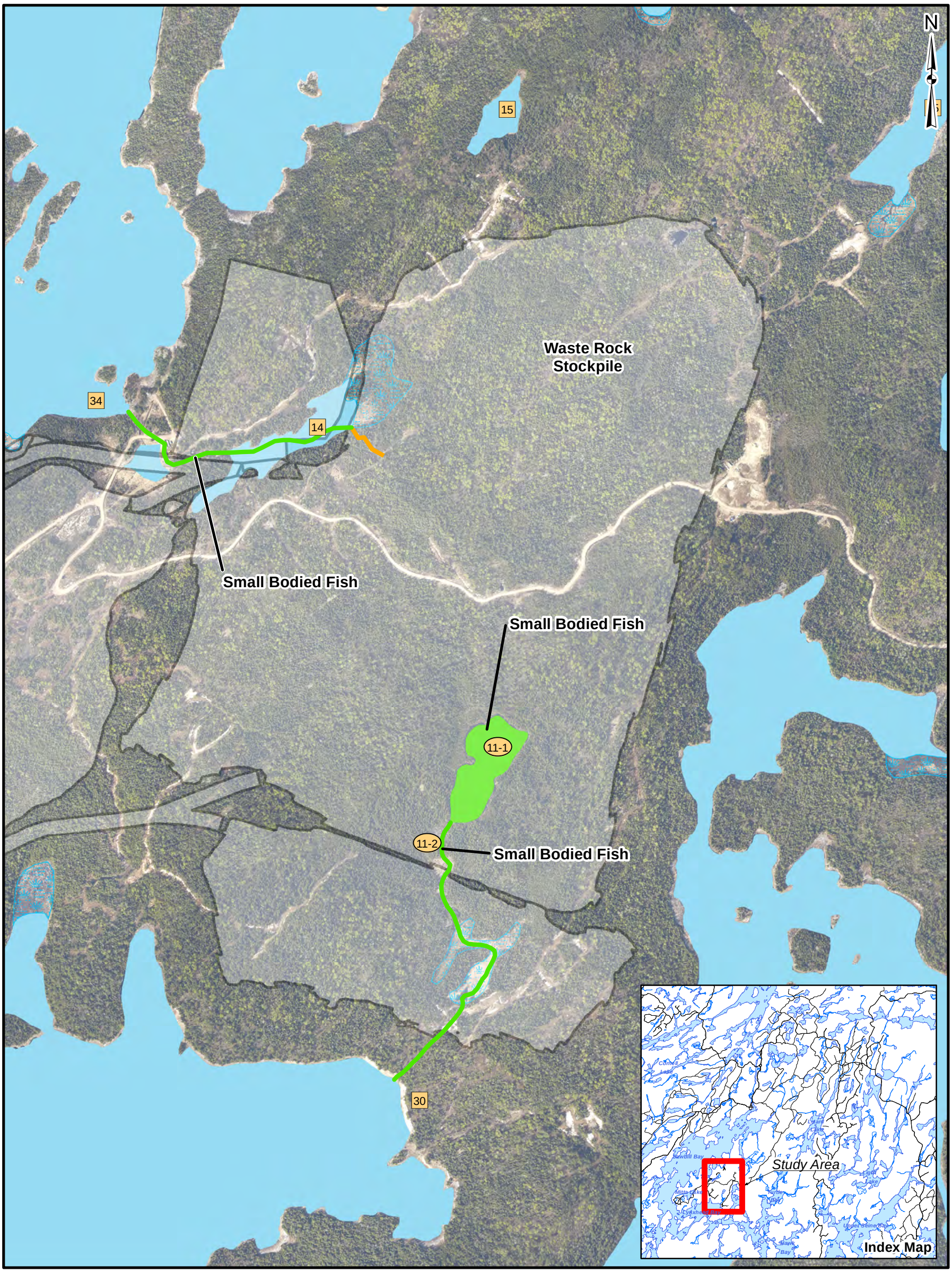
TITLE
AREAS OF POTENTIAL IMPACT REQUIRING METAL MINING EFFLUENT REGULATION LISTING IN THE TAILINGS MANAGEMENT FACILITY

Golder Associates
Sudbury, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	RRD	Dec. 2010	FIGURE 25	
GIS	PJM	Nov. 2012		
CHECK	BH	Feb. 2013		
REVIEW	GA	Apr. 2013		

Path: N:\Active\GIS\Clients\OsiskoHammondReefGoldLtd\10-1118-0020\GIS\MXDs\Fish_Bearing_Waters\FishFrequentedWaters_BaseCase9.mxd

Page left intentionally blank



LEGEND

- API Reach
- Area of Potential Impact
- Fish Bearing Waters
- Non Fish Bearing Waters
- Waste Rock Management Facility
- Waterbody
- Wetland

REFERENCE

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15

400 0 400

SCALE 1:10,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREAS OF POTENTIAL IMPACT REQUIRING METAL MINING EFFLUENT REGULATION LISTING IN THE WASTE ROCK MANAGEMENT FACILITY

Golder Associates
Sudbury, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	RRD	Dec. 2010	FIGURE 26	
GIS	PJM	Nov. 2012		
CHECK	BH	Feb. 2013		
REVIEW	GA	Apr. 2013		

Path: N:\Active\GIS\Clients\OsiskoHammondReefGoldLtd\10-1118-0020\GIS\MXDs\Fish_Bearing_Waters\FishFrequentedWaters_Stockpile10.mxd

Page left intentionally blank

8.6 Construction Monitoring

Field monitoring will be performed to ensure that the mitigation measures implemented during construction successfully minimize adverse environmental effects. Monitoring will focus on the effects of any sediment release and deposition during construction. Post-construction monitoring will be conducted in watercourses affected by the road culvert crossings to evaluate the effects of any sediment releases and deposition at crossing sites, and to evaluate fish passage potential (e.g., hydraulics) through culverts. The effectiveness of habitat reclamation following construction will also be evaluated. Monitoring will be adaptive in that, if changes to fish and fish habitat are detected, appropriate remedial actions will be implemented and subsequent monitoring programs adjusted to ensure the effectiveness of remedial actions and future operations.

A standardized monitoring procedure will be developed so that monitoring data can be used to validate impact predictions. Various environmental variables may be monitored during construction, depending on the concerns and crossing objectives:

- Suspended sediment load before, during and after construction to provide feedback to construction personnel and document the zone of influence and changes in water quality.
- Substrate composition before, during and after construction to document areas of sedimentation.
- Watercourse flows during construction to ensure that fish passage and minimum flows are maintained.
- Monitoring during blasting and diversion procedures.
- Confirm that specific crossing objectives have been achieved.
- Observe and document actual effects.
- Observe and document recovery.
- Determine the need for maintenance of structures and mitigation measures.
- Fulfil explicit mitigation and compensation requirements.

8.7 Blast Monitoring and Collection of Supplementary Fish Habitat Information (Sawbill Bay)

To assess potential for vibration impact to fish habitat, blasting operations will be monitored during initial pit development to obtain site-specific data on the potential for damaging vibrations to affect adjacent aquatic habitats. Baseline studies on habitat use, specifically timing and locations of spawning, have not been completed. It is recommended that these studies be undertaken to effectively mitigate the effects of blast vibration on fish in Sawbill Bay. Data from the fish and fish habitat studies will be combined with the site-specific blast monitoring data to develop guidance as to when, if at all, blast designs should be altered to accommodate vibration levels at the nearest active spawning beds and to assess the effectiveness of blast mitigation on fish.

9.0 REFERENCES

Bradbury C., M.M. Roberge and C.K. Minns. 1999. Life History Characteristics of Freshwater Fishes Occurring in Newfoundland and Labrador, with Major Emphasis on Lake Habitat Requirements Can. MS Rpt. Fish. Aquat. Sci. 2485.

Canadian Environmental Assessment Agency. 2011. Draft Guidelines for the Preparation of an Environmental Impact Statement Pursuant to the *Canadian Environmental Assessment Act* for the Hammond Reef Gold Mine Project. 72 p + references

Colby, P., R. E. McNicol and R. A. Ryder. 1979. Synopsis of biological data on the walleye *Stizostedion v. vitreum* (Mitchill 1818). FAO Fisheries Synopsis No. 119.

Drapack, Alexandra. 2012. Osisko Hammond Reef Gold Ltd. Personal communication. February 02, 2012

Edwards, E. A., G. Gebhart and O. E. Maughan. 1983. Habitat suitability information: Smallmouth bass. U.S. Department of the Interior, Fish and Wildlife Service FWS/OBS–82/10.36.

Fisheries and Oceans Canada. 1986. Policy for the Management of Fish Habitat. Ottawa, Canada: Department of Fisheries and Oceans.

Fisheries and Oceans Canada. 2006. Practitioners Guide to Compensation for DFO Habitat Management Staff. Version 1.1. Fisheries and Oceans Canada. Communications Branch 24 p.

Golder Associates Ltd (Golder). 2004. Fish Habitat Compensation Plan for the Northwest Peninsula of the De Beers Snap Lake Diamond Project. Prepared for De Beers Mining Canada Inc., Yellowknife, Northwest Territories.

Golder. 2007. Kearl Oil Sands Project - Mine Development. No Net Loss Plan. Prepared for Imperial Oil Resources Ventures Limited.

Golder. 2008. Fish Species Habitat Suitability Index Models for the Alberta Oil Sands Region. Version 2.0. October 2008.

Golder. 2011. Meliadine Project Conceptual Fish Habitat Compensation Plan [DRAFT]. 44 p.

Golder. 2012. Fish and Fish Habitat Baseline Studies Interim Report. Submitted to Osisko Hammond Reef Gold. 20 p. + appendices.

Golder. 2013a. Hammond Reef Gold Project – Aquatic Environment Technical Support Document. Version 1. Prepared for Osisko Hammond Reef Gold Ltd. Document No. 2012-075. February 2013.

Golder. 2013b. Hammond Reef Gold Project – Environmental Impact Statement/Environmental Assessment Report. Version 1 (Draft). Prepared for Osisko Hammond Reef Gold Ltd. February 2013.

Golder. 2013c. Hammond Reef Gold Project – Hydrology Technical Support Document. Version 1. Prepared for Osisko Hammond Reef Gold Ltd. Document No. 2012-078. February 2013.

Golder. 2013d. Hammond Reef Gold Project – Lake Water Quality Technical Support Document. Version 1. Prepared for Osisko Hammond Reef Gold Ltd. Document No. 2012-076. February 2013.

Golder. 2013e. Hammond Reef Gold Project – Site Water Quality Technical Support Document. Version 1. Prepared for Osisko Hammond Reef Gold Ltd. February 2013.

Golder. 2013f. Hammond Reef Gold Project – Water and Sediment Quality Technical Support Document. Version 1. Prepared for Osisko Hammond Reef Gold Ltd. Document No. 2012-079. February 2013.

Hall-Armstrong, J., A.G. Harris and R.F. Foster. 1996. Fish use of wetlands in northwestern Ontario: A literature review and bibliography. Northwest Science & Technology, Ontario Ministry of Natural Resources, Thunder Bay, Ont. TR-90.

Inskip, P. D. 1982. Habitat suitability index models: Northern pike. U.S. Department of the Interior, Fish and Wildlife Service. FWS/OBS–82/10.17.

Jackson, B. 2012. Ontario Ministry of Natural Resources, Atikoken, Ontario. Personal Communication. June 4, 2012.

Janacek, J. A. 1988. Literature review on fishes interactions with aquatic macrophytes with special reference to the Upper Mississippi River system. Upper Mississippi River Conservation Committee (UMRCC), Fisheries Section. Rock Island, Illinois.

Kerr S.J., B. W. Corbett, D. Kinsman, J. H. Leach, D. Puddister, L. Stanfield, N. Ward, and N. J. Hutchinson. 1997. Walleye Habitat: A Synthesis of Current Knowledge with Guidelines for Conservation Ontario Ministry of Natural Resources.

Langhorne, A.L., M. Neufeld, G. Hoar, V. Bourhis, D.A. Fernet and C.K. Minns. 2001. Life History Characteristics of freshwater Fishes Occurring in Manitoba, Saskatchewan and Alberta, with Major Emphasis on Lake Habitat Requirements. Can. MS Rrp. of Fish. Aquat. Sci. 2579.

McCarragher, D. B., and R. E. Thomas. 1972. Ecological significance of vegetation to northern pike, *Esox lucius*, spawning. Trans. Amer. Fish. Soc. 1972(3).

McMahon, T. E., J. W. Terrell and P. C. Nielson. 1984. Habitat suitability information: Walleye. U.S. Department of the Interior, Fish and Wildlife Service. FWS/OBS-82/10.56.

Minns, C.K., J, E. Moore, M. Stoneman, and B. Cudmore-Vokey1. 2001. Defensible Methods Of Assessing Fish Habitat: Lacustrine Habitats In The Great Lakes Basin - Conceptual Basis And Approach Using A Habitat Suitability Matrix (HSM) Method. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2559. 80 p. + appendices.

Minns, C.K. 2010a. Ontario Stream Fishes Habitat Associations and Derivation of a Simple Habitat Assessment Model. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2909. 39 p. + appendices

Minns, C.K. 2010b. An Introductory Guide to Preparing and Assessing No Net Loss Plans. Canadian Science Advisory Secretariat Research Document [draft]. Fisheries and Oceans Canada. 2010.

Ontario Ministry of Natural Resources. 1987. Fort Francis District Fisheries Management Plan 1988-2000.

Ontario Ministry of Natural Resources. 1989. Atikokan District Fisheries Management Plan 1988-2000.

Packman et. al. 2006. Review of Approaches for Estimating Changes in Productive Capacity from Whole-lake/Stream Destruction and related Compensation Projects. Canadian Technical Report of Fisheries and Aquatic Sciences 2664.

Portt, C.B., G. Coker, and C.K. Minns. 1999. Riverine Habitat Characteristics of Fishes of the Great Lakes Watershed. Can. MS Rep. Fish. Aquat. Sci. 2481:vi + 62 p.

TRCA. 2003. Toronto Waterfront Aquatic Habitat Restoration Strategy. Toronto Region Conservation Authority.

U.S. Fish and Wildlife Service. 1980. Habitat Evaluations Procedures (HEP). ESM 102. U.S.D.I. Fish and Wildlife Service, Division of Ecological Services.

U.S. Fish and Wildlife Service. 1981. Standards for the Development of Habitat Suitability Index Models for Use in the Habitat Evaluation Procedures, USDI Fish and Wildlife Service. Division of Ecological Services. ESM 103.

10.0 CLOSURE

We trust that this report meets your requirements. If you have any questions, please do not hesitate to contact the undersigned.

Report Signature Page

GOLDER ASSOCIATES LTD.

<Original signed by>

Brian Hindley, M.Sc.
Technical Lead/Senior Biologist

<Original signed by>

Gary Ash, M.Sc., P. Biol.
Principal/Senior Biologist

BH/GA/NDR/sv

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

\\golder.gds\gal\mississauga\active\2013\1118\13-1118-0010 osisko-hammond reef - ea support\006 environmental\2003 aquatic biology\nnlp _rev-0_dec 04 2013.docx

Page left intentionally blank

APPENDIX A

Definitions for Habitat Variables

Table of Contents

LAKE HABITAT MAPPING **1**

WATERCOURSE HABITAT MAPPING **2**

TABLES

Table 1: List of Channel Units 3

DEFINITIONS FOR HABITAT VARIABLES

Page left intentionally blank

DEFINITIONS FOR HABITAT VARIABLES

LAKE HABITAT MAPPING

Limnetic Zone: The open-water region of a lake that is too deep to support rooted aquatic vegetation.

Littoral Zone: The shallow area of a lake that extends from the waterline to the lakeward limit of rooted aquatic vegetation.

Macrophytes: Macrophytes are aquatic plants which are large enough to be seen with the unaided eye, as opposed to phytoplanktonic organisms. Macrophytes are specifically adapted to aquatic habitats, growing either in the water or along the margins of waterbodies. Flooded terrestrial vegetation does not qualify. There are two basic types of macrophytes which are distinguished when habitat mapping lakes; emergent and submergent macrophytes.

> ***Emergent Macrophytes:*** Macrophytes which grow in wet or boggy areas or which are rooted in water but extend above the water surface. Typical examples include Cattails, Bulrushes and Sedges.
>
> ***Submergent Macrophytes:*** Macrophytes which are rooted and which grow under the water. This includes floating-leaved aquatic plants and plants which may have flower stalks that extend above the surface. Typical examples include pondweeds, Coontail and water lily.

Pinnacle: A small, isolated point of lake bottom, which is exposed above the water line and surrounded by a shoal. Can be thought of as a very small island or a shoal which has a small portion above water.

Shelf: Frequently observed in deep lakes; it is the area of the bottom located near shore, between the waterline and the drop-off. The distance between these points can be highly variable. In areas of shallow bottom slope, the shelf may be extensive, whereas, in areas of steep bottom slope the shelf may not exist. In deep, clear lakes, the shelf is typically the primary area that is habitat mapped since the bottom is visible and characteristics of substrate, cover and vegetation can be recorded.

Shoal: A shallow but submerged area isolated from the shorelines of a lake. Can be composed of a variety of materials depending upon regional geology. May be “clean” (free of fines) if shallow enough to be affected by wave action and may have a significant potential to provide spawning habitat. Therefore, shoal areas in large, deep lakes receive particular attention during habitat mapping.

Slope: The change in vertical height relative to the change in horizontal distance. For lakes, this measurement describes the steepness of the shoreline above and below the water surface.

> ***Bottom Slope:*** The slope of the lakebed on a line perpendicular to shore, from the waterline to the lakeward side.
>
> ***Shore Slope:*** The slope of the lake shore immediately above the waterline.

Substrate: The material which comprises the bottom of a water body. Can be highly variable depending on regional geology, weathering, location within the lake, etc. Described by substrate particle size. Particle sizes include fines (clay, silt and sand), gravel, cobble, boulder and bedrock. Golder employs specific criteria for particle size classes which are defined in this document.

Substrate particle size classes used for both lake and watercourse mapping include:

- Organic material.
- Si – silt/clay (<0.06 mm in diameter).
- Sa – sand (0.06-2.0 mm).
- Gr – gravel (2-64 mm).
- Co – cobble (64-256 mm).
- Bo – boulder (>256 mm).
- Bd – bedrock.

WATERCOURSE HABITAT MAPPING

Stream Pattern: Stream pattern describes the sinuosity of the channel or the degree to which the channel deviates from straightness. Sinuosity is the channels meander pattern which can range from straight to tortuously meandering. Sinuosity is expressed as the ratio of the length of channel between two points on the stream to the straight line distance between the same two points.

Substrate: Stream substrate is the material found on the bottom of the channel portion of the watercourse. It refers to the surficial deposits that can be seen when viewing the streambed. As part of the habitat evaluation process, the substrate is evaluated with respect to particle size composition. Particle size composition refers to the proportions of the substrate particles within each category from a series of size categories (Table C-1). These range from fine sediments (fines are particles <2 mm in size and include clay, silt and sand) through gravels, cobbles, boulders and bedrock. A substrate evaluation is conducted by visual observation. The observer estimates the percentage of the substrate particles, by surface area, in each of the size categories. Note: the term rubble is sometimes used for cobble sized particles – within this size class, cobble refers to rounded rock while rubble refers to angular rock.

Undercut Bank: An undercut bank is a bank that has been eroded at the base by flowing water, allowing water to be present underneath a portion of the bank. Although undercutting usually adds to bank instability, it may also provide cover for fish. If the overhanging portion of the bank provides and effective with >9 cm over water with a depth of >0.15 m, it provides a cover feature and the location and extent should be recorded on the habitat map.

Unstable Bank: A portion of the stream bank that is unstable in that it has, or has potential to, shed material into the stream. Instability may be due to various factors such as slumping, gullying, erosion or undercutting. Record the location and extent of unstable banks on the habitat map.

Wetted Width: The width of the water surface measured at right angles to the direction of flow. If an island(s) is present creating more than one channel, the total wetted width is the sum of the individual wetted widths. Wetted width is dependent on stream discharge and varies as water level varies.

DEFINITIONS FOR HABITAT VARIABLES

Channel Unit (sometimes referred to as habitat type): Channel units are the hydraulic and morphological features of a stream channel. A channel unit is a section of channel which is homogeneous with respect to water depth, velocity and cover and is separated from other channel units by gradients in these parameters. Channel units are sometimes referred to as habitat types. The most common channel units are **pool**, **riffle** and **run**, although a total of 12 channel units have been defined (Table 1).

Table 1: List of Channel Units

Channel Unit	Description
Falls	Highest water velocity; involves water falling over a vertical drop; impassable to fish
Cascade	Extremely high gradient and velocity; extremely turbulent with entire water surface broken; may have short vertical sections but overall is passable to fish; armoured substrate; may be associated with chute
Chute	Area of channel constriction, usually due to bedrock intrusions; associated with channel deepening and increased velocity
Rapids	Extremely high velocity; deeper than riffle; substrate extremely coarse (large cobble/boulder); instream cover in pocket eddies and associated with substrate
Riffle	High velocity/gradient relative to run habitat; surface broken due to submerged or exposed bed material; shallow relative to other channel units; coarse substrate; usually limited instream or overhead cover for juvenile or adult fish (generally ≤0.5 m deep)
Run	Moderate to high velocity; surface largely unbroken; usually deeper than a riffle; substrate size dependent on specific hydraulics
Flat	Low gradient area characterized by low velocity and near-laminar flow; differentiated from pool habitat by high channel uniformity; more depositional than run habitat
Pool (Scour)	Discrete portion of channel featuring increased depth and reduced velocity relative to riffle/run habitats; formed by channel scour
Impoundment Pool	Includes pools which are formed behind dams; tend to accumulate sediment/organic debris more than scour pools; may have cover associated with damming structure; identify as Class 1, 2 or 3 as for scour pools; record dam type (e.g., debris, beaver, landslide)
Backwater	Discrete, localized area of variable size exhibiting reverse flow direction; generally produced by bank irregularities; velocities variable but lower than main flow; substrate similar to adjacent channel with higher percentage of fines – record large/significant backwater areas
Snye	Discrete section of non-flowing water connected to a flowing channel only at its downstream end; generally formed in a side-channel or behind a peninsula
Boulder Garden	Significant occurrence of large boulders providing significant instream cover; always in association with an overall channel unit such as a riffle or run

\\golder.gds\gal\mississauga\active\2013\1118\13-1118-0010 osisko-hammond reef - ea support\006 environmental\2003 aquatic biology\appendix a definitions for habitat variables\appendix a definitions for habitat variables.docx

DEFINITIONS FOR HABITAT VARIABLES

Page left intentionally blank

APPENDIX B

Fish Habitat Preference Tables

December 2013
Report No. 13-1118-0010 (DOC028)

Golder Associates

Table of Contents

INTRODUCTION **1**

TABLES

Table 1: Fish Species Captured During Baseline Studies 2
Table 2: Habitat Preferences, Lake Whitefish (*Coregonus clupeaformis*) 3
Table 3: Habitat Preferences, Cisco (*Coregonus artedi*) 4
Table 4: Habitat Preferences, Central Mudminnow (*Umbra limi*) 5
Table 5: Habitat Preferences, Northern Pike (*Esox lucius*) 6
Table 6: Habitat Preferences, Longnose Dace (*Rhinichthys cataractae*) 7
Table 7: Habitat Preferences, Blacknose Dace (*Rhinichthys atratulus*) 8
Table 8: Habitat Preferences, Northern Redbelly Dace (*Chrosomus eos*) 9
Table 9: Habitat Preferences, Finescale Dace (*Chrosomus neogaeus*) 10
Table 10: Habitat Preferences, Pearl Dace (*Semotilus margarita*) 11
Table 11: Habitat Preferences, Fathead Minnow (*Pimephales promelas*) 12
Table 12: Habitat Preferences, Spottail Shiner (*Notropis hudsonius*) 13
Table 13: Habitat Preferences, Blacknose Shiner (*Notropis heterolepis*) 14
Table 14: Habitat Preferences, Brassy Minnow (*Hybognathus hankinsoni*) 15
Table 15: Habitat Preferences, Common White Sucker (*Catostomus commersoni* 16
Table 16: Habitat Preferences, Burbot (*Lota lota*) 17
Table 17: Habitat Preferences, Ninespine Stickleback (*Pungitius pungitius*) 18
Table 18: Habitat Preferences, Brook Stickleback(*Culaea inconstans*) 19
Table 19: Habitat Preferences, Smallmouth Bass (*Micropterus dolomieu*) 20
Table 20: Habitat Preferences, Pumpkinseed (*Lepomis gibbosus*) 21
Table 21: Habitat Preferences, Walleye (*Sander vitreus*) 22
Table 22: Habitat Preferences, Yellow Perch (*Perca flavescens)* 23
Table 23: Habitat Preferences, Iowa Darter (*Etheostoma exile)* 24
Table 24: Habitat Preferences, Mottled Sculpin (*Cottus bairdi*) 25

FISH HABITAT PREFERENCE TABLES

Page left intentionally blank

FISH HABITAT PREFERENCE TABLES

INTRODUCTION

The draft guidelines for the preparation of the Hammond Reef Mine Project (the Project) Environmental Impact Statement (EIS) requires that habitats for each potentially affected species identified be characterized as spawning, rearing/nursery, feeding, migratory corridor and overwintering/summer refuge habitats (Canadian Environmental Assessment Agency 2011). These habitat classes are proposed for No Net Loss (NNL) Planning and are defined as follows:

- spawning habitat is used by fish for the specific act of reproduction;
- nursery/rearing habitat is used by developing embryos and young-of-the-year (YOY) and sub-adult fish for foraging and refuge from predators;
- feeding habitat is used by adult fish for feeding or periods between feeding events;
- overwintering/summer refugia are used by YOY, sub-adult and adult fish to survive periods of hostile conditions (e.g. flows and water temperature extremes; and
- migratory corridors are used by fish to access important habitats described above.

Fish species considered in this report were identified during baseline studies completed in 2010 and 2011 (Table 1). Habitat suitability relationships describing spawning, rearing/nursery, feeding, migratory corridor and overwintering/summer refuge habitats for each of the species listed in Table 1 were derived using information obtained from published HSI models, technical papers and published literature.

Within each habitat class, information pertaining to habitat characteristics was divided between general information related to the type of habitat and specific information related to both lentic and lotic environments.

For many of the characteristics, strength of association (low, medium, high) between habitat and life stage was assessed in the literature. Definitions between sources were consistent and so where applicable, these strength associations and have been included as part of this review. The following provides a definition for each of the ratings used:

- High – Indicates that a fish species is always or nearly always associated with habitats possessing this character;
- Medium – indicates that a species is frequently or often associated with habitats possessing this character; and
- Low – Indicates a species is sometimes or infrequently associated with habitats possessing this character.

FISH HABITAT PREFERENCE TABLES

Table 1: Fish Species Captured During Baseline Studies

Family/Subfamily	Species Common Name	Species Scientific Name
Coregoninae	Lake Whitefish[1.] Cisco[1.]	*Coregonus clupeaformis* *Coregonus artedi*
Umbridae	Central Mudminnow	*Umbra limi*
Esocidae	Northern Pike	*Esox lucius*
Cyprinidae	Longnose Dace Blacknose Dace Northern Redbelly Dace Finescale Dace Pearl Dace Fathead Minnow Spottail Shiner[1.] Blacknose Shiner Brassy Minnow	*Rhinichthys cataractae* *Rhinichthys atratulus* *Chrosomus eos* *Chrosomus neogaeus* *Semotilus margarita* *Pimephales promelas* *Notropis hudsonius* *Notropis heterolepis* *Hybognathus hankinsoni*
Catostomidae	Common White Sucker	*Catostomus commersoni*
Gadidae	Burbot	*Lota lota*
Gasterosteidae	Ninespine Stickleback Brook Stickleback	*Pungitius pungitius* *Culaea inconstans*
Centrarchidae	Smallmouth Bass Pumpkinseed	*Micropterus dolomieu* *Lepomis gibbosus*
Percidae	Walleye Yellow Perch Iowa Darter	*Sander vitreus* *Perca flavescens* *Etheostoma exile*
Cottidae	Mottled Sculpin	*Cottus bairdi*

FISH HABITAT PREFERENCE TABLES

Table 2: Habitat Preferences, Lake Whitefish (*Coregonus clupeaformis*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Fall broadcast spawner with ideal water temperature range of 0.5 to 7.8 °C; flowing water not required for spawning (7) (11) **Lentic –** Spawning in shallow water over gravel, cobble, boulder and sometimes sand; infrequently over silt and clay substrate with emergent vegetation if slight current present (7) (8) (11) **Lotic –** Spawning from 0-5+m to 30 m over coarse substrates of boulder, cobble, rubble, gravel, sand (4) (7) (8) (11) (13)	**Lotic –** YOY with depth preference of 0-2 m in spring , no seasonal preference from 2-5 m, low association with emergent or submergent vegetation or over in-situ cover (5) (7) Juveniles associated with depths to 10 m with boulder, cobble, rubble and gravel substrate in association with vegetation and woody debris or in pelagic areas (7) (12)	**General –** YOY are initially limnetic feeders, switching to benthic feeding as fish learn local food availability (8) Adults benthic feeders on snails, clams, chironomid larvae and small fish (12)	**Lotic –** In summer, YOY in lotic environments leave shallow inshore waters as water temperature warms and move to deeper pelagic waters at depths of 5-10 m with substrate preference for boulder, cobble, gravel and sand (7) (12) Adults move into shallow waters in the fall to spawn on shoals or rocky ledges and return to deepwater habitat to overwinter (7) (12) Marked onshore movements into shallow water habitats at night, possibly to feed (12)	**General –** Late winter dissolved oxygen levels from 4 to >7 mg/L preferred (13) **Lentic –** associated with low velocity/pool habitat (10) **Lotic –** Typically associated throughout the year with depths of 5+m, below thermocline (6)

FISH HABITAT PREFERENCE TABLES

Table 3: Habitat Preferences, Cisco (*Coregonus artedi*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Fall broadcast spawners at water temperatures of 2 to 5°C with hatch occurring after ice break up (7) **Lentic -** Spawning over a range of depths from1 to 5+ m deep with primary preference for cobble, rubble, gravel or sand; secondary substrate of boulder, silt/clay or hard-pan clay (4) (7) (8) **Lotic –** Lacustrine areas of large rivers with spawning in pools at depths from 1 to 2+ m over boulder, cobble, rubble or gravel substrate (10)	**Lentic –** YOY in 0-2 m of water, in fall from 2 to 5+ m deep over boulder, boulder-cobble, rubble or gravel substrate (5) In spring, juveniles located in habitats of sparse vegetation over rock substrate, in fall in non-vegetated areas over rock (7) **Lotic –** Juveniles associated with pool or run habitats (10)	**General –** Adults feed in the water column on a wide variety of small prey including zooplankton, crustaceans, larval insects, algae and occasionally, small fish (9) Juveniles feed at or near bottom of nearshore areas, at night (8)	**Lentic –** YOY, juveniles and adults move below thermocline (from shallow to deep water) in spring and summer with movement in reverse direction when temperatures cool again (8)	**Lentic –** Adult habitat primarily the pelagic zone of lakes from 5 to 10+ m with late summer movement to just below thermocline and as upper waters cool, into shallower waters (6) (7) **Lotic –** Adults associated with pool or run habitats (10)

FISH HABITAT PREFERENCE TABLES

Table 4: Habitat Preferences, Central Mudminnow (*Umbra limi*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawners from mid to late April at water temperature of 13 °C along flooded stream and pond banks where eggs adhere to flooded vegetation (3) (7) **Lentic –** Spawning in 0-1 m in submergent/emergent vegetation (4) (7) **Lotic –** Spawning associated with pool habitat; strong association with flooded terrestrial vegetation (10)	**Lentic –** YOY with depth preference from 0-2 m; substrate preference of silt/clay or muck (organic detritus) and cover preference of submergent/emergent vegetation (7) **Lotic –** Depth preference from 0-0.2m, substrate preference for silt/clay and cover preference for vegetation; turbidity intolerant (10)	**General –** Nocturnal feeder on small crustaceans, insect larvae and molluscs near bottom in vegetation cover (3) (9) **Lentic –** YOY with depth preference from 0-2 m; substrate preference of silt/clay or muck (organic detritus) and cover preference of submergent/emergent vegetation (7) **Lotic –** Depth preference from 0-0.2m, substrate preference for silt/clay and cover preference for vegetation (10)	**General –** YOY move from flooded stream and pond banks back to main water body when approximately 30 mm in length (3)	**General –** Heavily vegetated ponds and pools of small creeks, including those with floating mat shores. Summer habitat of vegetated ponds or pools of small creeks where the bottom has a thick layer of organic material (3) (7) Tolerate of hypoxia and known to take atmospheric oxygen when dissolved oxygen levels are low allowing for survival in isolated pools which may become stagnant and warm (3) (7) Preferred substrate a thick layer of organic material and detritus to escape predation and survive drought **Lotic –** Adults in 0-2 m year round; high association with submergent and emergent vegetation (6)

FISH HABITAT PREFERENCE TABLES

Table 5: Habitat Preferences, Northern Pike (*Esox lucius*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawners, in colder areas, after ice break up at water temperatures between 4.4 to 12°C (8) Over flooded terrestrial vegetation in areas of calm, shallow water or weedy bays or backwaters (1) Optimum spawning habitat is a dense mat of flooded emergent vegetation such as sedges, cattails or grasses with a large basal coverage for egg adhesion (2) (3) Substrate preference for silt and sand although spawning-site preference is more related to adequate submergent vegetation (4) (7)	**General –** Shallow, vegetated areas such as flooded marshes, flooded terrestrial vegetation, or weedy bays (1) **Lentic –** Depth preference from 0-2 m in spring, 2-5 m in fall; over substrates of silt, clay or hardpan clay near submergent/emergent vegetation cover; specific preference by YOY for submerged vegetation versus other aquatic vegetation types (2) (5) (7) (8) Juveniles typically found along shorelines with adequate food and cover at depths of <2 m; same substrate preference as YOY, always in association with submergent vegetation (7)	**General –** Day active feeders with preference for ambush cover in the form of aquatic plants, tree stumps, fallen logs (1) YOY initial food preference for invertebrates such as Ephemeroptera, Isopoda, Cladocera with switch to vertebrate prey in fish ≥130 mm; habitat preference for submerged vegetation with rooted aquatic plants to offer cover and increased plankton and therefore the best food supply (2) (3)	**General –** From lakes and rivers up tributaries to flooded marshes, wetlands or shallow pools during spawning (1) **Lentic –** Adults usually found within shallow, vegetated regions of lakes in spring and fall, moving to deeper water as water temperature increases in summer and ice-cover forms in winter (7) (8) Movement by juveniles to areas of emergent vegetation in late summer where dissolved oxygen concentrations higher (3) **Lotic –** Avoidance for strong currents (>1.5 m/s) that can block spawning migrations (1)	**General –** Dissolved oxygen concentration important habitat variable affecting overwinter survival although NRPK more tolerant of low D.O. during winter than other temperate species; optimal temperature preference for adults between 19 and 21°C (1) (7) **Lotic –** Occur more frequently in lakes than rivers; summer habitat limited in some lakes by combination of high surface temperatures and low oxygen concentration in cooler, deeper strata (1) Adults at depths from 0-10 m throughout the year; along margins of vegetated areas or areas with in-situ materials (fallen logs, tree stumps, shoals, boulders) and substrates of mud, silt, or hardpan clay (6) (7)

FISH HABITAT PREFERENCE TABLES

Table 6: Habitat Preferences, Longnose Dace (*Rhinichthys cataractae*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawners, eggs settle in and adhere to substrate (4) (9) **Lentic –** Low association in lakes but where found spawning from 0 to 2 m over wave swept inshore areas with gravel, cobble, rubble and/or boulder substrates (4) (7) **Lotic –** Depth from 0-0.2 m over gravel in riffle habitat (10)	**Lentic –** Low association in lakes but where found nursery habitat in inshore shallow areas where YOY utilize overhanging vegetation for cover; juveniles in 0-2 m of water, low association with submergent/emergent vegetation (5) (7) **Lotic –** Juveniles in 0-0.6 m of water with high preference for boulder, cobble, rubble, gravel; low preference for bedrock, sand, silt/clay, detritus; not associated with emergent/submergent vegetation, algae, woody debris; in riffle or rapid habitat(10)	**General –** Night feeder on aquatic insects, worms, crustaceans and molluscs (9)	**Lentic –** Low association in lakes but where found movement off-shore to deeper areas of lakes after ~4 months (7)	**General –** Late winter dissolved oxygen levels of 2 mg/L considered ideal with pH range of 6 to 9 (13) **Lentic –** Low association in lentic environments, where found, adults in 0-2 m of water with preference for rubble, gravel, sand substrate (6) **Lotic –** Adults in 0-0.6 m of water with high preference for boulder, cobble, rubble, gravel; low preference for bedrock, sand, silt/clay, detritus; not associated with emergent/submergent vegetation, algae or woody debris; in riffle or rapid habitat(10)

FISH HABITAT PREFERENCE TABLES

Table 7: Habitat Preferences, Blacknose Dace (*Rhinichthys atratulus*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/ Summer Refuge
General – Spring spawner in water temperatures between 12 and 27°C; eggs pushed into substrate in shallow riffles, fertilized and guarded by male (9) **Lentic –** Low association with lake spawning but when present in 0-1 m of water with high association for rubble and gravel, medium association for sand (4) **Lotic –** High association for gravel substrate in the fast water of shallow riffles (1) (14)	**Lentic –** Low association with lake habitat for YOY, where present in 0-2 m water with no seasonal preference; high association with silt (5) **Lotic –** Juveniles with depth preference for 0-0.6 m; high substrate association for rubble, gravel, sand, silt/clay substrate, medium for boulder, cobble; low for bedrock; high association for wood, substrate and overhead cover; high association for pool, riffle and run habitat, low turbidity tolerance (10)	**General –** Benthic feeder, primarily aquatic insect larvae and to a lesser extent worms and algae; adults will prey on their own eggs during spawning (9)		**Lentic –** In water from 0-2 m deep with no seasonal preference (6) **Lotic –** Depth preference from 0-0.6 m, with high association for rubble, gravel, sand, silt/clay substrate, medium for boulder, cobble; low for bedrock; cover preference with high association for wood, substrate and overhead cover; velocity preference with high association for pool, riffle and run, low turbidity tolerance (10)

FISH HABITAT PREFERENCE TABLES

Table 8: Habitat Preferences, Northern Redbelly Dace (*Chrosomus eos*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring/summer broadcast spawner on masses of filamentous algae at water temperatures of 21-27°C (3) (4) **Lentic –** High association with lake habitats; high association for water depth of 0-2 m; medium association with gravel substrate, high association with sand and silt substrate; high association with submergent vegetative cover (4.) (7.) **Lotic –** High association for spawning locations with pool habitat and algae cover (10.)	**Lentic –** YOYs with high association for water depth from 0-2 m; high association for silt/clay and detritus substrate (5) (7) **Lotic –** Juveniles with high association for depth from 0-0.6 m; medium from 0.61 to 1 m; high association for silt and detritus substrates (10)	**Lentic –** Young feed on diatoms, algae, zooplankton and aquatic insects; in wetlands associated with open water marsh/marsh wetland with mixed organic substrates and floating leaved plants (3)	**General –** Adults inhabit depths of <2 m but move into deeper water following a diel migration pattern (6) (7)	**General –** Preference for boggy lakes, creeks, ponds and quiet pool-like expansions of streams over detritus and silt substrates (?) **Lentic –** Adults with high association for water depth of 0-2 m and medium association for 2-5 m; high association with substrates ranging from gravel, sand, silt-clay and detritus; high association with submergent/emergent vegetation (6) (7) **Lotic –** Adults with high association for depth of 0-0.6 m; medium association for 0.61 to 1 m; high association for silt and detritus substrates (10)

FISH HABITAT PREFERENCE TABLES

Table 9: Habitat Preferences, Finescale Dace (*Chrosomus neogaeus*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Late spring at water temperature between 13 and 18 °C, broadcast spawners, often within masses of filamentous algae(4) (7) (9) **Lentic –** High association in lakes at depths from 0-2 m; high association for sand and silt substrate, medium for gravel; cover preference for logs and brush (4) (7) **Lotic –** high association 0.21 to 1 m; high silt/clay and detritus substrate; high wood cover; high pool velocity class (10)	**Lentic –** Medium association in lakes, where present found year round to depths of 2 m; high association with silt substrate; in wetlands associated with open water marsh/marsh wetland with mixed organic substrates and floating leaved plants (3) (5) **Lotic –** High association with depth from 0.6 m; high association with silt/clay and detritus substrate; high association with pool habitat;(10)	**General –** Small molluscs, aquatic and terrestrial insects and algae; in wetlands associated with open water marsh/marsh wetland with mixed organic substrates and floating leaved plants (3) (9)		**General –** Cool heavily vegetated slow moving shallow waters of lakes and streams with bottoms of silt and detritus, often associated with “tea” stained waters (9) **Lentic –** Year-round association from 0-5 m; high association with gravel, sand silt substrate; high association with submergent/emergent vegetation cover and logs; (6) **Lotic –** high association with depth from 0.6 m; high association with silt/clay and detritus substrate; high association with pool habitat (10)

FISH HABITAT PREFERENCE TABLES

Table 10: Habitat Preferences, Pearl Dace (*Semotilus margarita*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawner at water temperature between 13 and 18 °C; in northern lakes, spawn in tributary streams or in vegetation on the periphery of lakes in early spring, about the time of spring melt and ice-off occurs (3) (11) **Lentic –** Low lake affinity but where found in 0-1 m water, high association with gravel and sand substrate; in beaver ponds and small lakes typically over soft organic substrates; low association with submergent/emergent vegetation (4) (11) **Lotic –** High association with depth from 0.6-1.0 m; high association with gravel, sand substrate; high association with riffle habitat (10)	**Lentic –** YOY from 0-2 m deep year round; low association with emergent/submergent vegetation (5) **Lotic –** High association with gravel, sand, silt/clay substrate; medium boulder, cobble, rubble and detritus, low bedrock; high association with vegetative cover; high association with pool habitat, medium with run habitat, low with riffle habiatat; turbidity intolerant (10)	**General –** filamentous algae, small crustaceans, larval aquatic insects, molluscs and terrestrial insects that fall in the water; in wetlands in open water marshes with mixed organic substrate and floating leaved plants (3) (9)		**Lentic –** Low lake association but where found in 0-2 m water year round, high association with gravel, sand, silt substrate, medium with rubble low association with emergent/submergent vegetation; (6) **Lotic –** High association with gravel, sand, silt/clay substrate; medium with boulder, cobble, rubble, detritus, low with bedrock; high association with vegetative cover; high association with pool habitat, medium with run, low with riffle; turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 11: Habitat Preferences, Fathead Minnow (*Pimephales promelas*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawner in water temperatures of 16 to 29 C, nest builders under rock or wood (4) (9) **Lentic –** Medium association with lakes; high association for depth from 0-2 m; medium association for gravel, high rubble, sand and silt substrate; medium association for submergent/emergent vegetation; high association for overhead and in-situ cover (4) (7) (12) **Lotic –** High association for depth from 0.61-1.0 m; high association for wood, substrate and overhead cover; high association for pool habitat, turbidity tolerant, substrate irrelevant, except when it includes stones under which eggs may be laid (10)	**Lentic –** YOY medium association with lakes; high association with depths from 0-2 m; medium to high association with sand, silt/clay substrate; medium association with submergent/emergent vegetation; Juveniles, high association with depth from 0-2 m, low from 2-5 m; medium association with cobble, rubble, sand, silt/clay substrates, low with gravel; medium association with emergent vegetation and in-situ cover, high with no cover (5) (7) (12) **Lotic –** High association with depth from 0-0.6 m; high association for cobble, rubble, gravel, sand, silt/clay substrates; medium for boulder, detritus; low for bedrock; high association with pool and run habitat, turbidity tolerant (10)	**General –** feed on algae, organic detritus, aquatic insect larvae and zooplankton; in wetlands associated with open water marsh and marsh of mineral, organic or mixed substrate and submergent vegetation (3)		**Lentic –** Medium to high association with lakes; high association for depth from 0-2 m, low from 2-5 m; medium association with cobble rubble substrate, high for gravel, sand, silt/clay; high association for submergent/emergent vegetation, no cover and in-situ cover (6) (7) **Lotic –** High association with depth from 0-0.6 m; high association for cobble, rubble, gravel, sand, silt/clay substrate; medium for boulder, detritus; low for bedrock; high association for pool and run habitat,, turbidity tolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 12: Habitat Preferences, Spottail Shiner (*Notropis hudsonius*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spawning over open sand or gravel shoals in clear, cold or cool lakes and likely occurs in similar fashion in rivers (3) (4) (9) **Lentic –** Medium to high association with lakes; high association for depth from 0-2 m, medium from 2-5+ m; high association for gravel, sand substrate, medium to high for cobble, rubble substrate; medium to high association for submergent/emergent vegetation cover (4) (7) (8) (12) **Lotic –** High association for rubble, sand substrate; high association for pool, riffle, run habitats (10)	**Lentic –** YOY and juvenile with medium to high association for lake environment. YOY at depths from 0-10+ m with high association for rubble, cobble, gravel, sand substrate, medium for silt/clay; high association for submergent/emergent vegetation. Juveniles at depth to 2 m; with medium association for cobble and gravel substrates, high for sand, silt/clay; medium association for pelagic areas; medium association for submergent vegetation or no cover, high for emergent vegetation (5) (7) (12) **Lotic –** High association for depths from 0-1 m; high association for gravel, sand substrates; high association for vegetative cover; high association for pool and riffle habitat, turbidity intolerant (10)	**General –** Plankton, aquatic insect larvae(especially Chironomidae and Emphemeroptera), algae, crustaceans, eggs, young fish within open water marsh or marsh with mineral substrate and emergent vegetation (3)	**General –** Known observations of spottail shiner migrating short distances up tributary streams to spawn in riffle areas (10)	**Lentic –** Medium to high lake association; year round at depths of 0 to 10+ m; medium association for cobble, rubble, silt/clay substrate, high for gravel, sand, medium association with pelagic areas; medium association for in-situ cover and medium to high association for submergent/emergent vegetation(6) (7) (8) (12) **Lotic –** High association for depth from 0-1 m; high association with gravel, sand substrates; high association with vegetation cover; high association for pool and riffle habitat, turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 13: Habitat Preferences, Blacknose Shiner (*Notropis heterolepis*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
Lentic – High association with lake environs at depths from 0-1 m; medium association for gravel substrate, high for sand; high association with submergent/emergent vegetation (4) (7) **Lotic –**high association with sand substrate (10)	**Lentic –** High association with lakes; YOY and juveniles at depth from 0-2 m; medium association with silt substrate, high for gravel sand; high association for submergent /emergent vegetation (5) (7) **Lotic –** High association for depths from 0-0.6 m; high association with gravel, sand substrates; high association with vegetation cover; high association with pool habitat, turbidity intolerant (10)	**General –**Cladocera, insects and green algae off of aquatic plants in open water marsh/marsh with mixed mineral and organic substrate (3)		**Lentic –** High association with lakes; year round at depths from 0-2 m; high association with gravel, sand substrate; high association with submergent and emergent veg. cover (6) (7) **Lotic –** High association with depths from 0-0.6 m; high association with gravel, sand substrate; high association with vegetation cover; high association with pool habitat, turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 14: Habitat Preferences, Brassy Minnow (*Hybognathus hankinsoni*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring broadcast spawner in shallow areas depositing eggs near or on vegetation at water temperature of 10 to 13 °C (3) (8) **Lentic –** At depths from 0-1 m; medium association with gravel substrate, high with sand, silt/clay; medium to high association for submergent /emergent vegetation cover, high for in-situ cover (4) (7) **Lotic –** High association for silt/clay substrate; high association for pool habitat, turbidity intolerant (10)	**Lentic –** Low lake association; YOY and juvenile with medium association at depths from 0-2 m; low association for rubble substrate, medium to high for gravel, sand, silt/clay; medium association with submergent/emergent vegetation cover for juveniles (5) (7) **Lotic –**High association for depths from 0-2 m; high association for gravel, sand, silt/clay substrates; medium for cobble, rubble; low for bedrock, boulder, detritus; high association for pool habitat (10)	**General –** In schools feeds on aquatic insect larvae, tiny crustaceans and algae from the bottom; associated with open water marsh, marsh and meadow marsh with mixed mineral or organic substrates and submergent/emergent vegetation (3) (9)	**General –** Schools often use shallow, flooded ground where water temperature is warmer than in deeper pools or channels, especially in late summer; return to main water body when temperature relationship is reversed (3)	**General –** Inhabit small, slow flowing weedy creeks, cool, acidic, boggy streams and shallow lakes (8) **Lentic –** Low lake association but where found at depths from at 0-2 m year round; medium to high association for gravel, sand, silt/clay substrate; medium association for submergent and emergent vegetation cover (6) (7) **Lotic –**At depths from 0-2 m; high association with gravel, sand, silt/clay substrates; medium with cobble, rubble; low with bedrock, boulder, detritus; high association with pool habitat (10)

FISH HABITAT PREFERENCE TABLES

Table 15: Habitat Preferences, Common White Sucker (*Catostomus commersoni*

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spawning occurs in spring at water temperatures from 6 to 23 °C, broadcast spawning over sand or gravel in streams or along lake margins and shoals, with eggs adhering to the substrate (3) (4) Spawning habitat in inlets, outlets, small creeks and rivers with relatively swift shallow waters running over a gravel bottom. Stream populations reach maximum abundance in low to moderate gradient streams (15) **Lentic –** Low to medium association for lakes at depths from 0-2 m; medium association with rubble, and sand substrate, high for gravel; low association with submergent/emergent vegetation (4) (7) (12) **Lotic –** High substrate association with rubble and gravel, turbidity tolerant (10) (15)	**General –** Larvae 10-12 mm remain among sand and gravel in shallow water; 12-17 mm larvae feed at surface in moderate current, often in association with water weed (3) **Lentic** – YOY and juveniles with year round association at depths from 0-5 m; low association with boulder/cobble substrate, medium with silt, high with sand; high association with submergent vegetation (5) (7) (12) **Lotic –** Juveniles with high depth association from 0-0.6 m; low substrate association for boulder and rubble, medium for cobble, gravel, sand and detritus, high for bedrock and silt/clay; low cover association with substrate, medium for vegetation and high for wood and overhead cover; high association for riffle and run habitat (10)	**General –** Sac-fry feed on surface associated zooplankton, after yolk absorption to benthic organisms such as chironomids and fingernail clams, juveniles feed primarily on benthic organisms, adults on amphipods, gastropods and large immature aquatic insects (15). In wetlands consists of open water marsh with mixed mineral and organic substrates(3) (9)	**General –** Upstream spawning migration in spring to early summer, from lentic systems or stream pools to spawning riffles when daily maximum water temperature reaches 10°C (15)	**General –** Broad temperature tolerance with optimal summer temperature of 24°C (15) **Lentic –** Adults with medium lake presence and year round association for depths from 0-10+ m; low association for bedrock, boulder, cobble and silt; medium for rubble, high for gravel and sand; medium association with emergent vegetation, high for in-situ cover (6) (7) (12) **Lotic** – Adults with high depth association from 0-1.0 m; low substrate association for bedrock, boulder, cobble and silt/clay, medium for rubble and high for gravel, sand; high cover association with wood; high velocity association for pool and run, turbidity tolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 16: Habitat Preferences, Burbot (*Lota lota*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Winter broadcast spawners at water temperatures from 1-10 °C (4) **Lentic –** High association for lakes at depths from at least 0-5 m; medium association for sand and silt substrate, high for boulder, cobble, rubble and gravel; (4) (7) **Lotic –** High association for depth from 1 to >2 m; high substrate association with gravel and sand (10)	**Lentic –** YOY with high lake presence, in spring from 0-5 m, 5+ m in fall; YOY and juveniles with medium to high association for boulder, cobble, rubble, gravel and sand; medium association with submergent/emergent vegetation and overhead cover, high for in-situ cover (5) (7) **Lotic –** Juveniles with medium substrate association for boulder, cobble, gravel, silt/clay, high association for rubble and sand substrate; medium cover association for vegetation, high for wood; high association with pool and run	**General –** Forages at night on bottom for crustaceans and a wide variety of fishes (9)	**General –** Increased flow of water and oxygenation of eggs in riverine enviro. May influence tributary spawning migrations in lacustrine populations (12)	**Lentic –** Adults with high lake presence at depths from 5 to 10+ m year round; medium association with rubble and gravel, high with bedrock, boulder, cobble, sand, silt /clay and muck; medium association with submergent/emergent vegetation, overhead or no cover; high association with in situ cover(6) (7)

FISH HABITAT PREFERENCE TABLES

Table 17: Habitat Preferences, Ninespine Stickleback (*Pungitius pungitius*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawners at water temperatures from 9-17 °C, nest builders (4) **Lentic –** High association in lakes at depths from 0-5+ m;medium association with cobble, sand and silt substrate, high for rubble and gravel; high association with submergent/emergent vegetation cover, and between rocks; (4) (7) **Lotic –** High substrate association for rubble; high cover association (10)	**Lentic** – YOY and juveniles with high lake presence; in spring from 0-2 m, in fall from 2 to 5+ m; low association with gravel substrate, high with cobble, rubble, sand and silt/clay; medium association with submergent /emergent vegetation and in-situ cover (5) (7) **Lotic** – High cover association for submerged vegetation and algae; high association for pool and run habitat	**General –** Feed on aquatic insects, crustaceans, fish eggs and fry in wetlands of open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3)		**Lentic –** Adults with high lake presence in summer at depths from 0-2 m, 2-10+ m year round; low association with gravel substrate, medium with pelagic zone, high with cobble, rubble, sand, silt/clay, hard-pan clay; medium association with submergent /emergent vegetation and in-situ cover medium association with gravel substrate, high with sand and silt; high association for submergent vegetation; (6) (7)

FISH HABITAT PREFERENCE TABLES

Table 18: Habitat Preferences, Brook Stickleback(*Culaea inconstans*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General –Spring spawners at water temperature of 8-19°C in shallow water where they construct a nest of grass, green algae or reeds (3) (4) **Lentic –** High association with lakes at depths from 0-1 m; medium association with gravel substrate, high for sand and silt; high association with submergent/emergent cover and sticks (4) (7) (12)	**Lentic -** YOY and juveniles with medium to high presence in lakes; in spring from 0-2 m, in fall from 2 to 5+ m; high association with gravel substrate, medium with sand and silt/clay; medium to high association with submergent/emergent vegetation; (5) (7) (12) **Lotic –** Juveniles with medium association for depth from 1.0 to 2.0 m, high from 0 to 1.0 m; low substrate association for bedrock and detritus, medium for boulder, cobble, rubble, high for gravel, sand and silt/clay; high cover association for vegetation; high association for pool and run habitat, turbidity intolerant	**General –** Feed on aquatic insects, larvae and small crustaceans, fish eggs and fry, snails, worms and algae in wetlands of open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3)		**Lentic –** Adults with high lake presence in summer at depths from 0-2 m, 2-10+ m year round; Low association for muck and clay, medium for rubble substrate, high for gravel, sand and silt; medium association for in-situ cover, high for submergent /emergent vegetation; (6) (7) (12) **Lotic -** ; Medium association for depth from 1.0 to 2.0 m, high from 0 to 1.0 m Low substrate association for bedrock and detritus, medium for boulder, cobble, rubble, high for gravel, sand and silt/clay high association for pool and run habitat, turbidity intolerant, turbidity

FISH HABITAT PREFERENCE TABLES

Table 19: Habitat Preferences, Smallmouth Bass (*Micropterus dolomieu*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawners at water temperature from 13-24 °C, nest builders (4) **Lentic –** high association for lakes at depths from 0-2 m; medium association for bedrock, and sand substrate, high for rubble, and gravel; low association with submergent/emergent vegetation; with boulders, docks and logs; (4) (7) **Lotic –** High association for depth from 0.21 to >2 m; high association for rubble, gravel and sand	**Lentic –** YOY and juveniles with high presence in lakes at depths from 0-2 m in spring and 2-5+ m in fall; low association with silt substrates, medium with bedrock, gravel, sand, high with boulder and boulder/cobble;low association with submergent/emergent vegetation, medium with in-situ cover (5) (7) **Lotic –** Juveniles with low depth association from 0 to 0.2 m, medium from 0.21 to 0.6 m, high from 0.61 to >2.0 m; medium substrate association for gravel, high for boulder and cobble; high association for wood, substrate and overhead cover; high association for pool habitat, turbidity intolerant (10)	General – Feed on crayfish, aquatic insects, fish, tadpoles, frogs and plant material in wetlands of open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3) (9)		**Lentic –** Adults with high lake presence at depths from 0-2 m in summer, 2-10 m year round; low association with sand substrate, medium with hard-pan clay, high with boulder, cobble, rubble and gravel; low association with submergent/emergent vegetation, medium with in-situ cover (6) (7) **Lotic -** Adults with low depth association from 0.2 to 0.6 m, medium from 0.61 to 1.0 m, high from 1.0 to >2.0 m; low substrate association with sand, silt/clay and detritus, medium for bedrock and high for boulder, cobble, rubble and gravel; high association for wood, substrate and overhead cover; high association for pool and riffle habitat, turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 20: Habitat Preferences, Pumpkinseed (*Lepomis gibbosus*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spawning in late spring/early summer at water temperatures of 13-24°C in shallow inshore waters of ponds, lakes or slow moving rivers at depths from 0.15-0.30 m, nest builders using rocky, sandy or clay substrates, near or in submergent vegetation (3) (4) **Lentic –** High association with lakes at depths from 0-2 m; medium association with clay substrate, high for gravel and sand; high association with submergent/emergent vegetation cover; (4) (7) **Lotic –** Medium association with depth from 0-0.21 m, high for 0-0.2 m; high substrate association for gravel, sand, silt/clay and detritus	**General** – Often show distinct habitat segregation according to age class with younger fish amongst denser vegetation (3) **Lentic –** YOY and juveniles with high lake presence; year round at depths from 0-2 m; high association with sand and silt substrate; high association with submergent/emergent vegetation and overhead cover (5) (7) **Lotic –** Juveniles with high depth association from 0-1.0 m; low substrate association for bedrock, hard-pan, detritus, medium association for cobble, rubble and high association for gravel, sand, silt/clay; high cover association for vegetation and wood; high association for pool habitat, turbidity intolerant	**General** – Feed primarily on invertebrates living on aquatic plants although molluscs, small fish and aquatic vegetation also eaten; in wetlands in open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3) (9)		**Lentic –** Adults with high lake presence at depth of 0-2 m year round; low association with rubble substrate, medium for gravel, high for sand and silt; high association with submergent/emergent vegetation; (6) (7) **Lotic –** Adults with high depth association from 0-1.0 m; low substrate association for bedrock, hard-pan, detritus, medium association for cobble, rubble and high association for gravel, sand, silt/clay; high cover association for vegetation and wood; high association for pool habitat, turbidity intolerant

FISH HABITAT PREFERENCE TABLES

Table 21: Habitat Preferences, Walleye (*Sander vitreus*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General –Spring broadcast spawner at water temperatures from 4-12°C, at night, on windswept, coarse gravelly to boulder shoals of lakes after ice-out, or in rocky riffles and rapids of rivers. Homing behaviour for repeat spawning locations has been reported in the literature (3) (16) (18) Submergent vegetation is rarely used for spawning but may be used, along with other types of substrate if gravel-rubble is not present (17) (18) **Lentic –** Medium association for lakes at depths from 0-5+ m; low to high association with bedrock, boulder, cobble, rubble, gravel, sand and hard-pan clay substrates; low to medium association with submergent/emergent vegetation; spawning locations have sufficient exchanges or movements of water to permit adequate oxygen supply to developing embryo (4) (7) (12) (18) **Lotic –** Medium association for depth from 0.2 to 0.6 m, high from 0.61 to 1.0 m; high substrate association for cobble and rubble ; many spawning sites are below barriers of some sort (either natural or man-made) spawning locations have sufficient exchanges or movements of water to permit adequate oxygen supply to developing embryo (10) (17) (18)	**General –** Inshore areas important as nursery habitat for YOY; strong schooling tendencies and often associated with Yellow Perch; (12) (17) (18) **Lentic –** YOY and juveniles with high lake presence; in spring at depths from 0-5 m, in fall from 5+ m; medium association with boulder, cobble substrate, high with gravel, sand, YOY also with muck, hard-pan clay and pelagic zone; medium association with submergent/emergent vegetation (5) (7) (12) (17) **Lotic –** Juveniles with low depth association from 0 to 0.6 m, medium 0.61 to 1.0 m, high from 1.0 to >2.0 m; low substrate association for boulder and detritus, medium association for cobble and rubble, high for gravel and sand; high cover association for vegetation, wood and substrate; medium association with run habitat, high with pool, turbidity intolerant (10) (17)	**General –** Fry eat zooplankton and aquatic insects before switching to fish at 1.5 to 2.5 cm in length; diet of juveniles and adults consists primarily of fish and to lesser extent on aquatic invertebrates such as mayfly larvae and crayfish(3) (9) (16) (18) Feeding occurs near or at the bottom In wetlands in open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation although not preferred habitat (3)	**Lentic –** YOY with movement pattern towards the bottom at depths of 3-9 m in late summer; larval movement and dispersion influenced by lake currents, prevailing winds and wave action (3) (17) Adults in lakes often migrate up rivers to spawn (16) **Lotic –** The drift of larvae fish has been documented in several river systems (17)	**General -** d **Lentic –** Adults with high lake presence at depths from 0-5 m year round, 5-10 m in summer; low association for hard-pan clay, medium for boulder, cobble and silt, high for rubble, gravel, sand, silt/clay and muck; low association with submergent/emergent vegetation, high overhead and in-situ cover (6) (7) (12) **Lotic –** Adults with low depth association from 0 to 0.6 m, medium 0.61 to 1.0 m, high from 1.0 to >2.0 m; low substrate association for boulder and detritus, medium association for cobble and rubble, high for gravel and sand; high cover association for vegetation, wood and substrate; medium association with run habitat, high with pool, turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 22: Habitat Preferences, Yellow Perch (*Perca flavescens)*

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring broadcast spawner at water temperatures from 7-22°C (4) **Lentic –** High association with lakes at depths from 0-5+ m; medium association for rubble, silt/clay substrate, high for gravel and sand; medium association with submergent/emergent vegetation; (4) (7) **Lotic –** High association for depth from 0.21 to >2 m; high substrate association for gravel and sand (10)	**Lentic –** YOY and juveniles with high lake presence; in spring at depths from 0-5 m, 5+ m in fall; medium to high association with cobble rubble, gravel, sand and silt substrate; medium to high association with submergent/emergent vegetation, high with pelagic zone, YOY with medium association to overhead and in-situ cover (5) (7) **Lotic –** Juveniles with high depth association from 0-1.0 m;	**General –** Yellow Perch will occupy holes in dense vegetation and ambush prey; in wetlands feed in open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3)		**Lentic –** Adults with high lake presence at depths from 0-10+ m year round; low association with bedrock, boulder, cobble, rubble and clay, medium with gravel, high with sand, silt and muck; high association with submergent/emergent vegetation; (6) (7) **Lotic –** Adults with high depth association from 0->2.0 m; low substrate association with detritus, medium association with boulder, cobble, rubble and silt/clay, high association for gravel, sand; medium cover association for wood, high for vegetation; high association with pool habitat, turbidity intolerant

FISH HABITAT PREFERENCE TABLES

Table 23: Habitat Preferences, Iowa Darter (*Etheostoma exile)*

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring broadcast spawner at 12-15 °C in shallow waters near shore of lakes and streams on bottom organic debris, aquatic vegetation or fibrous root material; on sand or on organic material on sand when no undercut bank available (3) (4) (9) (14) **Lentic –** Medium association for lake environments in depths of 0-1 m; high association for rubble, gravel, sand and silt substrates (4) **Lotic –** High association for depth of 0.2-0.6 m; high association for gravel, sand substrate; high association for vegetation and overhead cover; high association for pool habitat (10)	**General -** Larval fish use pools 0.9-1.2 m deep (3) **Lentic –** YOY with medium association for lakes at depths from 0-5 m year round; high association for gravel, sand, silt substrate; medium association with submergent vegetation (5) **Lotic –** High association for depth of 0-0.61 m; high association for gravel and sand substrates, medium association for silt/clay and detritus, low for bedrock and boulder; High cover association for vegetation and algae; high association for pool habitat; low turbidity tolerance (10)	**General –** Bottom feeder on insect larvae of midge and mayfly, small crustaceans including amphipods, copepods and cladocerans; molluscs (3) (9) (14) **Lentic –** Wetland habitats of open water marsh and marsh with mixed mineral or organic substrates and submergent, floating, emergent vegetation (3)		**General –** Clear standing or slow moving waters of ponds, lakes or rivers at depths of<1.5 m (3) **Lentic –** Low association for lake environs, where found year round association at depths from 0-5 m; high association for gravel, sand, silt substrate; medium cover association for submergent vegetation; (6) **Lotic –** High association for depth from 0-0.6 m; high association for gravel, sand, medium silt/clay, detritus substrates; low for bedrock and boulder; high cover association for vegetation and algae; high association for pool habitat, low turbidity tolerance (10)

FISH HABITAT PREFERENCE TABLES

Table 24: Habitat Preferences, Mottled Sculpin (*Cottus bairdi*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring spawners at temperatures from 6-16°C; nest builders (4) **Lentic –** Medium association with lake environments, where present in 0-1 m of water under rocks and logs; high association with boulder, cobble, rubble, gravel, sand, silt/clay substrates (4) (7) (11) **Lotic –** High association with depths from 0-0.2 m; high association with rubble or gravel substrates, medium with sand and silt/clay; high association for substrate and overhead cover (10)	**Lentic –** YOY typically inhabit 0-2 m, up to 5+ m in some cases with high association for boulder, cobble, rubble substrate, medium for gravel and sand; juveniles associated with substrates of boulder, rubble and sand and use in-situ cover under rocks and logs in littoral zone from summer through fall (5) (7) **Lotic –** Juveniles with high association for depth from 0-0.6 m; high association for gravel, sand, silt/clay substrates; medium for boulder, cobble, rubble, low for bedrock and detritus; high association with instream vegetation, substrate and overhead cover; high association for pool and riffle habitat (10)	**General -** Bottom substrates, feeds on aquatic insect larvae and occasionally worms and small crustaceans of streams and lakes (9) **Lentic –** at night in open sandy areas (11)		**General -** Intolerant of high water temperatures, occupy an average temperature of approx 17°C **Lentic –** High association for depth from 0-2 m; high association for boulder, gravel, sand substrate; high association with use of substrate for cover (6) (7) **Lotic –** Adults with high association for depths from 0-0.6 m; high association for gravel, sand, silt/clay substrate; medium for boulder, cobble, rubble, low for bedrock and detritus; high association with instream vegetation, substrate and overhead cover; high association for pool and riffle habitat (10)

REFERENCES CITED

1 Inskip, P.D. 1982. Habitat suitability index models: Northern Pike. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.17. 40 p.

2 Holland, L.E. and M.L. Huston. 1984. Relationship of young-of-the-year Northern Pike to aquatic vegetation types in backwaters of the upper Mississippi River. North American Journal of Fisheries Management 4:514-522.

3 Hall-Armstrong, J, A.G. Harris and R.F. Foster. 1996. Fish use of wetlands in Northwestern Ontario: a literature review and bibliography. Northwest Sci. & Technol., Ont. Min. Natur. Resour., Thunder Bay, Ont. TR-90. 54 pp+.

4 Lane, J.A., C.B. Portt and C.K. Minns. 1996. Spawning habitat characteristics of Great Lakes fishes. Can. MS Rep. Fish. Aquat. Sci. 2368: v+48p.

5 Lane, J.A., C.B. Portt and C.K. Minns. 1996. Nursery habitat characteristics of Great Lakes fishes. Can. MS Rep. Fis. Aquat. Sci. 2338: v+42p.

6 Lane, J.A., C.B. Portt and C.K. Minns. 1996. Adult habitat characteristics of Great Lakes fishes. Can. MS Rep. Fis. Aquat. Sci. 2358: v+43p.

7 Langhorne, A.L., M. Neufeld, G. Hoar, V. Bourhis, D.A. Fernet, and C.K. Minns. 2001. Life history characteristics of freshwater fishes occuring in Manitoba, Saskatchewan, and Alberta, with major emphasis on lake habitat requirements. Can. MS Rpt. Fish. Aquat. Sci. 2579:xii+170p.

8 Roberge, M., T. Slaney and C.K. Minns. 2001. Life history characteristics of freshwater fishes occurring in British Columbia with major emphasis on lake habitat requirements. Can. MS Rpt. Fish. Aquat. Sci. 2574: i + 41 p.

9 Holm, E., N.E. Mandrak and M.E. Burridge. 2009. The ROM field guide to freshwater fishes of Ontario. Royal Ontario Museum, Friesens Printers , Altona, MB. 462p.

10 Portt, C.B., G. Coker and C.K. Minns. 1999. Riverine habitat characteristics of fishes of the Great Lakes watershed. Can. MS Rpt. Fish. Aquat. Sci. 2481:vi+62p.

11 Bradbury, C. M., M. Roberge and C.K. Minns. 1999. Life history characteristics of freshwater fishes occurring in Newfoundland and Labrador, with major emphasis on lake habitat characteristics. Can. MS Rep. Fish. Aquat. Sci. 2485:vii+150p.

12 Richardson, E.S., J.D. Resit and C.K. Minns. 2001. Life history characteristics of freshwater fishes occurring in the Northwest Territories and Nunavut, with major emphasis on lake habitat characteristics. Can. MS Rep. Fish. Aquat. Sci. 2569:vii+146p.

13 Fish Species Habitat Suitability Index Models for the Alberta Oil Sands Region (Golder 2008).

14 Scott, W.B. and E. J. Crossman, 1973. Freshwater fishes of Canada. Bulletin 184, Fisheries Research Board of Canada, Ottawa, ON. xviii + 966p.

FISH HABITAT PREFERENCE TABLES

15 Twomey, K.A., K.L. Williamson and P.C. Nelson. 1984. Habitat suitability index models and instream flow suitability curves: White Sucker. U.S. Fish Wildl. Serv. FWS/OBS-82/10.64. 56 pp.

16 McMahon, T.E., J.W. Terrell, and P.C. Nelson. 1984. Habitat suitability information: Walleye. U.S. Fish Wildl. Serv. FWS/OBS-82/10.56. 43 pp.

17 Kerr, S.J., B.W. Corbett, N.J. Hutchinson, D. Kinsman, J.H. Leach, D. Puddister, L. Stanfield and N. Ward. 1997. Walleye habitat: A synthesis of current knowledge with guidelines for conservation. Pecid Community Synthesis, Walleye Habitat Working Group, Ontario Ministry of Natural Resources, Peterborough, Ontario. 82 p.

18 Colby, P.J., R.E. McNicol and R.A. Ryder. 1979. FAO Fish. Synop. Synopsis of biological data on the walleye, *Stizostedion v. vitreum* (119): 139 p.

FISH HABITAT PREFERENCE TABLES

Page left intentionally blank

APPENDIX C

Habitat Accounting Model

December 2013
Report No. 13-1118-0010 (DOC028)

Golder Associates

TABLE 1
No Net Loss Plan – Species Weights

Species Groupings and Weights

Group	Species	Weight
Group 1: Cold + A1 - Lake: Non-Pisc	lake whitefish	0.040
	lake ciscoe	0.040
Group 2: Cold + A1 - Stream: Non-Piscivore	pearl dace	0.030
Group 3: Cold + A1 - Stream: Piscivore	burbot	0.030
Group 4: Cold + B: Non- Piscivore	ninespine stickleback	0.013
	brook stickleback	0.013
	mottled sculpin	0.013
Group 5: Cool + A1: Non-Piscivore	blacknose dace	0.000
	brassy minnow	0.000
	finescale dace	0.030
	redbelly dace	0.030
	golden shiner	0.030
	longnose dace	0.013
	white sucker	0.030
	iowa darter	0.013
	yellow perch	0.040
Group 6: Cool + A1: Piscivore	yellow walleye	0.170
	northern pike	0.170
Group 7: Warm + A: Non-Piscivore	blacknose shiner	0.013
	emerald shiner	0.030
	spottail shiner	0.030
	central mudminnow	0.013
Group 8: Warm + B: Non-Piscivore	fathead minnow	0.030
	pumpkinseed	0.013
Group 9: Warm + B: Piscivore	smallmouth bass	0.170
Total		**1.00**

Ecotype Weightings

Ecotype	Ecotyp Weight - Productive Capacity Index
Receiver Ecotype Habitat	1.5
Lake Ecotype Habitat	1
Headwater Pond Ecotype Habitat	1
Inlet Stream Ecotype Habitat	2.5
Warmwater Stream Ecotype Habitat	2.5
Intermittent Stream Ecotype	0.75

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

Osisko Hammond Reef Gold Ltd.

TABLE 2
No Net Loss Plan – Habitat Summary by Ecotype

Ecotype	Units	HA – Total Area of Habitat Feature	Habitat Expansion Factor (<7 sp=4; 7-12=3; 13-18=2;>18=1)	Total Weighted Useable Area	Ecotype Productive Capacity Index	Ecotype Weighted Useable Area
Receiver Ecotype Habitat	m^2	19,551,783.69	1	9,942,504.82	1.5	14,913,757.23
Lake Ecotype Habitat	m^2	297,088.78	1	24,093.56	1	24,093.56
Headwater Pond Ecotype Habitat	m^2	48,082.43	1	2,437.84	1	2,437.84
Inlet Stream Ecotype Habitat	m	92,657.67	1	4,312.83	2.5	10,782.06
Warmwater Stream Ecotype Habitat	m	216,355.01	1	13,303.67	2.5	33,259.18
Intermittent Stream Ecotype	m	1,964.09	1	27.72	0.75	20.79
Totals excluding Receiver		656,147.98		44,175.62		70,593.43
Totals		**20,207,931.67**		**9,986,680.44**		**15,054,944.10**

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 3
No Net Loss Plan – Receiver Ecotype Habitat

			Group 1: Cold + A1 - Lake: Non-Pisc							Group 1: Cold + A1 - Lake: Non-Piscivore						
			Lake Whitefish HSI Factor Score (0 - 1)							Lake Ciscoe HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**
Sawbill Bay	Littoral (1 - 3 m)	2,412,200.055	0.05	1	1	0.75	0.75	1	0.9							
API 34 and 49	Open Water/Profundal (> 3 m)	13,028,357.95	0.05	1	1	0.75	0.75	1	0.9							
Lynxhead Bay and Turtle Bay	Littoral (1 - 3 m)	46,827.33063														
API 29 and 31	Open Water/Profundal (> 3 m)	1,955,173.746														
Lizard Lake	Littoral (1 - 3 m)	66,600.197								0.04	0.75	0.5	0.5	1	1	0.75
API 38 and 39	Open Water/Profundal (> 3 m)	1,863,088.026								0.04	0.75	0.5	0.5	1	1	0.75
API 8	Littoral (1 - 3 m)	6,568.26568														
	Open Water/Profundal (> 3 m)	172,968.1247														
Habitat loss - Hammond Peninsula		**8,000**	**0.04**	**0**	**0**	**0**	**0**	**0**	**0**	**0.04**	**0**	**0**	**0**	**0**	**0**	**0**

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species .

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present)

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognises that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 3
No Net Loss Plan – Receiver Ecotype Habitat

			Group 3: Cold + A1 - Stream: Piscivore							Group 5: Cool + A1: Non-Piscivore						
			Burbot HSI Factor Score (0 - 1)							Golden Shiner HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**
Sawbill Bay	Littoral (1 - 3 m)	2,412,200.055								0.03	0.5	1	1	1	n/a	0.875
API 34 and 49	Open Water/Profundal (> 3 m)	13,028,357.95								0.03	0.5	1	1	1	n/a	0.875
Lynxhead Bay and Turtle Bay	Littoral (1 - 3 m)	46,827.33063														
API 29 and 31	Open Water/Profundal (> 3 m)	1,955,173.746														
Lizard Lake	Littoral (1 - 3 m)	66,600.197														
API 38 and 39	Open Water/Profundal (> 3 m)	1,863,088.026														
API 8	Littoral (1 - 3 m)	6,568.26568	0.015	1	1	1	1	n/a		0.03	0.5	1	1	1	n/a	0.875
	Open Water/Profundal (> 3 m)	172,968.1247	0.015	1	1	1	1	n/a		0.03	0.5	1	1	1	n/a	0.875
Habitat loss - Hammond Peninsula		**8,000**	**0.03**	**0**	**0**	**0**	**0**	**0**	**0**	**0.03**	**0.25**	**0.25**	**0.25**	**0**	**n/a**	**0.1875**

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species .

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present)

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognises that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 3
No Net Loss Plan – Receiver Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
			White Sucker HSI Factor Score (0 - 1)							Iowa Darter HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**
Sawbill Bay	Littoral (1 - 3 m)	2,412,200.055	0.03	0.25	0.25	0.5	0.75	0.25	0.4	0.013	0.5	0.5	0.5	0.75	n/a	0.5625
API 34 and 49	Open Water/Profundal (> 3 m)	13,028,357.95	0.03	0.25	0.25	0.5	0.75	0.25	0.4	0.013	0.5	0.5	0.5	0.75	n/a	0.5625
Lynxhead Bay and Turtle Bay	Littoral (1 - 3 m)	46,827.33063	0.03	0.25	0.25	0.5	0.75	0.25	0.4							
API 29 and 31	Open Water/Profundal (> 3 m)	1,955,173.746	0.03	0.25	0.25	0.5	0.75	0.25	0.4							
Lizard Lake	Littoral (1 - 3 m)	66,600.197	0.03	0.25	0.25	0.5	0.75	0.25	0.4	0.013	0.5	0.5	0.5	0.75	n/a	0.5625
API 38 and 39	Open Water/Profundal (> 3 m)	1,863,088.026	0.03	0.25	0.25	0.5	0.75	0.25	0.4	0.013	0.5	0.5	0.5	0.75	n/a	0.5625
API 8	Littoral (1 - 3 m)	6,568.26568														
	Open Water/Profundal (> 3 m)	172,968.1247														
Habitat loss - Hammond Peninsula		**8,000**	**0.03**	**0.25**	**0.25**	**0.25**	**0**	**0**	**0.15**	**0.013**	**0**	**0**	**0**	**0**	**n/a**	**0**

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species .

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present)

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognises that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 3
No Net Loss Plan – Receiver Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore							Group 6: Cool + A1: Piscivore						
			Yellow Perch HSI Factor Score (0 - 1)							Yellow Walleye HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**
Sawbill Bay	Littoral (1 - 3 m)	2,412,200.055	0.04	1	1	1	1	n/a	1	0.17	0.75	1	0.75	0.75	0.5	0.75
API 34 and 49	Open Water/Profundal (> 3 m)	13,028,357.95	0.04	1	1	1	1	n/a	1	0.17	0.75	1	0.75	0.75	0.5	0.75
Lynxhead Bay and Turtle Bay	Littoral (1 - 3 m)	46,827.33063	0.04	1	1	1	1	n/a	1	0.17	0.75	1	0.75	0.75	0.5	0.75
API 29 and 31	Open Water/Profundal (> 3 m)	1,955,173.746	0.04	1	1	1	1	n/a	1	0.17	0.75	1	0.75	0.75	0.5	0.75
Lizard Lake	Littoral (1 - 3 m)	66,600.197	0.04	1	1	1	1	n/a	1	0.17	0.75	1	0.75	0.75	0.5	0.75
API 38 and 39	Open Water/Profundal (> 3 m)	1,863,088.026	0.04	1	1	1	1	n/a	1	0.17	0.75	1	0.75	0.75	0.5	0.75
API 8	Littoral (1 - 3 m)	6,568.26568														
	Open Water/Profundal (> 3 m)	172,968.1247														
Habitat loss - Hammond Peninsula		**8,000**	**0.04**		**0.25**	**0.25**		**n/a**	**0.125**	**0.17**	**0**	**0**	**0**	**0**	**0**	**0**

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species .

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present)

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognises that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 3
No Net Loss Plan – Receiver Ecotype Habitat

			Group 6: Cool + A1: Piscivore							Group 7: Warm + A: Non-Piscivore						
			Northern Pike HSI Factor Score (0 - 1)							Blacknose Shiner HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**
Sawbill Bay	Littoral (1 - 3 m)	2,412,200.055	0.17	0.5	0.75	0.75	0.75	0.25	0.6	0.013	1	1	1	1	n/a	1
API 34 and 49	Open Water/Profundal (> 3 m)	13,028,357.95	0.17	0.5	0.75	0.75	0.75	0.25	0.6	0.013	1	1	1	1	n/a	1
Lynxhead Bay and Turtle Bay	Littoral (1 - 3 m)	46,827.33063	0.10	0.5	0.75	0.75	0.75	0.25	0.6							
API 29 and 31	Open Water/Profundal (> 3 m)	1,955,173.746	0.17	0.5	0.75	0.75	0.75	0.25	0.6							
Lizard Lake	Littoral (1 - 3 m)	66,600.197	0.17	0.5	0.75	0.75	0.75	0.25	0.6	0.013	1	1	1	1	n/a	1
API 38 and 39	Open Water/Profundal (> 3 m)	1,863,088.026	0.17	0.5	0.75	0.75	0.75	0.25	0.6	0.013	1	1	1	1	n/a	1
API 8	Littoral (1 - 3 m)	6,568.26568	0.17	0.5	0.75	0.75	0.75	0.25	0.6							
	Open Water/Profundal (> 3 m)	172,968.1247	0.17	0.5	0.75	0.75	0.75	0.25	0.6							
Habitat loss - Hammond Peninsula		**8,000**	**0.17**		**0.25**	**0.25**			**0.1**	**0.013**	**0.25**	**0.25**	**0.25**	**0**	**n/a**	**0.1875**

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species .

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present)

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognises that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 3
No Net Loss Plan – Receiver Ecotype Habitat

			Group 7: Warm + A: Non-Piscivore							Group 8: Warm + B: Non-Piscivore						
			Spottail Shiner HSI Factor Score (0 - 1)							Pumpkinseed HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**
Sawbill Bay	Littoral (1 - 3 m)	2,412,200.055	0.03	0.75	0.75	0.5	0.25	0.25	0.5							
API 34 and 49	Open Water/Profundal (> 3 m)	13,028,357.95	0.03	0.75	0.75	0.5	0.25	0.25	0.5							
Lynxhead Bay and Turtle Bay	Littoral (1 - 3 m)	46,827.33063														
API 29 and 31	Open Water/Profundal (> 3 m)	1,955,173.746														
Lizard Lake	Littoral (1 - 3 m)	66,600.197	0.03	0.75	0.75	0.5	0.25	0.25	0.5	0.013	0.5	0.75	0.75	0.75	n/a	0.6875
API 38 and 39	Open Water/Profundal (> 3 m)	1,863,088.026	0.03	0.75	0.75	0.5	0.25	0.25	0.5	0.013	0.5	0.75	0.75	0.75	n/a	0.6875
API 8	Littoral (1 - 3 m)	6,568.26568								0.030	0.5	0.75	0.75	0.75	n/a	0.6875
	Open Water/Profundal (> 3 m)	172,968.1247								0.030	0.5	0.75	0.75	0.75	n/a	0.6875
Habitat loss - Hammond Peninsula		**8,000**	**0.03**	**0.25**	**0.25**	**0.25**	**0**	**0**	**0.15**	**0.013**	**0.25**	**0.25**	**0.25**		**n/a**	**0.1875**

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species .

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present)

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognises that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 3
No Net Loss Plan – Receiver Ecotype Habitat

			Group 9: Warm + B: Piscivore										
			Smallmouth Bass HSI Factor Score (0 - 1)										
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Habitat Expansion Factor (<7 sp=4; 7-12=3; 13-18=2;>18=1)**	**Total Weighted Useable Area (HU)**	**Ecotype Productive Capacity Index**	**Ecotype Weighted Useable Area (HU)**
Sawbill Bay	Littoral (1 - 3 m)	2,412,200.055	0.17	1	0.75	0.75	0.75	n/a	0.8125	1	1,269,269.516	1.5	1,903,904.275
API 34 and 49	Open Water/Profundal (> 3 m)	13,028,357.95	0.17	1	0.75	0.75	0.75	n/a	0.8125	1	6,855,359.099	1.5	10,283,038.65
Lynxhead Bay and Turtle Bay	Littoral (1 - 3 m)	46,827.33063	0.17	1	0.75	0.75	0.75	n/a	0.8125	1	17,683.17073	1.5	26,524.75609
API 29 and 31	Open Water/Profundal (> 3 m)	1,955,173.746	0.17	1	0.75	0.75	0.75	n/a	0.8125	1	820,439.7832	1.5	1,230,659.675
Lizard Lake	Littoral (1 - 3 m)	66,600.197	0.17	1	0.75	0.75	0.75	n/a	0.8125	1	32,892.17229	1.5	49,338.25844
API 38 and 39	Open Water/Profundal (> 3 m)	1,863,088.026	0.17	1	0.75	0.75	0.75	n/a	0.8125	1	920,132.5988	1.5	1,380,198.898
API 8	Littoral (1 - 3 m)	6,568.26568								1	977.8505531	1.5	1,466.77583
	Open Water/Profundal (> 3 m)	172,968.1247								1	25,750.62956	1.5	38,625.94435
Habitat loss - Hammond Peninsula		**8,000**	**0.17**	**0.25**	**0.25**	**0.25**	**0**	**n/a**	**0.1875**	**1**	**915.5**	**1**	**915.5**

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species .

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present)

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognises that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 1: Cold + A1 - Lake: Non-Pisc							Group 1: Cold + A1 - Lake: Non-Piscivore						
			Lake Whitefish HSI Factor Score (0 - 1)							Lake Ciscoe HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0
	Open Water/Profundal (= Littoral)	163,846.1897	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0
	Open Water/Profundal (= Littoral)	118,361.4678	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 2: Cold + A1 - Stream: Non-Piscivore							Group 3: Cold + A1 - Stream: Piscivore						
			Pearl Dace HSI Factor Score (0 - 1)							Burbot HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0.03	0	0	0	0	n/a	0	0.03	0	0	0	0	0	0
	Open Water/Profundal (= Littoral)	163,846.1897	0.03	0	0	0	0	n/a	0	0.03	0	0	0	0	0	0
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878	0.03	0	0	0	0	n/a	0	0.03	0	0	0	0	0	0
	Open Water/Profundal (= Littoral)	118,361.4678	0.03	0	0	0	0	n/a	0	0.03	0	0	0	0	0	0

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 4: Cold + B: Non- Piscivore							Group 4: Cold + B: Non- Piscivore						
			Ninespine Stickleback HSI Factor Score (0 - 1)							Brook Stickleback HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0.013	0.5	0.5	0.25	0.5	n/a	0.4375	0.013	0.5	0.5	0.25	0.5	n/a	0.4375
	Open Water/Profundal (= Littoral)	163,846.1897	0.013	0.5	0.5	0.25	0.5	n/a	0.4375	0.013	0.5	0.5	0.25	0.5	n/a	0.4375
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878														
	Open Water/Profundal (= Littoral)	118,361.4678														

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 4: Cold + B: Non- Piscivore							Group 5: Cool + A1: Non-Piscivore						
			Mottled Sculpin HSI Factor Score (0 - 1)							blacknose dace						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0.013	0.5	0.5	0.25	0.5	n/a	0.4375	0	0	0	0	0	n/a	0
	Open Water/Profundal (= Littoral)	163,846.1897	0.013	0.5	0.5	0.25	0.5	n/a	0.4375	0	0	0	0	0	n/a	0
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878								0	0	0	0	0	n/a	0
	Open Water/Profundal (= Littoral)	118,361.4678								0	0	0	0	0	n/a	0

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
			Brassy Minnow HSI Factor Score (0 - 1)							Finescale Dace HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0	0	0	0	0	0	0	0.03	0.25	0.25	0.25	0.25	n/a	0.25
	Open Water/Profundal (= Littoral)	163,846.1897	0	0	0	0	0	0	0	0.03	0.25	0.25	0.25	0.25	n/a	0.25
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878	0	0	0	0	0	0	0							
	Open Water/Profundal (= Littoral)	118,361.4678	0	0	0	0	0	0	0							

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
			Redbelly Dace HSI Factor Score (0 - 1)							Golden Shiner HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0.03	0.25	0.25	0.25	0.25	0.5	0.3	0.03	0	0	0	0	n/a	0
	Open Water/Profundal (= Littoral)	163,846.1897	0.03	0.25	0.25	0.25	0.25	0.5	0.3	0.03	0	0	0	0	n/a	0
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
	Open Water/Profundal (= Littoral)	118,361.4678	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
			Longnose Dace HSI Factor Score (0 - 1)							White Sucker HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0.013	0	0	0	0	0	0	0.03	0.5	0.25	0.5	0.5	0	0.35
	Open Water/Profundal (= Littoral)	163,846.1897	0.013	0	0	0	0	0	0	0.03	0.5	0.25	0.5	0.5	0	0.35
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878	0.013	0	0	0	0	0	0	0.03	0.5	0.25	0.5	0.5	0	0.35
	Open Water/Profundal (= Littoral)	118,361.4678	0.013	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	0	0.4

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
			Iowa Darter HSI Factor Score (0 - 1)							Yellow Perch HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0.013	0.25	0.25	0.5	0.25	n/a	0.3125	0.04						
	Open Water/Profundal (= Littoral)	163,846.1897	0.013	0.25	0.25	0.5	0.25	n/a	0.3125							
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878	0.013	0.25	0.25	0.5	0.25	n/a	0.3125	0.04	0.5	0.25	0.5	0.5	n/a	0.4375
	Open Water/Profundal (= Littoral)	118,361.4678	0.013	0.25	0.25	0.5	0.25	n/a	0.3125	0.04	0.5	0.25	0.5	0.5	n/a	0.4375

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 6: Cool + A1: Piscivore							Group 6: Cool + A1: Piscivore						
			Yellow Walleye HSI Factor Score (0 - 1)							Northern Pike HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0.17	0	0	0	0	0	0	0.17						
	Open Water/Profundal (= Littoral)	163,846.1897	0.17	0	0	0	0	0	0							
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878	0.17	0	0	0	0	0	0	0.17	0.5	0.75	0.75	0.5	0.5	0.6
	Open Water/Profundal (= Littoral)	118,361.4678	0.17	0	0	0	0	0	0	0.17	0	0.5	0.75	0.5	0.5	0.45

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 7: Warm + A: Non-Piscivore							Group 7: Warm + A: Non-Piscivore						
			Blacknose Shiner HSI Factor Score (0 - 1)							Central Mudminnow HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0
	Open Water/Profundal (= Littoral)	163,846.1897	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878	0.013	0.5	0.5	0.5	0.5	n/a	0.5	0.013	0	0	0	0	0	0
	Open Water/Profundal (= Littoral)	118,361.4678	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 7: Warm + A: Non-Piscivore							Group 7: Warm + A: Non-Piscivore						
			Emerald Shiner HSI Factor Score (0 - 1)							Spottail Shiner HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0.03	0	0	0	0	0	0	0.03	0	0	0	0	0	0
	Open Water/Profundal (= Littoral)	163,846.1897	0.03	0	0	0	0	0	0	0.03	0	0	0	0	0	0
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878	0.03	0	0	0	0	0	0	0.03	0	0	0	0	0	0
	Open Water/Profundal (= Littoral)	118,361.4678	0.03	0	0	0	0	0	0	0.03	0	0	0	0	0	0

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 8: Warm + B: Non-Piscivore							Group 8: Warm + B: Non-Piscivore						
			Fathead Minnow HSI Factor Score (0 - 1)							Pumpkinseed HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0.03	0.25	0.25	0.25	0.25	n/a	0.25	0.013						
	Open Water/Profundal (= Littoral)	163,846.1897	0.03	0.25	0.25	0.25	0.25	n/a	0.25							
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878								0.013	0.5	0.5	0.5	0.5	n/a	0.5
	Open Water/Profundal (= Littoral)	118,361.4678								0.013	0	0.5	0.5	0.5	n/a	0.375

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 9: Warm + B: Piscivore											
			Smallmouth Bass HSI Factor Score (0 - 1)											
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Habitat Expansion Factor (<7 sp=4; 7-12=3; 13-18=2;>18=1)	Total Weighted Useable Area (HU)	Ecotype Productive Capacity Index	Ecotype Weighted Useable Area (HU)	
API 12 - Mitta s.a.= 172,737	Littoral (0 - 3 m)	8,891.417048	0.17	0	0	0	0	n/a	0	1	494.5850733	1	494.5850733	9,608.529
	Open Water/Profundal (= Littoral)	163,846.1897	0.17	0	0	0	0	n/a	0	1	9113.944302	1	9,113.944302	
API 2 s.a.= 124,351	Littoral (0 - 3 m)	5,989.703878	0.17	0	0	0	0	n/a	0	1	880.8608266	1	880.8608266	14,485.032
	Open Water/Profundal (= Littoral)	118,361.4678	0.17	0	0	0	0	n/a	0	1	13604.17121	1	13,604.17121	

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overall Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others, for example streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
No Net Loss Plan – Hdwater Pond Ecotype Habitat

			Group 2: Cold + A1 - Stream: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
			Pearl Dace HSI Factor Score (0 - 1)							Brassy Minnow HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 6	Littoral (1 - 3 m)	1,198.118891														
	Open Water/Profundal (> 3 m)	4,637.49105														
API 7	Littoral (1 - 3 m)	2,224.111416														
	Open Water/Profundal (> 3 m)	8,737.95333														
API 11	Littoral (1 - 3 m)	2,563.887351														
	Open Water/Profundal (> 3 m)	25,213.67332														
API 13	Littoral (1 - 3 m)	2,054.367803														
	Open Water/Profundal (> 3 m)	17,320.88549														
API 69	Littoral (1 - 3 m)	1,695.555	0.03	0.75	1	0.75	0.75	n/a	0.8125	0.015	0.75	1	0.75	0.75	0.75	1
	Open Water/Profundal (> 3 m)	8,175.904	0.03	0.75	1	0.75	0.75	n/a	0.8125	0.015	0.75	1	0.75	0.75	0.75	1
API 48	Littoral (1 - 3 m)	610.23														
	Open Water/Profundal (> 3 m)	1,440.95														
API 17	Littoral (1 - 3 m)	1,810.73779														
	Open Water/Profundal (> 3 m)	14,973.80087														

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
No Net Loss Plan – Hdwater Pond Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
			Finescale Dace HSI Factor Score (0 - 1)							Redbelly Dace HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 6	Littoral (1 - 3 m)	1,198.118891														
	Open Water/Profundal (> 3 m)	4,637.49105														
API 7	Littoral (1 - 3 m)	2,224.111416														
	Open Water/Profundal (> 3 m)	8,737.95333														
API 11	Littoral (1 - 3 m)	2,563.887351	0.03	0.25	0.75	0.75	1	-	0.6875	0.03	0.75	0.75	0.75	1	0.75	1
	Open Water/Profundal (> 3 m)	25,213.67332	0.03	0.25	0.75	0.75	1	-	0.6875	0.03	0.75	0.75	0.75	1	0.75	1
API 13	Littoral (1 - 3 m)	2,054.367803														
	Open Water/Profundal (> 3 m)	17,320.88549														
API 69	Littoral (1 - 3 m)	1,695.555	0.03	0.25	0.75	0.75	1	n/a	0.6875	0.03	0.75	0.75	0.75	1	0.75	1
	Open Water/Profundal (> 3 m)	8,175.904	0.03	0.25	0.75	0.75	1	n/a	0.6875	0.03	0.75	0.75	0.75	1	0.75	1
API 48	Littoral (1 - 3 m)	610.23														
	Open Water/Profundal (> 3 m)	1,440.95														
API 17	Littoral (1 - 3 m)	1,810.73779	0.03	0.25	0.75	0.75	1	n/a	0.6875	0.03	0.75	0.75	0.75	1	0.75	1
	Open Water/Profundal (> 3 m)	14,973.80087	0.03	0.25	0.75	0.75	1	n/a	0.6875	0.03	0.75	0.75	0.75	1	0.75	1

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
No Net Loss Plan – Hdwater Pond Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
			White Sucker HSI Factor Score (0 - 1)							Iowa Darter HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 6	Littoral (1 - 3 m)	1,198.118891														
	Open Water/Profundal (> 3 m)	4,637.49105														
API 7	Littoral (1 - 3 m)	2,224.111416														
	Open Water/Profundal (> 3 m)	8,737.95333														
API 11	Littoral (1 - 3 m)	2,563.887351														
	Open Water/Profundal (> 3 m)	25,213.67332														
API 13	Littoral (1 - 3 m)	2,054.367803														
	Open Water/Profundal (> 3 m)	17,320.88549														
API 69	Littoral (1 - 3 m)	1,695.555	0.015	0.25	0.25	0.25	0.25	-	0.25	0.015	0.75	0.75	0.75	0.75	n/a	0.75
	Open Water/Profundal (> 3 m)	8,175.904	0.015	0.25	0.25	0.25	0.25	-	0.25	0.015	0.75	0.75	0.75	0.75	n/a	0.75
API 48	Littoral (1 - 3 m)	610.23														
	Open Water/Profundal (> 3 m)	1,440.95														
API 17	Littoral (1 - 3 m)	1,810.73779														
	Open Water/Profundal (> 3 m)	14,973.80087														

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
No Net Loss Plan – Hdwater Pond Ecotype Habitat

			Group 7: Warm + A: Non-Piscivore							Group 7: Warm + A: Non-Piscivore						
			Blacknose Shiner HSI Factor Score (0 - 1)							Central Mudminnow HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 6	Littoral (1 - 3 m)	1,198.118891														
	Open Water/Profundal (> 3 m)	4,637.49105														
API 7	Littoral (1 - 3 m)	2,224.111416														
	Open Water/Profundal (> 3 m)	8,737.95333														
API 11	Littoral (1 - 3 m)	2,563.887351														
	Open Water/Profundal (> 3 m)	25,213.67332														
API 13	Littoral (1 - 3 m)	2,054.367803														
	Open Water/Profundal (> 3 m)	17,320.88549														
API 69	Littoral (1 - 3 m)	1,695.555	0.015	0.75	0.75	0.75	0.75	n/a	0.75	0.015	1	0.75	0.75	1	0.75	1.0625
	Open Water/Profundal (> 3 m)	8,175.904	0.015	0.75	0.75	0.75	0.75	n/a	0.75	0.015	1	0.75	0.75	1	0.75	1.0625
API 48	Littoral (1 - 3 m)	610.23														
	Open Water/Profundal (> 3 m)	1,440.95														
API 17	Littoral (1 - 3 m)	1,810.73779														
	Open Water/Profundal (> 3 m)	14,973.80087														

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
No Net Loss Plan – Hdwater Pond Ecotype Habitat

			Group 8: Warm + B: Non-Piscivore										
			Fathead Minnow HSI Factor Score (0 - 1)										
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Habitat Expansion Factor (<7 sp=4; 7-12=3; 13-18=2;>18=1)	Total Weighted Useable Area (HU)	Ecotype Productive Capacity Index	Ecotype Weighted Useable Area (HU)
API 6	Littoral (1 - 3 m)	1,198.118891								1	0	1	0
	Open Water/Profundal (> 3 m)	4,637.49105								1	0	1	0
API 7	Littoral (1 - 3 m)	2,224.111416								1	0	1	0
	Open Water/Profundal (> 3 m)	8,737.95333								1	0	1	0
API 11	Littoral (1 - 3 m)	2,563.887351	0.03	0.75	0.5	0.75	0.25	-	0.5625	1	173.0623962	1	173.0623962
	Open Water/Profundal (> 3 m)	25,213.67332	0.03	0.75	0.5	0.75	0.25	-	0.5625	1	1,701.922949	1	1,701.922949
API 13	Littoral (1 - 3 m)	2,054.367803								1	0	1	0
	Open Water/Profundal (> 3 m)	17,320.88549								1	0	1	0
API 69	Littoral (1 - 3 m)	1,695.555								1	224.1311766	1	224.1311766
	Open Water/Profundal (> 3 m)	8,175.904								1	1,080.75231	1	1,080.75231
API 48	Littoral (1 - 3 m)	610.23								1	0	1	0
	Open Water/Profundal (> 3 m)	1,440.95								1	0	1	0
API 17	Littoral (1 - 3 m)	1,810.73779	0.03	0.75	0.5	0.75	0.25	-	0.5625	1	122.2248008	1	122.2248008
	Open Water/Profundal (> 3 m)	14,973.80087	0.03	0.75	0.5	0.75	0.25	-	0.5625	1	1,010.731559	1	1,010.731559

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 6
No Net Loss Plan – Inlet Stream Ecotype Habitat

				Group 2: Cold + A1 - Stream: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
				Pearl Dace HSI Factor Score (0 - 1)							Brassy Minnow HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	Fish?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 1	Low gradient	y	894.13	0.03	0.75	0.5	0.25	0.5	n/a	0.5							
access to Sawbill	High gradient	-	0	0.03	0.75	0.5	0.25	0.5	n/a	0.5							
	pond	y	5,835.61	0.03	0.75	0.5	0.25	0.5	n/a	0.5							
API 6	Low gradient	y	437.212														
lower end accessible but no link to API 6 and 7	High gradient	-	0														
	pond	n	5,835.61														
API 14	Low gradient	n	86														
	Low gradient	y	280.32								0.015	0.75	0.75	0.5	0.75	0.75	0.7
	High gradient	n	70.62														
	High gradient	y	731.61								0.015	0.75	0.75	0.5	0.75	0.75	0.7
	pond	-	0								0.015	0.75	0.75	0.5	0.75	0.75	0.7
API 47	Low gradient	y	194.16	0.03	0.75	0.5	0.25	0.5	n/a	0.5							
	High gradient	y	568.27	0.03	0.75	0.5	0.25	0.5	n/a	0.5							
	pond	y	29,944.7	0.03	0.75	0.5	0.25	0.5	n/a	0.5							
API 8																	
API 10																	

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 6
No Net Loss Plan – Inlet Stream Ecotype Habitat

				Group 5: Cool + A1: Non-Piscivore Finescale Dace HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore Redbelly Dace HSi Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**Fish?**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**
API 1	Low gradient	y	894.13	0.03	0.5	0.25	0.25	0.25	n/a	0.3125							
access to Sawbill	High gradient	-	0	0.03	0.5	0.25	0.25	0.25	n/a	0.3125							
	pond	y	5,835.61	0.03	0.5	0.25	0.25	0.25	n/a	0.3125							
API 6	Low gradient	y	437.212														
lower end accessible but no link to API 6 and 7	High gradient	-	0														
	pond	n	5,835.61														
API 14	Low gradient	n	86														
	Low gradient	y	280.32	0.03	0.5	0.25	0.25	0.25	n/a	0.3125	0.03	0.25	0.5	0.25	0.75	0.5	0.45
	High gradient	n	70.62														
	High gradient	y	731.61	0.03	0.5	0.25	0.25	0.25	n/a	0.3125	0.03	0.25	0.5	0.25	0.75	0.5	0.45
	pond	-	0	0.03	0.5	0.25	0.25	0.25	n/a	0.3125	0.03	0.25	0.5	0.25	0.75	0.5	0.45
API 47	Low gradient	y	194.16	0.03	0.5	0.25	0.25	0.25	n/a	0.3125							
	High gradient	y	568.27	0.03	0.5	0.25	0.25	0.25	n/a	0.3125							
	pond	y	29,944.7	0.03	0.5	0.25	0.25	0.25	n/a	0.3125							
API 8																	
API 10																	

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 6
No Net Loss Plan – Inlet Stream Ecotype Habitat

				Group 5: Cool + A1: Non-Piscivore White Sucker HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore Iowa Darter HSi Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	Fish?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 1	Low gradient	y	894.13	0.03	1	0.75	0.5	0.5	1	0.75							
access to Sawbill	High gradient	-	0	0.015	1	0.75	0.5	0.5	1	0.75							
	pond	y	5,835.61	0.015	1	0.75	0.5	0.5	1	0.75							
API 6	Low gradient	y	437.212	0.015	1	0.75	0.5	0.5	1	0.75	0.013	0.5	0.75	0.75	0.25	n/a	0.5625
lower end accessible but no link to API 6 and 7	High gradient	-	0	0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.75	0.75	0.25	n/a	0.5625
	pond	n	5,835.61														
API 14	Low gradient	n	86														
	Low gradient	y	280.32	0.015	1	0.75	0.5	0.5	1	0.75							
	High gradient	n	70.62														
	High gradient	y	731.61	0.015	1	0.75	0.5	0.5	1	0.75							
	pond	-	0	0.015	1	0.75	0.5	0.5	1	0.75							
API 47	Low gradient	y	194.16														
	High gradient	y	568.27														
	pond	y	29,944.7														
API 8																	
API 10																	

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 6
No Net Loss Plan – Inlet Stream Ecotype Habitat

				Group 8: Warm + B: Non-Piscivore Fathead Minnow HSI Factor Score (0 - 1)										
API Number	**Habitat Unit Ref.**	**Fish?**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Habitat Expansion Factor (<7 sp=4; 7-12=3; 13-18=2;>18=1)**	**Total Weighted Useable Area (HU)**	**Ecotype Productive Capacity Index**	**Ecotype Weighted Useable Area (HU)**
API 1	Low gradient	y	894.13	0.03	1	0.75	0.25	0.75	n/a	0.6875	1	60.35378	2.5	150.8844375
access to Sawbill	High gradient	-	0	0.03	1	0.75	0.25	0.75	n/a	0.6875	1	0	2.5	0
	pond	y	5,835.61	0.03	1	0.75	0.25	0.75	n/a	0.6875	1	328.25306	2.5	820.6326563
API 6	Low gradient	y	437.212								1	8.11574775	2.5	20.28936938
lower end accessible but no link to API 6 and 7	High gradient	-	0								1	0	2.5	0
	pond	n	5,835.61								1	0	2.5	0
API 14	Low gradient	n	86								1	0	2.5	0
	Low gradient	y	280.32	0.03	1	0.75	0.25	0.75	n/a	0.6875	1	18.29088	2.5	45.7272
	High gradient	n	70.62								1	0	2.5	0
	High gradient	y	731.61	0.03	1	0.75	0.25	0.75	n/a	0.6875	1	47.7375525	2.5	119.3438813
	pond	-	0	0.03	1	0.75	0.25	0.75	n/a	0.6875	1	0	2.5	0
API 47	Low gradient	y	194.16								1	4.73265	2.5	11.831625
	High gradient	y	568.27								1	13.85158125	2.5	34.62895313
	pond	y	29,944.7								1	729.9020625	2.5	1,824.755156
API 8														
API 10														

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 7
No Net Loss Plan – Wmwater Ecotype Habitat

				Group 2: Cold + A1 - Stream: Non-Piscivore							Group 4: Cold + B: Non- Piscivore							Group 4: Cold + B: Non- Piscivore						
				Pearl Dace HSI Factor Score (0 - 1)							Ninespine Stickleback HSI Factor Score (0 - 1)							Brook Stickleback HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	Fish?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 1	Ponds	y	20,745.021	0.03	0.75	0.5	0.25	0.5	n/a	0.5														
	High gradient	y	165	0.03	0.75	0.5	0.25	0.5	n/a	0.5														
	Low gradient	y	2,026.22	0.03	0.75	0.5	0.25	0.5	n/a	0.5														
API 2	Ponds	y	3,808.79515																					
	High gradient	-	0																					
	Low gradient	y	2,217.84																					
API 6 lower end accessible but no link to API 6 and 7	**Low gradient**	**y**	**0**																					
	High gradient	**-**	**0**																					
	Pond	**n**	**0**																					
API 7	Ponds	n	721.138																					
	High gradient	n	0																					
	Low gradient	n	0																					
API 11	Low gradient	y	559.59																					
NO ACCESS	High gradient	y	227.44																					
	pond	y	1,030.51																					
API 13	Low gradient	n	307.72																					
NO ACCESS	High gradient	n	89.03																					
	pond	n	475.75																					
API 69	Low gradient	-	0	0.03	0.75	0.5	0.25	0.5	n/a	0.5														
NO ACCESS	High gradient	n	165.19																					
	pond	-	0	0.03	0.75	0.5	0.25	0.5	n/a	0.5														
API 12	Low gradient	y	84.99								0.013	0	0.75	0.5	0	n/a	0.3125	0.015	0	0.25	0.5	0.5	n/a	0.3125
NO ACCESS		n	67.95																					
	High gradient	y	272.56								0.013	0	0.75	0.5	0	n/a	0.3125	0.015	0	0.25	0.5	0.5	n/a	0.3125
		n	23.97																					
	pond	y	172,737.6067								0.013	0	0.75	0.5	0	n/a	0.3125	0.015	0	0.25	0.5	0.5	n/a	0.3125
API 48	Low gradient	n	131																					
	High gradient	n	298.77																					
	pond	n	10,198.92																					
API 10																								
API 14			—																					
API 47																								

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present)

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA

Ecotype Weighted Useable Area: t his is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 7
No Net Loss Plan – Wmwater Ecotype Habitat

				Group 4: Cold + B: Non- Piscivore							Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
				Mottled Sculpin HSI Factor Score (0 - 1)							Blacknose Dace HSI Factor Score (0 - 1)							Brassy Minnow HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	Fish?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 1	Ponds	y	20,745.021																					
	High gradient	y	165																					
	Low gradient	y	2,026.22																					
API 2	Ponds	y	3,808.79515								0.015	1	0.75	0.75	0.75	n/a	0.8125							
	High gradient	-	0								0.015	1	0.75	0.75	0.75	n/a	0.8125							
	Low gradient	y	2,217.84								0.015	1	0.75	0.75	0.75	n/a	0.8125							
API 6 lower end accessible but no link to API 6 and 7	**Low gradient**	**y**	**0**																					
	High gradient	**-**	**0**																					
	Pond	**n**	**0**																					
API 7	Ponds	n	721.138																					
	High gradient	n	0																					
	Low gradient	n	0																					
API 11	Low gradient	y	559.59																					
NO ACCESS	High gradient	y	227.44																					
	pond	y	1,030.51																					
API 13	Low gradient	n	307.72																					
NO ACCESS	High gradient	n	89.03																					
	pond	n	475.75																					
API 69	Low gradient	-	0								0.015	1	0.75	0.75	0.75	n/a	0.8125	0	0.75	0.75	0.5	0.75	0.75	0.7
NO ACCESS	High gradient	n	165.19																					
	pond	-	0								0.015	1	0.75	0.75	0.75	n/a	0.8125	0.015	0.75	0.75	0.5	0.75	0.75	0.7
API 12	Low gradient	y	84.99	0.015	0.5	0.75	0.75	0.75	n/a	0.6875														
NO ACCESS		n	67.95																					
	High gradient	y	272.56	0.015	0.5	0.75	0.75	0.75	n/a	0.6875														
		n	23.97																					
	pond	y	172,737.6067	0.015	0.5	0.75	0.75	0.75	n/a	0.6875														
API 48	Low gradient	n	131																					
	High gradient	n	298.77																					
	pond	n	10,198.92																					
API 10																								
API 14			—																					
API 47																								

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present)

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA

Ecotype Weighted Useable Area: t his is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 7
No Net Loss Plan – Wmwater Ecotype Habitat

				Group 5: Cool + A1: Non-Piscivore Finescale Dace HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore Redbelly Dace HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore White Sucker HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**Fish?**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**
API 1	Ponds	y	20,745.021	0.03	0.5	0.25	0.25	0.25	n/a	0.3125								0.03	1	0.75	0.5	0.5	1	0.75
	High gradient	y	165	0.03	0.5	0.25	0.25	0.25	n/a	0.3125								0.015	1	0.75	0.5	0.5	1	0.75
	Low gradient	y	2,026.22	0.03	0.5	0.25	0.25	0.25	n/a	0.3125								0.015	1	0.75	0.5	0.5	1	0.75
API 2	Ponds	y	3,808.79515															0.015	1	0.75	0.5	0.5	1	0.75
	High gradient	-	0															0.015	1	0.75	0.5	0.5	1	0.75
	Low gradient	y	2,217.84															0.015	1	0.75	0.5	0.5	1	0.75
API 6 lower end accessible but no link to API 6 and 7	**Low gradient**	**y**	**0**															**0.015**	1	0.75	0.5	0.5	1	0.75
	High gradient	**-**	**0**															**0.015**	1	0.75	0.5	0.5	1	0.75
	Pond	**n**	**0**															**0.015**	1	0.75	0.5	0.5	1	0.75
API 7	Ponds	n	721.138																					
	High gradient	n	0																					
	Low gradient	n	0																					
API 11	Low gradient	y	559.59	0.03	0.5	0.25	0.25	0.25	n/a	0.3125	0.03	0.25	0.5	0.25	0.75	0.5	0.45							
NO ACCESS	High gradient	y	227.44	0.03	0.5	0.25	0.25	0.25	n/a	0.3125	0.03	0.25	0.5	0.25	0.75	0.5	0.45							
	pond	y	1,030.51	0.03	0.5	0.25	0.25	0.25	n/a	0.3125	0.03	0.25	0.5	0.25	0.75	0.5	0.45							
API 13	Low gradient	n	307.72																					
NO ACCESS	High gradient	n	89.03																					
	pond	n	475.75																					
API 69	Low gradient	-	0	0.03	0.5	0.25	0.25	0.25	n/a	0.3125	0.03	0.25	0.5	0.25	0.75	0.5	0.45	0.015	1	0.75	0.5	0.5	1	0.75
NO ACCESS	High gradient	n	165.19																					
	pond	-	0	0.03	0.5	0.25	0.25	0.25	n/a	0.3125	0.03	0.25	0.5	0.25	0.75	0.5	0.45	0.015	1	0.75	0.5	0.5	1	0.75
API 12	Low gradient	y	84.99	0.03	0.5	0.25	0.25	0.25	n/a	0.3125								0.015	1	0.75	0.5	0.5	1	0.75
NO ACCESS		n	67.95																					
	High gradient	y	272.56	0.03	0.5	0.25	0.25	0.25	n/a	0.3125								0.015	1	0.75	0.5	0.5	1	0.75
		n	23.97																					
	pond	y	172,737.6067	0.03	0.5	0.25	0.25	0.25	n/a	0.3125								0.015	1	0.75	0.5	0.5	1	0.75
API 48	Low gradient	n	131																					
	High gradient	n	298.77																					
	pond	n	10,198.92	0.03	0.5	0.25	0.25	0.25	n/a	0.3125														
API 10																								
API 14			—																					
API 47																								

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present)

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA

Ecotype Weighted Useable Area: t his is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 7
No Net Loss Plan – Wmwater Ecotype Habitat

				Group 5: Cool + A1: Non-Piscivore Iowa Darter HSI Factor Score (0 - 1)							Group 6: Cool + A1: Piscivore Northern Pike HSI Factor Score (0 - 1)							Group 7: Warm + A: Non-Piscivore Central Mudminnow HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**Fish?**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**
API 1	Ponds	y	20,745.021																					
	High gradient	y	165																					
	Low gradient	y	2,026.22																					
API 2	Ponds	y	3,808.79515	0.015	0.5	0.5	0.5	0.25	n/a	0.4375	0.17	0.5	0.5	0.5	0.5	0.75	0.55							
	High gradient	-	0	0.015	0.5	0.5	0.5	0.25	n/a	0.4375	0.17	0.5	0.5	0.5	0.5	0.75	0.55							
	Low gradient	y	2,217.84	0.015	0.5	0.5	0.5	0.25	n/a	0.4375	0.17	0.5	0.5	0.5	0.5	0.75	0.55							
API 6 lower end accessible but no link to API 6 and 7	**Low gradient**	**y**	**0**	**0.015**	0.5	0.5	0.5	0.25	n/a	0.4375														
	High gradient	**-**	**0**	**0.015**	0.5	0.5	0.5	0.25	n/a	0.4375														
	Pond	**n**	**0**	**0.015**	0.5	0.5	0.5	0.25	n/a	0.4375														
API 7	Ponds	n	721.138																					
	High gradient	n	0																					
	Low gradient	n	0																					
API 11	Low gradient	y	559.59																					
NO ACCESS	High gradient	y	227.44																					
	pond	y	1,030.51																					
API 13	Low gradient	n	307.72																					
NO ACCESS	High gradient	n	89.03																					
	pond	n	475.75																					
API 69	Low gradient	-	0	0.015	0.5	0.5	0.5	0.25	n/a	0.4375								0.015	0.25	0.5	0.5	0	0.75	0.4
NO ACCESS	High gradient	n	165.19																					
	pond	-	0	0.015	0.5	0.5	0.5	0.25	n/a	0.4375								0.015	0.25	0.5	0.5	0	0.75	0.4
API 12	Low gradient	y	84.99	0.015	0.5	0.5	0.5	0.25	n/a	0.4375														
NO ACCESS		n	67.95																					
	High gradient	y	272.56	0.015	0.5	0.5	0.5	0.25	n/a	0.4375														
		n	23.97																					
	pond	y	172,737.6067	0.015	0.5	0.5	0.5	0.25	n/a	0.4375														
API 48	Low gradient	n	131																					
	High gradient	n	298.77																					
	pond	n	10,198.92																					
API 10																								
API 14			—																					
API 47																								

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present)

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA

Ecotype Weighted Useable Area: t his is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 7
No Net Loss Plan – Wmwater Ecotype Habitat

				Group 8: Warm + B: Non-Piscivore Fathead Minnow HSI Factor Score (0 - 1)							Group 8: Warm + B: Non-Piscivore Pumpkinseed HSI Factor Score (0 - 1)										
API Number	**Habitat Unit Ref.**	**Fish?**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/ Summer Refuge**	**Migration**	**HU Score**	**Habitat Expansion Factor (<7 sp=4; 7-12=3; 13-18=2;>18=1)**	**Total Weighted Useable Area (HU)**	**Ecotype Productive Capacity Index**	**Ecotype Weighted Useable Area (HU)**
API 1	Ponds	y	20,745.021	0.03	0.75	0.5	0.75	0.25	n/a	0.5625								1	1,322.495089	2.5	3,306.237722
	High gradient	y	165	0.03	0.75	0.5	0.75	0.25	n/a	0.5625								1	8.6625	2.5	21.65625
	Low gradient	y	2,026.22	0.03	0.75	0.5	0.75	0.25	n/a	0.5625								1	106.37655	2.5	265.941375
API 2	Ponds	y	3,808.79515								0.013	0.5	0.5	0.5	0.5	n/a	0.5	1	495.1433695	2.5	1237.858424
	High gradient	-	0								0.03	0.5	0.5	0.5	0.5	n/a	0.5	1	0	2.5	0
	Low gradient	y	2,217.84								0.03	0.5	0.5	0.5	0.5	n/a	0.5	1	307.17084	2.5	767.9271
API 6 lower end accessible but no link to API 6 and 7	**Low gradient**	**y**	**0**															1	0	2.5	0
	High gradient	**-**	**0**															1	0	2.5	0
	Pond	**n**	**0**															1	0	2.5	0
API 7	Ponds	n	721.138															1	0	2.5	0
	High gradient	n	0															1	0	2.5	0
	Low gradient	n	0															1	0	2.5	0
API 11	Low gradient	y	559.59															1	12.80062125	2.5	32.00155313
NO ACCESS	High gradient	y	227.44															1	5.20269	2.5	13.006725
	pond	y	1,030.51															1	23.57291625	2.5	58.93229063
API 13	Low gradient	n	307.72															1	0	2.5	0
NO ACCESS	High gradient	n	89.03															1	0	2.5	0
	pond	n	475.75															1	0	2.5	0
API 69	Low gradient	-	0															1	0	2.5	0
NO ACCESS	High gradient	n	165.19															1	0	2.5	0
	pond	-	0															1	0	2.5	0
API 12	Low gradient	y	84.99	0.03	0.75	0.5	0.75	0.25	n/a	0.5625								1	5.36499375	2.5	13.41248438
NO ACCESS		n	67.95															1	0	2.5	0
	High gradient	y	272.56	0.03	0.75	0.5	0.75	0.25	n/a	0.5625								1	17.20535	2.5	43.013375
		n	23.97															1	0	2.5	0
	pond	y	172,737.6067	0.03	0.75	0.5	0.75	0.25	n/a	0.5625								1	10,904.06142	2.5	27260.15356
API 48	Low gradient	n	131															1	0	2.5	0
	High gradient	n	298.77															1	0	2.5	0
	pond	n	10,198.92															1	95.614875	2.5	239.0371875
API 10																		1	0	2.5	0
API 14			—																		
API 47																					

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present)

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA

Ecotype Weighted Useable Area: t his is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 8
No Net Loss Plan – Intermt Stream Ecotype Habitat

				Group 1: Cold + A1 - Lake: Non-Pisc							Group 1: Cold + A1 - Lake: Non-Piscivore						
				Lake Whitefish HSI Factor Score (0 - 1)							Lake Ciscoe HSi Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	Fish within segment?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 1	ephemeral	y	613.18	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0
API 47	ephemeral	n	110.94														
API 48	ephemeral	n	123														
API 12	ephemeral	n	82.58														
	ephemeral	y	30.68														
API 6	ephemeral	n	1,003.71														

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present),

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 8
No Net Loss Plan – Intermt Stream Ecotype Habitat

				Group 2: Cold + A1 - Stream: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
				Pearl Dace HSI Factor Score (0 - 1)							Finescale Dace HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	Fish within segment?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 1	ephemeral	y	613.18	0.03	0.25	0.25	0.5	0.5	n/a	0.375	0.03	0.25	0.25	0.25	0.25	n/a	0.25
API 47	ephemeral	n	110.94														
API 48	ephemeral	n	123														
API 12	ephemeral	n	82.58														
	ephemeral	y	30.68								0.03	0.25	0.25	0.25	0.25	n/a	0.25
API 6	ephemeral	n	1,003.71														

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present),

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 8
No Net Loss Plan – Intermt Stream Ecotype Habitat

				Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
				Redbelly Dace HSi Factor Score (0 - 1)							White Sucker HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	Fish within segment?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 1	ephemeral	y	613.18								0.03	0.5	0.25	0.25	0.25	0.75	0.4
API 47	ephemeral	n	110.94														
API 48	ephemeral	n	123														
API 12	ephemeral	n	82.58														
	ephemeral	y	30.68	0.03	0.25	0.25	0.25	0.25	0	0.2							
API 6	ephemeral	n	1,003.71														

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present),

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 8
No Net Loss Plan – Intermt Stream Ecotype Habitat

				Group 5: Cool + A1: Non-Piscivore							Group 8: Warm + B: Non-Piscivore						
				Iowa Darter HSi Factor Score (0 - 1)							Fathead Minnow HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	Fish within segment?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
API 1	ephemeral	y	613.18								0.03	0.5	0.5	0.25	0.5	n/a	0.4375
API 47	ephemeral	n	110.94														
API 48	ephemeral	n	123														
API 12	ephemeral	n	82.58														
	ephemeral	y	30.68								0.03	0.5	0.5	0.25	0.5	n/a	0.4375
API 6	ephemeral	n	1,003.71														

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present),

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 8
No Net Loss Plan – Intermt Stream Ecotype Habitat

API Number	Habitat Unit Ref.	Fish within segment?	HA (m^2 or ha)	Habitat Expansion Factor (<7 sp=4; 7-12=3; 13-18=2;>18=1)	Total Weighted Useable Area (HU)	Ecotype Productive Capacity Index	Ecotype Weighted Useable Area (HU)
API 1	ephemeral	y	613.18	1	26.9032725	0.75	20.17745438
API 47	ephemeral	n	110.94	1	0	0.75	0
API 48	ephemeral	n	123	1	0	0.75	0
API 12	ephemeral	n	82.58	1	0	0.75	0
	ephemeral	y	30.68	1	0.816855	0.75	0.6126413
API 6	ephemeral	n	1,003.71	1	0	0.75	0

Note:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present),

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 9
No Net Loss Plan – Area and Length Calculations

API 1	Stream Segment	Type	Group	Category	Accessible?[a]	Fish presence?
1	5,463.13	IP3(1)	warm	pond	y	no
1	218.96	FL(2)	intermittant	ephemeral	y	assume no
1	634.901	IP3(2)	warm	pond	y	finescale dace, fathead minnow
1	369.49	FL(3)	warm	Low Gradient	y	finescale dace, fathead minnow
1	112.71	FL(1)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow
1	894.13	Sawbill Bay Inlet	inlet	Low Gradient	y	finescale dace, white sucker, burbot
1	145.62	FL(1)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow
1	5	RF(1)	warm	High Gradient	y	white sucker, finescale dace, fathead minnow
1	157	R3(1)	warm	High Gradient	y	white sucker, finescale dace, fathead minnow
1	42.43	FL(2)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow
1	7	culvert	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow
1	308.78	FL(1)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow
1	6,609.89	IP3(1)	warm	pond	y	white sucker, finescale dace, fathead minnow
1	33	FL(2)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow
1	3	CA(1)	warm	High Gradient	y	white sucker, finescale dace, fathead minnow
1	174.86	FL(3)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow
1	1,348.7	IP3(2)	warm	pond	y	white sucker, finescale dace, fathead minnow
1	224.73	FL(4)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow
1	483.91	(FL(1)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow
1	412.22	No defined channel	intermittant	Ephemeral	y	assume no
1	6,688.4	IP3(1)	warm	pond	y	white sucker, finescale dace, fathead minnow
1	123.69	FL(2)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow
2	5,989.703878	Lake	Lake	Littoral	y	pumpkinseed, yellow perch, northern pike, white sucker, Iowa darter, blacknose shiner
2	118,361.4678	Lake	Lake	Profundal	y	pumpkinseed, yellow perch, northern pike, white sucker, Iowa darter, blacknose shiner
2	1,979.84	FL(1)	warm	Low Gradient	y	central mudminnow
2	205.29	FL(2)	warm	Low Gradient	y	central mudminnow
2	3,808.79515	IP3(1)	warm	pond	y	central mudminnow
2	32.71	FL(1)	warm	Low Gradient	y	assume yes
6	418.2	FL(1)	inlet	Low Gradient	y	Iowa darter, white sucker
6	19.012	undefined on map	inlet	Low Gradient	y	assume no
6	1,003.71	No defined channel	intermittant	Ephemeral	n	No
6	5,835.61	pond	headwater	pond	n	no
7	10,962.06472	lake	headwater	lake	?	No
7	721.138	IP3(1)	warm	pond	n	No
7		IP3(2)	warm	pond	n	No
7		IP3(3)	warm	pond	n	No
7		IP3(4)	warm	pond	n	No
7		IP3(5)	warm	pond	n	No
7		IP3(6)	warm	pond	n	No
11	4	CA(1)	inlet	High Gradient	n	finescale dace, northern redbelly dace
11	20	IP3(1)	inlet	Low Gradient	n	finescale dace, northern redbelly dace
11	13	CA(2)	inlet	High Gradient	n	finescale dace, northern redbelly dace
11	70.82	FL(1)	inlet	Low Gradient	n	finescale dace, northern redbelly dace
11	82.8	CA(3)	inlet	High Gradient	n	finescale dace, northern redbelly dace
11	67.47	R3(1)	inlet	High Gradient	n	finescale dace, northern redbelly dace
11	29.87	CA(4)	inlet	High Gradient	n	finescale dace, northern redbelly dace
11	697.97	IP3(2)	inlet	Pond	n	finescale dace, northern redbelly dace
11	224.15	FL(2)	inlet	Low Gradient	n	finescale dace, northern redbelly dace
11	30.3	CA(5)	inlet	High Gradient	n	finescale dace, northern redbelly dace
11	30	FL(3)	inlet	Low Gradient	n	finescale dace, northern redbelly dace
11	52.48	IP3(3)	inlet	Low Gradient	n	finescale dace, northern redbelly dace
11	332.54	IP3(4)	inlet	Pond	n	finescale dace, northern redbelly dace
11	86.73	FL(4)	inlet	Low Gradient	n	finescale dace, northern redbelly dace
11	75.41	IP3(5)	inlet	Low Gradient	n	finescale dace, northern redbelly dace
11	2,563.887351	Lake	headwater	Littoral	y	finescale dace, northern redbelly dace, fathead minnow
11	25,213.67332	Lake	headwater	Profundal	y	finescale dace, northern redbelly dace, fathead minnow

Sum of Stream Segment			
		y	731.61
47	Ephemeral	n	110.94
	High Gradient	y	568.27
	Low Gradient	y	194.16
	Pond	y	29,944.7
69	High Gradient	n	165.19
Sawbill Bay	full	y	1,326,955.8
	littoral	y	241,200.0548
	Profundal	y	13,028,357.95
Lynxhead Bay	full	y	2,002,001.007
	littoral	y	46,827.33063
	Profundal	y	1,955,173.746
Lizard Lake	full	y	1,929,688.223
	littoral	y	66,600.197
	Profundal	y	1,863,088.026
13	High Gradient	n	89.03
	Low Gradient	n	307.72
	Pond	n	475.75
	full	n	19,375.25329
	littoral	n	2,054.367803
	Profundal	n	17,320.88549
12	Ephemeral	n	82.58
	High Gradient	n	23.97
		y	272.56
	Low Gradient	n	67.95
		y	84.99
	Pond	y	
	full	y	172,737.6067
	littoral	y	8,891.417048
	Profundal	y	163,846.1897
2	Low Gradient	y	2,217.84
	Pond	y	3,808.79515
	full	y	124,351.17
	littoral	y	5,989.703878
	Profundal	y	118,361.4678
7	Pond	n	
	lake	?	10,962.06472
48	Ephemeral	n	123
	High Gradient	n	298.77
	Low Gradient	n	131
17	littoral	(blank)	1,810.7399
	Profundal	(blank)	14,973.80087
Grand Total			**23,259,715.65**

Note:
(a) Y or N determined by barriers to fish movement as per Jay Dickinson (cascades, subsurface flow etc).

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 10
No Net Loss Plan –
TMA and WRST Impact Watercourses

API	Reach	Area of fish-bearing waters (m^2)	Fish species present
TMA impacted watercourses			
1	1-1	1,592.4	White Sucker
			Finescale Dace
			Fathead Minnow
			Burbot
	1-2	204.07	White Sucker
			Fathead Minnow
			Finescale Dace
	1-3	1,250.45	Finescale Dace
			Fathead Minnow
47	47-1	1,196.14	Finescale Dace
			Pearl Dace
			Northern Redbelly Dace
2	2-1	124,351.1717	Pumpkinseed
			Yellow Perch
			Northern Pike
			White Sucker
			Iowa Darter
			Blacknose Dace
	2-2	249.72	Central Mudminnow
6	6-1	523.39	Iowa Darter
			White Sucker
Waste Rock Stockpile impacted watercourses			
11	11-1	27,777.56067	Finescale Dace
			Northern Redbelly Dace
			Fathead Minnow
	11-2	154.56	Finescale Dace
			Northern Redbelly Dace

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 11
No Net Loss Plan – Hab. Comp. Headwater Ponds

			Group 1: Cold + A1 - Lake: Non-Pisc							Group 1: Cold + A1 - Lake: Non-Piscivore							Group 2: Cold + A1 - Stream: Non-Piscivore						
			Lake Whitefish HSI Factor Score (0 - 1)							Lake Ciscoe HSI Factor Score (0 - 1)							Pearl Dace HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
Template	Littoral (0 - 3 m)	8,891.417048	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
API 10 s.a.= 13881	Littoral (0 - 3 m)	6,763	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	7,118	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
API 16 s.a.= 6142	Littoral (0 - 3 m)	5,032	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	1,109	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
API 44 s.a.= 8039	Littoral (0 - 3 m)	3,652	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	4,387	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
API 43 s.a.= 28954	Littoral (0 - 3 m)	13,826	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	15,128	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
BM #3 (API 14) s.a.= 33163	Littoral (0 - 3 m)	17,263	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	15,900	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
BM #2 s.a.= 33163	Littoral (0 - 3 m)	38,120	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	37,000	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
BM #1 s.a.= 33163	Littoral (0 - 3 m)	24,176	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	24,000	0.04	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0

Note:
Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 11
No Net Loss Plan – Hab. Comp. Headwater Ponds

			Group 3: Cold + A1 - Stream: Piscivore							Group 4: Cold + B: Non- Piscivore							Group 4: Cold + B: Non- Piscivore						
			Burbot HSI Factor Score (0 - 1)							Ninespine Stickleback HSI Factor Score (0 - 1)							Brook Stickleback HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
Template	Littoral (0 - 3 m)	8,891.417048	0.03	0	0	0	0	0	0	0.013	0.5	0.5	0.25	0.5	n/a	0.4375	0.013	0.5	0.5	0.25	0.5	n/a	0.4375
API 10 s.a.= 13881	Littoral (0 - 3 m)	6,763	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	7,118	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
API 16 s.a.= 6142	Littoral (0 - 3 m)	5,032	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	1,109	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
API 44 s.a.= 8039	Littoral (0 - 3 m)	3,652	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	4,387	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
API 43 s.a.= 28954	Littoral (0 - 3 m)	13,826	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	15,128	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
BM #3 (API 14) s.a.= 33163	Littoral (0 - 3 m)	17,263	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	15,900	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
BM #2 s.a.= 33163	Littoral (0 - 3 m)	38,120	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	37,000	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
BM #1 s.a.= 33163	Littoral (0 - 3 m)	24,176	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	24,000	0.03	0	0	0	0	0	0	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	n/a	0

Note:
Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 11
No Net Loss Plan – Hab. Comp. Headwater Ponds

			Group 4: Cold + B: Non- Piscivore							Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
			Mottled Sculpin HSI Factor Score (0 - 1)							Blacknose Dace HSI Factor Score (0 - 1)							Brassy Minnow HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
Template	Littoral (0 - 3 m)	8,891.417048	0.013	0.5	0.5	0.25	0.5	n/a	0.4375	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
API 10 s.a.= 13881	Littoral (0 - 3 m)	6,763	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	7,118	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
API 16 s.a.= 6142	Littoral (0 - 3 m)	5,032	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	1,109	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
API 44 s.a.= 8039	Littoral (0 - 3 m)	3,652	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	4,387	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
API 43 s.a.= 28954	Littoral (0 - 3 m)	13,826	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	15,128	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
BM #3 (API 14) s.a.= 33163	Littoral (0 - 3 m)	17,263	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	15,900	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
BM #2 s.a.= 33163	Littoral (0 - 3 m)	38,120	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	37,000	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
BM #1 s.a.= 33163	Littoral (0 - 3 m)	24,176	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	24,000	0.013	0	0	0	0	n/a	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0

Note:
Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 11
No Net Loss Plan – Hab. Comp. Headwater Ponds

			Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
			Finescale Dace HSI Factor Score (0 - 1)							Redbelly Dace HSI Factor Score (0 - 1)							Golden Shiner HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
Template	Littoral (0 - 3 m)	8,891.417048	0.03	0.25	0.25	0.25	0.25	n/a	0.25	0.03	0.25	0.25	0.25	0.25	0.5	0.3	0.03	0	0	0	0	n/a	0
API 10 s.a.= 13881	Littoral (0 - 3 m)	6,763	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.03	0.5	0.5	0.5	0.5	0.5	0.5	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	7,118	0.03	0	0	0	0	n/a	0	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
API 16 s.a.= 6142	Littoral (0 - 3 m)	5,032	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.03	0.5	0.5	0.5	0.5	0.5	0.5	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	1,109	0.03	0	0	0	0	n/a	0	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
API 44 s.a.= 8039	Littoral (0 - 3 m)	3,652	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.03	0.5	0.5	0.5	0.5	0.5	0.5	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	4,387	0.03	0	0	0	0	n/a	0	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
API 43 s.a.= 28954	Littoral (0 - 3 m)	13,826	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.03	0.5	0.5	0.5	0.5	0.5	0.5	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	15,128	0.03	0	0	0	0	n/a	0	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
BM #3 (API 14) s.a.= 33163	Littoral (0 - 3 m)	17,263	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.03	0.5	0.5	0.5	0.5	0.5	0.5	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	15,900	0.03	0	0	0	0	n/a	0	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
BM #2 s.a.= 33163	Littoral (0 - 3 m)	38,120	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.03	0.5	0.5	0.5	0.5	0.5	0.5	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	37,000	0.03	0	0	0	0	n/a	0	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
BM #1 s.a.= 33163	Littoral (0 - 3 m)	24,176	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.03	0.5	0.5	0.5	0.5	0.5	0.5	0.03	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	24,000	0.03	0	0	0	0	n/a	0	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0

Note:
Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 11
No Net Loss Plan – Hab. Comp. Headwater Ponds

			Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
			Longnose Dace HSI Factor Score (0 - 1)							White Sucker HSI Factor Score (0 - 1)							Iowa Darter HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
Template	Littoral (0 - 3 m)	8,891.417048	0.013	0	0	0	0	0	0	0.03	0.5	0.25	0.5	0.5	0	0.35	0.013	0.25	0.25	0.5	0.25	n/a	0.3125
API 10 s.a.= 13881	Littoral (0 - 3 m)	6,763	0.013	0	0	0	0	0	0	0.03	0.5	0.25	0.5	0.5	0	0.35	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	7,118	0.013	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	0	0.4	0.013	0	0	0	0	n/a	0
API 16 s.a.= 6142	Littoral (0 - 3 m)	5,032	0.013	0	0	0	0	0	0	0.03	0.5	0.25	0.5	0.5	0	0.35	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	1,109	0.013	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	0	0.4	0.013	0	0	0	0	n/a	0
API 44 s.a.= 8039	Littoral (0 - 3 m)	3,652	0.013	0	0	0	0	0	0	0.03	0.5	0.25	0.5	0.5	0	0.35	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	4,387	0.013	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	0	0.4	0.013	0	0	0	0	n/a	0
API 43 s.a.= 28954	Littoral (0 - 3 m)	13,826	0.013	0	0	0	0	0	0	0.03	0.5	0.25	0.5	0.5	0	0.35	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	15,128	0.013	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	0	0.4	0.013	0	0	0	0	n/a	0
BM #3 (API 14) s.a.= 33163	Littoral (0 - 3 m)	17,263	0.013	0	0	0	0	0	0	0.03	0.5	0.25	0.5	0.5	0	0.35	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	15,900	0.013	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	0	0.4	0.013	0	0	0	0	n/a	0
BM #2 s.a.= 33163	Littoral (0 - 3 m)	38,120	0.013	0	0	0	0	0	0	0.03	0.5	0.25	0.5	0.5	0	0.35	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	37,000	0.013	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	0	0.4	0.013	0	0	0	0	n/a	0
BM #1 s.a.= 33163	Littoral (0 - 3 m)	24,176	0.013	0	0	0	0	0	0	0.03	0.5	0.25	0.5	0.5	0	0.35	0.013	0	0	0	0	n/a	0
	Open Water/ Profundal (= Littoral)	24,000	0.013	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	0	0.4	0.013	0	0	0	0	n/a	0

Note:
Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 11
No Net Loss Plan – Hab. Comp. Headwater Ponds

			Group 5: Cool + A1: Non-Piscivore							Group 6: Cool + A1: Piscivore							Group 6: Cool + A1: Piscivore						
			Yellow Perch HSI Factor Score (0 - 1)							Yellow Walleye HSI Factor Score (0 - 1)							Northern Pike HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
Template	Littoral (0 - 3 m)	8,891.417048	0.04					n/a	0	0.17	0	0	0	0	0	0	0.17						0
API 10 s.a.= 13881	Littoral (0 - 3 m)	6,763	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	7,118	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
API 16 s.a.= 6142	Littoral (0 - 3 m)	5,032	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	1,109	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
API 44 s.a.= 8039	Littoral (0 - 3 m)	3,652	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	4,387	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
API 43 s.a.= 28954	Littoral (0 - 3 m)	13,826	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	15,128	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
BM #3 (API 14) s.a.= 33163	Littoral (0 - 3 m)	17,263	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	15,900	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
BM #2 s.a.= 33163	Littoral (0 - 3 m)	38,120	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	37,000	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
BM #1 s.a.= 33163	Littoral (0 - 3 m)	24,176	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	24,000	0.04	0	0	0	0	n/a	0	0.17	0	0	0	0	0	0	0.17	0	0	0	0	0	0

Note:
Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 11
No Net Loss Plan – Hab. Comp. Headwater Ponds

			Group 7: Warm + A: Non-Piscivore							Group 7: Warm + A: Non-Piscivore							Group 7: Warm + A: Non-Piscivore						
			Blacknose Shiner HSI Factor Score (0 - 1)							Central Mudminnow HSI Factor Score (0 - 1)							Emerald Shiner HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
Template	Littoral (0 - 3 m)	8,891.417048	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
API 10 s.a.= 13881	Littoral (0 - 3 m)	6,763	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	7,118	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
API 16 s.a.= 6142	Littoral (0 - 3 m)	5,032	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	1,109	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
API 44 s.a.= 8039	Littoral (0 - 3 m)	3,652	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	4,387	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
API 43 s.a.= 28954	Littoral (0 - 3 m)	13,826	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	15,128	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
BM #3 (API 14) s.a.= 33163	Littoral (0 - 3 m)	17,263	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	15,900	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
BM #2 s.a.= 33163	Littoral (0 - 3 m)	38,120	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	37,000	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
BM #1 s.a.= 33163	Littoral (0 - 3 m)	24,176	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0
	Open Water/ Profundal (= Littoral)	24,000	0.013	0	0	0	0	n/a	0	0.013	0	0	0	0	0	0	0.03	0	0	0	0	0	0

Note:
Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 11
No Net Loss Plan – Hab. Comp. Headwater Ponds

			Group 7: Warm + A: Non-Piscivore							Group 8: Warm + B: Non-Piscivore							Group 8: Warm + B: Non-Piscivore						
			Spottail Shiner HSI Factor Score (0 - 1)							Fathead Minnow HSI Factor Score (0 - 1)							Pumpkinseed HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
Template	Littoral (0 - 3 m)	8,891.417048	0.03	0	0	0	0	0	0	0.03	0.25	0.25	0.25	0.25	n/a	0.25	0.013					n/a	0
API 10 s.a.= 13881	Littoral (0 - 3 m)	6,763	0.03	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.013	0.5	0.5	0.5	0.5	n/a	0.5
	Open Water/ Profundal (= Littoral)	7,118	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0	0.013	0	0.5	0.5	0.5	n/a	0.375
API 16 s.a.= 6142	Littoral (0 - 3 m)	5,032	0.03	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.013	0.5	0.5	0.5	0.5	n/a	0.5
	Open Water/ Profundal (= Littoral)	1,109	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0	0.013	0	0.5	0.5	0.5	n/a	0.375
API 44 s.a.= 8039	Littoral (0 - 3 m)	3,652	0.03	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.013	0.5	0.5	0.5	0.5	n/a	0.5
	Open Water/ Profundal (= Littoral)	4,387	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0	0.013	0	0.5	0.5	0.5	n/a	0.375
API 43 s.a.= 28954	Littoral (0 - 3 m)	13,826	0.03	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.013	0.5	0.5	0.5	0.5	n/a	0.5
	Open Water/ Profundal (= Littoral)	15,128	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0	0.013	0	0.5	0.5	0.5	n/a	0.375
BM #3 (API 14) s.a.= 33163	Littoral (0 - 3 m)	17,263	0.03	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.013	0.5	0.5	0.5	0.5	n/a	0.5
	Open Water/ Profundal (= Littoral)	15,900	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0	0.013	0	0.5	0.5	0.5	n/a	0.375
BM #2 s.a.= 33163	Littoral (0 - 3 m)	38,120	0.03	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.013	0.5	0.5	0.5	0.5	n/a	0.5
	Open Water/ Profundal (= Littoral)	37,000	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0	0.013	0	0.5	0.5	0.5	n/a	0.375
BM #1 s.a.= 33163	Littoral (0 - 3 m)	24,176	0.03	0	0	0	0	0	0	0.03	0.5	0.5	0.5	0.5	n/a	0.5	0.013	0.5	0.5	0.5	0.5	n/a	0.5
	Open Water/ Profundal (= Littoral)	24,000	0.03	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0	0.013	0	0.5	0.5	0.5	n/a	0.375

Note:
Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 11
No Net Loss Plan – Hab. Comp. Headwater Ponds

			Group 9: Warm + B: Piscivore											
			Smallmouth Bass HSI Factor Score (0 - 1)											
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Habitat Expansion Factor (<7 sp=4; 7-12=3; 13-18=2;>18=1)	Total Weighted Useable Area (HU)	Ecotype Productive Capacity Index	Ecotype Weighted Useable Area (HU)	
Template	Littoral (0 - 3 m)	8,891.417048	0.17	0	0	0	0	n/a	0	1	494.5850733	1	494.5851	
API 10 s.a.= 13881	Littoral (0 - 3 m)	6,763	0.17	0	0	0	0	n/a	0	1	419.306	1	419.306	
	Open Water/ Profundal (= Littoral)	7,118	0.17	0	0	0	0	n/a	0	1	120.11625	1	120.11625	
API 16 s.a.= 6142	Littoral (0 - 3 m)	5,032	0.17	0	0	0	0	n/a	0	1	311.984	1	311.98	
	Open Water/ Profundal (= Littoral)	1,109	0.17	0	0	0	0	n/a	0	1	18.714375	1	18.714375	
API 44 s.a.= 8039	Littoral (0 - 3 m)	3,652	0.17	0	0	0	0	n/a	0	1	226.424	1	226.424	
	Open Water/ Profundal (= Littoral)	4,387	0.17	0	0	0	0	n/a	0	1	74.030625	1	74.030625	
API 43 s.a.= 28954	Littoral (0 - 3 m)	13,826	0.17	0	0	0	0	n/a	0	1	857.212	1	857.212	
	Open Water/ Profundal (= Littoral)	15,128	0.17	0	0	0	0	n/a	0	1	255.285	1	255.285	
BM #3 (API 14) s.a.= 33163	Littoral (0 - 3 m)	17,263	0.17	0	0	0	0	n/a	0	1	1070.306	1	1,070.306	
	Open Water/ Profundal (= Littoral)	15,900	0.17	0	0	0	0	n/a	0	1	268.3125	1	268.3125	
BM #2 s.a.= 33163	Littoral (0 - 3 m)	38,120	0.17	0	0	0	0	n/a	0	1	2363.44	1	2,363.44	
	Open Water/ Profundal (= Littoral)	37,000	0.17	0	0	0	0	n/a	0	1	624.375	1	624.375	
BM #1 s.a.= 33163	Littoral (0 - 3 m)	24,176	0.17	0	0	0	0	n/a	0	1	1498.912	1	1,498.912	
	Open Water/ Profundal (= Littoral)	24,000	0.17	0	0	0	0	n/a	0	1	405	1	405	8,513.418

Note:
Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present - scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score. It recognizes that some habitats are more productive per unit area than others. For example, streams are more productive than lakes.

APPENDIX D

Winter Dissolved Oxygen Measurements

December 2013
Report No. 13-1118-0010 (DOC028)

Golder Associates

Table of Contents

API 2 ..... **5**

API 5 ..... **5**

API 8 ..... **5**

API 10 ..... **6**

API 12 – MITTA LAKE **7**

API 16 ..... **9**

API 43 ..... **9**

API 44 ..... **10**

API 46 ..... **10**

API 47 ..... **11**

TABLES

Table 1: API 2 Water Quality Profile 5

Table 2: API 5 Water Quality Profile 5

Table 3: API 8 Water Quality Profile 6

Table 4: API 10 Water Quality Profile 6

Table 5: API 12 (Mitta Lake) Water Quality Profile 7

Table 6: API 16 Water Quality Profile 9

Table 7: API 43 Water Quality Profile 9

Table 8: API 44 Water Quality Profile 10

Table 9: API 46 Water Quality Profile 11

Table 10: API 47 Water Quality Profile 11

FIGURES

Figure 1: Location of Fishless Ponds 3

Page left intentionally blank

WINTER DISSOLVED OXYGEN MEASUREMENTS

Osisko Mining Corporation (Osisko) is presently evaluating a number of potential fish habitat compensation initiatives at their Hammond Reef Property (the Property) near Atikokan, Ontario. Fish habitat compensation will be required at the Property in order to offset potential habitat alterations and losses that would occur with the development of the Hammond Reef gold deposit.

Osisko environmental staff recently completed a series of late winter water quality profiles to evaluate dissolved oxygen levels in several small fishless ponds and lakes within the Mine Study Area that are being considered for fish introductions. For comparative purposes several nearby similar sized waterbodies that contain fish were also monitored. The objective of the monitoring is to help determine the suitability of the fishless waterbodies for possible fish introductions.

Water quality profiles were completed during ice covered conditions between the dates of April 18 and April 25, 2013. A Yellow Springs Instruments (YSI) model 556 multi-meter was used to measure water temperature, dissolved oxygen, pH and conductivity at approximately 1m intervals from just below the ice to just above bottom.

Monitoring locations are provided in Figure 1, results of the water quality profiles are provided in the tables below.

WINTER DISSOLVED OXYGEN MEASUREMENTS

Page left intentionally blank

610000 620000 630000

5430000

5420000

N

Serpent Lake

Cornell Lake

Sawbill Bay

Mitta Lake

Lynxhead Bay

Marmion Reservoir

Hawk Bay

Upper Seine Bay

Light Lake

1 2 3 4 5 6 7 10 16 43 44

LEGEND

- Additional Habitat Compensation Projects
- Pond Creation
- Fish Introduction
- Watercrossing Enhancement
- Trail
- Road
- River/Stream
- Raft Lake Cut Location
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
LOCATION OF FISHLESS PONDS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. A
DESIGN	CGE	14 Nov. 2008	FIGURE: 1	
GIS	JO	10 Apr. 2013		
CHECK	BH	10 Apr. 2013		
REVIEW	GA	10 Apr. 2013		

G:\Projects\2010\10-1118-0020_BrettResources_HammondReefGIS\MXDs\Draft\Aquatics\NoNetLossPlan\Potential_Fish_Habitat_Compensation_Works_Appendix.mxd

WINTER DISSOLVED OXYGEN MEASUREMENTS

Page left intentionally blank

API 2

A water quality profile was completed to a depth of 4 m on April 22, ice thickness was 53cm. Results indicate low dissolved oxygen levels through the water column with less than 1mg/L at a depth of 1 m and below. Conductivity was low and had a slight increasing trend from top to bottom; pH was slightly below neutral, ranging from 6.5 to 6.9.

Profiles taken previously during the open water period (Oct 2010 and Sept 2011) had high levels of dissolved oxygen throughout the water column. API 2 supports a fish community that includes northern pike, white sucker, pumpkinseed, yellow perch, Iowa darter and blacknose shiner.

Table 1: API 2 Water Quality Profile

Depth (m)	Dissolved oxygen (mg/L)	Temp. (^{o}C)	Conductivity (µS/cm)	pH
0.5	5.03	0.82	41	6.94
1	0.95	3.24	56	6.52
2	0.46	4.1	59	6.5
3	0.36	4.5	63	6.52
4	0.24	4.85	79	6.72

API 5

Water quality measurements were taken to a depth of 1 m on April 23, ice thickness was 71 cm. Results indicate very low dissolved oxygen levels of approximately 1mg/L immediately below the ice and at 1 m. Conductivity ranged between 114 µS/cm and 138 µS/cm, pH was slightly acidic at values of approximately 6.

API 5 supports a fish community of finescale dace and northern redbelly dace. A water quality profile taken to a depth of 5 m during open water conditions in October of 2010 indicated dissolved oxygen levels ranging from 7.8 to 6.0 mg/L from top to bottom.

Table 2: API 5 Water Quality Profile

Depth (m)	Dissolved oxygen (mg/L)	Temp. (^{o}C)	Conductivity (µS/cm)	pH
0.5	1.18	0.15	114	5.9
1	0.85	0.85	138	6.13

API 8

Water quality measurements were taken to a depth of 5 m on April 22, ice thickness was 61 cm. Results indicate a steep dissolved oxygen gradient with reasonably high levels (>8 mg/l) near the surface, dropping to close to zero near the bottom. Conductivity was low and had a slight increasing trend from top to bottom, pH was acidic at approximately 6.

API 8 supports populations of northern pike, white sucker, yellow perch, pumpkinseed and burbot. A water quality profile completed during the open water season in October 2010 indicated dissolved oxygen of approximately 9 mg/L at all depths and a September 2012 profile showed dissolved oxygen levels of 8 mg/L at surface and 6 mg/L just above bottom.

Table 3: API 8 Water Quality Profile

Depth (m)	Dissolved oxygen (mg/L)	Temp. (^{o}C)	Conductivity (µS/cm)	pH
0.5	8.85	0.46	56	5.72
1	8.12	1.83	61	5.89
2	5.04	3.17	68	6.05
3	4.14	3.75	74	6.09
4	2.05	3.97	81	6.15
5	0.30	4.49	102	6.38

API 10

Water quality measurements were completed to a depth of 9m on April 19, ice thickness was 66 cm. Results indicate low dissolved oxygen levels throughout the water column, with most readings below 1 mg/L. Conductivity was very low near the surface (>30 µS/cm) and increased to over 100 µS/cm at bottom, suggesting the probe may have entered fine sediments near the bottom, pH was acidic at 5.6 to 6.

API 10 does not support a fish population based on fishing effort applied in 2010, 2011 and 2012. A water quality profile completed during the open water period in September 2012 also indicated low dissolved oxygen, with less than 1 mg/L at a depth of only 1 m.

Table 4: API 10 Water Quality Profile

Depth (m)	Dissolved oxygen (mg/L)	Temp. (^{o}C)	Conductivity (µS/cm)	pH
0.5	1.10	0.3	27	5.64
1	0.88	1.69	30	5.58
2	0.66	3.17	28	5.56
3	0.54	3.62	33	5.75
4	0.48	3.82	34	5.8
5	0.44	3.9	38	5.83
6	0.40	3.97	43	5.86
7	0.37	4.04	56	5.91
8	0.32	4.13	81	6.04
9	0.31	4.18	122	6.06

API 12 – MITTA LAKE

Water quality measurements were completed at three separate locations on Mitta Lake on April 18 and 19. Location 1 was sampled to a depth of 10 m, Location 2 to 15 m and Location 3 to 14 m. Ice depth was approximately 69 cm. Results at all three locations show a steep dissolved oxygen gradient with oxygen levels of approximately 8 mg/L near the surface, dropping to less than 4mg/L by 5m and less than 1 mg/L by 7 m. Above 8 to 9 m in depth conductivity was generally in the 85 to 89 µS/cm range; below that depth conductivity increased to 200 µS/cm or more, with a high of 271 µS/cm recorded at Location 3.

Previous water quality profiles in August 2010 and September 2011 showed a sharp drop in dissolved oxygen levels between the depths of 6 and 7 m, with measurements of 5 to 6 mg/L at 6 m and measurements of less than 1.5 mg/L at 7 m. Profiles completed in March and June of 2011 had dissolved oxygen levels of approximately 4.5 and 5.0mg/L at a depth of 7 m, while a November 2011 profile had dissolved oxygen levels of greater than 9 mg/L to a depth of 12 m.

Mitta Lake supports populations of white sucker, brook stickleback, ninespine stickleback, fathead minnow, Iowa darter, mottled sculpin and finescale dace.

Table 5: API 12 (Mitta Lake) Water Quality Profile

Depth (m)	Dissolved oxygen (mg/L)	Temp. (^{o}C)	Conductivity (µS/cm)	pH
Location 1				
0.5	7.99	0.18	83	8.29
1	7.21	1.63	86	8.04
2	6.29	2.96	87	7.78
3	5.13	3.65	86	7.56
4	4.51	3.83	85	7.4
5	3.51	3.93	87	7.24
6	1.50	3.99	87	7.11
7	0.39	4.06	86	7.01
8	0.27	4.07	86	6.92
9	0.17	4.21	136	7.21
10	0.19	4.36	208	7.13
Location 2				
0.5	7.87	0.75	89	7.99
1	7.16	1.74	87	7.77
2	6.01	3	86	7.56
3	5.26	3.6	86	7.43
4	4.45	3.85	85	7.32
5	3.68	3.91	86	7.23

WINTER DISSOLVED OXYGEN MEASUREMENTS

Table 5: API 12 (Mitta Lake) Water Quality Profile (Continued)

Depth (m)	Dissolved oxygen (mg/L)	Temp. (°C)	Conductivity (µS/cm)	pH
Location 2 (Continued)				
6	2.31	3.99	86	7.10
7	0.73	4.05	88	6.97
8	0.36	4.09	87	7.00
9	0.25	4.1	89	6.91
10	0.22	4.12	101	6.96
11	0.19	4.13	109	6.94
12	0.17	4.1	120	7.06
13	0.16	4.14	131	7.11
14	0.16	4.2	150	7.16
15	0.16	4.26	200	7.00
Location 3				
0.5	8.27	0.23	82	3.68
1	7.78	1.58	86	3.84
2	6.73	2.94	86	4.05
3	5.68	3.54	87	4.21
4	5.15	3.69	86	4.41
5	3.54	3.84	85	4.43
6	2.12	3.91	88	4.55
7	0.57	3.98	88	4.65
8	0.37	4	86	4.72
9	0.29	4.07	103	4.75
10	0.24	4.08	125	4.79
11	0.21	4.13	146	4.84
12	0.22	4.18	159	4.89
13	0.20	4.28	204	4.92
14	0.20	4.34	271	4.93

API 16

Water quality measurements were completed to a depth of 4m on April 18, ice depth was approximately 30cm. Results indicate low dissolved oxygen levels at all depths, with less than 1 mg/L at depths of 1m or more. Conductivity was moderate, ranging from 138 µS/cm near surface to 241 µS/cm near bottom; pH was slightly acidic and showed a slight increasing trend from top to bottom.

API 16 does not support a fish community based on two rounds of sampling. A water quality profile completed in August of 2010 indicated dissolved oxygen levels of 7 mg/L or greater, throughout the water column. An August 2012 profile indicated dissolved oxygen was high at the surface (8 mg/L) but dropped to approximately 4 mg/L at a depth of 1 m and 1.3 mg/L at 3 m.

Based on fishing effort expended in 2010 and 2012, API 16 does not support a fish community.

Table 6: API 16 Water Quality Profile

Depth (m)	Dissolved oxygen (mg/L)	Temp. (°C)	Conductivity (µS/cm)	pH
0.5	3.63	0.26	138	5.75
1	0.74	3.27	193	5.92
2	0.41	4.33	223	6.32
3	0.33	4.46	229	6.61
4	0.29	4.81	241	6.84

API 43

Water quality measurements were completed to a depth of 5 m on April 25; ice thickness was 66 cm. Results indicate dissolved oxygen drops quickly through the water column, with 8 mg/L recorded just below the ice to less than 1 mg/L at a depth of 2 m and below. Conductivity was very low at surface (>20 µS/cm) and showed a slight increasing trend from top to bottom where it was 57 µS/cm; pH was slightly acidic, ranging from 5.6 to 6.2.

A profile completed in May of 2011 indicated dissolved oxygen of 9 mg/L or greater in the top 3 m of the water column, dropping to under 5 mg/L at a depth of 5 m. An August 2012 profile indicated approximately 8 mg/L in the top 2 m of the water column, dropping to 5 mg/L at 3 m and less than 3 mg/L at 4 m.

API 43 does not support a fish community based on fishing effort applied in 2011 and 2012.

Table 7: API 43 Water Quality Profile

Depth (m)	Dissolved oxygen (mg/L)	Temp. (°C)	Conductivity (µS/cm)	pH
0.5	8.16	0.88	16	6.24
1	5.24	2.2	18	5.83
2	0.58	3.63	19	5.59

Table 7: API 43 Water Quality Profile (Continued)

Depth (m)	Dissolved oxygen (mg/L)	Temp. (°C)	Conductivity (µS/cm)	pH
3	0.39	4.03	20	5.7
4	0.32	4.42	30	5.91
5	0.29	4.76	57	6.17

API 44

Water quality measurements were completed to a depth of 7 m on April 25; ice thickness was 69 cm. Results indicate very low dissolved oxygen levels throughout the water column; dissolved oxygen was 1 mg/l or less at all depths. Conductivity was low ranging from 20 µS/cm near surface to 85 µS/cm near bottom; pH was slightly acidic ranging from approximately 6.1 to 6.5.

A water quality profile completed in May of 2011 measured dissolved oxygen levels of approximately 9 mg/L in the upper 2 m of the water column, dropping to less than 3 mg/L at a depth of 4 m. An August 2012 profile measured low oxygen levels (1.5 mg/L or less) at a depth of 2 m and below.

No fish species have been captured in API 44 during 2011 or 2012 assessments.

Table 8: API 44 Water Quality Profile

Depth (m)	Dissolved oxygen (mg/L)	Temp. (°C)	Conductivity (µS/cm)	pH
0.5	0.99	0.84	20	6.39
1	0.63	1.81	22	6.34
2	0.37	3.44	22	6.1
3	0.34	3.87	21	6.07
4	0.31	4.03	26	6.21
5	0.24	4.13	30	6.38
6	0.25	4.25	44	6.5
7	0.22	4.35	85	6.45

API 46

Water quality measurements were completed to a depth of 9 m on April 23; ice thickness was 66 cm. Results indicate approximately 4 mg/L of dissolved oxygen near surface and levels of less than 1 mg/L at 2 m and beyond. Conductivity increased slightly from top to bottom, ranging from 80 µS/cm to 110 µS/cm, pH was close to neutral ranging from 6.7 to 6.9.

This was the first full water quality profile completed on API 46, water quality measurements taken near surface in May 2011 indicated a water temperature of 16°C, dissolved oxygen of 10.4 mg/L, conductivity of 60 µS/cm and a pH of approximately 8.

API 46 is known to support populations of finescale dace and fathead minnows.

Table 9: API 46 Water Quality Profile

Depth (m)	Dissolved oxygen (mg/L)	Temp. (°C)	Conductivity (µS/cm)	pH
0.5	3.82	0.96	80	6.94
1	1.69	2.47	82	6.85
2	0.45	4.00	83	6.78
3	0.35	4.27	87	6.78
4	0.32	4.35	90	6.76
5	0.27	4.39	91	6.7
6	0.27	4.43	93	6.85
7	0.25	4.43	96	6.9
8	0.25	4.47	101	6.94
9	0.22	4.56	110	6.9

API 47

Water quality measurements were completed to a depth of 8 m on April 29; ice thickness was 53 cm. Results indicate less than 3 mg/L of dissolved oxygen 1 m below the surface, and less than 1 mg/L from 2 m to bottom. Conductivity showed a slight increasing trend from near surface (66 µS/cm) to near bottom (98 µS/cm); pH was approximately neutral ranging from 7.1 to 7.5.

A water quality profile completed in May of 2011 measured dissolved oxygen levels of 8 mg/L or greater above depths of 4 m, with oxygen dropping to less than 3 mg/L at 6 m and below 1 mg/L at 7 m. An August 2012 profile indicated dissolved oxygen levels of 8 mg/L or more to a depth of 3 m, dropping to less than 3 mg/L at 5 m and below 1 mg/L at 6 m.

API is inhabited by finescale dace and pearl dace.

Table 10: API 47 Water Quality Profile

Depth (m)	Dissolved oxygen (mg/L)	Temp. (°C)	Conductivity (µS/cm)	pH
0.5	7.98	0.9	66	7.12
1	2.37	3.84	75	7.08
2	0.71	4.26	75	7.13
3	0.68	4.26	75	7.17
4	0.57	4.27	75	7.18
5	0.38	4.8	89	7.24

WINTER DISSOLVED OXYGEN MEASUREMENTS

Table 10: API 47 Water Quality Profile (Continued)

Depth (m)	Dissolved oxygen (mg/L)	Temp. (^{o}C)	Conductivity (µS/cm)	pH
6	0.33	4.92	97	7.37
7	0.32	4.93	98	7.45
8	0.27	4.94	98	7.47

\\golder.gds\gal\mississauga\active\2013\1118\13-1118-0010 osisko-hammond reef - ea support\006 environmental\2003 aquatic biology\appendix d winter dissolved oxygen measurements\appendix d winter dissolved oxygen measurements.docx

APPENDIX E

Stream Crossings

December 2013
Report No. 13-1118-0010 (DOC028)

Golder Associates

Table of Contents

BACKGROUND **1**

METHODS **5**

API 1 ..... **6**

Crossing Description 6

Habitat 6

Fish Community 6

Proposed Compensation 6

API 20 ..... **7**

Crossing Description 7

Habitat 7

Fish Community 7

Proposed Compensation 7

API 21 ..... **7**

Crossing Description 7

Habitat 8

Fish Community 8

Proposed Compensation 8

API 22 ..... **8**

Crossing Description 8

Habitat 8

Fish community 9

Proposed Compensation 9

API 23 ..... **9**

Crossing Description 9

Habitat 10

Fish Community 10
Proposed Mitigation and Compensation 10
API 60 10
Crossing Description 10
Habitat 10
Fish Community 11
Proposed Compensation 11
API 61 11
Crossing Description 11
Habitat 11
Fish Community 11
Proposed Compensation 11
API 62 12
Crossing Description 12
Habitat 12
Fish Community 12
Proposed Compensation 12
API 63 12
Crossing Description 12
Habitat 12
Fish Community 13
Proposed Compensation 13
API 64 13
Crossing Description 13
Habitat 13
Fish Community 13
Proposed Compensation 14

API 65 14

Crossing Description 14

Habitat 14

Fish Community 14

Proposed Compensation 14

API 66 15

Crossing Description 15

Habitat 15

Fish Community 15

Proposed Compensation 15

API 56 15

Crossing Description 15

Habitat 15

Fish Community 16

Proposed Compensation 16

API 58 16

Crossing Description 16

Habitat 16

Fish Community 16

Proposed Compensation 17

API 70 17

Crossing Description 17

Habitat 17

Fish Community 17

Proposed Mitigation and Compensation 17

FIGURES

Figure 1: Water Crossing Locations 3

ATTACHMENTS

ATTACHMENT E-1

Photos

BACKGROUND

Osisko Mining Corporation (Osisko) is proposing to upgrade the existing access road to their Hammond Reef Property north of Atikokan as part of the Hammond Reef Project EA. Upgrades are proposed for the following roads.

- 6.6 km of the Hardtack Road from Highway #602 to the Sawbill Road;
- 19.4 km of the Sawbill Road between the Hardtack Road and the mine exploration camp and;
- Approximately 10 km of an exploration road known locally as the Hammond Reef Road that runs from the exploration camp to the mineral deposit.

The rights of way for the Hardtack and Sawbill roads are public roads owned by the Ontario Ministry of Natural Resources (MNR) and are maintained by Abitibi Forest Products and Osisko respectively. The Hammond Reef road is a private road owned by Osisko.

Proposed upgrades to the road will include widening, raising the road bed in some areas and possibly some minor realignment. The proposed widening would bring the roads to a 12 m topwidth. Fifteen permanent water crossings (Figure 1) have been identified along the three access roads. These crossings currently consist of one single lane wood decked span bridge and 14 crossings with either single or double corrugated steel culverts. It is anticipated that all or most of these crossings will need to be widened as part of the upgrade.

STREAM CROSSINGS

Page left intentionally blank

600000 610000 620000

5430000

5420000

Serpent Lake

Corkell

Sawbill Bay

Mitta Lake

Marmion Lake

Lynxhead Bay

Hawk Bay

N

1 20 21 22 23 66 65 64 63 62 61 60 58 56 70

LEGEND

- Water Crossing Location (by API#)
- Hardtack Road
- Hammond Reef Road
- Sawbill Road
- River/Stream
- Lake
- Wetland

DRAFT

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
METRES

SCALE 1:80,000

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
Water Crossing Locations

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 2.0
DESIGN	CGE	14 Nov. 2008		
GIS	RRD	Nov. 2011		
CHECK	JD	Mar 2012		
REVIEW	JS	Mar 2012		

FIGURE: 1

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\5200_5210WaterCrossingLocations.mxd

Page left intentionally blank

At many crossings, it is anticipated that existing culverts will be left in place and extensions will be added as needed to accommodate the increased width. Extending existing culverts will result in the loss of existing fish habitat. As a requirement of the Federal Fisheries Act, this loss will need to be compensated for through the creation and or improvement of new or existing habitat.

This technical memo identifies the permanent water crossings found along the three access roads, the proposed nature of the upgrade anticipated for each crossing, the anticipated area of habitat loss associated with each water crossing (if known) and identifies conceptual compensation measures for each crossing.

METHODS

Mitigation and compensation techniques will be based on those identified by Golder Associates Ltd. (Golder) in the Fish habitat No Net Loss Plan/Habitat Offset Plan (NNLP) for the Hammond Reef Gold Project Rev. A (Golder 2013). Specifically this includes:

- Installation of open bottomed culverts to preserve aquatic habitat.
- Remediate existing barriers in the stream being crossed to provide access by fish to more habitat area (equal to or greater than the area of habitat occupied by the culvert).
- Undertake a channel restoration associated with the culvert installation to increase stream area (by increasing channel length and/or width) and offset the habitat lost to the culvert.

By implementing these measures onsite to offset the habitat losses within the culverts, these crossings are considered to be self-compensating. All works associated with the crossing upgrades and any proposed compensation measures will incorporate appropriate mitigation measures such as the use of timing windows, sediment and erosion control techniques, bank protection and stabilization, working in the dry whenever possible

The crossings listed below were visited during the summer (August/September) of 2010 (API's 1, 20, 21, 22 and 23) or the spring of 2011(API's 56, 58, 60,61,62,63,64,65,66 and 70) by Golder Associates Ltd. (Golder). Crossing locations were fished with either a backpack electrofisher, or a combination of gillnets and minnow traps. The backpack electrofisher was used in shallow stream habitats while gillnets and minnow traps were used in ponds and lakes. In some instances a combination of all three fishing methods may have been used at a given crossing.

Habitat mapping was also completed at the crossings. Crossing locations assessed in 2010 were mapped for approximately 50m upstream and downstream of the road, crossings assessed in 2011 were mapped for approximately 100m upstream and downstream of the crossing. Mapping included stream morphology, substrate representative wetted widths, channel widths and water depths, obstacles and barriers to fish passage, and surrounding land use. Written summaries and habitat mapping for many of the water crossings have been included in the Interim Aquatic Baseline Report (Golder 2012).

Information provided below with respect to anticipated upgrades to the roads and expected increases to culvert lengths was taken from Golder technical memo "Preliminary Recommendation – Mine Access Road" (Golder November 2010). Area estimates for required habitat compensation are based on the expected additional length

of new culvert to be added and an average of the upstream and downstream channel width. Area calculations for habitat compensation provided below are estimates only and may change once more detailed design information is available.

Attachment E-1 includes photographs of the crossing structures at the time of the assessments.

API 1

Crossing Description

This crossing is located on the Hammond Reef Road (mine access road) at approximately km 1.7. The crossing consists of a small low gradient stream that drains a sizable area of cedar and spruce swamp before reporting to Sawbill Bay on Marmion Lake. At the time of the stream assessment the crossing was serviced by two corrugated steel culverts of approximately 0.8 m in diameter each. A new culvert or culverts may have since replaced the original ones. When Marmion Lake is at its upper operating level water from Sawbill bay is backed up the stream channel approximately to the culverts.

Habitat

Upstream of the crossing, stream morphology consists of a long section of shallow run, with mainly soft substrates. A representative channel width through this reach measured 1.44 m and had a maximum water depth of 0.26 m. This reach of stream flows through a sedge meadow, with alders.

Downstream of the crossing, stream characteristics are influenced by water levels in Marmion Lake. At low water, a short, shallow riffle exists immediately below the culvert. At high water, the stream channel is backed up with water from Sawbill Bay.

Fish Community

The stream is known to support finescale dace *Chromos neogaeus*, fathead minnows *Pimephales promelas*, white sucker (juvenile) *Catostomus commersonii*, and burbot (juvenile) *Lota lota*. A wide variety of sport and bait fish species occur in Sawbill Bay and have access to the lower end of this stream.

Proposed Compensation

Proposed compensation for this crossing includes the placement of mixed coarse substrate immediately upstream and downstream of the culvert(s) to provide spawning substrate for white sucker and walleye from Sawbill Bay. Stream banks should be vegetated with woody shrubs and trees to provide overhead cover. In the event that the current culvert(s) need to be replaced for road upgrades, open bottom culvert(s) should be considered for replacement at this crossing.

API 20

Crossing Description

This crossing is located on the Sawbill Road at approximately km 19.4. This crossing consists of a moderate size stream that drains a number of waterbodies several km north of the road. The crossing is currently serviced by an approximately 2 m corrugated steel culvert. Downstream of the culvert the stream flows for approximately 25 m before reaching Sawbill Bay. Presently, the culvert is not seated into the substrate and sits at a slope from upstream to downstream, creating high water velocities through the culvert.

Habitat

Immediately upstream and downstream of the crossing the stream consists of high gradient rapids with coarse cobble and boulder substrate. Stream channel widths upstream and downstream of the culvert were 8.8 m and 7.5 m, respectively, and maximum water depths at the same locations were 0.90 m and 0.75 m. A high gradient high velocity rapid exists a short distance (approx. 10 m) upstream of the crossing and likely represents a substantial obstacle to most fish species.

Fish Community

The mouth of this stream is well known as an important spawning location for walleye (*Sander vitreus*) and white suckers. Backpack electrofishing in August of 2010 identified white sucker (juvenile), burbot (juvenile) and central mudminnow (*Umbra limi*) near the crossing. Netting approximately 1.5 km upstream of the crossing in September of 2012 captured blacknose shiners (*Notropis heterolepis*), northern pike (*Esox Lucius*) and yellow perch (*Perca flavescens*). Visual observation approximately 300 m upstream of the crossing in August of 2012 indicated the presence of smallmouth bass (*Micropterus dolomieu)*

Proposed Compensation

This crossing is best suited to either an open bottom culvert or a span bridge. These designs would allow more natural stream processes through the crossing area and could be constructed to better encourage fish passage and lost habitat would be recovered from the current closed bottom culvert design. A series of large boulders could be strategically placed in the lower stream and under the crossing structure to act as baffles, allowing fish better access these high gradient areas. It may also be possible to reduce the gradient of the upstream rapids, potentially allowing additional access to additional spawning habitat for suckers and walleye.

API 21

Crossing Description

This crossing is located on the Sawbill Road at approximately km 17.6 and consists of a defined stream channel flowing from an upstream beaver impoundment. The road bisects the stream approximately 45m downstream of the beaver impoundment. The stream eventually reports to Sawbill Bay. Currently, the crossing is serviced by a 1.4 m diameter corrugated steel culvert. The downstream end of the culvert currently directs flow towards the bank.

Habitat

The 45 m section of stream, above the culvert, to the upper waterbody consists of shallow (<20 cm) flat and shallow run habitat (Golder August 2010). Bankfull widths ranged from 3.87 m to 6.52 m. Substrate in the flats is silt while the run is primarily boulder/coble substrate. The upstream waterbody is maintained by a 2 m beaver dam that acts as a barrier to fish movement. A low bedrock ridge and an inactive beaver dam also create obstacles to fish movement upstream of the culvert. Maximum depth measured upstream of the road in August 2010 was 0.18 m. This area drains coniferous forest.

Downstream of the culvert is a shallow run extending approximately 31m, with boulder/cobble substrate and a depth of 0.08 m as measured in August 2010. This is followed by a shallow flat with dark organic substrate, the banks are low and flat here and are also organic in nature. This area appears to have been previously impounded and the riparian zone consists primarily of sedges. Approximately 70 m downstream of the culvert the stream converges with the stream from water crossing API 23. Instream cover both upstream and downstream of the culvert was low.

Fish Community

This stream is known to support populations of finescale dace, northern redbelly dace (*Chrosomus eos*) and Iowa darter (*Etheostoma exile*).

Proposed Compensation

In the event that the existing culvert is lengthened to accommodate the proposed widening a habitat loss of approximately 35 m² to 54 m² would occur. This could be replaced through the creation of one or two small backwater areas connected to the main stream channel, creating additional nursery and feeding areas for the existing fish community, it is anticipated that these areas would become established with aquatic macrophyte growth. The banks of the new backwater areas would be graded and protected with cobble to reduce erosion.

API 22

Crossing Description

This crossing is located on the Sawbill Road at km 16.3. The stream consists of a defined channel extending for approximately 200 m between two small unnamed waterbodies. The road bisects the stream approximately 65 m downstream of the upper waterbody. Much of the stream between the upper waterbody and the culvert flows along the road base on the west side.

Currently this crossing is serviced by a 1.2 m diameter corrugated steel culvert with a length of approximately 12 m. This culvert is poorly aligned on both the upstream and downstream ends and would require additional improvements beyond lengthening if the road is widened.

Habitat

Immediately upstream of the culvert the stream consists of shallow run habitat with cobble and boulder substrate, the channel width was measured at 1.28 m, and water depth was very shallow (0.04 m in August 2010). The gradient is moderate and the banks are well vegetated with grasses and shrubs. Upstream

of the run, the stream becomes wider and slower and was characterized as a flat with a silt and boulder substrate; channel width in this stream unit was just over 3 m in width and depth was 0.22 m.

Downstream of the culvert the stream flows through a flat meadow of sedge and dead conifers. The stream channel unit is flat, with a silt bottom and low organic banks, channel width was 3.25 m, water depth was 0.50 m. Floating and submerged aquatic vegetation is abundant in this reach. In August 2010, the discharge was calculated to be 0.001 m^3/s.

Fish community

This stream is known to support populations of finescale dace, northern redbelly dace, and Iowa darters. The unnamed upstream waterbody is known to support pearl dace (*Margariscus nachtriebi*), blacknose dace (*Rhinichthys atratulus*), finescale dace, fathead minnow, blacknose shiner, yellow perch and white sucker

Proposed Compensation

Deficiencies identified with the existing culvert suggest that realignment may be needed. If this is the case an open bottom culvert should be considered for this crossing. A sufficiently wide open bottom culvert could be placed across the stream channel rather than in the stream channel as occurs with standard culverts. This would recover previous habitat losses associated with the existing culvert and would allow for a stream simulation design through the length of the culvert. This design would potentially benefit fish passage, as well as amphibians and small mammals.

Given that the stream flows so close to the existing road base upstream of the culvert a realignment of the stream channel in this area may be required to accommodate the road widening. This would provide an opportunity to lengthen the existing channel and create additional habitat. This could be done irrespective of weather an open bottom or closed bottom culvert is used for this crossing. The estimate length required for a new culvert at this location is 20.6 m, an increase of 8.6 m. This would translate into a HADD requiring compensation of between 11 m^2 and 28 m^2.

API 23

Crossing Description

This crossing is located on the Sawbill Road at approximately km 15.4 and consists of a poorly defined channel that drains a low flat lying area of coniferous forest. This drainage was dry a short distance upstream of the road in August 2010. Evidence of a channel also quickly disappears as you move upstream from the road, suggesting that flows are ephemeral or seasonal.

At the time of the August 2010 assessment of this crossing, the upstream end of the culvert was plugged with road material, and a small area of ponded water was evident on the upstream side of the roadbed. Only minor seepage was observed upstream of the crossing.

An unnamed waterbody is located on the downstream side of the crossing about 22m from the road. The connecting channel between the downstream end of the culvert and the waterbody is inundated with backflow from the waterbody.

At the time of the August 2010 site visit this crossing was serviced by a small diameter corrugated culvert of PVC or ABS construction. A new corrugated steel culvert laying roadside at the crossing has presumably since been installed. Observations from a Golder Technical Memorandum (Golder 2010) following a preliminary reconnaissance of the road estimated that the culvert length at this crossing would need to be extended to 16m from the current 14m length.

Habitat

Habitat upstream of the crossing consists of a poorly defined channel that quickly becomes indistinguishable as you move upstream. The only water evident on the upstream side of the crossing in August was a small area of ponded water that appeared to be trapped by the road bed. It is unclear whether fish have ever been able to access areas upstream of the crossing before the road existed or not.

The channel downstream of the culvert has no discernible flow and consists of a U-shaped channel with a bankfull with of approximately 2.2 m and a silt bottom. Water depth in August 2010 was 0.56 m, fish can move freely from the downstream waterbody into the channel. The stream banks are low and of an organic composition. Some overhead cover is provided by overhanging sedge and shrubs.

Fish Community

The unnamed downstream waterbody is known to support finescale dace, northern redbelly dace, pearl dace, fathead minnows and white sucker. With the exception of a small (15m long) area of ponded water at the base of the road, the upstream portion of the crossing was dry.

Proposed Mitigation and Compensation

Current estimates suggest this crossing will be lengthened modestly from 14 m to 16.8 m to accommodate road widening. This would create a HADD requiring compensation of approximately 5 m^2. Suggested compensation for this crossing includes modestly increasing the area of the downstream channel to recover the lost 5 m^2.

API 60

Crossing Description

This crossing is located on the Sawbill Road at approximately km 1.1 and consists of a single corrugated steel culvert 0.8 m in diameter and approximately 26.5 m in length placed between two small ponds. At the time of the assessment, the downstream end of the culvert was out of the water. The upstream end of the culvert is screened.

Habitat

The upstream side of the crossing consists of a small shallow pond approximately 2 m in depth with soft organic and silt substrates and abundant woody debris. Much of the west shoreline is steeply sloping bedrock, the eastern shore is gradual sloping and comprised of fines with occasional cobbles and boulders. The area abutting the road bed has been riprapped with angular cobbles and boulders.

The downstream side of the crossing consists of a similar shallow pond approximately 1.5 m in depth with fine organic and silt substrates. Woody debris is common but not as prolific as the upstream pond, several floating mats of vegetation occur near the center of the pond.

Fish Community

Both the upstream and downstream ponds are known to support finescale dace and fathead minnows.

Proposed Compensation

The alignment of the current culvert is problematic, with the downstream end out of the water at times. It is recommended that the current culvert be realigned to allow water flow at all water levels between the ponds. It is anticipated that the culvert will need to be lengthened to accommodate the proposed upgrades. The estimated habitat requiring compensation for at this time is unknown. It is recommended that an excavation could be used to enlarge either the upstream or downstream pond to replace the final amount of habitat lost. The newly excavated area could be used to place substrates that are not currently available within the pond, increasing habitat diversity.

API 61

Crossing Description

This crossing is located on the Sawbill Road at km 2.5. The stream consists of a defined channel that drains a long narrow lake north of the road. The stream flows through coniferous forest downstream of the road and a couple of small waterbodies before reporting to Finlayson Lake approximately 1 km downstream. This crossing is currently serviced with a single lane, steel beam, wooden deck span bridge with a running width of 3.8 m.

Habitat

Upstream of the crossing this stream is high gradient with rapids and deep fast runs under high water conditions, and mainly riffles during low water. Substrate is predominately a mix of boulders and cobble additional instream cover is provided by log jams and other large woody debris. Bankfull width measured in an upstream run and riffle was 6.30 m and 4.80 m, respectively.

Downstream of the crossing, the stream gradient becomes even higher with numerous riffles and rapids. The stream is often highly confined by bedrock and the bottom substrate is mainly large boulders and cobble with sand in back eddy areas. In-stream cover is provided by large woody debris. Typical channel width was approximately 16 m, while water depths recorded in May 2011 ranged from 0.30 m to 0.80 m.

Fish Community

This stream is known to support populations of longnose dace (Rhinichthys cataractae), Iowa darter and white sucker.

Proposed Compensation

The current bridge is single lane only and will likely require upgrading to a wider structure. It is anticipated that the new structure would also be a span bridge and will not impact existing fish habitat, as such no habitat

compensation is planed for this crossing. Standard mitigation measures to prevent erosion and sedimentation will be applied during the replacement.

API 62

Crossing Description

This crossing is located on the Sawbill Road at approximately km 5.4 and consists of a poorly defined stream channel draining a low sedge meadow on the upstream side of the road and a narrow defined stream channel flowing through coniferous forest downstream of the road. The crossing is serviced by a 0.8 m corrugated steel culvert approximately 16 m in length.

Habitat

Upstream of the road this stream consists primarily of slow flowing flats with a soft detritus bottom, with channel widths ranging from 5.80 m to 15 m. Downstream of the crossing the stream channel is narrower, more defined and higher gradient, consisting of numerous chutes shallow runs and riffles. Downstream channel widths ranged from 0.8 m to 3.55 m and substrates were primarily gravel, cobble, bedrock and sand.

Fish Community

This stream is known to support finescale dace.

Proposed Compensation

It is anticipated that the current culvert will need to be lengthened from 16 m to 27 m to accommodate the proposed upgrades. This will require habitat compensation of approximately 96 m² to 165 m². Proposed compensation would include excavating additional area upstream of the crossing to increase the area of the undefined channel in the sedge meadow.

API 63

Crossing Description

This crossing is located on the Sawbill Road at approximately km 9.8. The stream consists of a defined channel that flows from a small unnamed lake approximately 500 m upstream of the road. Downstream of the road the stream continues for approximately 300 m before emptying into Finlayson Lake. The crossing is currently serviced by two 1.6 m corrugated steel culverts 22 m in length. It is anticipated that the culverts will need to be lengthened to 26 m to accommodate the proposed upgrades.

Habitat

Upstream of the road, stream morphology consists of shallow runs with clean gravel and sand substrates, bankfull width was 4.5 m. The banks are vegetated with woody shrubs, grasses and forbes and surrounding land is primarily coniferous forest. The road bed and stream banks at the crossing location have been armoured with cobbles.

Downstream of the road a mix of riffle and run habitat occurs, bankfull widths are more variable ranging from 2.8 m to 13.8 m. Maximum measured riffle depth was 0.32 m and maximum run depth was 0.98 m. Substrate in the riffle areas was cobble and boulders while the runs were mainly sand and gravel. Stream banks were vegetated with grasses and forbs, surrounding areas were primarily coniferous forest.

Fish Community

The stream is known to support white sucker, finescale dace and Iowa darter.

Proposed Compensation

It is anticipated that approximately 24m² of habitat compensation will be required for this crossing. Proposed compensation includes the placement of course cobble and gravel substrates in the stream mouth and lake shoreline at the stream mouth to provide potential spawning locations for white sucker and walleye.

API 64

Crossing Description

This crossing is located on the Sawbill Road at approximately km 11.1 and consists of a small pond draining directly to a single 1.5 m diameter corrugated steel culvert under the Sawbill Road. Downstream of the road, the stream flows over placed cobbles for a short distance before seeping through an area of cattails and flowing to Finlayson Lake. Total distance from the downstream side of the culvert to Finlayson Lake is approximately 60 m.

Habitat

The upstream pond is shallow with a maximum depth of just over 3 m; substrate is primarily clay and silt. Submergent aquatic vegetation is abundant in areas of the pond adjacent to the road. The shoreline consists of cobbles where the pond abuts the road bed; much of the remaining shoreline is grass, forbes and some woody shrubs, with occasional boulders and bedrock. The surrounding land is mixed deciduous and coniferous forest.

Water exiting the culvert downstream of the road flows through a short area of cobble riffle, this cobble appears to have been placed in the channel as part of the road bed construction. The downstream side of the culvert and stream banks adjacent to the road are heavily armoured with cobble and small boulders. The stream then percolates through cattails before reaching Finlayson Lake. This area of Finlayson Lake is shallow with a soft bottom of silt and clay, emergent vegetation is common in near shore areas. Channel width downstream of the culvert was measured as 0.8 m.

Fish Community

The short stream portion of this crossing was not fished. Finescale dace and fathead minnows were captured in the upstream pond. Fish species captured in proximity to the stream in Finlayson Lake at the time of the survey (May 2011) included yellow perch, white sucker, lake whitefish (Coregonus clupeaformis) and northern pike.

Proposed Compensation

The existing culvert is approximately 15 m in length, it is anticipated that this will be lengthened to 20 m in order to accommodate the proposed upgrades. Approximately 4 m² of habitat will need to be compensated for. Suggested compensation for this crossing includes adding a mix of course substrate to the stream mouth at Finlayson Lake, to provide spawning substrate for white sucker and walleye.

API 65

Crossing Description

This crossing is located on the Sawbill Road at approximately km 12.7. The crossing consists of a small stream with a defined channel that originates from the outflow of several small lakes approximately 1 km north of the road. The crossing is currently serviced by two 1.4 m corrugated steel culverts 29.5 m in length. Downstream of the road the stream flows for approximately 100m before joining the outflow of Detach Lake, the combined flows continue for 1.5 km before reporting to Finlayson Lake.

Habitat

Upstream of the road, stream morphology is primarily shallow run, with gravel and sand substrate. Representative measurements of stream channel width and water depth were 2.5 m and 0.24 m, respectively. Instream cover is primarily provided by woody debris. The riparian zone consists of alders and coniferous forest.

Downstream of the road stream morphology is also primarily shallow run; however, short sections of flat and riffle also occur. Substrate in the downstream runs was a combination of cobbles, gravel and sand, stream channel width was measured as 2.1 m and 4.1 m in the two assessed runs. A short flat comprised of sand substrate and had a channel width of 4.5 m and a water depth of 0.46 m. Two short cobble/gravel riffles had channel widths of 1.25 m and 2.3 m respectively and a water depth of 0.12 m.

Fish Community

This stream is known to support populations of longnose dace and white suckers.

Proposed Compensation

It is anticipated that the two 29.5 m culverts will need to be lengthened to 37.5 m in order to accommodate the proposed road upgrades. Compensation measures will be required to replace approximately 56 m² of habitat. Proposed compensation for this crossing includes the creation of pool habitat a short distance upstream or downstream of the culvert. Pool habitat is lacking in this section of the stream and would provide refuge during low water periods. Pool habitat could be created through a combination of excavation and scouring features such as wing deflectors, boulder placements digger logs etc. Banks would be stabilized with course substrate and vegetation will be planted.

API 66

Crossing Description

This crossing is located on the Sawbill Road at approximately km 14.1. This stream consists of a defined channel that captures flow from a number of small lakes north of the road. The crossing is serviced by a single 2.2 m diameter corrugated steel culvert 30.5 m in length. The stream reports to Detach Lake approximately 500m downstream of the road and eventually flows to Finlayson Lake.

Habitat

Much of the stream morphology upstream of the crossing consists of run habitat of moderate depth with gravel and sand substrates. A representative stream channel width of 4.3 m was measured along with a water depth of 0.7 m. A bedrock intrusion approximately 12 m upstream of the culvert creates a low head chute and short rapids. This obstacle is likely passable to white suckers during spring flows but may present a barriers to small body species.

Downstream of the road the stream is comprised primarily of riffles and runs, with a couple of small pools present. Substrate in the riffles is primarily cobbles, with some gravel and modest amounts of sand. Measured stream channel widths in the riffles were 8.5 m and 9.9 m and maximum riffle depths were 0.34 m and 0.48 m.

Fish Community

The stream is known to support longnose dace, white sucker and northern pike.

Proposed Compensation

It is anticipated that the existing culvert will need to be lengthened from 30.5 m to 37.5 m to accommodate proposed upgrades. Approximately 69 m² of habitat will need to be compensated for. Proposed compensation includes the removal of part of the bedrock chute upstream of the culvert to facilitate better upstream fish movement at all water levels. Part of the bedrock structure could be left in place to maintain the small scour pool at the bottom of the chute. Some additional cobble/gravel substrate could be added below the opened chute and scour pool to encourage white sucker spawning at this location.

API 56

Crossing Description

This crossing is located on the Hardtack Road at approximately km 2.0. The crossing consists of a small pond on the south side of the road; this pond discharges directly to the road culvert and then flows approximately 110 m before reporting to a small lake. The crossing is currently serviced by a 1.2 m corrugated steel culvert approximately 17 m in length. The upstream portion of the culvert is partly filled with debris and the bottom portion of the culvert is rusted.

Habitat

The small pond located on the south (upstream) side of the crossing is approximately 1.5 m deep with a fine texture bottom, cover is provided by woody debris. The pond flows directly to the culvert under the road.

Downstream of the road the stream is small and consists of moderate gradient runs with a short riffle immediately downstream of the culvert and one short flat. A small vertical drop of approximately 0.60m occurs approximately halfway between the road and the downstream lake. Stream channel widths measured between the road crossing and the downstream lake varied between 0.80m and 1.70m, while stream depths varied from 0.04 m and 0.12 m.

Fish Community

The stream is known to support Iowa darters and central mudminnow. The small pond on the south side of the crossing supports Iowa darters, central mudminnow, finescale dace and fathead minnows. The downstream lake is known to support walleye, northern pike, white sucker, yellow perch and central mudminnow.

Proposed Compensation

It is anticipated that the current culvert length will need to be extended from 17 m to 28.5 m to accommodate the proposed road upgrades. Given the relatively poor condition of the existing culvert consideration should be given to replacing this culvert with an open bottom culvert that spans the natural stream channel. This would allow natural stream processes to occur without disturbance of the habitat. Replacing the existing culvert with an open bottom culvert will allow the recovery of habitat previously lost with the conventional culvert.

API 58

Crossing Description

This crossing is located on the Hardtack Road at approximately km 5.3 and is on a side hill. This is a small high gradient stream that drains an unnamed lake approximately 100 m north of the road. The stream flows for another 130 m or so before entering a wetland or shallow waterbody. The crossing is currently serviced by a single 0.60 m corrugated steel culvert. At the time of the stream assessment stream in May 2011, stream flow was running under the culvert through coarse cobble and boulder material. The upstream end of the culvert does not extend sufficiently out from the road bed and is partially plugged with gravel and cobble that has fallen into the stream from the road bed. The bottom of the culvert is rusted.

Habitat

Areas immediately upstream and downstream of the crossing consist of high gradient cascades and runs with coarse substrates of boulder and cobble. These cascades are sufficiently steep to prohibit upstream fish movement.

Channel widths upstream of the crossing were narrow ranging between (1.10 m to 1.60 m), with the exception of a beaver impounded area approximately 40 m from the lake outflow which was 10m in width. Water depth in upstream run and cascade areas were 0.18 m and 0.10 m, respectively.

Downstream of the crossing the channel was also narrow with channel widths ranging from 0.75 m to 1.05 m, while typical water depths were 0.04 m to 0.26 m.

Fish Community

The stream is known to support populations of finescale dace and pearl dace. The upstream lake is known to support finescale dace and lake chub (Couesius plumbeus).

Proposed Compensation

Given the poor condition of the existing culvert, proposed compensation includes the installation of an open bottom culvert sufficiently wide to allow natural stream and flood plan processes. This would recover habitat lost with the conventional culvert. The open bottom culvert would also allow passage of reptiles and amphibians under the roadway. Unfortunately fish passage will not likely be enhanced with the open bottom culvert as there are numerous high gradient barriers upstream and downstream of the culvert. The steep topography in this area likely precludes any barrier removal compensation strategies for this crossing.

API 70

Crossing Description

This crossing is located on the Hardtack Road at approximately km 1.7 and consists of a small stream with a defined channel. The stream flows from a small unnamed lake approximately 100 m upstream (south) of the road. The crossing is serviced by a 1 m corrugated steel culvert. Downstream of the culvert the stream continues for approximately 500 m before reporting to a small lake.

Habitat

Upstream of the crossing this stream consists primarily of slow flowing shallow flats with sand, silt and detritus substrate. Stream channel widths in this reach ranged from 0.50m to 6.30m and water depths ranged from 0.10 m to 0.75 m. The stream flows through an area of mixed coniferous and deciduous forest.

Downstream of the crossing the stream also consists of shallow flat habitat with sand, silt and detritus substrate, representative channel width and water depth measurements were 1.10 m and 0.10 m, respectively.

Fish Community

The stream is known to support central mudminnow, finescale dace, pearl dace, blacknose shiner, fathead minnow and white sucker.

Proposed Mitigation and Compensation

Proposed compensation for this crossing includes increasing the surface area of a small pool located a short distance upstream of the crossing. This would be done by excavating additional area from the pool along one of the banks. The shoreline would be stabilized with stone or geotextile. It is anticipated that the area requiring compensation at this location would be relatively small (14m² to 25m²).

STREAM CROSSINGS

Page left intentionally blank

STREAM CROSSINGS

ATTACHMENT E-1
Photos

December 2013
Project No. 13-1118-0010 (DOC028)

Golder Associates

ATTACHMENT E-1 – PHOTOS

Photo 1: Looking downstream from crossing API 1.

Photo 2: Looking upstream from crossing API1

ATTACHMENT E-1 – PHOTOS

Photo 3: The downstream side of the culvert at crossing API 20

Photo 4: The upstream side of the culvert at crossing API 20

ATTACHMENT E-1 – PHOTOS

Photo 5: Looking downstream from crossing API 21.

Photo 6: Looking upstream from crossing API 21

ATTACHMENT E-1 – PHOTOS

Photo 7: looking upstream at crossing API 22.

Photo 8: Looking downstream at API crossing 22.

ATTACHMENT E-1 – PHOTOS

Photo 9: Looking upstream toward road crossing at API 23

Photo 10: Looking downstream from crossing API 23

ATTACHMENT E-1 – PHOTOS

Photo 11: Looking upstream at crossing API 66

Photo 12: Looking downstream at crossing API 66.

ATTACHMENT E-1 – PHOTOS

Photo 13: Looking upstream at crossing API 65

Photo 14: Looking downstream at crossing API 65

ATTACHMENT E-1 – PHOTOS

Photo 15: Looking at the road bed from the upstream pond at crossing API 64

Photo 16: Looking upstream at crossing API 64

ATTACHMENT E-1 – PHOTOS

Photo 17: Looking upstream from crossing API 63

Photo 18: Looking downstream from crossing API 63

ATTACHMENT E-1 – PHOTOS

Photo 19: Looking upstream from crossing API 62

Photo 20: Looking upstream at crossing API 62

ATTACHMENT E-1 – PHOTOS

Photo 21: Looking upstream from below the bridge at crossing API 61

ATTACHMENT E-1 – PHOTOS

Photo 22: Looking down gradient towards crossing API 60

ATTACHMENT E-1 – PHOTOS

Photo 23: Looking up gradient towards culvert (perched) at crossing API 60

Photo 24: Looking upstream at crossing API 58

ATTACHMENT E-1 – PHOTOS

Photo 25: Looking downstream at the culvert inlet, crossing API 58

Photo 26: Looking upstream toward culvert (obscured by alders, top center) at crossing API 56.

ATTACHMENT E-1 – PHOTOS

Photo 27: Looking down gradient toward the road bed at crossing API 56

Photo 28: Looking downstream at crossing API 70

ATTACHMENT E-1 – PHOTOS

Photo 29: Looking upstream at crossing API 70

AQUATIC ENVIRONMENT TECHNICAL SUPPORT DOCUMENT
VERSION 2

PART C

Aquatic Environment Technical Support Document, Version 1

December 2013
Project No. 13-1118-0010
Hammond Reef Gold Project

February 2013

HAMMOND REEF GOLD PROJECT
Aquatic Environment Technical Support Document

VERSION 1

Submitted to:
Osisko Hammond Reef Gold Ltd.
155 University Avenue, Suite 1440
Toronto, Ontario M5H 3B7

Project Number: 10-1118-0020
Document Number: 2012-075
Distribution:

Alexandra Drapack, Director Sustainable Development
Cathryn Moffett, Project Manager Sustainable Development

Golder Associates

Hammond Reef Gold Project
Aquatic Environment Technical Support Document

<Original signed by>

Prepared by: Brian Hindley, M.Sc. Date: February 20, 2013
Senior Biologist
Golder Associates Ltd.
<Original signed by>

Prepared by: John Seyler, B.Sc. Date: February 20, 2013
Senior Biologist
Golder Associates Ltd.
<Original signed by>

Reviewed by: Gary Ash, MSc, P. Biol Date: February 20, 2013
Principal, Senior Biologist
Golder Associates Ltd.

Table of Contents

1.0 INTRODUCTION 1

1.1 Purpose and Scope 1

1.2 Report Organization 3

1.3 Project Overview 4

1.3.1 Project Location 4

1.3.2 Climate 4

1.3.3 Project Phases 4

1.3.4 Project Components 6

1.4 Incorporation of Traditional Knowledge 8

1.5 Precautionary Approach 8

1.6 Selection of Valued Ecosystem Components 9

1.7 Temporal and Spatial Boundaries 18

1.7.1 Temporal Boundaries 18

1.7.2 Spatial Boundaries 18

1.7.2.1 Local Study Area 22

1.7.2.2 Mine Study Area 22

1.7.2.3 Linear Infrastructure Study Area 22

1.7.2.4 Regional Study Area 22

2.0 EXISTING CONDITIONS 23

2.1 Methods 23

2.1.1 Regulatory Consultation 23

2.1.2 Aboriginal Engagement 26

2.1.4 Field Studies 27

2.1.4.1 Fish Collection Methods 31

2.1.4.2 Fish Habitat Mapping 32

2.1.4.3 Fish Tissues Analysis 34

2.1.4.4 Benthic Invertebrate Community Assessment 35

2.1.4.4.1 Data Analysis 35

2.1.4.4.2 Aquatic Sediment Sampling 36
2.2 Results (Baseline Conditions) 36
2.2.1 Aquatic Features within the Local Study Area and Mine Study Area 36
2.2.1.1 Upper Marmion Reservoir 36
2.2.1.2 Lizard Lake 42
2.2.1.3 Hammond Reef Peninsula Waterbodies 46
2.2.2 Fish Tissue Analysis 67
2.2.3 Aquatic Sediment Analysis 69
2.2.4 Benthic Community Assessment 70
3.0 EFFECTS ASSESSMENT 75
3.1 Effects Assessment Methods 75
3.2 Determining Project Activity and Valued Ecosystem Components Interactions 80
3.2.1 Construction Phase 81
3.2.2 Operations Phase 89
3.2.3 Closure Phase 94
3.2.4 Post-closure Phase 94
3.3 Assessment of Effects on Valued Ecosystem Components 95
3.4 Construction Phase Effects and Mitigation 96
3.5 Operations Phase Effects and Mitigation 103
3.5.1 Water Withdrawal from Sawbill Bay 103
3.5.2 Mine Effluent Discharge 103
3.5.3 Treated Sewage Effluent Discharge to Sawbill Bay 105
3.5.4 Operational Blasting of the Open Pits 105
3.5.5 Pit Inflow from Upper Marmion Reservoir 105
3.5.6 Seepage Losses from the Tailings Management Facility and the Waste Rock Management Facility 105
3.5.7 Atmospheric deposition of dust and contaminants 105
3.6 Closure Phase Effects and Mitigation 106
3.7 Post-closure Phase Effects and Mitigation 106
3.8 Additional Project Mitigation and Compensation Measures and Conceptual No Net Loss Plan 107
3.8.1 Fish Salvage and Rescue Protocols 111

3.8.2 Compensation Measures Selection 111
3.8.3 Compensation Calculations 112
3.8.4 Additional Mitigation and Compensation Measures 115
3.8.5 Steep Rock Mine Habitat Compensation 116
3.9 Residual Effects 117
4.0 MONITORING PROGRAMS AND COMMITMENTS 118
4.1 Aquatic Monitoring Program 118
4.2 Final No Net Loss Plan 118
4.3 Scheduling of Waterbodies under Metal Mining Effluent Regulation 119
4.4 Environmental Effects Monitoring (MMER) 122
4.5 Construction Monitoring 122
4.6 Blast Monitoring and Collection of Supplementary Fish Habitat Information (Sawbill Bay) 123
5.0 SUMMARY OF FINDINGS 124
5.1 Key Baseline Conditions 125
5.2 Potential Effects 126
5.2.1 Construction 126
5.2.2 Operations 127
5.2.3 Closure and Post-closure 128
5.3 Fish Habitat Compensation 129
6.0 LIST OF REFERENCES 131
7.0 GLOSSARY OF TERMS 136
8.0 LIST OF ABBREVIATIONS, ACRONYMS AND INITIALISMS 139
9.0 LIST OF UNITS 141

TABLES

Table 1-1: Canadian Environmental Assessment Agency Environmental Impact Statement Guidelines Concordance Table 2
Table 1-2: Valued Ecosystem Components Selected for the Aquatic Environment 11
Table 2-1: Regulatory Agency Consultation for Aquatic Ecology Studies 24
Table 2-2: Summary of Field Program Dates 28
Table 2-3: Summary of Field Sampling Efforts by Area of Potential Impact 28

Table 2-4: Habitat Features and Variables Measured During Baseline Studies 33
Table 2-5: Fish Species Captured During Baseline Studies 39
Table 2-6: Fish Community Composition by Ecotype 64
Table 2-7: Selected Fish Tissue Metal Results Summary (mg/kg wwt) 68
Table 2-8: Total Mercury Levels in Fish Tissue Samples (µg/g wet weight; Detection Limit 0.050 µg/g) 69
Table 2-9: Sediment Grain Size and Total Organic Content Analysis Results 70
Table 2-10: Benthic Invertebrate Community Indices Summary Statistics 71
Table 2-11: Water quality conditions at benthic monitoring stations 72
Table 3-1: Assessment Criteria and Levels for Determining Significance 76
Table 3-2: Magnitude Levels for Aquatic Environment VECs Indicator Measures 77
Table 3-3: Construction Phase Activities and Interaction with the Aquatic Environment 87
Table 3-4: Operations Phase Activities and Interaction with the Aquatic Environment 93
Table 3-5: Aquatic APIs Potentially Directly Affected by the Osisko Hammond Reef Gold Project (Preferred Option) 97
Table 3-6: Aquatic Areas of Potential Impact Potentially Indirectly Affected by the Osisko Hammond Reef Gold Project (Preferred Option) 102
Table 3-7: Fish Habitat Groupings 108
Table 3-8 Species Habitat Weights (SHW) by Habitat Group 109
Table 3-9: Preliminary WUA Calculation Showing Estimates of Habitat Gains for Specific Areas of Potential Impact 112
Table 7-1: Glossary of Terms 136
Table 8-1: List of Abbreviations, Acronyms and Initialisms 139
Table 9-1: List of Units 141

FIGURES

Figure 1-1: Project Location 5
Figure 1-2: Site Layout 7
Figure 1-3: Aquatic Environment Regional Study Area 19
Figure 1-4: Aquatic Environment Local Study Area 20
Figure 1-5: Linear Infrastructure and Mine Study Areas 21
Figure 2-1: Areas of Potential Impact 30
Figure 2-2: Upper Marmion Reservoir Annual Water Level Fluctuations Pre Seine River Management Plan 37
Figure 2-3: Upper Marmion Reservoir Annual Water Level Fluctuations Post Seine River Management Plan 38
Figure 2-4: Minimum and Maximum Water Levels for Upper Marmion Reservoir (Hydrology TSD) 42
Figure 2-5: Lizard Lake Bathymetry Map 43

Figure 2-6: Mitta Lake Bathymetry Map 56
Figure 2-7: Area of Potential Impact #2 Bathymetry Map 59
Figure 2-8: Area of Potential Impact #8 Habitat map showing depth soundings. 61
Figure 2-9: Benthic Invertebrate Community Major Taxonomic Groups (0= Order; C= Class) Relative Abundance 74
Figure 3-1: Decision Tree for Assigning Significance to Effects on Aquatic Environment 79
Figure 3-2: Areas of Potential Impact for the Project 82
Figure 3-3: Potential Fish Habitat Compensation Works 114
Figure 4-1: Areas of Potential Impact Requiring Metal Mining Effluent Regulation Listing in the Tailings Management Facility 120
Figure 4-2: Areas of Potential Impact Requiring Metal Mining Effluent Regulation Listing in the Waste Rock Stockpile 121

PHOTOS

Photo 2-1: Exposed shoreline of Sawbill Bay during low water, near the mouth of API #33 (June 2010) 40
Photo 2-2: Exposed shoreline of Snail Bay during low water elevation, mouths of APIs #15 and #50 in foreground) 41
Photo 2-3: Northern section of Lizard Lake, inflow (mouth of Lumby Creek) in foreground 44
Photo 2-4: Southern section of Lizard Lake looking towards outflow 44
Photo 2-5: Cascade in central portion channel connecting Lizard Lake to Turtle Bay (May, 2011) 45
Photo 2-6: Mouth of channel connecting Lizard Lake to Turtle Bay during low flow conditions (August 2010) 46
Photo 2-7: API #44, headwater pond 49
Photo 2-8: API #11, headwater pond 49
Photo 2-9: API #69, headwater pond 50
Photo 2-10: API #14, headwater pond 50
Photo 2-11: API #6 (foreground) and API #7 (background) 51
Photo 2-12: Seasonal stream channel, lower portion of API #6 (September, 2012) 51
Photo 2-13: Seasonal stream channel, lower portion of API #15 (September, 2012) 52
Photo 2-14: APIs #3, #4 and #5; beaver impoundments and connecting channels 53
Photo 2-15: Lower section of API #9 during period of low flow and low water elevation in Upper Marmion Reservoir (August 2011) 53
Photo 2-16: Southern shoreline of the Hammond Peninsula. Note the steep shoreline gradient. 54
Photo 2-17: API #13 and its connecting channel to Sawbill Bay 54
Photo 2-18: Portion of cascade that connects API #13 to Sawbill Bay 55
Photo 2-19: Mitta Lake, Sawbill Bay (Receiver) in background) 57
Photo 2-20: API #2 (unnamed lake within TMF boundary) 58
Photo 2-21: API #8, inflow in foreground, Lizard Lake (Receiver) in background 60

APPENDICES

APPENDIX 2.I
Definitions for Fish Habitat Mapping Variables

APPENDIX 2.II
Aquatic Existing Conditions Study Results

APPENDIX 2.III
Draft Habitat Accounting Procedure and Conceptual No Net Loss Plan

APPENDIX 3.I
Aquatic Environment Valued Ecosystem Components Interactions Table

1.0 INTRODUCTION

Osisko Hammond Reef Gold Ltd. (OHRG) proposes the development of an open pit gold mine in northwestern Ontario, herein referred to as the Hammond Reef Gold Project (Project). This Technical Support Document (TSD) is one of a series of reports in support of the Project's Environmental Impact Statement/Environmental Assessment Report (EIS/EA Report).

The following reports have been prepared to support the EIS/EA Report:

- Atmospheric Environment TSD.
- Geochemistry, Geology and Soil TSD.
- Hydrogeology TSD.
- Hydrology TSD.
- Water and Sediment Quality TSD.
- Site Water Quality TSD.
- Lake Water Quality TSD.
- **Aquatic Environment TSD.**
- Terrestrial Ecology TSD.
- Aboriginal Interests TSD.
- Cultural Heritage Resources TSD.
- Human Health and Ecological Risk Assessment TSD.
- Socio economic Environment TSD.
- Alternatives Assessment Report.
- Conceptual Closure and Rehabilitation Plan.

The EIS/EA Report will summarize the findings of this TSD and of the above-listed supporting reports.

1.1 Purpose and Scope

The purpose of this TSD is to fulfill the assessment scope outlined in the Project's Terms of Reference (ToR) approved by the Ontario Minister of the Environment (July 2012), and in the Environmental Impact Statement Guidelines (EIS Guidelines) published by the Canadian Environmental Assessment Agency (CEA Agency) (December 2011). Table 1-1 contains the contents of the EIS Guidelines that pertain to the aquatic environment and compares these to the applicable discussions in this TSD.

Table 1-1: Canadian Environmental Assessment Agency Environmental Impact Statement Guidelines Concordance Table

Section in Environmental Impact Statement Guidelines	Requirement	Section in Aquatic Environment Technical Support Document
9.1.4 Water Quality and Quantity	**Benthic Invertebrates** ■ The description of the existing aquatic environment shall include information on benthic invertebrate communities, including sediment quality, characterization of the community diversity and abundance. The baseline sediment data gathered shall be sufficient to support the development of biological monitoring programs and shall assess variation relative to historical data. The Proponent should give due consideration to sample benthic invertebrate communities, including sediment quality in areas identified as potential final discharge locations. The proponent shall also provide in the EIS a description of benthic invertebrate and sediment sampling protocols and analytical methods and the quality assurance/quality control program followed.	Aquatic Environment TSD, Section 2 (Existing Conditions) Water and Sediment Quality TSD, Section 3.0 (Existing Conditions), and Section 3.2 (Sediment Quality) Water and Sediment Quality TSD, Section 2.0 (Methods) and Section 2.2.2.3 (Sediment)
9.1.5 Fish and Fish Habitat	The EIS shall include: ■ Scientifically defensible baseline data that characterizes fish habitat, fish habitat use and fish community, within each waterbody and their inter-connecting channel(s) in the context of the local and regional sub-watershed areas. This should include, as appropriate to the circumstances:	Section 2 (Existing Conditions)
9.1.5 Fish and Fish Habitat	■ The characterization of fish habitat use as spawning, rearing/nursery, feeding, migratory corridor and over wintering/summer refuge,	Section 2 (Existing Conditions)
9.1.5 Fish and Fish Habitat	■ A quantification of habitat by watercourse reach and/or type within the local watershed, including measures such as direction of flow, length of stream, surface area and/or mean bank full width, depths, monthly/seasonal/annual discharge volumes/velocities and natural or anthropogenic barriers to fish passage,	Section 2 (Existing Conditions)
9.1.5 Fish and Fish Habitat	■ For each potentially affected lake, measures of total surface area, water elevation above mean sea level, shoal area, surface area of submerged and emergent aquatic vegetation, maximum and mean depths and water quality parameters (e.g., profiles of water temperature, turbidity, pH, dissolved oxygen),	Section 2 (Existing Conditions) Section 3 (Impact Assessment) Appendix 2.II (Aquatic Baseline Report)

Table 1-1: Canadian Environmental Assessment Agency Environmental Impact Statement Guidelines Concordance Table (Continued)

Section in Environmental Impact Statement Guidelines	Requirement	Section in Aquatic Environment Technical Support Document
9.1.5 Fish and Fish Habitat	■ Distribution, abundance and characterization of fish by species and life stages;	Section 2 (Existing Conditions) Section 3 (Impact Assessment) Appendix 2.II (Aquatic Baseline Report)
9.1.5 Fish and Fish Habitat	■ Characterization of existing metal levels in fish tissue in areas that may be impacted by effluent or seepage from the mine; and	Section 2 Existing Conditions
9.1.5 Fish and Fish Habitat	■ The results of fish and fish habitat surveys along existing roads and the transmission line right of way.	Section 2 Existing Conditions
9.2.1 Aboriginal Interest and Land and Resource Use: Fishing	■ The EIS shall describe the commercial, recreational and subsistence, lake and stream fisheries that may be affected by the Project, including water body use and the importance of the water body in a regional and provincial context.	Section 2 Existing Condition Section 3 Impact Assessment

This TSD describes the aquatic environment existing conditions focusing on Valued Ecosystem Components (VECs). The TSD provides sufficient detail to allow the prediction and assessment of potential effects on aquatic environment VECs, and to determine the significance of these effects. The TSD also proposes mitigation measures, and outlines monitoring programs to enable effective testing of predictions. An explanation of the approach used for this TSD is provided in Section 3.1.

1.2 Report Organization

This TSD is structured as follows:

- Section 1 presents the purpose and scope of the TSD, an overview of the Project, the general assessment approach, VECs, assessment boundaries of the TSD, and other aspects of the Project relevant to the aquatic environment.
- Section 2 describes the existing aquatic environment conditions within the Project's spatial boundaries.
- Section 3 presents the assessment of Project effects on the aquatic environment, focusing on VECs. The effects assessment includes the screening of effects, the identification of additional mitigation measures, the description of residual effects, and the assessment of significance of residual effects.
- Section 4 outlines the monitoring program requirements for the aquatic environment during each of the Project's phases.
- Section 5 summarizes the findings of this report.

1.3 Project Overview

The Project overview and Project description are provided in Chapter 5 of the EIS/EA Report. Project aspects that influence the evaluation of the aquatic environment are described in Sections 1.3.1 to 1.3.4.

1.3.1 Project Location

The Project is located within the Thunder Bay Mining District in northwestern Ontario, approximately 170 km west of Thunder Bay and 23 km northeast of the town of Atikokan (Figure 1-1).

Access to the Hammond Reef property is presently via two routes: sections of the Premier Lake Road, a gravel road that intersects Highway 623, near Sapawe, and the Hardtack-Sawbill Road, a gravel road that intersects Highway 622 northwest of the Town of Atikokan. Currently, an exploration camp is located at the northern end of Sawbill Bay in Upper Marmion Reservoir. The Project Site is also accessible by water from the southwest end of the Marmion Reservoir at its access point from Highway 622. The existing Hardtack-Sawbill road, located to the north of Finlayson Lake, has been upgraded to provide an improved and more direct linkage to the Project Site in support of the expanded exploration program.

The Hammond Reef deposit is located mainly on a peninsula of land extending into the north end of the Upper Marmion Reservoir. The peninsula containing the deposit is surrounded by the Upper Marmion Reservoir on three sides, with Sawbill Bay to the northwest and Lynxhead Bay to the southeast. The property also contains a number of smaller lakes. Mitta Lake is a small, waterbody with steep littoral bottom gradients located atop mineralized zones of the deposit. Due to its location, the proposed open pit mine will encompass Mitta Lake.

1.3.2 Climate

The Project is located in a boreal climate region, which is characterized by long, usually very cold winters, and short, cool to mild summers. The annual temperature average is 1.6 °C for Atikokan, with a seasonal maximum of 16.2°C (average) for summer and a minimum of -5.4 C (average) for winter. Temperatures lower than -37°C have been recorded during the fall and winter. The annual normal total for precipitation is 788 mm (568 mm of rainfall and 220 mm of snowfall) for Atikokan, with a seasonal maximum of 299 mm for the summer period.

1.3.3 Project Phases

The Project comprises four phases: construction, operations, closure and post-closure. With regards to aquatic environment assessment, the most relevant Project phase is the construction phase.

Activities expected to have the greatest potential effects include the following:

- Construction of the Mine footprint, including the sites of the open pits and the Tailings Management Facility (TMF) – direct effects, short duration but potentially greatest magnitude.
- Upgrading of the access road (Hardtack/Sawbill) to the Project Site – direct effects, short duration and lower magnitude.
- Operation of the Mine, primarily intakes/discharges to environment associated with the mine water use and the accommodation camp - indirect effects, longer duration, and lowest magnitude.
- Post-closure of the Mine, related to filling and ultimately overflowing of the open pits, and seepage associated with the TMF - indirect effects, longer duration, and lowest magnitude.

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004. Produced by Golder Associates Ltd.
under licence from Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

100 0 100 200 300 400
SCALE 1:10,000,000 KILOMETRES

Golder Associates
Mississauga, Ontario

PROJECT No.	10-1118-0020	CHECK	BH
SCALE	AS SHOWN	VERSION 1	REVIEW GA
DATE	February, 2013		
DESIGN	CGE		
GIS	JO		

TITLE

PROJECT LOCATION

PROJECT HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

FIGURE: 1-1

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\TSD\ProjectLocation.mxd

Additional details regarding activities expected to take place in each phase of the Project are provided in Chapter 5 of the EIS/EA Report.

1.3.4 Project Components

The Project consists of the following eight main components:

- Mine, including two open pits (i.e., east pit and west pit).
- Waste Rock Management Facility (WRMF).
- Ore Processing Facility.
- Tailings Management Facility (TMF).
- Support and Ancillary Infrastructure.
- Water Management System.
- Linear Infrastructure.
- Borrow Sites.

Project components are shown in Figure 1-2. A detailed description of Project components is provided in Chapter 5 of the EIS/EA Report.

610000 615000 620000

5430000 5425000 5420000

Serpent Lake
Cornell Lake
Long Hike Lake
Vista Lake
Lizard Lake
Light Lake
Upper Seine Bay
Turtle Bay
Trap Bay
Sawbill Bay
Marmion Reservoir
Lynxhead Bay
Mills Lake

ACCOMMODATION CAMP
PUMPING STATION
TAILINGS MANAGEMENT FACILITY
PUMPING STATION
DETONATOR STORAGE
EMULSION PLANT
PEBBLE CRUSHING STATION
CONCENTRATOR
POWER SUBSTATION
PROPANE FARM
EFFLUENT TREATMENT PLANT
PROCESS PLANT COLLECTION POND
GYRATORY CRUSHER PAD
LIVE ORE STOCKPILE
PARKING LOT
SECURITY STATION
TRUCK SHOP / MINE OFFICE
PARKING LOT
FUEL BAY
EAST PIT
WEST PIT
WASTE ROCK STOCKPILE
LOW-GRADE ORE STOCKPILE
OVERBURDEN STOCKPILE

N

LEGEND

- Index Contour (5m interval)
- Ditch
- Marsh/Swamp
- River/Stream
- Road
- Trail
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Accommodation Camp
- Laydown Area
- Office and Truck Shop, Explosives Storage and Processing Plant
- Open Pits
- Low-Grade Ore Stockpile
- Overburden Stockpile
- Process Plant Collection Pond
- Pumping Station
- Tailings Management Facility
- Tailings Management Facility Reclaim Pond
- Waste Rock Stockpile

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd. under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

500 0 500 1,000 1,500 2,000 2,500
METERS

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
SITE LAYOUT

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008		
GIS	JO	7 Feb. 2013		
CHECK	BH	7 Feb. 2013		
REVIEW	GA	7 Feb. 2013		

FIGURE: 1-2

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\TSDSiteLayout.mxd

1.4 Incorporation of Traditional Knowledge

Traditional knowledge in combination with other information sources is valuable in achieving a better understanding of the Project's potential effects on the biophysical and socio-economic environment. It also contributes to the description of the existing biophysical and human environment, natural cycles, resource distribution and abundance, and the use of land and water resources. A detailed discussion on traditional knowledge, including any aspects relevant to the aquatic environment, is included in the Aboriginal Interests TSD.

An Aboriginal workshop focusing specifically on traditional land use in the Local Study Area was held at the Lac Des Milles Lacs First Nations Roundhouse on August 16, 2012. A number of key points were raised in this workshop concerning the aquatic environment:

- Aboriginal community members use the Upper Marmion Reservoir and vicinity for hunting, trapping and fishing (both subsistence and commercial). These individuals use both modern and traditional methods of fishing to obtain fish that may be distributed among their community.
- The maintenance of healthy, robust fish populations, particularly those species that have cultural significance is an important Aboriginal value.
- Specific walleye spawning locations in the Upper Marmion Reservoir and its vicinity were shared and recognized as being important.
- Traditional ceremonies that recognize disruptions to the environment, for example the relocation of fish in Mitta Lake, are important. Aboriginal people would like to participate in the development of the planned fish relocation program.
- The potential to restore Mitta Lake to an open pit lake during the post-closure phase of the Project was discussed.

1.5 Precautionary Approach

Environmental assessments are forward-looking planning tools, used in early stages of Project development. As such, environmental assessments are based on a precautionary approach. This approach is guided by judgement, based on values, and intended to address uncertainties in the assessment. This approach is consistent with the Canadian government's framework for applying precaution in decision making processes.

This TSD applies a precautionary approach to the assessment of potential Project effects. The Project is conservatively considered, and effects are advanced through the assessment process if they cannot be systematically removed from consideration through rigorous scientific evidence. The evaluation of effects is based both on regulatory compliance and on predicted changes to the existing environment. This captures and assesses changes to the existing environment that may fall outside or below applicable regulatory frameworks. In addition, all residual effects are assumed to occur and assessed for significance.

1.6 Selection of Valued Ecosystem Components

The purpose of this TSD is to address the requirements of the EIS Guidelines and the ToR approved by regulatory agencies. This will be accomplished by determining whether the Project will have effects on the aquatic environment, the extent to which the Project may affect the aquatic environment, and to identify means by which potential effects can be avoided and/or mitigated. While all aspects of the aquatic environment are important, it is neither practicable nor necessary to assess every potential effect of the Project on every aspect of the aquatic environment. To focus the assessment on those components that are of greatest relevance in terms of value and sensitivity, Valued Ecosystem Components (VECs) have been identified and selected as endpoints for the assessment. In addition to VECs, Valued Socio-economic Components (VSCs) have been identified and forwarded for evaluation in the Socio-economic Environment TSD.

The CEA Agency describes VECs as follows:

"Any part of the environment that is considered important by the proponent, public, scientists and government involved in the assessment process. Importance may be determined on the basis of cultural values or scientific concerns" (Hegmann et al. 1999).

The VECs are typically selected through an issues scoping exercise that identifies the particular components of the environment for which there is public, aboriginal, regulatory or scientific concern. The VECs provide structure and focus for the environmental assessment and ensure that the likely effects of a project are considered.

Since the VECs are assessment endpoints, it is important that the selected VECs can be used to meaningfully measure the potential effects of the Project. The VECs for this TSD were selected based on the following considerations:

1) What major or special ecological features of the Project Site or surrounding area should be protected from adverse effects from the Project?

2) What aspects of the physical environment could be sensitive to the effects from the Project?

3) What individual species or range of species, of wildlife and plants could be sensitive to the effects of the Project?

4) What aspects of the socio-economic environment should be considered in assessing the Project?

A VEC can be an individual component of the environment (e.g., a species), or a collection of components that represent one aspect of the environment (e.g., a wetland ecosystem).

From an ecological perspective, VECs can represent features of the natural environment considered to be culturally or scientifically important (e.g., a known spawning area or a rare species). These ecological feature VECs are complex, comprising several ecological aspects, and affected by a range of pathways (i.e., routes of exposure or effect). Ecological feature VECs encompass a number of individual VECs such as:

- An aspect of the physical environment (e.g., air, water quality or aquatic habitat).
- An individual plant or animal species (e.g., walleye).

The VECs are characterized using indicators; where indicators are the attributes of the VEC that might be affected by the Project. Each indicator requires specific measures that can be quantified and assessed.

The identification of VECs, indicators and measures for the aquatic effects assessment was developed based, in part, on extensive consultation with key regulatory agencies through a series of workshops. These workshops were planned in order to build consensus among agencies for the process of sampling and inventorying fish communities and habitat, for developing a procedure for quantifying aquatic habitat losses and gains, and for developing a No Net Loss Plan (NNLP) for the Project, consistent with the requirements of the *Fisheries Act*. This is further discussed in Section 4.2. Agencies included the Ontario Ministry of Natural Resources (MNR), Fisheries and Oceans Canada (DFO), the Ministry of Northern Development and Mining (MNDM), the Ontario Ministry of Natural Resources (MOE), Environment Canada (EC), and the CEA Agency.

Table 1-2 provides the list of VECs selected for this TSD, the rationales for their selection, and indicators and measures. While there are many indicators and measures possible for each VEC, only those described in this TSD are used for the effects assessment.

Table 1-2: Valued Ecosystem Components Selected for the Aquatic Environment

VEC/VSC	Rationale for Selection	Indicators	Measures
Lower Reaches of Headwater drainage features: Downstream of the Project Site, the accessible portions of streams, including mainstem ponds, and stream crossings, are important areas due to their contribution to fish populations in Lizard Lake and Upper Marmion Reservoir, particularly Sawbill Bay and Lynxhead Bay. They provide direct and indirect habitat to fish VECs (walleye, smallmouth bass, northern pike) through the transport of food and nutrients as well as habitat for baitfish and other small bodied fishes. These reaches are a concern of regulatory agencies, as they provide spawning and rearing habitat for a variety of species that reside in Upper Marmion Reservoir. Habitat conditions are closely linked to headwater features within the Project Site. Effects on these reaches provide a measure of Project impacts at the local scale on the following populations/communities: ■ **Headwater features and drainage systems and associated fish communities:** These exist upstream of the lower reaches and contribute indirectly to the quality and quantity of fish habitat within the lower reaches. They include permanent and intermittent streams and small waterbodies (beaver impoundments and ponds), and several small, natural lakes. Fish communities consist of few species, predominantly limited to baitfish and other small-bodied fish. Northern pike are present in two small natural lakes. Headwaters and ponds likely act as sources of fish to repopulate shallow or intermittent reaches that may only support fish during periods of high flow. Upstream passage of fish from the lower reaches is limited by barriers (e.g., falls and beaver dams). ■ **Lower Reaches:** These include permanent streams and small waterbodies (beaver impoundments and ponds), that may be accessible by fish from Lizard Lake, Sawbill and Lynxhead Bays. Fish communities are more diverse than in headwater features, consisting of a greater diversity of small-bodied fish, and common sportfish species such as northern pike, white sucker, and yellow perch. Fish passage to and from the lower reaches occurs throughout the year; however, it may be impeded some years by low water levels in Sawbill and Lynxhead Bays. There is no documented use of these features by walleye or smallmouth bass, although these species benefit from food resources produced in them.	■ Supports ecological integrity ■ Potentially affected (altered, diverted) by Project infrastructure ■ Alteration may result in loss of fish and productivity (e.g., critical habitats, food resources for fish) ■ Changes can be measured using a variety of standard indicators available (e.g., provincial and federal government criteria) ■ Baseline studies have shown lower reaches are used by fish from receiving waters as spawning and nursery habitat ■ Agency[(a)] concern	Benthic invertebrate community.	Density, Taxa Richness, Diversity, Evenness, Ephemeroptera Plecoptera Trichoptera (EPT) Index, water quality, aquatic sediment quality.
		Fish habitat suitability.	Percentage of waterbodies (within the Local Study Area (LSA)) with suitable habitat, habitat quantity, habitat quality (flows, water quality), habitat fragmentation, habitat use (e.g., distribution of fish within affected catchments).
		Persistence of fish community (resident assemblages/species present).	Fish community composition (e.g., species present) Species abundance Fish health (e.g., condition, parasites) Survival and reproduction

Table 1-2: Valued Ecosystem Components Selected for the Aquatic Environment (Continued)

VEC/VSC	Rationale for Selection	Indicators	Measures
Receivers: Sawbill/Lynxhead Bay (part of Upper Marmion Reservoir): Large bays and lakes are important both socio-economically and biologically. They provide an environment for tourism and angling and are sensitive receiving waters for any contaminants occurring within their watersheds. The receiving bays (Sawbill Bay and Lynxhead Bay) represent important habitat for locally important fish species and alteration of these habitats may result in loss of fish and productivity. These aquatic features are also a prime concern of regulatory agencies, the public and Aboriginal stakeholders. These habitats are currently impacted by water level fluctuations associated with operation of the Upper Marmion Reservoir. Sawbill Bay and Lynxhead Bay are the two bays of the Upper Marmion Reservoir that flank the Hammond Reef peninsula where the Project is located. Lynxhead Bay, on the southeasterly side of the peninsula, carries flows from the Upper Seine River westward past the end of the peninsula towards the Raft Lake Dam outflow of the Upper Marmion Reservoir. Sawbill Bay, on the northwesterly side of the peninsula, receives inflows from a number of small watersheds to the north and west of the peninsula. The bays provide habitat for walleye, small mouth bass, northern pike and baitfish species.	▪ Socio-economic importance (tourism, angling) ▪ Public and Aboriginal concern ▪ Primary receiving water environment ▪ Intake for Mine process water ▪ Receiving bays (mouths of small streams) potentially affected (altered, diverted) by Project infrastructure. ▪ Receiving bays may represent important habitat for locally important fish species. Alteration of habitats may result in loss of fish and productivity (e.g., critical habitats, food resources for fish) ▪ Changes can be measured using a variety of standard indicators available (e.g., provincial and federal government criteria) ▪ Agency concern	Benthic invertebrate community.	Density, Taxa Richness, Diversity, Evenness, EPT Index, water quality, aquatic sediment quality
		Fish habitat suitability (receiving bays).	Habitat suitability, habitat quantity, habitat quality (flows, water quality), habitat fragmentation, habitat use (e.g., distribution of fish within affected catchments).
		Persistence of fish community (resident assemblages/species present in receiving bays).	Fish community composition (e.g., species present) Species abundance Fish health (e.g., condition, parasites) Survival and reproduction
		Contaminants in fish tissue.	Concentration of Contaminants of Concern (COC) in fish tissue
Receivers: Lizard Lake, Area of Potential Impact (API) #8: Lizard Lake is important both socio-economically and biologically. It provides an environment for tourism and angling and is a primary receiver for any contaminants occurring within its watershed. Lizard Lake is a medium-sized lake located at the mouth of Lumby Creek, and empties into Turtle Bay and then into Hawke Bay/Lynxhead Bay of the Upper Marmion Reservoir. Lizard Lake has been identified as a lake with potential recreational value in MNRs Land Use Planning Guidelines. Lizard Lake provides habitat for walleye, small mouth bass, northern pike and baitfish species. This lake is also a concern of the public, regulatory agencies, and Aboriginal stakeholders. API#8 is a small lake that is tributary to Lizard lake and receives drainage from the TMF. It provides habitat for northern pike, yellow perch, pumpkinseed and baitfish species.	▪ Socio-economic importance (tourism, angling) ▪ Public and Aboriginal concern ▪ Primary receiving water environment ▪ Receiving bays (mouths of small streams) potentially affected (altered, diverted) by Project infrastructure. ▪ Receiving bays may represent important habitat for locally important fish species; alteration of habitats may result in loss of fish and productivity (e.g., critical habitats, food resources for fish) ▪ Changes can be measured using a variety of standard indicators available (e.g., provincial and federal government criteria) ▪ Agency concern	Benthic invertebrate community.	Density, Taxa Richness, Diversity, Evenness, EPT Index, water quality, aquatic sediment quality
		Fish habitat suitability (receiving bays).	Percentage of waterbodies (within LSA) with suitable habitat, habitat quantity, habitat quality (flows, water quality), habitat fragmentation, habitat use (e.g., distribution of fish within affected catchments)
		Persistence of fish community (resident assemblages/species present in receiving bays).	Fish community composition (e.g., species present) Species abundance Fish health (e.g., condition, parasites) Survival and reproduction
		Contaminants in fish tissue.	Concentration of COC in fish tissue

Table 1-2: Valued Ecosystem Components Selected for the Aquatic Environment (Continued)

VEC/VSC	Rationale for Selection	Indicators	Measures
Walleye: Walleye (*Stizostedion vitreum*) generally inhabit large shallow turbid lakes but can tolerate a wide variety of environments including large rivers. (Scott and Crossman 1973; Colby et al. 1979; Becker 1983). Lacustrine populations spawn in the lake itself or in tributary streams. Spawning occurs in the spring during April to June when water temperatures reach from 4.5 to 14°C. Eggs are laid over a substrate of rock, rubble, or gravel although if these are not available spawning may occur over sand or silt. (Eschmeyer 1950; Rawson 1957; Jessop et al 1973; Scott and Crossman 1973; Colby et al. 1979; Bodaly 1980; Becker 1983; Corbett and Powles 1986; Harbicht and Franzin 1988). Eggs are broadcast over the spawning substrate and fall into cracks and crevices. The eggs are adhesive and attach to the substrate where they will incubate. At temperatures between 6 and 12°C incubation takes approximately 15 to 34 days (Marshall 1977; Scott and Crossman 1973; Colby et al. 1979; Becker 1983). After hatching, fry migrate passively, carried by flowing water downstream into adjoining lakes or low flow areas. Young walleye will remain in the lake until they become mature and migrate into the river to spawn. Riverine fish, as they become stronger, will begin to swim continuously, find areas of little flow and cease to move downstream (Becker 1983; Corbett and Powles 1986; Jude 1992; Johnston et al. 1995; Mitro and Parrish 1997). Fry prefer habitats in which the water velocity is low, depths of 0.30 to 1.52 m and substrate of mud, silt, sand and gravel (McMahon et al. 1984). Juveniles prefer habitats where the water velocity is below 30 cm/s, depth between 0.91 and 2.13 m and a substrate of sand (McMahon et al. 1984; Ford et al. 1995). Juveniles will utilize turbidity, dark waters, logs and river banks as cover (Ford et al. 1995). In spring, walleye remain in the stream on average for five to six days to spawn and then move out of the stream to surrounding channels and lakes to feed for the summer (Falk et al. 1980). After spawning riverine adults move downstream or into larger tributaries or downstream lakes (Rawson 1957; Scott and Crossman 1973; Bodaly 1980). Most walleye, in northern rivers, are caught in the mouths of fast-flowing, rocky streams, having low turbidity levels. Adult walleye, like juveniles, are photosensitive and use turbidity, boulders, submerged logs, dark (“tea coloured” or otherwise pigmented) water, thick layers of ice, brush, river banks and submerged vegetation as cover (Scott and Crossman 1973; Ryder 1977; McMahon et al. 1984; Ford et al. 1995). Walleye are locally and regionally important to Aboriginal peoples and the public and have been a managed species in the Upper Marmion Reservoir. They provide economic value through angling for the local Aboriginal peoples and the public. Walleye are long-lived, top predator species (piscivorous) and will accumulate contaminants. They are consumed by anglers and subsistence fishers in the area and can potentially pass on their contaminant loads to these consumers.	▪ Socio-economic importance (angling) ▪ Traditional resource use (Aboriginal concern) ▪ Public concern ▪ Long lived, top predator species (piscivorous), will accumulate contaminants ▪ Human health; consumed by anglers, subsistence fishers	Walleye habitat. Contaminants in walleye flesh.	Habitat suitability, habitat quantity, habitat quality (flows, water quality), habitat fragmentation, habitat use (e.g., distribution of fish within affected catchments), Concentration of COC in fish tissue

Table 1-2: Valued Ecosystem Components Selected for the Aquatic Environment (Continued)

VEC/VSC	Rationale for Selection	Indicators	Measures
Smallmouth Bass: Smallmouth bass are associated with rocky and sandy regions of shallow areas of lakes and rivers (Scott and Crossman 1998). They are found throughout the water column; however, their occurrence varies with the season. In the winter, they are inactive and near the bottom. In the spring they occupy spawning areas and shallows. In the heat of the summer, they move to the deeper zones of the lake where the water is cooler (Scott and Crossman 1998). They are also highly associated with the cover of rocks and logs (Scott and Crossman 1998). In contrast to the largemouth bass, smallmouth bass are not often found in amongst dense vegetation, and they prefer lower temperatures of about 20ºC (Lane et al. 1996c). Sexual maturity is reached at the ages of 3 to 5 years for males and 4 to 6 years for females (Scott and Crossman 1998). In late spring to mid-summer, at water temperatures between 12 and 20ºC, the adult males move into the spawning areas and begin building nests. The females do not deposit eggs until the water temperature is between 16 and 18ºC. The nests are at depths between 1 and 6 m, and generally on sand, gravel, or rock bottom substrates. Nests are usually associated with in situ cover of rocks, logs or, less frequently, dense vegetation (Scott and Crossman 1998). The male guards the eggs and alevins, which emerge within four to 10 days of spawning (Scott and Crossman 1998). Small mouth bass are locally and regionally important to the Aboriginal Peoples and the public and have been a managed species in the Upper Marmion Reservoir. They provide economic value through angling and are the target species of a major fishing derby that occurs annually.	▪ Socio-economic importance (angling, Bass Classic fishing derby) ▪ Long lived, top predator species (piscivorous), will accumulate contaminants in water bodies where fish make up major portion of diet ▪ Sensitive to changes in littoral (shallow water) habitat ▪ Human health; consumed by anglers ▪ Public and Aboriginal Concern	Smallmouth bass habitat.	Habitat suitability, habitat quantity, habitat quality (flows, water quality), habitat fragmentation, habitat use (e.g., distribution of fish within affected catchments)

Table 1-2: Valued Ecosystem Components Selected for the Aquatic Environment (Continued)

VEC/VSC	Rationale for Selection	Indicators	Measures
Northern Pike: Northern pike (*Esox lucius*) generally inhabit weedy areas of slow meandering rivers and shallow areas of lakes (McPhail and Lindsey 1970; Scott and Crossman 1973; Becker 1983). They are not adapted for life in strong currents (rivers), and they occur more frequently in low flow or lake habitats (Crossman 1978). Northern pike spawn in the spring in rivers, streams, ditches, marshes, floodplains and inshore and offshore areas of lakes in areas with aquatic vegetation (Machniak 1975a). Fertilized eggs are adhesive and attach to the vegetation (Scott and Crossman 1973). In addition to aquatic vegetation, northern pike will also utilize vegetation consisting of hummocks of grasses and sedges to spawn (Casselman and Lewis 1996). Eggs hatch in 12 to14 days. After hatching the young immediately attach to flooded vegetation with an adhesive gland on top of the head until the yolk sac has been absorbed (Scott and Crossman 1973). Nursery habitats are located close to or at spawning areas and consist of dense submergent and emergent aquatic vegetation in back eddies or at the mouths of tributary streams (Jessop et al 1973; Casselman and Lewis 1996) or in submergent/emergent aquatic vegetation in shallow nearshore areas in lakes/ponds. Young remain in the spawning area for several weeks after hatching (Machniak 1975a). After spawning adults may remain in the spawning stream or move downstream to larger associated river channels or lakes. After spawning northern pike disperse to large weedy back eddies and mouths of tributaries that have a high abundance of forage fish or to areas, often remote from the spawning area, that consist of small back eddies or river mouths to feed (Jessop and Lilley 1975). Adults are typically found in shallow portions of rivers, with no velocity, over mud and silt, with aquatic vegetation used as cover (Ford et al. 1995). They will also utilize shallow, weedy bays of lakes. Pike are ambush predators and require cover in the form of aquatic plants, tree stumps, and fallen logs, and are usually most active during the daylight (Inskip 1982). Juveniles are typically found in depths less than 2 m, over mud and silt substrate with aquatic vegetation used as cover (Inskip 1982; Ford et al 1995). Northern pike were found to exist within several aquatic features within the MSA and LSA including Sawbill Bay, Lynxhead Bay and Lizard Lake.	▪ Socio-economic importance (angling). ▪ Long lived, top predator species (piscivorous), will accumulate contaminants ▪ Sensitive to changes in flow and are often found in small to moderate sized streams, with slackwater habitat or in shallow bays ▪ Human health; consumed by anglers, subsistence fishers ▪ Public and Aboriginal Concern	Northern pike habitat.	Habitat suitability, habitat quantity, habitat quality (flows, water quality), habitat fragmentation, habitat use (e.g., distribution of fish within affected catchments).

Table 1-2: Valued Ecosystem Components Selected for the Aquatic Environment (Continued)

VEC/VSC	Rationale for Selection	Indicators	Measures
Baitfish Species: Baitfish species are short-lived species whose populations can be expected to fluctuate substantially in dynamic environments such as streams. They are an important food resource for piscivorous species and, as such, impacts to baitfish directly impact higher trophic level species. Baitfish species also accumulate contaminants in their tissues through absorption over the gills, and the contaminants are then passed on to the higher trophic levels and contribute to the bioaccumulation of contaminants in predator species such as smallmouth bass, northern pike and walleye. Within the RSA, baitfish species have socio-economic importance as a commercial baitfish fishery. Typically, the baitfish species within the RSA include white sucker, finescale dace, northern redbelly dace, pearl dace, fathead minnow, log perch, and shiner species. Consultation with Aboriginal communities has indicated that baitfish are valued and represent a commercial fishery opportunity. White sucker, considered one of the baitfish species, is important due to the role the species plays in the food chain. They are valued by Aboriginal communities and even provide a commercial fishery for these communities as they are used as bait fish for angling and as bait on trap lines.	▪ Socio-economic importance (commercial baitfish fishery) ▪ Important food resource for large fish species (e.g., walleye, northern pike, smallmouth bass) ▪ Public and Aboriginal Concern	Baitfish habitat.	Habitat suitability, habitat quantity, habitat quality (flows, water quality), habitat fragmentation, habitat use (e.g., distribution of fish within affected catchments).

Notes:
(a) Agencies include the Ontario Ministry of Natural Resources (MNR), Fisheries and Oceans Canada (DFO), the Ministry of Northern Development and Mining (MNDM), the Ontario Ministry of Natural Resources (MOE), Environment Canada (EC), and the Canadian Environmental Assessment Agency (CEA Agency).

Healthy aquatic populations persist and thrive within a range of physical and chemical conditions. Fish require suitable areas to reproduce, feed and seek refuge from predators and hostile conditions (e.g., during extended periods of cold or hot weather) and the opportunity to move between such areas. If habitat quantity or suitability is altered, some of the fish species may avoid unfavourable conditions, and abandon sections of aquatic features. Quantitative indices of fish community dynamics, such as population size, recruitment and relative abundance, are difficult to measure and highly variable. Fish populations fluctuate naturally in response to climatic variables, and natural fluctuations are difficult to discern from changes in response to anthropogenic stressors. However, changes in habitat suitability (e.g., the ranges of physical and chemical conditions preferred or tolerated by fish), fish community composition and distribution are measurable indicators.

Benthic invertebrates are animals without backbones that live on the bottoms of rivers and lakes. They are an important source of food for fish. Many are immature stages of insects such as mayflies (Ephemeroptera), stoneflies (Plecoptera), caddisflies (Trichoptera), and midges (Diptera: Chironomidae). Benthic invertebrates also include non-insect groups such as aquatic worms (Oligochaeta), leeches (Hirudinea), snails (Gastropoda), clams (Pelecypoda), crustaceans (e.g., Amphipoda), and mites (Acari). The variety and abundance of these animals reflect the type of habitats they inhabit, as well as water and sediment quality conditions. They are also less mobile than fish and though largely sedentary, they often exploit a much broader range of habitat conditions than fish. For these reasons, benthic invertebrate communities are commonly used for monitoring potential effects of industrial activities (Rosenberg and Resh 1993), such as the proposed Project. The Metal Mining Environmental Effects Monitoring Technical Guidance Document (EC 2011) provides guidance on appropriate indices used to monitor the health of benthic communities. These indices are useful for environmental monitoring programs to assess future changes in the aquatic environment due to Project activities.

There are existing federal and provincial criteria for measuring water quality and aquatic sediment parameters. Sediments are an important “sink” (or site/source for deposition/accumulation) for most metals in the aquatic environment. Provincial and Canadian guidelines or objectives for water quality (Ontario 1994; CCME 1999) and aquatic sediment (MOE 1993; CCME 2001) should be consulted to assess the suitability of surface water and sediment quality to support aquatic life. Fish community diversity and distribution (e.g., habitat use) should reflect changes in habitat suitability. These indices can be readily measured and monitored using the techniques employed during baseline studies.

Many metals do not bioaccumulate in fish tissue. Metals accumulation is dependent on bioavailability, which is primarily determined by metal speciation. Most metals, when ingested, have low toxicity to consumers including humans, and health related metal concentration criteria have not been developed for many metals. Fish can assimilate metals by ingestion of particulate matter suspended in the water column, food, ion exchange and adsorption on tissue and membrane surfaces. Metal scans were completed on muscle tissue and whole body composite samples from a variety of fish species, representing various trophic levels of the aquatic environment, during baseline studies. Metals that were measured during baseline studies and having the highest toxicity to humans (Phillips and Russo 1978) included arsenic, cadmium, lead, mercury and selenium. Methylmercury (MeHg) has high potential for bioaccumulation and biomagnifications with increasing trophic levels. Inorganic mercury and MeHg can be taken up by aquatic organisms directly from water or through their diet. Uptake is the result of dissolved mercury absorption through the body surface or gills or through the digestion of other aquatic biota. Some fish may be affected by sediment mercury levels, particularly bottom-feeding species (i.e., sucker species) that incidentally ingest sediment. Mercury sources are generally the result of loading to the water body, from air deposition, erosion from the watershed, or in heavily developed areas, direct discharges. A fraction of

the mercury deposited to sensitive landscapes is converted to the bioaccumulative form, methylmercury, in wetlands, sediments and other favourable environments. This conversion process is amplified under conditions of low pH, high sulphate concentrations, and in dark water systems (i.e., high dissolved organic carbon) (Evers et al. 2011). Microbial activity converts some of the inorganic mercury to methylmercury (Matilainen 1995). Fish and fish eating mammals and birds accumulate most of their mercury burdens through their diet (Evers et al. 2011).

1.7 Temporal and Spatial Boundaries

Project activities and the potential changes that they may produce on the environment are subject to temporal and spatial boundaries. These boundaries are common to all environmental components but with some modifications. The temporal and spatial boundaries specific the Aquatic Environment TSD are described in the following sections.

1.7.1 Temporal Boundaries

The Project's temporal boundaries for the assessment of the aquatic environment are directly related to the Project phases:

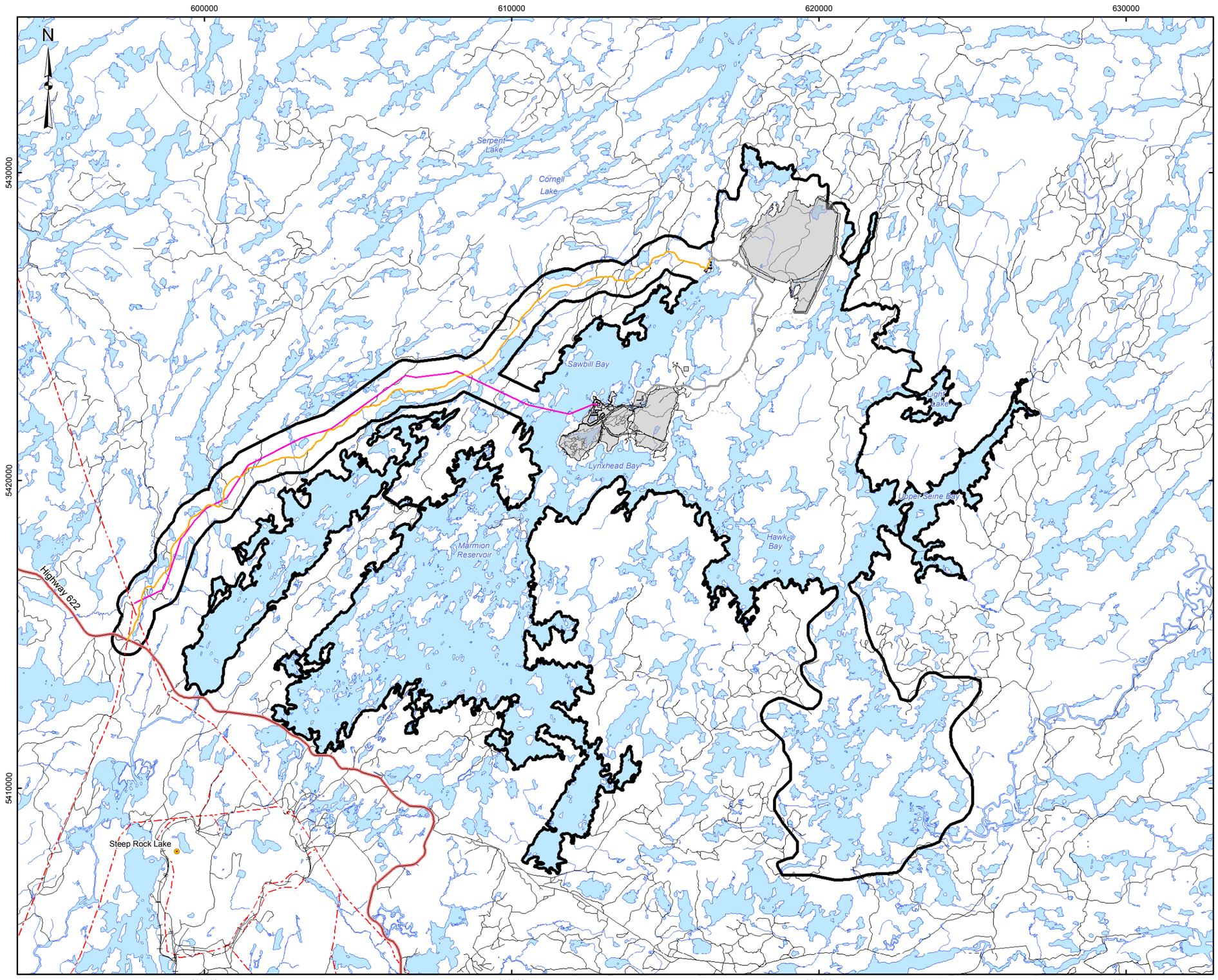
- Construction phase: 30 months.
- Operations phase: 11 years.
- Closure phase: 2 years.
- Post-closure phase: 10 years minimum

1.7.2 Spatial Boundaries

Spatial boundaries define the geographical extents within which potential environmental changes may occur. As such, spatial boundaries become the Project's study areas. The study areas for the aquatic environment were selected based on the following factors:

- Project Site (i.e., potential for direct effects).
- Potential for indirect effects.

This TSD has four study areas, as described in the following sections (Figures 1.3, 1.4 and 1.5).



LEGEND

- Small Community
- Provincial Highway
- Road
- Existing Railway
- Power Transmission Line
- River/Stream
- Lake
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities
- Aquatic Environment Regional Study Area

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd. under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2.5 1.25 0 2.5 5 7.5
KILOMETRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

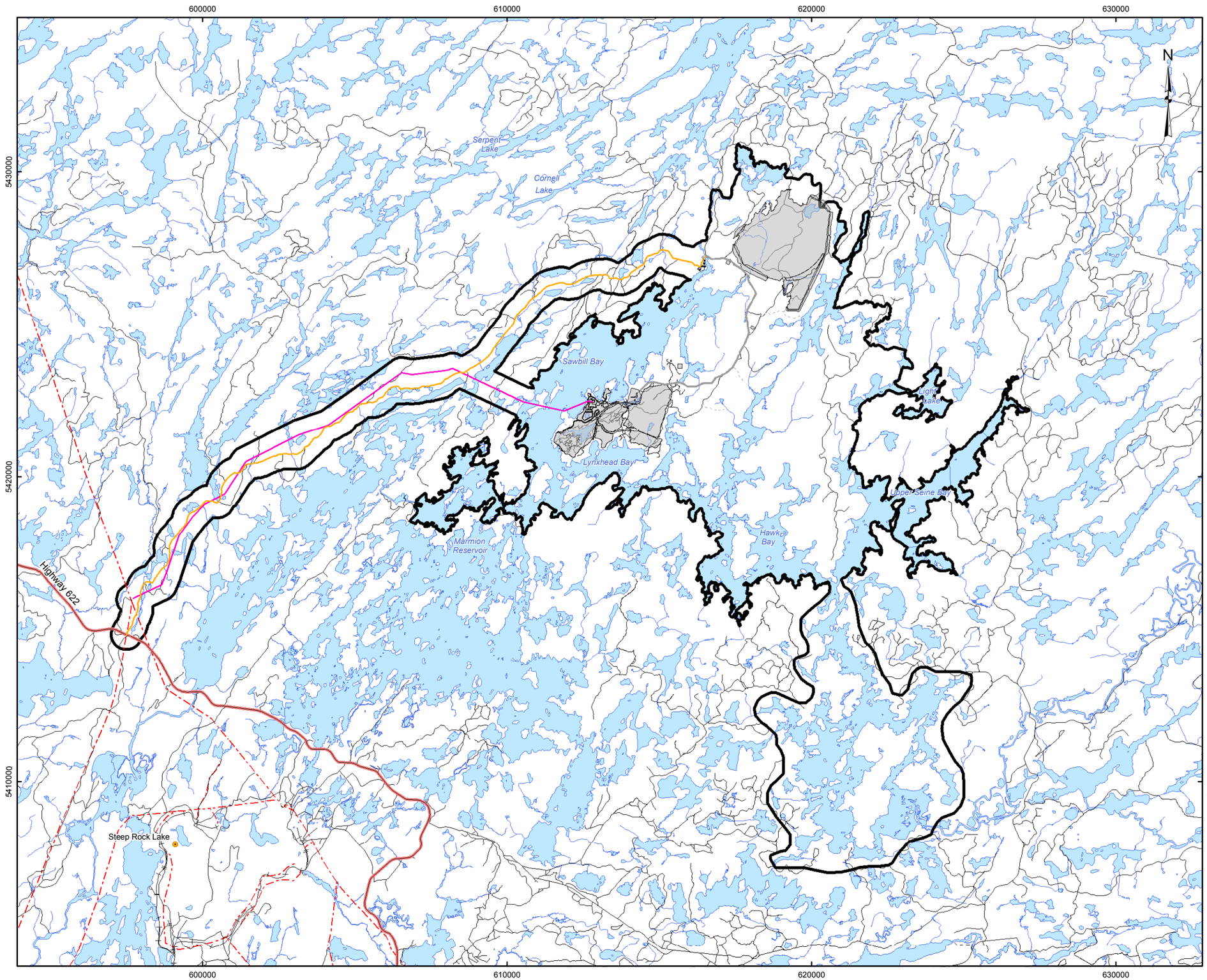
TITLE
AQUATIC ENVIRONMENT REGIONAL STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	8 Jan. 2013		
GIS	JO	7 Feb. 2013		
CHECK	BH	7 Feb. 2013		
REVIEW	GA	7 Feb. 2013		

FIGURE: 1-3

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\TSD\AquaticEnvironmentRSA.mxd



LEGEND

- Small Community
- Provincial Highway
- Road
- Existing Railway
- Power Transmission Line
- River/Stream
- Lake
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities
- Aquatic Environment Local Study Area

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2.5 1.25 0 2.5 5 7.5
KILOMETRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

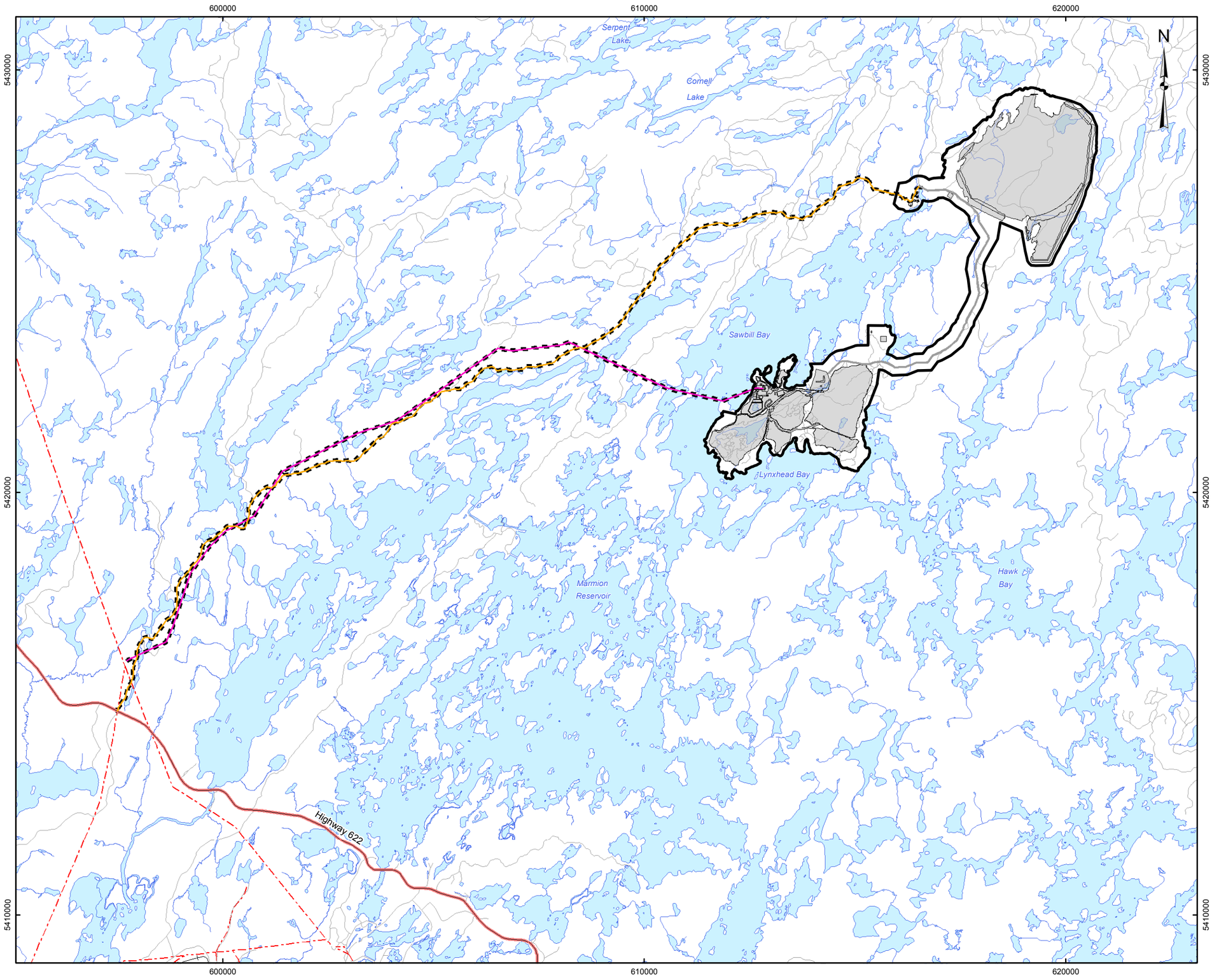
TITLE
AQUATIC ENVIRONMENT LOCAL STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	8 Jan. 2013		
GIS	JO	7 Feb. 2013		
CHECK	BH	7 Feb. 2013		
REVIEW	GA	7 Feb. 2013		

FIGURE: 1-4

G:\Projects\2010\10-1118-0020_Brett\Resources_HammondReef\GIS\MXDs\Draft\Aquatics\TSD\AquaticEnvironmentLSA.mxd



LEGEND

- Provincial Highway
- Road
- Existing Railway
- Power Transmission Line
- River/Stream
- Lake
- Linear Infrastructure Study Area
- Mine Study Area
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2 1 0 2 4
KILOMETRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
LINEAR INFRASTRUCTURE AND MINE SITE STUDY AREAS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	8 Jan. 2013		
GIS	JO	7 Feb. 2013		
CHECK	BH	7 Feb. 2013		
REVIEW	GA	7 Feb. 2013		

FIGURE: 1-5

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\DraftAquaticsTSDStudyAreas.mxd

1.7.2.1 Local Study Area

The Local Study Area (LSA) encompasses all water courses within the Project Site as well as the watercourses crossed by the linear infrastructure features (see Section 1.7.2.3), or within a 1 km wide corridor, centred on the proposed access road (Hardtack/Sawbill) and the right-of-way (RoW) of the project transmission line. The boundaries of the LSA are defined by the extent of Upper Marmion Reservoir (also known as the Upper Floodwaters Area) from the inlet of the Seine River in Upper Seine Bay to the Raft Lake and the Marmion Reservoir dam and sluiceway, as shown in Figure 1-4. The primary rationale for the selection of these boundaries is that fish populations in Upper Marmion Reservoir may be indirectly or directly impacted by the Project. Fish populations within the LSA are somewhat isolated from other water bodies in the Seine River watershed.

1.7.2.2 Mine Study Area

The Mine Study Area (MSA) encompasses the footprints of the Mine, the Waste Rock Management Facility, the Ore Processing Facility, the Tailings Management Facility, and the Support and Ancillary Infrastructure. The MSA is show in Figure 1-5.

1.7.2.3 Linear Infrastructure Study Area

The Linear Infrastructure Study Area (LISA) encompasses the footprints of the access road (Hardtack/Sawbill) and the project transmission line (Figure 1-4). The LISA is represented by a Y-shaped area that extends 30 m on either side of the central line of the access road (Hardtack/Sawbill) and a 50 m wide corridor for the project transmission line.

1.7.2.4 Regional Study Area

The Regional Study Area (RSA) includes the Local Study Area, as well as the adjacent waterbodies that are connected to the LSA, immediately downstream as shown in Figure 1-3. This includes Lower Marmion Reservoir and Finlayson Lake. These waterbodies are included in the RSA because of the potential for indirect effects of the Project to impact them, and because there is some movement of fish between the Upper Marmion Reservoir and these two waterbodies. Fish are able to pass over the Raft Lake Dam into Finlayson Lake and fish may pass in both directions through the Marmion Reservoir sluiceway at certain times of the year (Jackson 2007).

2.0 EXISTING CONDITIONS

2.1 Methods

Golder Associates Ltd. (Golder) conducted aquatic habitat and community mapping and field studies for the MSA and LSA to characterize and evaluate the existing environment and to provide baseline data to support the environmental assessment process and permitting for the Project. The process consisted of consultation with regulatory agencies, Aboriginal engagement, a review of existing data sources, and aquatic field studies, which were conducted during the spring and summer of 2010, 2011 and 2012. Detailed methods and results summaries are provided in Appendix 2.II.

Based on a preliminary site plan and alternatives for the access road provided by OHRG, Golder developed a sampling program to characterize existing conditions, describe aquatic habitats and communities in potentially affected water bodies, confirm reference locations and identify opportunities for habitat compensation. Within each potentially affected catchment, watercourses, beaver ponds and lakes were identified as Areas of Potential Impact (APIs) and effort was focussed on the assessment of all APIs, on multiple occasions. A total of 55 APIs within and adjacent to the proposed Mine and TMF and 14 APIs along the proposed alternatives for the access road were assessed. In addition, sampling and habitat mapping was also completed at the mouths of watercourses reporting to Sawbill Bay, Lynxhead Bay and Lizard Lake, the primary receivers.

Areas of Potential Impact (APIs) are any waterbody within the MSA and its immediate vicinity and along the right-of-way of the access road (Hardtack/Sawbill) and the project transmission line that could potentially be impacted by the Project and that potentially could represent fish habitat. These included major receivers, such as Sawbill Bay and Lynxhead Bay of Upper Marmion Reservoir, Lizard Lake, API#8; small lakes such as API#2; beaver ponds; and streams. All APIs were visited during the sampling program and either walked for their entire length or traversed by boat, to comprehensively evaluate aquatic habitats present, document species present, and identify habitat constraints, such as barriers to fish movement. A number of APIs also were assessed in terms of their potential to be part of the fish habitat compensation planning for the Project.

The APIs assessed included water bodies potentially indirectly affected by Mine operations (e.g., up and down gradient of the Project Site) and aquatic features directly affected (e.g., water bodies potentially eliminated by construction and operation of the mine), including natural water bodies frequented by fish (fish-bearing waters) that may require listing within Schedule 2 of the Metal Mining Effluent Regulation (MMER).

Golder completed aquatic field studies in 2010, 2011 and 2012. They included the characterization of aquatic habitat, collection of basic surface water quality data (e.g., pH, temperature, dissolved oxygen, conductivity), benthic invertebrate community (BIC) and fish community assessment, and the analysis of metals concentrations in fish muscle tissue. Data were collected and archived using the field methods outlined in Golder's technical procedures and described in Appendix 2.II.

2.1.1 Regulatory Consultation

Recognizing the importance of addressing aquatic community and aquatic habitat concerns, OHRG initiated consultation with regulatory agencies early in the Project planning phase. A series of meetings and workshops were held with regulatory agencies to review and discuss a number of aquatics related issues.

These included soliciting input on baseline studies and on the development of a fish habitat No Net Loss Plan (NNLP) for the Project. Participating agencies included local and regional offices of the Ontario Ministry of Natural Resources (MNR) and Fisheries and Oceans Canada (DFO). Other agencies including the Canadian Environmental Assessment Agency (CEA Agency), Environment Canada (EC), Ontario Ministry of Northern Development and Mines (MNDM) and Ontario Ministry of Environment (MOE) were consulted early and throughout the environmental assessment process. MNR and DFO were given an opportunity to review fish and fish habitat baseline studies, to identify locations where additional aquatic information may be required to support the environmental assessment and permitting processes. Agencies were provided with opportunities to review and comment on baseline study methods and results, and on the development of an acceptable method of quantifying fish habitat losses and gains. A habitat accounting protocol was developed consistent with other NNLPs developed and approved for other mining projects by Golder, which was reviewed by Dr. C.K. Minns, an expert in habitat modeling and former DFO staff member, at the request of DFO. The workshops were also used to discuss options for providing compensation to offset habitat losses.

Table 2-1 shows a chronology of agency consultation for aquatic ecology studies for the Project. Additional meetings will be organized as part of the development and finalization of the NNLP.

Table 2-1: Regulatory Agency Consultation for Aquatic Ecology Studies

Date	Agency/Staff Invited/*Attended*	Consultation
April 13, 2011 (Thunder Bay)	*DFO/T. Kleinboeck*, DFO/N. Ward, *MNR/B. Jackson, MNR/A. Godwin*, MNR/K. Armstrong, MNR/ Sobchuk, *CEAA/A. Lui*, ENE/M. Whitmore, ENE, T. Kondrat, MOE/J. Sutton, MNDM/M. O'Brien	■ Overview of 2010 baseline work ■ Summary of key results ■ Presentation of 2011 field program
July 12, 2011 (Atikokan)	*DFO/T. Kleinboeck*, DFO/N. Ward, *MNR/B. Jackson, MNR/A. Godwin*, MNR/K. Armstrong, MNR/ Sobchek, CEAA/A. Lui, ENE/M. Whitmore, ENE, T. Kondrat, MOE/J. Sutton, MNDM/M. O'Brien	■ Overview of 2011 baseline work ■ Review of data collection methods ■ Initiate discussion on compensation ■ Discuss potential compensation opportunities
September 14, 2011 (Atikokan)	*DFO/T. Kleinboeck*, DFO/N. Ward, *MNR/B. Jackson, MNR/A. Godwin*, MNR/K. Armstrong, MNR/ Sobchek, CEAA/A. Lui, ENE/M. Whitmore, ENE, T. Kondrat, MOE/J. Sutton, MNDM/M. O'Brien	■ Discussion on sampling effort and treatment of wetlands ■ Review of approach to habitat accounting ■ Discuss collection of additional data to fill gaps ■ Helicopter tour of APIs/project site
February 29, 2012 (Thunder Bay)	*DFO/T. Kleinboeck, DFO/N. Ward, MNR/B. Jackson, MNR/A. Godwin, MNR/K. Armstrong, MNR/Sobchuk*, *CEAA/A. Lui*, ENE/M. Whitmore, ENE, T. Kondrat, MOE/J. Sutton, *MNDM/M.* O'Brien/*P. Barnes*	■ Present habitat preference tables ■ Discussion of compensation opportunities ■ Discussion of alternative habitat accounting methods – HATT/HEP/Meliadine ■ Discussion of baseline results and 2012 field program suggestions

Table 2-1: Regulatory Agency Consultation for Aquatic Ecology Studies (Continued)

Date	Agency/Staff Invited/*Attended*	Consultation
June 4, 2012 (Thunder Bay)	DFO/T. Kleinboeck, DFO/N. Ward, MNR/B. Jackson, MNR/A. Godwin, MNR/K. Armstrong, MNR/S. Bobrowicz, CEAA/A. Lui, ENE/M. Whitmore, ENE, T. Kondrat, MOE/J. Sutton, MNDM/M. O'Brien	■ Presentation and discussion of Interim Baseline Report ■ Discussion of potential data gaps and 2012 field sampling program ■ Presentation and discussion of Baseline Report conclusions
June 19, 2012 (Atikokan)	MNR/B. Jackson, MNR/A. Godwin, MNR Steep Rock Project Staff	■ Tour and discussion of Steep Rock Site and Project
October 22, 2012 (Thunder Bay)	*DFO/T. Kleinboeck, DFO/N. Ward, MNR/B. Jackson, MNR/A. Godwin,* MNR/K. Armstrong, MNR/S. *Bobrowicz, CEAA/A. Lui, ENE/M.* Whitmore, ENE, T. Kondrat, *MOE/J. Sutton, MNDM/M. O'Brien*	■ Presentation of fish habitat accounting procedure and NNLP approach ■ Discussion of preliminary calculations of habitat losses and gains ■ Review proposed Fisheries Act changes ■ Presentation of fish salvage and rescue plan
October 31, 2012 (Toronto)	*DFO/L. Fowler, CEAA/A. Lui,*	■ Presentation on overview of the Project ■ Presentation of fish habitat accounting procedure and NNLP approach ■ Discussion of preliminary calculations of habitat losses and gains ■ Review proposed Fisheries Act changes ■ Presentation of fish salvage and rescue plan
November 20, 2012 (Toronto)	*CEAA/A. Blajchman, MOE/S. Hysenaj, MOE/D. Laverdiere, NCR/C. Dumaresq, NCR/P. Billau, EC/F.Beaudet, NRC/A. Magee, EC/R. Dobos, DFO/N.Ward, DFO/L. Fowler*, DFO/T. Kleinboeck, MNDM/P. *Barnes, CEAA/A. Lui*, ENE/M. Whitmore	■ Presented and discussed approach to evaluating TMF alternatives ■ Reviewed "dry land" TMF alternative ■ Discussion of Detour Lake Project Agency review letters ■ Preliminary discussion of MMER Schedule 2 requirements and listed waterbodies

These meetings and discussions with regulators occurred throughout the project investigations and led to a number of key changes to address the concerns of these agencies as the study progressed. Key changes included the following:

- Expansion of the field program to increase the level of effort on selected waterbodies and to increase agency confidence in field study findings; for example, conclusions that some waterbodies were fishless.

- Changes to the fish habitat accounting procedure, including consensus on the approach taken, review of the methodology by a DFO recommended expert and inclusion of additional reference material.
- Detailed discussion of compensation measures and alternatives, in particular, site visits to Steep Rock site and support for use of Steep Rock remediation as an offsite compensation alternative.

2.1.2 Aboriginal Engagement

During the aquatic field investigations of 2011, Aboriginal monitors accompanied field crews conducting fish sampling, aquatic habitat mapping, bathymetric surveys and collection of fish for analyses. Aboriginal monitors participated in the aquatic field activities July 4 to 8, 2011 (bathymetry), and August 22 to September 2, 2011 (aquatic biology). Participation of the representatives facilitated an exchange of traditional knowledge with Project knowledge.

Additionally, Aboriginal consultation raised the concern for traditional use of fisheries resources in the LSA and near the MSA.

2.1.3 Secondary Data Review

The Marmion Reservoir has been a focus of MNR fisheries management over the past two decades, and, in particular, MNR has been interested in potential impacts on the walleye sports fishery, which was closed in the late 1990s in response to estimates of population declines (MNR 1989, Jackson 1995, 1996, 2007a, 2007b). MNR identified a reduction of spawning success related to the Atikokan Thermal Generating Station (TGS), and a walleye spawning shoal was constructed at the inlet to Abie Lake to enhance spawning habitat. Monitoring of this spawning shoal and subsequent population assessments indicate that the walleye population is showing signs of recovery. As part of their past assessment work, MNR have identified Lynxhead Narrows as a potential walleye spawning area in Upper Marmion Reservoir.

Available MNR data were reviewed in development of the VECs and baseline programs. Additional information sources included the following:

- **Land Information Ontario (LIO):** LIO manages key provincial geospatial datasets. Examples of datasets are Ontario roads and trails. LIO also coordinates public and private sector organizations to collect high resolution satellite imagery for Ontario (MNR 2012a).
- **Natural Resource Values Information System (NRVIS):** NRVIS is a GIS-based system for managing the storage of the MNR's digital land information. It provides the ability to store, maintain and access information on over 690 different geographic feature types, such as roads, lakes, spawning sites, and traplines (MNR 2012b).
- **Natural Heritage Information Centre (NHIC):** The NHIC compiles, maintains and distributes information on natural species, plant communities and spaces of conservation concern in Ontario. This information is stored in a spatial database used for tracking this information (MNR 2009a).
- **Royal Ontario Museum (ROM) Species at Risk Website:** The ROM website provides regional lists and factsheets on Ontario's Species at Risk (ROM 2012).
- **Contact with Local Naturalists and Hunters:** Knowledge of fishing activities in the area was provided in consultation with Mr. Jeremy Dickson, local resident and owner of Canoe Canada Outfitters and John

Charbonneau (Atikokan Sportsman Club). Other fishing information was obtained through Aboriginal and public consultation.

- **Forest Management Plans:** 2007-2017 Forest Management Plan for the Cross Route forest (Abitibi Consolidated 2006).
- **Other Resources for Fish:** Other on-line resources for fish data were searched but did not have coverage for our study areas. Additional information was obtained through interviews/discussion with local and regional MNR staff and from the Atikokan District Fisheries Management Plan (MNR 1989).

2.1.4 Field Studies

The aquatic study was developed to provide a comprehensive database of aquatic communities and aquatic habitats that may be affected by the Project and as a baseline against which to measure Project effects on the aquatic environment from all phases of the Project. Initially, a reconnaissance level aerial and ground survey of the MSA was completed to identify all waterbodies that were potentially affected by the Project, including the preliminary access roads and TMF alternatives. Based on this preliminary work, a list of waterbodies to be inventoried was prepared. In preparation for field work, catchment areas of the MSA were identified and field maps and standard datasheets were prepared.

Geo-referenced sampling locations and effort data were recorded at each API. Detailed field maps were prepared for each API and an extensive library of photographs was collected. The objective of the field program was to physically walk all stream APIs and visit all API waterbodies on multiple occasions to ensure that habitats were observed/assessed in multiple seasons, and for key features, in multiple years.

A range of fish collection methods were employed, depending on physical characteristics of each aquatic feature (e.g., stream/pond depth). Descriptions of each type of gear and its range of application are provided in Section 2.1.4.2. A backpack electrofisher was used in wadable streams and the margins of small waterbodies such as beaver ponds. A portable, boat mounted electrofisher and netting gear was used in the vicinity of existing dams and near the mouths of small streams. Minnow traps, small mesh Nordic gill nets and Experimental gill nets (see Section 2.1.4.2 for definitions of fishing gear) were deployed overnight in headwater lakes and ponds located within study areas, and to collect fish tissue samples for background contaminant analyses.

For each stream API, backpack electrofishing, minnow traps and expert observations were employed at a minimum. Where streams were impounded by beaver dams, the same sampling gear was used. If the beaver ponds were sufficiently large or deep, gillnets also were employed. In such cases, where the size and depth of beaver ponds and other small headwater ponds were conducive to gillnetting, Experimental gangs or, where fishable area was limited, single panels of Experimental gangs (38 mm and 76 mm mesh) were deployed. Multiple gears were deployed during the assessment of each aquatic feature.

For larger ponds, small lakes and receiving waterbodies, backpack electrofisher or seine nets, Broadscale gillnets and Experimental gillnets, boat electrofisher and minnow traps were all utilized, depending on the physical characteristics of the waterbody, to effectively sample the range of habitats present in each waterbody.

All stationary gear (gillnets and minnow traps) were deployed overnight and fished for 15 to 20 hours.

Basic water quality data (in situ measurements of pH, conductivity, water temperature, dissolved oxygen concentration, and turbidity) were collected to supplement fish habitat characterization.

Samples of tissues from fish species captured in potential receiving water bodies were retained for analyses of heavy metals and other contaminants that may pose risks for human health.

Locations of all gear sampling locations were recoded and mapped. Detailed catch records of each gear sampling event were recorded and all species were identified and enumerated. Subsamples of each sportfish were also weighed and measured. Enumeration of species was also split into the following categories: young-of-the-year, juveniles, and adults.

Aquatic baseline studies were carried out in 2010, 2011 and 2012. All lakes, ponds, beaver ponds, and tributaries in the MSA were visited on at least two occasions over the three year sampling program. A number of key features were sampled in all sampling years as shown in Table 2-2, and in Figure 2-1.

Table 2-2: Summary of Field Program Dates

Field Data Collected	2010	2011	2012
Fish and Aquatic Habitat	May 8 -15, August 1-6, 18-29, September 23-30, October 14-20	May 3-10, May 27 - June 5, August 26-30, September 23-29	August 22-31, September 13-22
Fish Tissue	August 18-29	September 23-29	
Benthic Invertebrates	October 14-20		
Aquatic Sediments	October 14-20		

Details on sampling of each of the APIs are provided in Appendix 2.II. A summary of field sampling efforts for the Project from 2010 to 2012 is provided in Table 2-3 by each of the APIs within the MSA. Details of sampling of other APIs are provided in Appendix 2.II.

Table 2-3: Summary of Field Sampling Efforts by Area of Potential Impact

Area of Potential Impact	Sample Dates	Sampling
API #1	May 2011	Water Chemistry, Fish Inventory, Habitat Mapping
	June 2011	Fish Inventory, Habitat Mapping
	August 2011	Fish Inventory, Habitat Mapping
API #2	October 2010	Water Chemistry
	June 2011	Water Chemistry
	September 2012	Fish Inventory, Habitat Mapping
API #6	October 2010	Water Chemistry, Fish Inventory, Habitat Mapping
	May 2011	Water Chemistry, Fish Inventory, Habitat Mapping
	August 2011	Water Chemistry, Fish Inventory, Habitat Mapping
	August 2012	Water Chemistry, Fish Inventory, Habitat Mapping
	September 2012	Water Chemistry, Fish Inventory, Habitat Mapping

Table 2-3: Summary of Field Sampling Efforts by Area of Potential Impact (Continued)

Area of Potential Impact	Sample Dates	Sampling
API #7	May 2010	Water Chemistry, Fish Inventory, Habitat Mapping
	October 2010	Water Chemistry, Fish Inventory, Habitat Mapping
	May 2011	Water Chemistry, Fish Inventory, Habitat Mapping
	August 2011	Water Chemistry, Fish Inventory, Habitat Mapping
API #8	October 2010	Water Chemistry, Fish Inventory, Habitat Mapping
	September 2012	Water Chemistry, Fish Inventory, Habitat Mapping
API #11	September 2010	Water Chemistry, Fish Inventory, Habitat Mapping
	October 2010	Water Chemistry
	August 2011	Water Chemistry, Fish Inventory, Habitat Mapping
	September 2011	Water Chemistry, Fish Inventory, Habitat Mapping
API #12	August 2010	Water Chemistry, Fish Inventory, Habitat Mapping
	September 2010	Fish Inventory, Habitat Mapping
	March 2011	Water Chemistry
	May 2011	Fish Inventory, Habitat Mapping
	June 2011	Water Chemistry, Fish Inventory, Habitat Mapping
	September 2011	Water Chemistry
	November 2011	Water Chemistry
API #13	August 2010	Water Chemistry, Fish Inventory, Habitat Mapping
	September 2010	Water Chemistry, Fish Inventory, Habitat Mapping
	May 2011	Water Chemistry, Fish Inventory, Habitat Mapping
	August 2011	Water Chemistry, Fish Inventory, Habitat Mapping
	September 2011	Water Chemistry, Fish Inventory, Habitat Mapping
	September 2012	Water Chemistry, Fish Inventory, Habitat Mapping
API #14	August 2010	Water Chemistry, Fish Inventory, Habitat Mapping
	May 2011	Water Chemistry, Fish Inventory, Habitat Mapping
	September 2011	Water Chemistry, Fish Inventory, Habitat Mapping

610000 620000 630000

5430000 5420000

N

Serpent Lake
Cornell Lake
Sawbill Bay
Mitta Lake
Lynxhead Bay
Marmion Reservoir
Light Lake
Upper Seine Bay
Hawk Bay

LEGEND

- Area of Potential Impact (API); Assessed 2010 - 2012
- Raft Lake Cut Location
- Trail
- Road
- River/Stream
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREAS OF POTENTIAL IMPACT

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008		
GIS	JO	11 Feb. 2013		
CHECK	BH	11 Feb. 2013		
REVIEW	GA	11 Feb. 2013		

FIGURE: 2-1

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\AquaticsTSD\foot_print_api.mxd

2.1.4.1 Fish Collection Methods

The objectives of fish community assessment studies were to establish what fish species were present, verify the presence of various life history stages, identify fish frequented waters and non-fish bearing waters relative to the MSA and collect samples to determine baseline concentrations of metals in fish muscle tissue. A variety of gears and techniques were utilized to confirm fish presence and fish community composition. Stationary fishing gears were set for 18 to 24-hour periods and at variety of depths in ponds and small lakes, and in a variety of habitats in watercourses. Because of the nature of gillnetting gear (e.g., tangling gear) and the duration of sets, a large proportion of fish captured in gillnets were mortalities. Fishing gears included the following:

- **Nordic Nets:** The Nordic net is an internationally adopted netting gear used to characterize fish assemblages and assess fish community diversity in a variety of Scandinavian countries and within the Province of Ontario (Morgan and Snucins 2005). Nordic nets consist of 30 m long, 1.5 m high gangs of 12 different 2.5 m-long panels of 10 mm to 55 mm nylon mesh. These nets are suited to smaller, shallower lakes and where there is potential to capture smaller fish.

- **Standard Experimental Gill Net Gangs:** The standard Experimental gang was adopted by the MNR in the late 1970s as the standard gear used to determine fish community composition for the Province's lake and river assessment program (MNR 1979). Experimental gangs consist of eight, 1.5 m-high, 15.2 m-long panels of 38 mm, 51 mm, 64 mm, 76 mm, 89 mm, 102 mm, 114 mm and 127 mm stretched multifilament mesh. These nets are suited to a range of lake sizes, and are standardized to capture small and large-bodied fish.

- **Large and Small Mesh Broadscale Monitoring Nets:** The large mesh gillnet has been proposed by the American Fisheries Society as a North American standard for sampling angler harvested freshwater species. The small mesh gillnet is a new standard, developed in Ontario (Sandstrom et al. 2010). Jointly, the large and small mesh gillnets span a mesh size range that is similar to the Nordic gang. Large mesh broadscale nets are 49.6 m long and are comprised of eight, 3.1 m panels consisting of 38 mm, 51 mm, 64 mm, 76 mm, 102 mm, 114 mm and 127 mm stretched, monofilament mesh. Small mesh Broadscale nets are 25 m long and are comprised of 1.8 m high panels of 13 mm, 19 mm, 25 mm, 32 mm and 38 mm stretched monofilament mesh. This nets have similar application to standard Experimental gillnet gangs but they generally are more suited to short duration sets and can cover a wider depth range per net set than other gillnet types.

- **Minnow Traps:** A minnow trap is a small metal cylinder with narrow openings at either end that is typically used by anglers to collect baitfish. It can be baited with different baits, such as bread or meat scraps, to attract different small-bodied fish, and is usually used as a scientific apparatus to collect small fish or young-of-the-year (YOY) fish. These are best suited for shallow inshore waters of lakes, ponds and wetlands, as well as streams and rivers and are effective at capturing small bodied fish and the juvenile stages of large-bodied fish.

- **Seine Netting:** A 15.2 m bag seine consisting of 6 mm nylon mesh was used to capture fish in shallow habitats where the bottom consisted of hard, near-flat substrates with minimal organic debris (e.g., sunken branches). Seining effort is presented as area seined in square metres (m^2). This technique is best suited to shallow inshore waters of lakes and ponds and rivers and streams and is effective at capturing a range of small and large bodied fish. Seining is not effective in waters over 1 m depth or where the substrate has

numerous snags to catch the net or soft bottoms where wading is impractical. Seining also requires an open area on shore to pull the net out of the water, such as a beach.

- **Backpack Electrofishing:** A backpack electrofisher is a device that consists of an anode (usually designed as a dipnet) and cathode (usually designed as a trailing metal wire or "rat tail") that creates an electric field around the operator. The operator walks in wadable waters, such as small streams, and fish are momentarily rendered immobile by the electric field and can be captured on the anode or by a second person with a dipnet. Fish generally recover quickly and can be released. Backpack electrofishers are best suited to shallow water habitats, usually up to 1 m deep, and are effective in sampling streams and rivers and shallow nearshores of lakes, ponds and wetlands. They capture both small and large-bodied fish, but may miss benthic fish species that remain on the bottom.

- **Boat Electroshocking:** A boat electrofisher is a larger version of a backpack electrofisher that is set up on a boat. The cathode is generally a series of wires suspended from the sides of the boat and the anodes are on two booms that are placed off the front of the boat. One person operates the boat and one or two staff man dipnets in order to retrieve fish immobilized by the electric field. A boat electrofisher is designed to sample larger rivers or the littoral areas of lakes, and was used primarily in receiving bays of Upper Marmion Reservoir and Lizard Lake. Boat electrofishers are similar to backpack electrofishing, but is effective at depths of up to 2 m and for streams and waterbodies that are navigable. They capture both large and small-bodied fish.

- **Observations** in streams too narrow to electroshock or set other gears.

The selection of sampling gear used for sampling each aquatic feature was based on the limitations of each gear type relative to characteristics of each water body (e.g., depth, conductivity). However, every effort was made to sample each feature with several gears to identify all fish species present. Data recorded on catch records included location (Global Positioning System [GPS] coordinates) at each end of stationary gear, start and end locations for electrofishing, time, date, gear type, depth, effort (square metres seined, meters of stream electroshocked or hours fished), numbers and life history stage (young-of-the-year, juvenile and adults) of all fish species captured by species. Each location where fishing effort was expended has been assigned a unique number and these numbers appear in catch tables and on fish habitat maps created for each aquatic feature.

2.1.4.2 Fish Habitat Mapping

Fish habitat was mapped to provide an inventory of the available habitats and to show the locations of sensitive habitats, such as spawning and rearing areas. Table 2-4 contains a summary of data/variables measured during habitat mapping. These variables are defined in Appendix 2.I. Some variables (e.g., substrate) are further broken down into classes (e.g., size ranges of gravel or cobble substrate) for the purpose of habitat mapping. Physical features, their locations and/or distribution were measured and recorded on data sheets and field maps by field crews who walked or navigated each aquatic feature. GPS-referenced digital photos illustrating channel/shoreline characteristics were collected for each aquatic feature. Habitat maps for the Project were created by overlaying Light Detection and Ranging (LiDAR) images of aquatic features with field data. For potential MMER Scheduled waterbodies, side scan sonar imaging was conducted to map bathymetry and bottom substrate. A differential GPS was used for positioning, to sub metre accuracy. Navigation data were merged in real time with the bathymetry and side scan sonar data and collected using the Chesapeake software

system SonarWiz. The SonarWiz software allows for surveying along pre-plotted survey lines with an off-track indicator but also supports ad-hoc survey requirements around shoals and along shorelines.

The survey was completed to generate an accurate Digital Elevation Model (DEM) for the bathymetry within the water bodies noted above for use during fish habitat offset (No Net Loss) planning. Data were acquired at a rate of 5 Hz with a survey vessel speed of 10 km/h to yield data along the survey track lines at a separation of approximately 0.5 m. The survey line data were acquired with two lines around the perimeter of the survey area 25 m out from the shore and at 50 m out from the shoreline and with line spacing of 50 m or 75 m depending on the area of the water bodies and the water bottom relief and with crossing lines at 100 m intervals for additional data and Quality Assurance/Quality Control (QA/QC).

Bathymetry data were collected on all of the sidescan sonar transects, using a single beam automated hydrographic system (Odom Hydrotrack). This system provides digital output to the navigation computer and also prints a continuous profile of the lake bed on a thermal graphic recorder. The complete system produces accurate depth measurements (International Hydrographic Organization [IHO] standards) at a rate up to five soundings per second. The depth range is from 0.25 m to 600 m and the system supports the use of different frequency transducers selectable for the water bottom conditions. A “bar check” was completed in each of the main water bodies for calibrating the sound velocity in water.

Acoustic images of the lake bottom were acquired using a 500 kHz side scan sonar system (GeoAcoustics). The survey transects were collected to provide 125% coverage of the lake bottom. Data were recorded and reviewed in real-time on the navigation computer (SonarWiz) and a full backup was recorded onto a Sony DAT, 16 channel tape recorder. The sidescan tow-fish was towed from the stern or off the bow of the survey vessel.

The results are presented in Section 2.2 and in Appendix 2.II on maps that include the following:

- Bathymetric contour maps (0.5 m contours) and digital DEM.
- Surficial features maps based on interpretation of the sidescan sonar.

In beaver ponds, littoral zone habitat was mapped. Spot depths and bottom grabs were collected in order to determine general bathymetric and substrate characteristics. Habitat characteristics including maximum depth, temperature, dissolved oxygen and substrate characteristics were recorded.

Table 2-4: Habitat Features and Variables Measured During Baseline Studies

Habitat Features (Waterbodies)	Channel Units (Watercourses)	Habitat Features (Watercourses)	Substrate Types
Littoral/limnetic zones	Falls	Shoal	organic material
Shelf	Cascade	Slough	clay/silt
Shoals	Chute	Log jam	Sand
Bottom slope	Rapids	Undercut banks	Gravel
Submerged vegetation	Riffle	Unstable banks	Cobble
Emergent vegetation	Run	Inundated vegetation	Boulder
Depth	Flat	Beaver dam	Bedrock

Table 2-4: Habitat Features and Variables Measured During Baseline Studies (Continued)

Habitat Features (Waterbodies)	Channel Units (Watercourses)	Habitat Features (Watercourses)	Substrate Types
Water Quality Parameters	Pool	Exposed bar	**Channel Unit Measures**
	Impoundment pool	Islands	
Dissolved oxygen	Backwater	Bank/riparian vegetation	Wetted width
Water temperature	Snye	Bank slope	Channel width
pH	Boulder garden	Gradient	Channel unit length
Conductivity		Overhead cover	Channel profile (depth)
		Instream cover	Velocity

Notes:
Definitions for habitat variables can be found in Appendix 2.III.

2.1.4.3 Fish Tissues Analysis

Samples of tissues were collected from fish species captured in receiving waterbodies using minnow traps, small mesh Nordic nets and Experimental gill nets and were analyzed to determine the baseline levels of metals and other contaminants. Samples of tissues (e.g., muscle) from a minimum of five individuals representing various trophic levels (e.g., planktivorous, benthic grazer and piscivorous species) and whole body samples of a small body fish species (e.g., cyprinids) were collected and analyzed to determine the existing concentrations of metals (e.g., using Inductively Coupled Plasma mass spectrometry [ICP] metal scan including total mercury) for consideration in the human health and ecological risk assessment.

Sample collection and storage followed Golder's Fish Health Assessment Technical Procedures (Golder 1997). Samples were not collected from discrete size classes. Rather, sampling was carried out to obtain average concentrations of metals based upon the most common size class of representative species from each trophic class. A sample consisting of approximately 100 g of unexposed muscle tissue was excised from each large bodied fish in the field. Composite samples of small bodied fish species, made up of several individuals, were collected and submitted for analyses. Summaries of the fish tissue results are provided in Appendix 2.IV. Samples were preserved (frozen) on-site and delivered to ALS Laboratory Group in Thunder Bay, Ontario. Analytical results provide a baseline for future conditions and results were interpreted using existing sport fish consumption guidelines and Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota (CCME 2001).

The metals and metalloids analyzed included total silver, total aluminum, total arsenic, total barium, total beryllium, total bismuth, total boron, total calcium, total cadmium, total cerium, total cobalt, total chromium, total cesium, total copper, total europium, total iron, total gallium, total mercury, total lanthanum, total lithium, total magnesium, total manganese, total molybdenum, total niobium, total nickel, total lead, total rubidium, total antimony, total scandium, total selenium, total tin, total strontium, total thorium, total titanium, total thallium, total uranium, total vanadium, total tungsten, total yttrium, total zinc and total zirconium. Average metal concentrations for each fish species were calculated using all samples. A conservative approach in calculating the average was used in which concentrations reported as less than the detection limit were included at the detection limit.

It is generally accepted that total mercury levels in fish muscle are reliable indicators of MeHg as MeHg contributes at least 90% of total mercury concentration values (Lasorsa and Allen-Gil 1995; Rai et al. 2002). The Canadian tissue residue guideline for MeHg for the protection of wildlife consumers of aquatic biota is 0.033 mg/kg or parts per million (ppm) (CCME 2000). For the purpose of interpreting fish tissue data collected during baseline studies, samples exceeding 0.037 (0.033 x 1.1) mg/kg of total mercury will be interpreted as exceeding the CCME guideline.

Ontario publishes human consumption guidelines for sport fish species based upon size ranges of fish. For women of child-bearing age and children under 15, consumption restrictions for sport fish containing total mercury begin at levels of 0.26 mg/kg, with total restriction advised for levels above 0.52 mg/kg. For the general population, consumption restrictions begin at levels above 0.61 mg/kg, with total restriction advised for levels above 1.84 mg/kg (MOE 2011).

2.1.4.4 Benthic Invertebrate Community Assessment

A benthic invertebrate community (BIC) assessment was conducted in October 2010 in the lower reaches of APIs (Figure 2-1). Sample locations were selected above the influence of the receiving water bodies (i.e., Upper Marmion Reservoir, Lizard Lake). At each sample location, five replicate samples were collected. Benthic samples were collected using a standard petite ponar dredge measuring 15 cm by 15 cm square. Samples were washed through a 500 µm sieve bag to remove fine particulates. Samples were transferred to labelled 1 Litre (L) sample bottles and preserved with 10% buffered formalin. All containers were also labelled internally with Project number, date, and station information. All sieves and containers were rinsed with ambient water to ensure that all organisms were collected. Additional site specific data also were collected in support of the benthic sampling.

Benthic samples were submitted to Zaranko Environmental Assessment Services (ZEAS) for identification and enumeration. Benthic invertebrates were identified to the lowest practical taxonomic level, typically genus and species for most taxa, and family or order for specimens that could not be identified to a lower level.

Data quality was assessed visually in a spreadsheet format to identify potential data entry errors. Non-benthic organisms were removed from the data (springtails, indeterminate species of the order Diptera, and the phantom midge *Chaoborus favicans).* Nematodes (round worms) were also excluded as they are not accurately sampled by the sieving protocol. Pupae of benthic invertebrates were not included in the data analysis.

2.1.4.4.1 Data Analysis

Five benthic invertebrate community descriptors were calculated for each of the 15 sampling stations.

- Mean density, expressed as number of invertebrates per square metre.
- Mean taxa richness, the number of taxa (families) present at each station.
- Mean Simpson's Diversity index (SDI) value, based on the formula provided by Krebs (1985):

  $D = 1 - \sum (p_i)^2$, where D = Simpson's Diversity Index, p_i = the proportion of the i^{th} taxa at the station.

- Mean Simpson's Evenness Index (SEI), evenness is calculated following Smith and Wilson (1996):

  $E = 1/\sum (p_i)^2/S$, where E = Simpson's Evenness Index, p_i = the proportion of the i^{th} taxa at the station.

  S = the total number of taxa at the station.

- %EPT, total percentage of the orders Ephemeroptera, Plecoptera and Trichoptera.

- Community composition, the percent representation (relative abundance) of major taxonomic groups at each station.

Mean values for density, richness, SDI, SEI, %EPT, and percent relative abundance were derived from the five replicate samples collected at each station in 2010.

2.1.4.4.2 Aquatic Sediment Sampling

Sediment samples were collected concurrently with the benthic invertebrate sampling program in October 2010. All grab samples corresponded to the benthic sample locations. One sediment sample from each station was shipped on ice (along with a completed chain of custody form) to ALS Environmental in Thunder Bay, Ontario, for analysis of total organic carbon (TOC), and particle size. Additional aquatic sediment sampling was completed as part of the Water and Sediment Quality study program and results are presented and discussed in the Water and Sediment Quality TSD.

2.2 Results (Baseline Conditions)

2.2.1 Aquatic Features within the Local Study Area and Mine Study Area

2.2.1.1 Upper Marmion Reservoir

Upper Marmion Reservoir was created in the 1920s and is managed under the Seine Watershed Management Agreement (Hydrology TSD). As part of its operation to meet flooding, hydropower and fisheries objectives, there is an annual fluctuation, in the order of 2.5 m (Hydrology TSD). Recorded water levels are shown in Figures 2-2 and 2-3 for pre and post Seine River Management Plan.

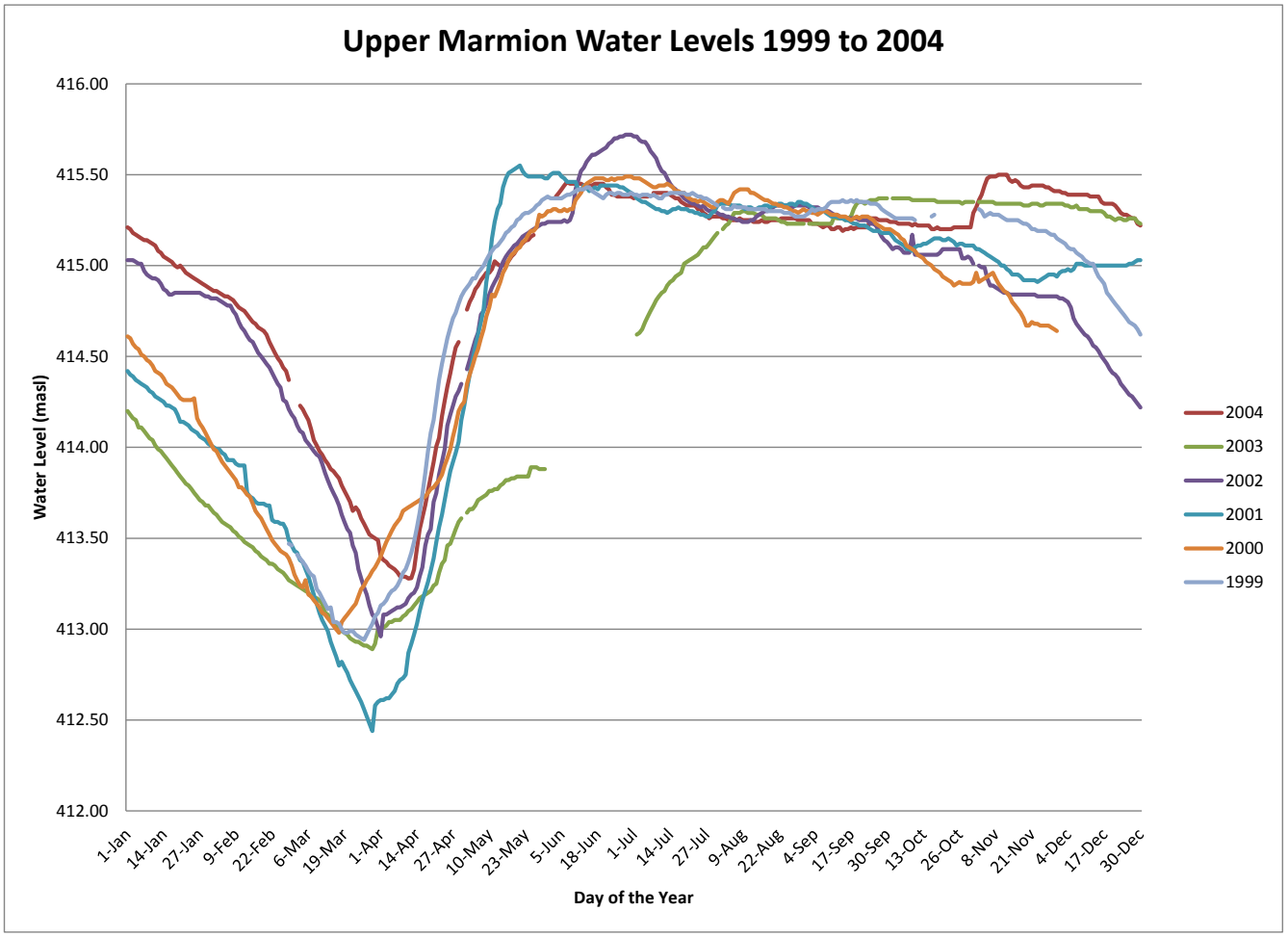


Figure 2-2: Upper Marmion Reservoir Annual Water Level Fluctuations Pre Seine River Management Plan

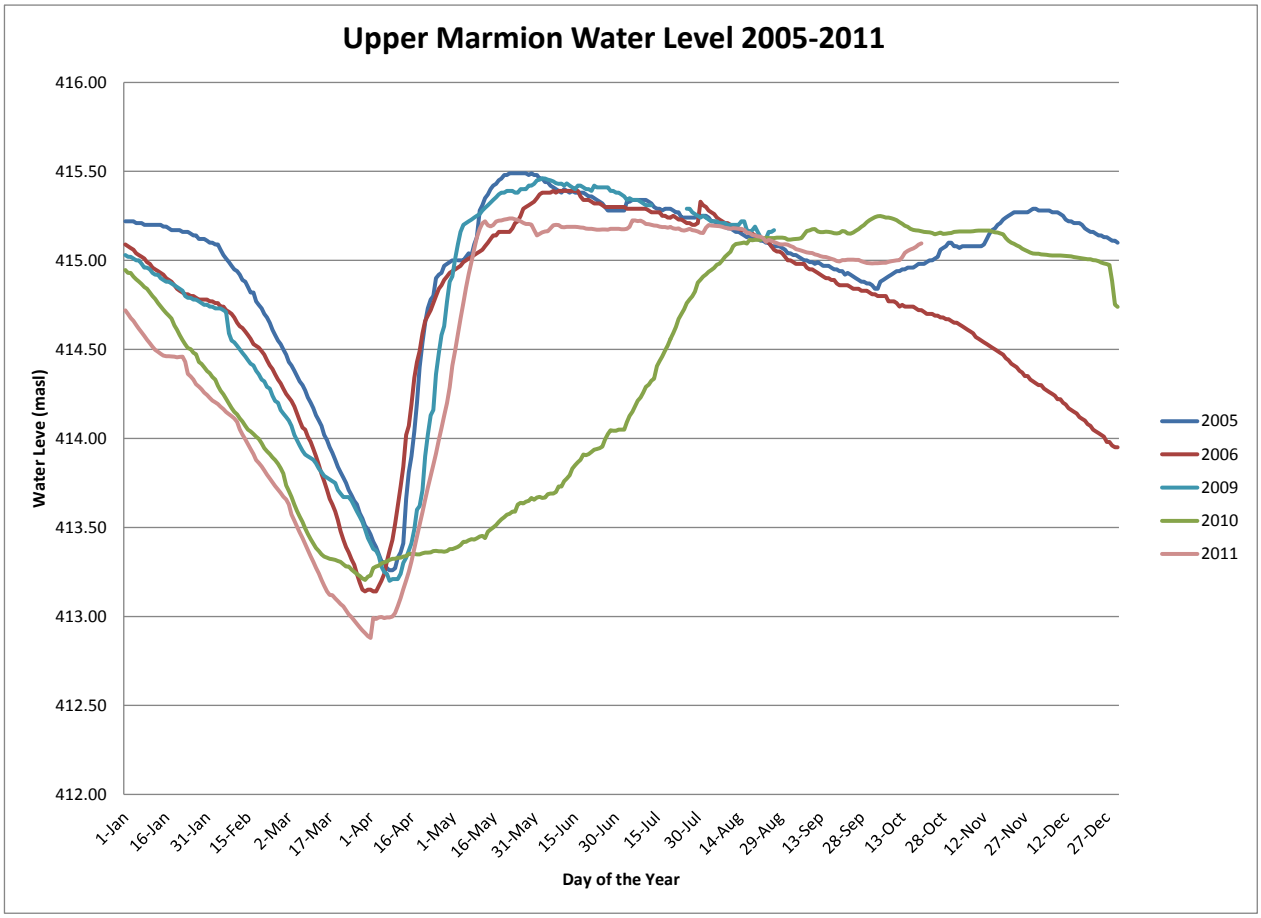


Figure 2-3: Upper Marmion Reservoir Annual Water Level Fluctuations Post Seine River Management Plan

The total area of all catchments within the MSA is small relative to the drainage area of Upper Marmion Reservoir. The contributions of drainage areas to Upper Marmion Reservoir are as follows:

- Upper Seine River, including Mercutio and Firesteel rivers and Lac des Mille Lacs Reservoir: 4,102 km^2.
- Other tributaries to Upper Marmion Reservoir: Caribou (113 km^2), Light (41.4 km^2), Lumby (62.8 km^2) and Sawbill (106 km^2) creeks: 323.2 km^2.
- Catchments potentially affected by the Project Site (including approximately 9 km^2 draining to Lizard Lake in Lumby Creek catchment): 19 km^2.

Excluding the upstream drainage area of the Upper Seine River at the inlet to Upper Marmion Lake, the catchments draining the Project Site represent about 5.9% of the drainage to Upper Marmion Reservoir or 0.43% (including the Upper Seine River drainage) to Upper Marmion Reservoir.

The Hammond Reef peninsula is bordered on its west, south and southwest shorelines by Sawbill Bay and Lynxhead Bay. There are three existing basins: two in Sawbill Bay and one in Lynxhead Bay. The maximum depth of the basin in upper Sawbill Bay and the basin in Lynxhead Bay exceeds 25 m, whereas the maximum

depth of the basin in lower Sawbill Bay is approximately 20 m. Thermal stratification occurs in both bays during summer (Water and Sediment Quality TSD).

A total of 24 species of fish were captured within the LSA (Table 2.5). The fish community of Sawbill and Lynxhead Bays is the most diverse waterbody, consisting of 13 fish species including baitfish and other small-bodied fish, lake whitefish, cisco, walleye, smallmouth bass, yellow perch, northern pike and common white sucker (genus/species names provided in Table 2-5). Walleye, northern pike and smallmouth bass fisheries are considered important to recreational anglers. The area is widely known for an annual smallmouth bass derby. Although Upper Marmion Reservoir is contained by dams at its outlet (Raft Lake Dam) and Marmion Lake (Marmion Sluiceway), fish can pass both ways between Marmion Lake and the Upper Marmion Reservoir, and fish can pass downstream from the Upper Marmion Reservoir into Finlayson Lake (through the Raft Lake Dam).

Table 2-5: Fish Species Captured During Baseline Studies

Family/Subfamily	Species Common Name	Species Scientific Name
Coregoninae	Lake Whitefish Cisco	*Coregonus clupeaformis* *Coregonus artedi*
Umbridae	Central Mudminnow	*Umbra limi*
Esocidae	Northern Pike	*Esox lucius*
Cyprinidae	Longnose Dace Eastern Blacknose Dace Northern Redbelly Dace Finescale Dace Pearl Dace Fathead Minnow Spottail Shiner Blacknose Shiner Brassy Minnow Golder Shiner	*Rhinichthys cataractae* *Rhinichthys atratulus* *Phoxinus eos* *Phoxinus neogaeus* *Margariscus margarita* *Pimephales promelas* *Notropis hudsonius* *Notropis heterolepis* *Hybognathus hankinsoni* *Notemigonus crysoleucas*
Catostomidae	White Sucker	*Catostomus commersoni*
Gadidae	Burbot	*Lota lota*
Gasterosteidae	Ninespine Stickleback Brook Stickleback	*Pungitius pungitius* *Culaea inconstans*
Centrarchidae	Smallmouth Bass Pumpkinseed	*Micropterus dolomieu* *Lepomis gibbosus*
Percidae	Walleye Yellow Perch Iowa Darter	*Sander vitreus* *Perca flavescens* *Etheostoma exile*
Cottidae	Mottled Sculpin	*Cottus bairdii*

Water levels in Upper Marmion Reservoir are managed according to a rule curve established for the Raft Lake Dam within the Seine River Watershed Management Plan (Hydrology TSD) (the rule curve limits are shown in Figure 2-4). While this rule curve anticipates a smooth transition of water levels at critical times of the year, while maintaining downstream flows to accommodate hydropower requirements, the mode of control is by manually operating stop logs within the spillway structure of the dam. This manual operation, combined with a

substantial contribution of uncontrolled and highly variable flows from tributaries of Upper Marmion Reservoir, which represents approximately 46% of the upstream contributing drainage, results in poor tracking of actual water levels within limits prescribed by the rule curve. The total annual fluctuation of the reservoir is, on average, approximately 2.5 m (Figures 2-2 and 2-3). The failure to reach prescribed spring water levels in some years may result in negative impacts to spawning success by northern pike, smallmouth bass and walleye, decreases in suitable nursery habitat in the shallow bays around Upper Marmion Reservoir, and may affect fish movement into and use of small tributary streams draining the Hammond Reef peninsula as shown in Photos 2-1 and 2-2. Supporting evidence for this is provided in the LiDAR imagery produced during the spring of 2010, when the reservoir experienced extremely low water conditions. This imagery was used to corroborate fish habitat mapping information collected during baseline studies, and is provided in Appendix 2.II.

Photo 2-1: Exposed shoreline of Sawbill Bay during low water, near the mouth of API #33 (June 2010)

Photo 2-2: Exposed shoreline of Snail Bay during low water elevation (June 2010); mouths of APIs #15 and #50 in foreground)

There is also some evidence that this fluctuation is also reflected in local groundwater elevations at the Mine (Hydrogeology TSD).

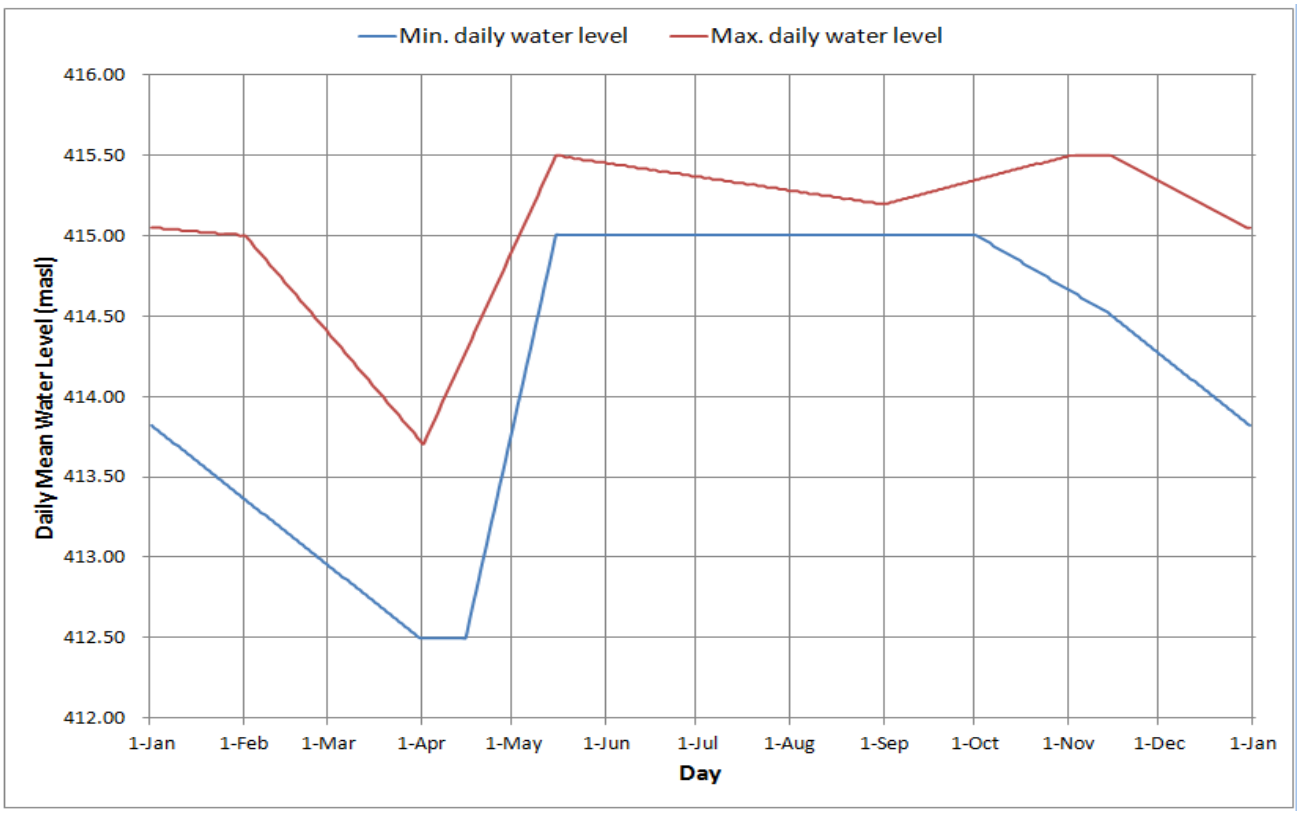
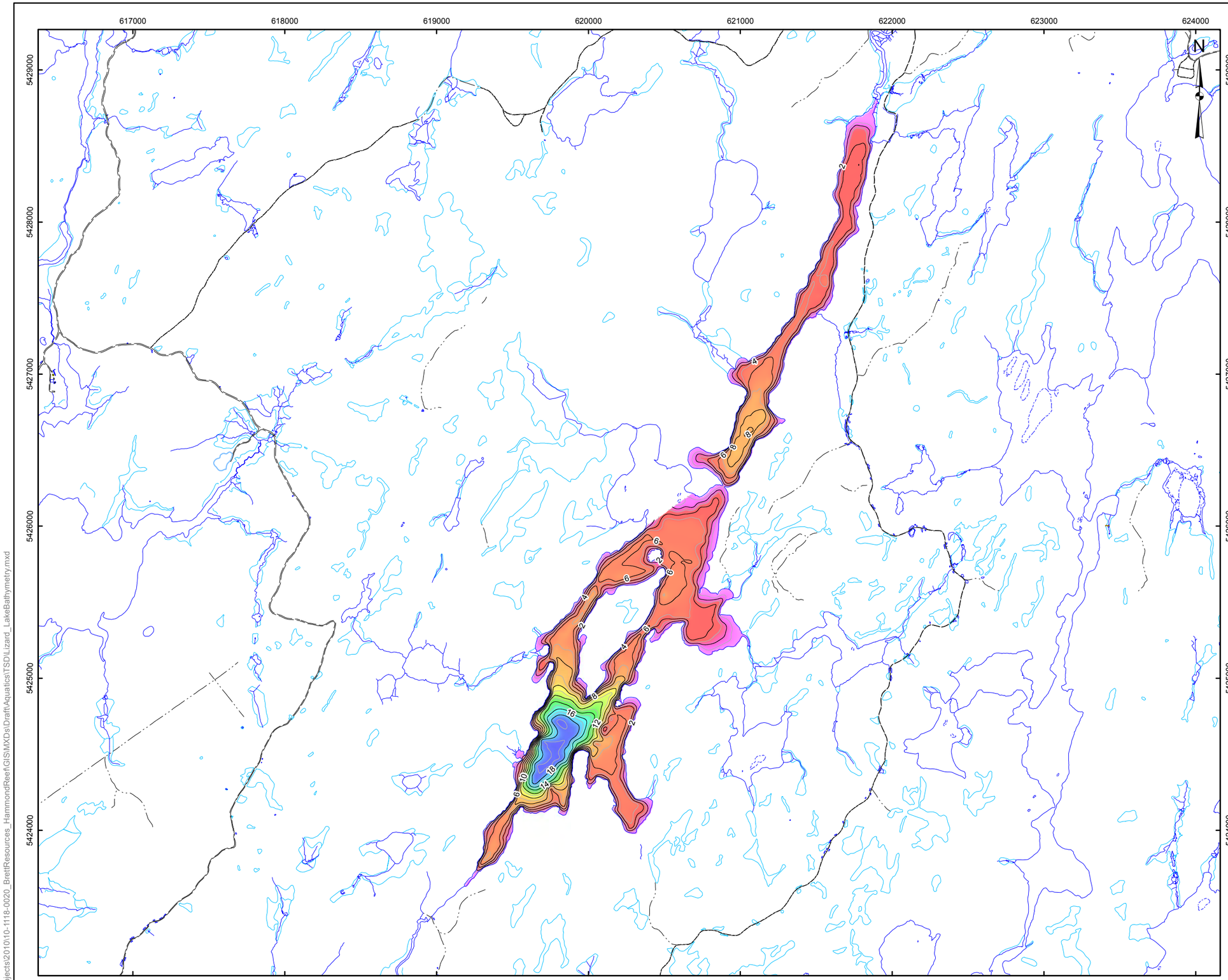


Figure 2-4: Minimum and Maximum Water Levels for Upper Marmion Reservoir (Hydrology TSD)

2.2.1.2 Lizard Lake

Lizard Lake has a surface area of about 180 ha and is located at the mouth of Lumby Creek, a 62.9 km^2 river system that discharges through Lizard Lake into Turtle Bay of the Upper Marmion Reservoir. Lizard Lake is a long narrow lake, consisting of two basins or sections joined by a short, shallow constriction (Figure 2-5). The northern portion of the lake (Photo 2-3) is shallow, with the majority of the area less than 4 m deep and only a small area greater than 8 m. The southern portion of the lake (Photo 2-4) is deeper, with a small area less than 4 m, a moderately large area greater than 8 m, and a maximum depth of over 20 m(Figure 2-5). The shoreline in this lower portion has narrow, steeply sloping littoral areas, and a steep drop off near the deepest part of the lake. The total catchment area of streams from the Project Site (predominantly the TMF) draining into Lizard Lake is about 9 km^2 or 14% of the total drainage to the lake. The fish community consists of the same species inhabiting the Upper Marmion Reservoir with the exception of lake whitefish.

The connecting channel between Lizard Lake's outflow and Turtle Bay (API #42) is 450 m in length and consists almost entirely of moderate to high gradient rapids and cascades (Photo 2-5). Aside from the ends of the channel, it is generally narrow (e.g., less than 5 m wetted width) and tightly confined by bedrock features. Bottom substrate consists of boulders and cobble. The downstream mouth of the channel, where it enters Turtle Bay, appears to be suitable spawning habitat for walleye and white sucker. Downstream passage of fish from Lizard Lake through API #42 to Turtle Bay is likely possible throughout most of the year. However, due to the steep gradient at the mouth (Photo 2-6) and high velocities in the cascades, it is unlikely that fish can move in the opposite direction.



LEGEND

- Lake Bottom Contours - 2 m interval
- Lake Bottom Contours - 1 m interval
- Dirt Road - Double
- Dirt Road - Single
- Trail
- River/Stream
- Lake
- Wetland/Swamp

Depth of Lake Bottom (metres)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

NOTES:

1. Water Surface Elevation = 426.55 m.
2. The contours were derived from a 20 metre cell size for the grid files. Minor contour errors exist at the shorelines where departures are at the scale of the grid dimension.

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

500 0 500 1,000
METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
LIZARD LAKE BATHYMETRY MAP

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008		
GIS	JO	11 Feb. 2013		
CHECK	BH	11 Feb. 2013		
REVIEW	RJ	11 Feb. 2013		

FIGURE: 2-5

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\TSD\Lizard_LakeBathymetry.mxd

Photo 2-3: Northern section of Lizard Lake; inflow (mouth of Lumby Creek) in foreground (June 2010)

Photo 2-4: Southern section of Lizard Lake looking towards outflow (June 2010)

Photo 2-5: Cascade in central portion of the channel connecting Lizard Lake to Turtle Bay (May 2011)

Photo 2-6: Mouth of channel connecting Lizard Lake to Turtle Bay during low flow conditions (August 2010)

2.2.1.3 Hammond Reef Peninsula Waterbodies

The total drainage area of the Project Site is about 19 km^2, approximately 9 km^2 of which flows through the proposed TMF footprint. The morphology of headwater bodies varies, but most are either natural depressions (Photos 2-7 and 2-8) or shallow beaver impoundments in various stages of infill (Photos 2-9 and 2-10). Some ponds may be subjected to freezing and/or anoxia, as indicated during summer dissolved oxygen profiling. Several headwater ponds are physically isolated from receiving water bodies seasonally by beaver dams such as at API #6 and #7 (Photo 2-11) or flows that are ephemeral or sub-surface (Photos 2-12 and 2-13). Flows in many watercourses are flashy. Table 2-6 provides measured flows and documented flow permanence for the catchment areas in the MSA.

Table 2-6: Measured flows and classification of tributaries in the Mine Study Area (Hydrology TSD)

Watershed ID	UTM NAD83 Zone 15N	Drainage Area (km²)	Stream Classification	Flow, May 2012		Flow, August 2012	
				$m^3 \cdot s^{-1}$	$L \cdot s^{-1} \cdot km^{-2}$	$m^3 \cdot s^{-1}$	$L \cdot s^{-1} \cdot km^{-2}$
A	616953 E; 5429178 N	5.81	Perennial	0.027	4.6	0.019	3.3
B	617837 E; 5426538 N	6.08	Intermittent/ ephemeral	0.042	6.9	0.143	23
C	617657 E; 5426048 N	1.35	Intermittent/ ephemeral	0.005	3.7	0.000	0.0
D	616838 E; 5424955 N	1.04	Perennial	0.006	5.8	0.007	6.7
E	616502 E; 5423489 N	11.67	Perennial	0.011	9.4	0.006	5.1
F	616259 E; 5423255 N	0.743	Intermittent/ ephemeral	0.005	6.7	0.019	26
G	615083 E; 5424006 N	0.305	—[a]	—[a]	—[a]	—[a]	—[a]
H	614430 E; 5423290 N	0.273	Intermittent/ ephemeral	0.003	11	0.000	0.0
I	613817 E; 5422546 N	0.852	Perennial	0.003	3.5	0.001	1.2
J	612538 E; 5422318 N	0.256	Intermittent/ ephemeral	0.003	12	0.000	0.0
K	611642 E; 5421001 N	0.890	Intermittent/ ephemeral	0.003	3.4	0.000	0.0
L	614480 E; 5420879 N	0.705	Intermittent/ ephemeral	0.005	7.1	0.000	0.0
M	617450 E; 5421757 N	1.12	Intermittent/ ephemeral	0.004	3.6	0.000	0.0
N	618028 E; 5422875 N	1.59	Intermittent/ ephemeral	0.008	5.0	0.000	0.0
O	619403 E; 5424440 N	0.388	Intermittent/ ephemeral	0.000	0.0	0.000	0.0
P	619565 E; 5425142 N	1.25	Perennial	0.004	3.4	0.010	8.0
Q	620234 E; 5426671 N	2.73	Perennial	0.027	9.9	0.048	18
R	620936 E; 5427051 N	6.33	Intermittent/ ephemeral	0.026	4.1	0.000	0.0
S	621005 E; 5425285 N	2.31	Perennial	0.023	10	0.010	4.3
T	618506 E; 5421573 N	3.37	Perennial	—[b]	—[b]	0.064	19

Table 2-6: Measured flows and classification of tributaries in the Mine Study Area (Hydrology TSD) (Continued)

Watershed ID	UTM NAD83 Zone 15N	Drainage Area (km²)	Stream Classification	Flow, May 2012		Flow, August 2012	
				$m^3 \cdot s^{-1}$	$L \cdot s^{-1} \cdot km^{-2}$	$m^3 \cdot s^{-1}$	$L \cdot s^{-1} \cdot km^{-2}$
U	620932 E; 5420684 N	1.57	Intermittent/ ephemeral	0.010	6.4	0.000	0.0
V	622814 E; 5423793 N	1.02	Intermittent/ ephemeral	—(c)	—(c)	0.000	0.0
W	620313 E; 5423976 N	1.15	Intermittent/ ephemeral	0.000	0.0	0.000	0.0
X	620680 E; 5420578 N	0.823	Intermittent/ ephemeral	—(a)	—(a)	0.022	27
Y	619285 E; 5420256 N	0.457	Intermittent/ ephemeral	0.006	13	0.000	0.0
Z	618468 E; 5422540 N	0.748	Intermittent/ ephemeral	0.004	5.4	0.000	0.0
AA	616878 E; 5421353 N	0.733	Intermittent/ ephemeral	0.000	0.0	0.000	0.0
AB	613579 E; 5421293 N	0.520	Intermittent/ ephemeral	0.002	3.8	0.000	0.0
AC	616459 E; 5425159 N	0.292	Intermittent/ ephemeral	0.002	6.8	0.000	0.0
AD	612992 E; 5421115 N	0.293	Intermittent/ ephemeral	—(a)	—(a)	0.000	0.0
AF	615619 E; 5423121 N	0.775	Perennial	0.003	3.9	0.009	12
AG	616332 E; 5423726 N	0.342	—(a)	—(a)	—(a)	—(a)	—(a)
AH	615549 E; 5422139 N	0.600	Intermittent/ ephemeral	0.000	0.0	0.000	0.0
AI	612133 E; 5420545 N	0.103	Intermittent/ ephemeral	0.002	19	0.000	0.0

Notes:

(a) No stream found during field survey(s).

(b) High flow, unsafe to measure high flow.

(c) Low flow could not be measured with available meter.

Photo 2-7: API #44, headwater pond (August 2010)

Photo 2-8: API #11, headwater pond (August 2010)

Photo 2-9: API #69, headwater pond (August 2010)

Photo 2-10: API #14, headwater pond (August 2010)

Photo 2-11: API #6 (foreground) and API #7 (background) (August 2010)

Photo 2-12: Seasonal stream channel, lower portion of API #6 (September, 2012)

Photo 2-13: Seasonal stream channel, lower portion of API #15 (September, 2012)

Flow within sections of many of the streams that drain the Hammond Reef peninsula are either seasonal (APIs #2, #15, #43, #48, #69), ephemeral (APIs #1, #10, #43, #44, #46, #47) or sub-surface (APIs #10, #16, #17, #47). The upper portions of streams report to permanent warm water stream channels. Generally, permanent watercourses are low gradient and highly influenced by beaver activity. Beaver dams have a pronounced effect on flows and connectivity of headwater ponds to streams and represent impediments to fish movement (Photo 2-14). The impounded areas created by dams serve as refugia for resident fish and reservoirs of fish to repopulate non-permanent flowing sections of streams.

Fishes from receiving waterbodies can access the lower reaches of many of the watercourses that drain the Project Site; however, this access is limited by upstream barriers. During periods of low water elevation in the reservoir and low flows in the watercourses, movement of fish into these streams is limited (Photo 2-15). This may have a large impact on the suitability and functionality of the lower reaches of many watercourses as spawning and nursery areas. Channels upstream of the backwater effect caused by reservoir water level fluctuations are generally shallow and narrow, and as a result offer little refugia habitat for fish. This is particularly the case for streams with small drainage areas.

The lower reaches of watercourses that drain the southern portion of the Hammond Reef peninsula in the vicinity of Sawbill and Lynxhead bays consist of steep cascades that likely prevent reservoir dwelling fish from entering them (Photo 2-16). As a result, some of these watercourses do not support fish communities (APIs #11, #13, #69; Photos 2-17 and 2-18).

Photo 2-14: APIs #3, #4 and #5; beaver impoundments and connecting channels (August 2010)

Photo 2-15: Lower section of API #9 during period of low flow and low water elevation in Upper Marmion Reservoir (August 2011)

Photo 2-16: Southern shoreline of the Hammond Peninsula. Note the steep shoreline gradient. (September 2012)

Photo 2-17: API #13 and its steep gradient connecting channel to Sawbill Bay which limit upstream fish movement (June 2010).

Photo 2-18: Portion of cascade that connects API #13 to Sawbill Bay (September 2012)

Groundwater is shallow, generally about 4 m below surface topography and generally stored in bedrock (Hydrogeology TSD). Groundwater storage volumes are low as a result and provide a limited source of baseflow to streams. Based on this, it would appear that "baseflow" in streams is supported more by delayed runoff, which is stored in hummocky topography and wetland systems and then gradually released, rather than groundwater discharge. No permanent ground water seeps were discovered within any of the APIs.

There are several natural lakes located within the MSA. Mitta Lake lies on top of the proposed west pit (Photo 2-19). Mitta Lake has a surface area of 17.1 ha. The shoreline is generally steep and the lake is surrounded by exposed bedrock. There are no shoals or islands on the lake. Side scan bathymetry mapping indicates that there are two basins in the lake, the deepest of which is located in the southern arm of Mitta Lake. It is 16 m deep, as show in Figure 2-6. There was a thermocline evident between 4 m and 7 m in August 2010 and between 2 m and 5 m in June 2011. The bottom of Mitta Lake (e.g., more than 7 m depth) experiences low dissolved oxygen levels during the summer. Late winter dissolved oxygen was greater than 1 ppm throughout most of the water column in March 2011 suggesting that winter anoxia conditions may occur. The pH was slightly acidic throughout the water column when measured in June and September 2011 and slightly alkaline in March and November 2011. The lake bottom in the littoral zone is a mix of fine and coarse substrates and bedrock. Within the deeper part of the lake basins, substrate consists of fine sediment. Aquatic macrophytes are abundant in shallow arms of the lake but not along the steep sloped bedrock portions of the shoreline. There are several seasonal inflows to the lake, and a single outflow located at the northeast corner. A beaver dam is located at the outflow. Water seeping through the dam maintains a constant supply of water to the upper section of a small stream that connects Mitta Lake to Marmion Reservoir. The fish community of Mitta Lake was assessed in September 2010 and June 2011. The lake supports populations of white sucker, brook stickleback, ninespine stickleback, fathead minnow, lowa darter, mottled sculpin and finescale dace.

611750 612000 612250 612500 612750 613000 613250

5422000 5421750 5421500 5421250 5421000

N

LEGEND

- Lake Bottom Contours - 2 m interval
- Lake Bottom Contours - 1 m interval
- Dirt Road - Double
- Dirt Road - Single
- Trail
- River/Stream
- Lake
- Wetland/Swamp

Depth of Lake Bottom (metres)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

NOTES:

1. Water Surface Elevation = 431.55 m
2. The contours were derived from a 20 metre cell size for the grid files. Minor contour errors exist at the shorelines where departures are at the scale of the grid dimension.

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

200 0 200
METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
MITTA LAKE BATHYMETRY MAP

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008		
GIS	JO	11 Feb. 2013		
CHECK	BH	11 Feb. 2013		
REVIEW	GA	11 Feb. 2013		

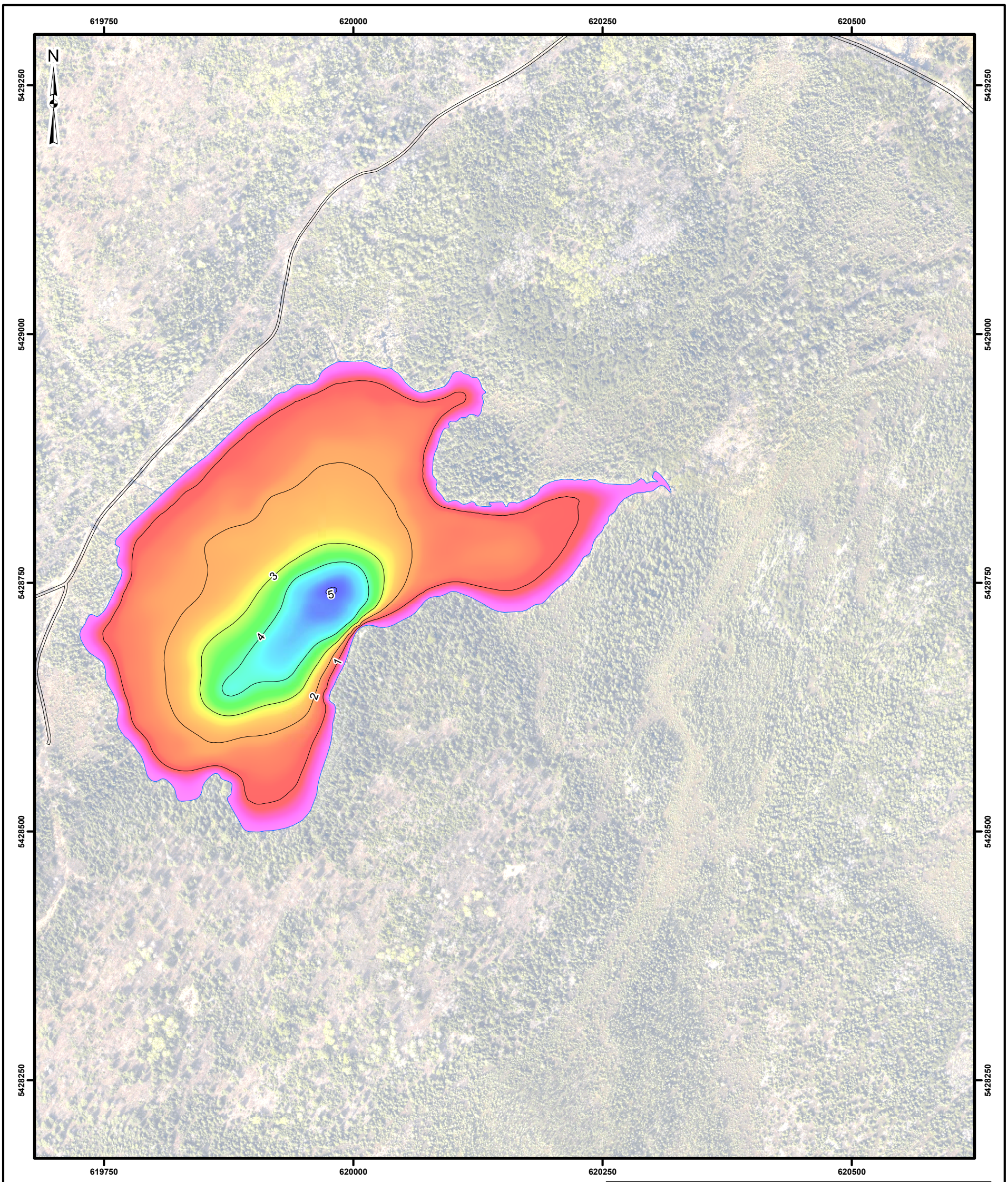
FIGURE: 2-6

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\TSD\Mitta_LakeBathymetry.mxd

Photo 2-19: Mitta Lake, with Sawbill Bay (Receiver) in background (August 2010)

API #2, an unnamed natural lake located within the proposed TMF, has a total surface area of 122,228 m^2 (Photo 2-20). The shoreline is generally steep and contained by thick coniferous forest and exposed bedrock outcrops. A narrow band of alders and grasses and aquatic vegetation rings most of the lake's perimeter. There are no shoals or islands on the lake. Side scan bathymetry mapping indicates that there is a single, 5 m deep basin on the southeast side of the lake, adjacent to a steep bedrock shoreline, as shown in Figure 2-7. The lake bottom in the littoral zone is mix of fine and coarse substrates and bedrock. The lake bottom in the deeper areas consists of a mixture of fine and coarse substrate with interspersed boulders. There is no inflow to the lake, and a single outflow located at the northeast corner. An active beaver lodge was documented on the lake and 0.4 m high dam is located at the outflow, at the end of a narrow, weedy bay. A temperature-dissolved oxygen profile was completed in October 2010 at the deepest location in the lake. High dissolved oxygen levels were present throughout the water column. The lake had mixed at the time the profile was completed. The lake was fished in 2010, 2011 and 2012. Seven fish species were identified in the lake, including pumpkinseed and northern pike. The forage base consists of white sucker, ninespine stickleback, yellow perch, Iowa darter and blacknose shiner.

Photo 2-20: API #2 (unnamed lake within TMF boundary) (August 2010)



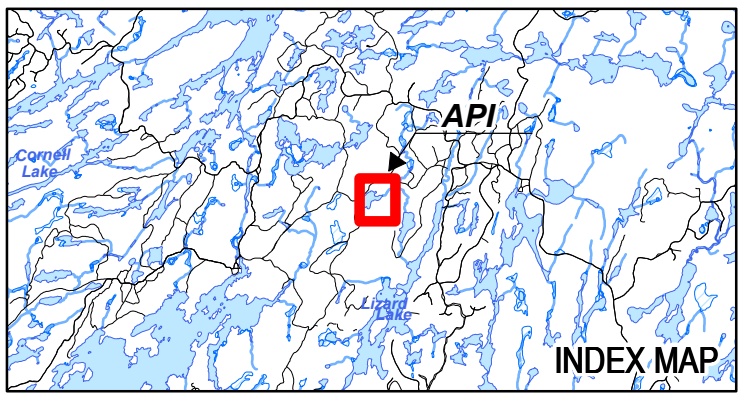
LEGEND:

Road

Lake Bottom Contours - 1 m interval

Depth of Lake Bottom (metres)

0
1
2
3
4
5



REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT #2 BATHYMETRY MAP

Golder Associates
Mississauga, Ontario

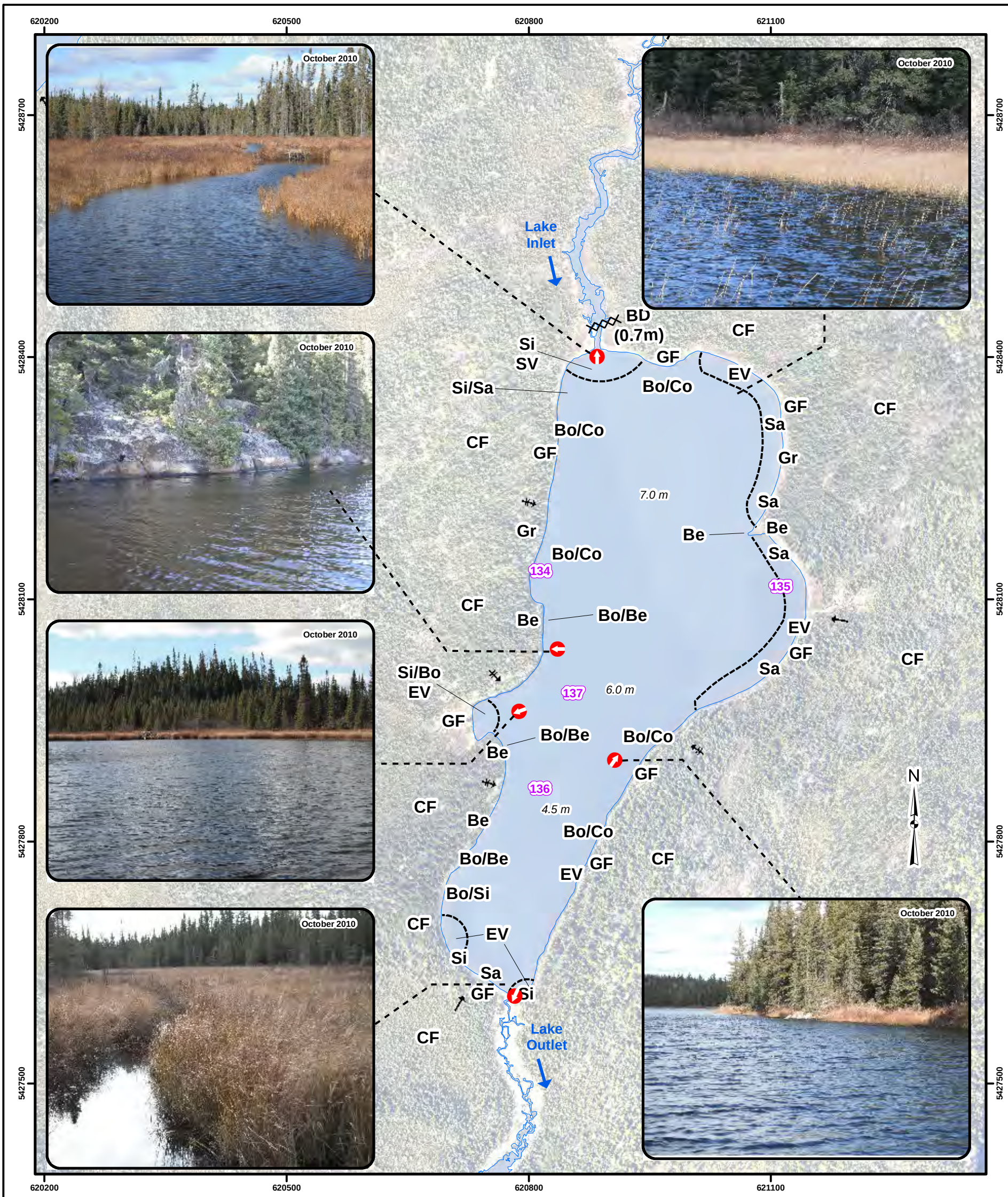
PROJECT No. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	RRD	06 Jan. 2012		
GIS	JO	11 Feb. 2013		
CHECK	BH	11 Feb. 2013		
REVIEW	GA	11 Feb. 2013		

FIGURE: 2-7

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\TSD\API_2_Bathymetry.mxd

API #8, an unnamed lake located down gradient of the TMF, has a surface area of 180,619 m^2 and a maximum depth of 7 m as shown in Photo 2-21 and Figure 2-8. Shoreline substrate is predominately boulder and cobble except for an extensive sandy section along the northeast shore. The inflow is flat and wide where it empties into the lake. The outflow is much narrower and is impounded downstream by beaver dams in several locations, although the backwater effect does not extend to the mouth of the lake's outflow. The pond is surrounded by a broad band of wetland habitat consisting of grasses and alders. Emergent vegetation is abundant at both the inflow and the outflow and along much of the shoreline. The pH in the lake was slightly acidic. Dissolved oxygen was high throughout the water column. The lake, netted in 2010 and 2012, supports populations of northern pike, yellow perch, pumpkinseed, white sucker, burbot and golden shiner. Finescale dace and northern redbelly dace were captured in watercourses flowing into API #8.

Photo 2-21: API #8, inflow in foreground, Lizard Lake (Receiver) in background (August 2010)



LEGEND

- Photo Location & Direction
- Fishing Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- EV Emergent Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Steep Slope (31 to 70%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Gr -Gravel
- Sa -Sand
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AQUATIC HABITAT MAP OF AREA OF POTENTIAL IMPACT #8 SHOWING DEPTHS

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	RRD	06 Jan. 2012	FIGURE: 2-8	
GIS	JO	11 Feb. 2013		
CHECK	BH	11 Feb. 2013		
REVIEW	GA	11 Feb. 2013		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_MapsvAPI_8.mxd

In total, 24 fish species, listed in Table 2-5, were captured during aquatic baseline studies in all of the APIs for the Project. There were no cold water fish species captured in any of the APIs. Water temperatures in ponds and streams tended to be warm during summer months, except where subsurface flows resurfaced or where heavy forest provided shading.

This list incorporates fish community sampling results from watercourses and water bodies that may be directly altered by the Project and fish species captured in aquatic features located immediately upstream and downstream of the Project Site including receiving water bodies. Fish community composition is variable between catchments potentially affected by the Project.

The lower segments of streams likely provide spawning and nursery habitats for some reservoir dwelling species, for example northern pike, yellow perch and white sucker. Although spawning activity was not documented in any of the streams, juvenile northern pike and white suckers and/or yellow perch were captured in lower sections of several of them (e.g., APIs #10, #40, #44, #49), providing indirect evidence that large bodied fish from Upper Marmion Reservoir and Lizard Lake use these locations to spawn. Juvenile burbot were captured in the lower reaches of two streams (APIs #2, #40). No adult, young-of-year or juvenile walleye or smallmouth bass were captured in any of the streams.

Generally, headwater ponds exhibited simple fish communities, dominated by cyprinids, including baitfish species. Large bodied fishes were captured in a single pond (API #3), and likely originated from a natural lake (API #8) located immediately downstream.

Fish habitat and fish community data for each individual API are presented by catchment in Appendix 2.II. API habitat maps and data summaries describe the physical and general chemical characteristics for each aquatic feature, fish community, sampling gear and locations, key habitat features/locations including barriers to fish movement, and provide representative photos. The data summaries also describe the locations of aquatic features in each catchment relative to the Project Site and receivers.

For each of the 24 fish species present in the study area, a life history/habitat preference table was prepared, using relevant scientific and technical literature. These tables summarize habitat use for each fish species and they are provided in Appendix 2.III. These habitat preference tables were used in conjunction with the habitat maps to identify critical habitats for both individual species and in the development of habitat guilds used in fish habitat compensation (No Net Loss) planning. Habitat utilization relationships and habitat maps were used to quantify available habitats for various species in each API and to develop mitigation and compensation strategies.

Based upon fish community and habitat data, each API was categorized into ecologically similar groups or ecotypes. These include the following:

- **Headwater Lakes (Mitta Lake, API #2):** Surrounded by natural shoreline features, diverse substrates and habitats (i.e., deeper than 5 m and may include several basins); generally support more diverse fish communities relative to other eco-types. These lakes will potentially be directly impacted by the Project.
- **Headwater Ponds**: Including their inflows and outflows (API #6, #7, #11, #17, #13, #48 and #69); generally shallow (i.e., less than 2 m deep) with outflows/water elevation controlled by beaver dams, substrate consists of silt, organic material, may be partially infilled and/or contain flooded terrestrial vegetation. Many of the headwater ponds assessed during baseline studies were found to be fishless.

- **Headwater Warm Water Streams**: With interspersed beaver impoundments (API #1, #2, #7, #11, #12, #13, #48 and #69), excluding lower reaches. Portions of some streams have no defined channels. In these locations flows are conveyed through flooded forest areas. Some streams have been characterized as seasonal (i.e., have defined channels but are dry for extended periods).
- **Lower Reaches or Inflows to Receiving Waters:** The lower reaches of warm water streams, some of which are used by fish in the receiving water bodies as spawning and/or nursery habitat (API #1, #6, #14 and #47). Juvenile white suckers, northern pike and yellow perch were captured in the lower segments of some streams flowing into the Upper Marmion Reservoir and Lizard Lake. The lower reaches of the streams in which these species were documented tend to be flat and are likely accessible to fish from receiving waters during periods of high flow/water elevation. Some of these inflows are not accessible to fish from downstream receivers due to steep cascades located at their mouths.
- **Headwater Intermittent/Ephemeral Streams:** these are drainage features with defined or ill-defined channels that flow seasonally or only in response to runoff events (API #1, #6, #12, #47 and #48).
- **Receiving Waters**: Upper Marmion Reservoir (including Sawbill Bay, Lynxhead Bay and Turtle Bay), Lizard Lake, and API #8. These features are located downstream of the MSA and the lower reaches.

Table 2-6 summarizes fish community composition within each ecotype. Based on this fish distribution table

- Lake whitefish, cisco, walleye and smallmouth bass are found only in receivers.
- Northern pike is the only sportfish that occurs in warm water streams and several headwater lakes.
- White sucker, baitfish species and other small bodied fish are supported in most ecotypes.
- There are a number of headwaters and watercourses that are fishless.
- Four of the stream crossings are on stream features linking waterbodies with sportfish, including walleye, northern pike, lake whitefish, and smallmouth bass; however, the connecting stream is generally inaccessible to these species. Habitat within these features is generally steeper gradient, with coarse or bedrock substrates, and often woody debris making the streams impassable.
- Six of the stream crossings are on stream features that contain baitfish species and some other small bodied fish. Habitat in these features is typically low gradient streams or beaver ponds.
- Four of the stream crossings may be accessible on a seasonal basis by baitfish and other small bodied fish or they cross a waterbody that contains baitfish but is generally isolated from other features.

Table 2-6: Fish Community Composition by Ecotype

API #	Fish Species Present																					
	lake whitefish	cisco	central mud minnow	northern pike	longnose dace	northern redbelly dace	finescale dace	pearl dace	fathead minnow	spottail shiner	blacknose shiner	golden shiner	brassy minnow	white sucker	burbot	9-spine stickleback	brook stickleback	smallmouth bass	pumpkinseed	walleye	yellow perch	lowa darter	mottled sculpin
Ecotype: Lakes																							
Mitta L.						X	X		X					X		X	X					X	X
#2				X							X			X		X			X		X	X	
#46[(a)]							X		X														
#45[(a)]				X										X					X		X		
#47[(a)]							X	X															
Ecotype: Headwater Ponds																							
#6	Fishless																						
#7	Fishless																						
#4[(a)]						X	X																
#5[(a)]						X	X																
#11						X	X		X														
#13	Fishless																						
#10[(a)]	Fishless																						
#15[(a)]	Fishless																						
#16[(a)]	Fishless																						
#17						X	X		X														
#43[(a)]	Fishless																						
#44[(a)]	Fishless																						
#48	Fishless																						
#69						X	X																
Ecotype: Warm Water Streams																							
#1							X		X														
#2			X																				
#3[(a)]				X		X	X																
#4[(a)]						X	X																
#5[(a)]						X	X																
#9[(a)]			X						X														
#6	Fishless																						
#7	Fishless																						

Table 2-6: Fish Community Composition by Ecotype (Continued)

API #	Fish Species Present																						
	lake whitefish	cisco	central mud minnow	northern pike	longnose dace	northern redbelly dace	finescale dace	pearl dace	fathead minnow	spottail shiner	blacknose shiner	golden shiner	brassy minnow	white sucker	burbot	9-spine stickleback	brook stickleback	smallmouth bass	pumpkinseed	walleye	yellow perch	lowa darter	mottled sculpin
#10	Fishless																						
#11						X	X																
#14						X	X		X														
#15[(a)]	Fishless																						
#16[(a)]	Fishless																						
#40[(a)]				X										X									
#47							X	X															
#44[(a)]							X							X									
#46[(a)]							X	X															
#43[(a)]	Fishless																						
#69	Fishless																						
Ecotype: Seasonal and Intermittent Streams																							
API #48							X																
Ecotype: Inflows to Receiving Waters																							
#1							X		X					X	X								
#6				X										X								X	
#8				X										X									
#10				X										X							X		
#11						X	X																
#12						X	X		X					X									
#13	Fishless																						
#14						X	X		X				X	X									
#40[(a)]				X										X									
#41[(a)]				X																			
#44																					X	X	
#49[(a)]				X							X			X							X	X	
#50[(a)]				X										X									
#69	Fishless																						

Table 2-6: Fish Community Composition by Ecotype (Continued)

API #	Fish Species Present																						
	lake whitefish	cisco	central mud minnow	northern pike	longnose dace	northern redbelly dace	finescale dace	pearl dace	fathead minnow	spottail shiner	blacknose shiner	golden shiner	brassy minnow	white sucker	burbot	9-spine stickleback	brook stickleback	smallmouth bass	pumpkinseed	walleye	yellow perch	lowa darter	mottled sculpin
Ecotype: Receiving Waters																							
Upper Reser -voir	X	X		X						X	X	X		X	X			X		X	X	X	
Lizard Lake		X		X	X					X	X			X	X			X	X	X	X	X	X
#8				X										X	X			X					

Notes:
(a) Assessed, will not be affected by the Project.

2.2.2 Fish Tissue Analysis

In total, 88 tissue samples were collected and analyzed from Lizard Lake, Sawbill Bay, and Turtle Bay. Five species were analysed for metal content using individual samples of muscle tissues (cisco, white sucker, walleye and lake whitefish) or whole fish (blacknose shiner). Table 2-7 provides a summary of the results for selected metals. Laboratory results of tissue sample analyses are provided in Appendix 2.IV.

Table 2-7: Selected Fish Tissue Metal Results Summary (mg/kg wwt)

		Blacknose Shiner (n=2)			Lake Whitefish (n=22)			White Sucker (n=22)			Cisco (n=8)			Walleye (n=34)		
Parameter	**MDL**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**
Aluminum (Al)	5.0	24.2	33.7	14.7	10.2	40.2	2.5	14.9	49.1	2.5	21.1	32.9	6.1	15.6	55.6	2.5
Antimony (Sb)	1.0	<1.0	<1.0	<1.0	0.53	1.10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic (As)	1.0	<1.0	<1.0	<1.0	0.54	1.30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Barium (Ba)	1.0	1.15	1.30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beryllium (Be)	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2
Bismuth (Bi)	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.73	2.30	<1.0	0.5	1.9	<1.0
Boron (B)	5.0	<5.0	<5.0	<5.0	2.65	5.9	<5.0	2.8	8.3	2.5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium (Cd)	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2
Chromium (Cr)	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cobalt (Co)	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper (Cu)	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.53	1.20	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Lead (Pb)	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.56	1.80	<1.0	<1.0	<1.0	<1.0	0.5	2.0	<1.0
Magnesium (Mg)	20	278.0	285	271	252.2	330	183	255.2	319	187	289.5	338	227	346.9	2,270	206
Silver (Ag)	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2
Tin (Sn)	1.0	1.50	1.70	1.30	1.16	2.30	<1.0	1.33	2.00	<1.0	1.05	1.80	<1.0	1.30	12.20	<1.0
Titanium (Ti)	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U)	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Vanadium (V)	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc (Zn)	10	46.5	53	40	<10	<10	<10	<10	<10	<10	<10	<10	<10	6.1	37	<10

Notes:
wwt = wet weight.

Total mercury content for fish tissue samples from Lizard Lake, Sawbill Bay and Turtle Bay are provided in Table 2-8.

Table 2-8: Total Mercury Levels in Fish Tissue Samples (µg/g wet weight; Detection Limit 0.050 µg/g)

Water Body	Species	Average	Maximum	Minimum
Turtle Bay	Blacknose Shiner (n= 1)	0.083	0.083	0.083
	Lake Whitefish (n=8)	0.241	0.329	0.135
	Walleye (n=8)	0.461	0.935	0.267
	White Sucker (n= 5)	0.185	0.301	0.072
Sawbill Bay	Blacknose Shiner (n=1)	0.066	0.066	0.066
	Lake Whitefish (n=14)	0.214	0.335	0.102
	Walleye (n=18)	0.523	1.660	0.232
	White Sucker (n= 11)	0.244	0.374	0.124
Lizard Lake	Cisco (n=8)	0.155	0.178	0.140
	Walleye (n= 8)	1.210	1.730	0.796
	White Sucker (n= 6)	0.239	0.408	0.140

Analytical results were compared to existing sport fish consumption guidelines and Canadian Tissue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota (CCME 2000).

Mercury is attracted to particles in the water and settles to the bottom sediments where it can be converted by microorganisms into methyl mercury. Methyl mercury is rapidly absorbed by a fish either directly from water passing over its gills or ingested with its diet. Since fish eliminate mercury at a very slow rate, concentrations of this substance gradually accumulate. For women of child-bearing age and children under 15, consumption restrictions for sport fish containing mercury begin at levels of 0.26 parts per million, with total restriction advised for levels above 0.52 parts per million (MOE 2011). For the general population, consumption restrictions begin at levels above 0.61 parts per million, with total restriction advised for levels above 1.84 parts per million" (MOE 2011).

Based on these guidelines, 97% of the walleye analyzed exceeded the consumption restrictions for sportfish containing mercury for women of child-bearing age and children under 15. Thirty-two percent of white suckers sampled and 27% of lake whitefish sampled also exceeded this guideline. Forty-one percent of walleye samples analyzed exceeded the total restriction advised for sportfish containing mercury for women of child-bearing age and children under 15 while 35% exceeded the general population consumption restriction level of 0.61 ppm. No fish sampled exceeded the total restriction for the general population of 1.84 ppm. Total mercury concentrations were highest in walleye collected in Lizard Lake. Higher background concentrations of mercury in Lizard Lake fish may be a function of the amount of wetlands present within the drainage of Lumby Creek.

2.2.3 Aquatic Sediment Analysis

Aquatic sediments collected at each benthic invertebrate community (BIC) sampling station were analyzed for total organic carbon (TOC) content and grain size (Table 2-9). Sediment grain size ranged between sand to silty clay loam, and TOC ranged between 0.94% and 35.6%.

Table 2-9: Sediment Grain Size and Total Organic Content Analysis Results

	Sand (2.0 mm - 0.05 mm)	Silt (0.05 mm - 2 um)	Clay (<2 um)	Texture	Total Organic Carbon
Units	***%***	***%***	***%***	**-**	***%***
DI[(a)]	***0.1***	***0.1***	***0.1***	**-**	***0.1***
R1	92.7	7.06	0.24	Sand	1.44
API #38*	55.7	42.6	1.65	Sandy loam	**32.1**
API #41	46.2	41	12.8	Loam	0.94
Turtle Bay	60.2	29.8	9.99	Sandy loam	1.64
API #36	18.2	66.3	15.5	Silt loam	**12.4**
API #9	24.6	47.9	27.5	Loam/Clay loam	**19.6**
Light Lake	5.1	82.1	12.8	Silt loam	5.76
API #30	48.3	41.2	10.5	Loam	**13.9**
API #69	8	62.3	29.7	Silty clay loam	**27.4**
API #12	17.3	67.4	15.3	Silt loam	7.38
API #33	22.5	51.6	25.8	Silt loam	**23.1**
API #34	37.1	47	15.9	Loam	8.91
Snail Bay	5.29	77.4	17.3	Silt loam	**35.6**
API #37	70.5	23.4	6.09	Sandy loam	1.19

Notes:
[(a)] Detection limit.
* = Results inconclusive/Insufficient sediment for analysis.
Bolding: Indicates that TOC values exceed Provincial Sediment Quality Guidelines (PSQG) of 10%.

A number of TOC values exceeded the PSQG of 10%; however, these higher values are typical of highly organic sediments in wetland-dominated natural systems, such as those found in the LSA.

2.2.4 Benthic Community Assessment

Benthic organisms were classified into dominant orders/groups and percent order/group was calculated (Figure 2-9). The most dominate family across all station was *Chironomidae (*non-biting midges; Order Diptera). The second most dominant family was *Sphaeriidae* (fingernail clams; Order Bivalvia). Table 2-10 provides a summary of indices and metrics used to characterize benthic invertebrate communities.

Table 2-10: Benthic Invertebrate Community Indices Summary Statistics

	API #39	API #38	API #41	Turtle Bay	API #36	API #9	Light Lake	API #30	API #69	API #12	API #33	API #34	Snail Bay	API #37
Simpson's Diversity Index														
Mean	0.68	0.43	0.59	0.44	0.51	0.52	0.59	0.35	0.52	0.71	0.42	0.63	0.58	0.66
Median	0.66	0.38	0.60	0.45	0.63	0.51	0.57	0.28	0.51	0.71	0.43	0.63	0.58	0.69
Min	0.63	0.18	0.38	0.31	0.00	0.41	0.43	0.16	0.35	0.68	0.00	0.49	0.38	0.45
Max	0.75	0.73	0.71	0.58	0.69	0.63	0.73	0.74	0.65	0.72	0.67	0.74	0.75	0.76
SD	0.06	0.22	0.13	0.10	0.29	0.09	0.13	0.23	0.12	0.01	0.27	0.09	0.14	0.13
SE	0.02	0.10	0.06	0.05	0.13	0.04	0.06	0.10	0.06	0.01	0.12	0.04	0.06	0.06
Simpson's Evenness Index														
Mean	0.52	0.52	0.42	0.30	0.62	0.40	0.55	0.31	0.41	0.40	0.60	0.32	0.47	0.36
Median	0.58	0.54	0.41	0.26	0.55	0.45	0.58	0.34	0.41	0.39	0.58	0.28	0.42	0.26
Min	0.40	0.28	0.23	0.16	0.35	0.28	0.35	0.11	0.22	0.26	0.39	0.23	0.20	0.23
Max	0.61	0.75	0.75	0.48	1.00	0.51	0.70	0.46	0.57	0.59	1.00	0.48	0.80	0.73
SD	0.09	0.18	0.20	0.13	0.28	0.11	0.13	0.14	0.13	0.13	0.25	0.10	0.26	0.21
SE	0.04	0.08	0.09	0.06	0.12	0.05	0.06	0.06	0.06	0.06	0.11	0.04	0.12	0.09
Taxa Richness														
Mean	6	4	7	7	5	6	5	7	6	9	4	9	7	11
Median	6	5	6	7	5	6	5	5	5	9	4	9	7	12
Min	5	2	4	5	1	4	3	3	5	6	1	7	2	4
Max	7	6	11	9	9	7	7	11	7	12	7	11	11	18
SD	0.84	1.64	2.59	1.67	2.92	1.14	1.58	3.90	0.89	2.39	2.24	1.58	3.39	5.45
SE	0.37	0.73	1.16	0.75	1.30	0.51	0.71	1.74	0.40	1.07	1.00	0.71	1.52	2.44
Density														
Mean	9,698	13,870	4,577	23,748	13,068	8,120	37,549	11,878	66,495	52,996	7,146	16,783	20,171	6,465
Median	8,318	11,723	2,931	18,792	14,137	7,241	28,963	12,068	17,240	43,445	2,802	18,619	19,352	8,663
Max	18,274	29,308	14,999	36,333	21,378	15,214	65,512	25,170	188,994	76,115	15,861	25,558	41,419	9,051
Min	2,112	2,414	388	16,895	3,793	4,138	12,499	3,189	15,861	38,618	1,896	7,241	2,758	2,758
SD	6,545.17	10,597.36	5,934.46	8,448.59	6,565.25	4,328.99	24,100.92	8,379.69	76,045.58	16,747.82	6,775.64	7,193.03	13,924.80	3,328.06
SE	2,927.09	4,739.28	2,653.97	3,778.32	2,936.07	1,935.98	10,778.26	3,747.51	34,008.62	7,489.85	3,030.16	3,216.82	6,227.36	1,488.35
%EPT														
Mean	0.48%	0.60%	1.05%	0.32%	0.87%	14.82%	0.00%	1.10%	0.00%	9.64%	3.64%	8.83%	0.00%	5.33%
Median	0.00%	0.00%	0.00%	0.00%	0.00%	16.67%	0.00%	1.37%	0.00%	6.80%	0.00%	9.44%	0.00%	5.71%
Max	2.42%	1.81%	2.94%	1.02%	4.35%	28.57%	0.00%	2.70%	0.00%	22.13%	18.18%	17.14%	0.00%	12.50%
Min	0.00%	0.00%	0.00%	0.00%	0.00%	3.98%	0.00%	0.00%	0.00%	4.76%	0.00%	1.69%	0.00%	0.00%
SD	1.08%	0.85%	1.45%	0.47%	1.94%	9.91%	0.00%	1.14%	0.00%	7.19%	8.13%	5.96%	0.00%	4.70%
SE	0.48%	0.38%	0.65%	0.21%	0.87%	4.43%	0.00%	0.51%	0.00%	3.21%	3.64%	2.67%	0.00%	2.10%

Benthic invertebrate densities are naturally variable, and can reflect changes caused by a variety of both natural and anthropogenic influences. Response to anthropogenic influences can result in either an increase or decrease in benthic invertebrate density depending on the nature of the influence. Influences such as increased nutrient inputs from anthropogenic sources may benefit certain taxonomic groups resulting in an overall increase in density, while declines in water or aquatic sediment quality can reduce the densities of sensitive or intolerant species.

Mean density of benthic invertebrates generally was low within all of the APIs sampled except API #12, the outflow of Mitta Lake and API #69, a small stream that also drains the lower peninsula (Appendix 2.IV).

The mean density at API #69 was significantly higher ($p<0.05$) than all other stations with the exception of stations Turtle Bay, API #12, API# 34, and Snail Bay. This is mainly attributable to high numbers of *Microtenpides* sp. *(*midge; *Chironomidae*) and *Bivalvia* sp. (bivalve) found at this station. At API #69, the dominance of highly organic sediments and high TOC concentrations may be the cause of the persistence of the disturbance-tolerant benthic species, as shown in Table 2-11. The higher density at API #69 may be a reflection of organic content.

Table 2-11: Water quality conditions at benthic monitoring stations

Station	Dissolved Oxygen (mg/L)	Conductivity (mS/cm)	pH (pH Units)	Temperature (degrees Celsius)
API #39 (inflow to Lizard Lake)	6.8	0.050	5.0	6.5
API #38 (inflow to Lizard Lake)	5.1	0.023	4.2	3.7
API #41 (inflow to Turtle Bay)	8.5	0.036	5.9	7.6
Turtle Bay	12.1	0.034	5.8	9.5
API #36 (inflow to Turtle Bay)	3.8	0.036	3.7	5.3
API #9 (inflow to Light Bay)	11.2	0.021	3.8	7.2
Light Lake	7.5	0.026	5.9	3.7
API #30 (inflow to Lynxhead Bay)	9.5	0.068	4.5	7.3
API #69 (inflow to Lynxhead Bay)	5.7	0.050	5.7	9.4
API #12 (inflow to Mitta Lake outflow)	7.6	0.063	4.9	7.5
API #33 (inflow to Sawbill Bay	11.1	0.046	6.1	8.5
API #34 (inflow to Sawbill Bay)	8.6	0.156	6.6	7.4
Snail Bay	6.4	0.027	5.4	7.9
API #37 (inflow to Sawbill Bay)	11.2	0.059	6.3	7.6

Benthic invertebrate richness indicates the health of the community through its influence on diversity, richness and increases with increasing habitat diversity, suitability, and water quality (Plafkin et al 1989). The healthier the community is the greater number of taxa found within that community. High species richness, therefore, is also an indicator of the overall health of the aquatic habitat or water body. Richness values depend on the number of species present, with higher values representing the “healthiest” communities. Mean taxa richness varied slightly between 4 at stations API #33 and API #38 and 11 at API #37 (inflow at the north end of

Sawbill Bay) (Appendix 2.IV). Richness in API #37 was significantly ($p<0.05$) higher taxa richness than API #33, API #38.

SDI values can range between 0 and 1, with higher values indicating greater diversity and lower values indicating lower diversity. Increasing diversity is positively correlated to overall community health. Average SDI values ranged between 0.35 at station API #30 and 0.71 at station API #12 (Mitta Lake Outflow) (Appendix 2.IV). The low SDI scores at API #30 are reflective of a combination of moderate taxa richness combined with low evenness (a representation of the relative abundance of the taxa present) due to the high density of Chironomidae (order Diptera) which accounted for 84.18% of the species collected (Figure 2-9). High densities of Chironomidae may be the result of a higher organic content in the sediments at this station.

The Evenness index can range from 0 to 1, and higher values are considered to reflect less impacted benthic communities. Healthier communities generally exhibit a more even distribution (higher evenness value) whereas lower evenness values generally indicate decreased health, with community structure favouring a few taxa. Evenness values were lowest of APIs #30 (inflow to Lynxhead Bay), #34 (inflow to Sawbill Bay) and at API #40 (Turtle Bay) and highest at station APIs #36 (inflow to Turtle Bay) and #33 (inflow to Sawbill Bay) (Appendix 2.IV). The low evenness value observed at station API#40 reflects the high percentage of *Tubificidae* worms (class Oligochaeta) and *Chironomidae* found at this station. These taxa account for an average of 20% of the community structure, the highest percentage of all APIs sampled (Figure 2-9). An over-abundance of chironomids and tubificids is likely a reflection of high organic content within sediments.

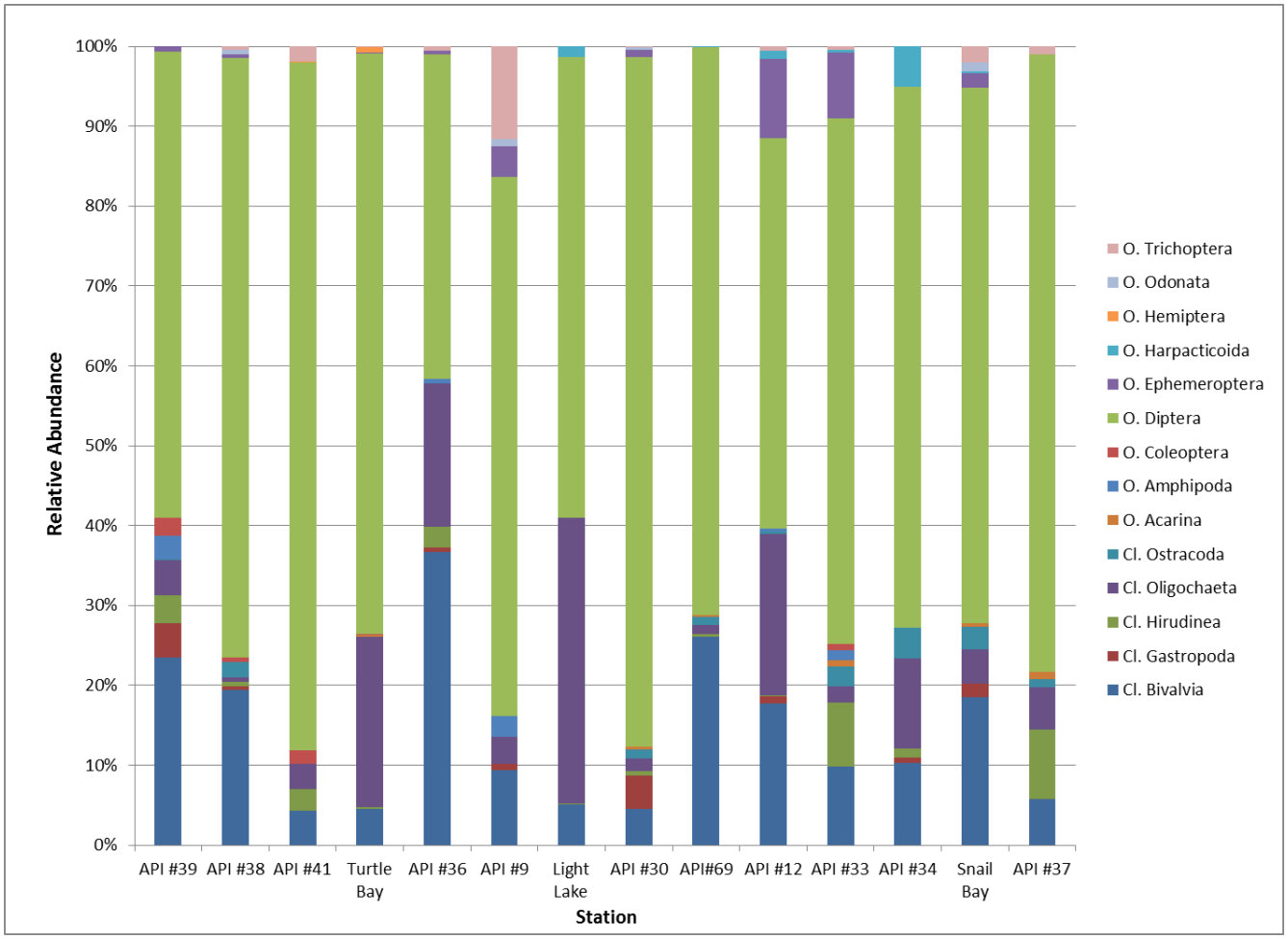


Figure 2-9: Benthic Invertebrate Community Major Taxonomic Groups (0= Order; C= Class) Relative Abundance

The percentage of the total abundance comprising Ephemeroptera, Placoptera and Trichoptera taxa (%EPT) is a useful measure of water quality. These taxa are known to be among the most intolerant taxa to conditions of nutrient enrichment, organic and trace metal contamination. Low EPT values are indicative of poor water quality and/or disturbance. Generally, percent EPT values were low in most of the APIs where the benthic invertebrate communities were sampled. APIs #9 (inflow to Light Bay), #12 (Mitta Lake outflow) and #34 (an inflow to Sawbill Bay) had the higher percent EPT values than the other sites, and this is likely a reflection of the habitat types. The occurrence of EPT species is influenced by substrate type, and these species are generally more common in areas of flowing water with gravel/rock substrates.

3.0 EFFECTS ASSESSMENT

This section predicts and describes the changes to the aquatic environment that are likely to result from the Project. These changes are then assessed to determine if an adverse effect is expected, whether an adverse effect can be mitigated, and for effects that cannot be fully mitigated (residual effects), a determination of the significance of the effect. All residual effects are assessed for significance. Section 3.1 provides a description of effects assessment methods.

3.1 Effects Assessment Methods

The effects assessment comprises the following steps:

- Step 1: Screening of Project activities with the potential to have interactions with the VECs of the aquatic environment.
- Step 2: Prediction (i.e., identification and description) of potential effects of the Project.
- Step 3: Identification of suitable mitigation measures to reduce or eliminate the identified effects.
- Step 4: Assessment of whether adverse effects remain after mitigation (i.e., residual effects).
- Step 5: Determination of the significance of residual effects. If there is uncertainty of whether an effect remains after mitigation, the effect is forwarded for determination of significance.

The effects assessment is completed within the framework of the temporal and spatial boundaries described in Section 1.7. The assessment takes into account a precautionary approach and incorporates Aboriginal traditional knowledge, where available. The effects of the Project on the aquatic environment are assessed through the following six criteria:

- Direction: the direction of the effect as positive or negative.
- Magnitude: the size or degree of the effect for a given parameter.
- Geographic extent: the spatial area over which the effect may occur.
- Duration: the length of time over which the effect may occur.
- Frequency: the rate of recurrence of the effect (or conditions causing the effect).
- Reversibility: whether the effect may or may not be reversed.

To determine the significance of an effect, three levels are associated to each criterion: low, medium and high, as shown in Table 3-1.

Table 3-1: Assessment Criteria and Levels for Determining Significance

Assessment Criteria	Level		
Geographic Extent (of effect)	**Low**	**Medium**	**High**
	Effect is within the Project Site (i.e., Mine Study Area or Linear Infrastructure Study Area)	Effect extends into the Local Study Area	Effect extends into the Regional Study Area
Frequency (of effect)	**Low**	**Medium**	**High**
	Conditions or phenomena causing the effect to occur infrequently (i.e., several times per year)	Conditions or phenomena causing the effect to occur at regular, although infrequent intervals (i.e., several times per month)	Conditions or phenomena causing the effect to occur at regular and frequent intervals (i.e., daily or continuously)
Duration (of conditions causing effect)	**Low**	**Medium**	**High**
	Conditions causing effect are evident during the site preparation and construction phase, or decommissioning phase	Conditions causing effect are evident during the operations phase	Conditions causing effect extend beyond any one phase
Degree of Reversibility (of effect)	**Low**	**Medium**	**High**
	Effect is readily (i.e., immediately) reversible	Effect is reversible with time	Effect is not reversible (i.e., permanent)

Effect levels for magnitude specific to each biological discipline VEC indicator measures are shown in Table 3-2. Assigning a 'magnitude' for any given effect may vary depending upon the scale at which the effect occurs. The permanent destruction of a small stream has severe implications to the baitfish and benthic invertebrate populations that rely directly on the habitat it provides, but there may be no detectable response or impact on sport fish populations or aquatic communities in large waterbodies located down gradient. Many aquatic species and communities can recover completely from or compensate for periodically occurring effects. These responses are generally extremely difficult to discern from responses to natural events. Aquatic communities can adapt to stressors of various magnitudes although they may continue to exist in a permanently altered state (e.g., different community composition, relative abundance, age structure). Where effects are widespread, alter a large proportion of important habitats and are permanent, populations become highly unstable, cannot sustain themselves and are eventually extirpated.

Table 3-2: Magnitude Levels for Aquatic Environment VECs Indicator Measures

VECs	Magnitude		
	Low	**Medium**	**High**
Lower reaches of headwater drainage features and receivers	Less than 10% loss (in drainage area or channel length) of any single habitat type (e.g., spawning, rearing/nursery, feeding, migratory corridor and summer/winter refugia) within an aquatic feature, or that fish within a particular aquatic feature rely upon (within an adjacent aquatic feature). Habitat remains functional and continues to be used by fish species. No difference in qualitative or quantitative population indices indicative of declining health of BIC populations within an aquatic feature that is not also observed in reference populations/location(s).	10% to 25% (in drainage area or channel length) loss of any single habitat type (e.g., spawning, rearing/nursery, feeding, migratory corridor and summer/winter refugia) within an aquatic feature or that fish within a particular aquatic feature rely upon (within an adjacent aquatic feature). Habitat feature(s) remain(s) functional. Periodic difference(s) in qualitative or quantitative population indices indicative of declining health of BIC populations within an aquatic feature that is not observed in reference populations/location(s) and is attributable to habitat degradation (e.g., water quality, sediment quality or loss of habitat) caused by the Project.	Greater than 25% (in drainage area or channel length) loss of any single habitat type (e.g., spawning, rearing/nursery, feeding, migratory corridor and summer/winter refugia) within an aquatic feature or that fish within a particular aquatic feature rely upon (within an adjacent aquatic feature). Habitat feature is no longer functional and ceases to be used by fish species. Habitat loss leads to local population decline and/or local extirpation of species. A permanent difference in qualitative or quantitative population indices indicative of declining health of BIC populations within an aquatic feature that is not observed in reference populations/location(s) and is attributable to habitat degradation (e.g., water quality, sediment quality or loss of habitat) caused by the Project. Results in permanent changes in species density, community richness and diversity and/or extirpation of sensitive species.

Table 3-2: Magnitude Levels for Aquatic Environment VECs Indicator Measures (Continued)

VECs	Magnitude		
	Low	**Medium**	**High**
Walleye, Smallmouth Bass, Northern Pike, Baitfish	Temporary or one time disruption of life history requirement or alteration of critical habitat(s) (e.g., decrease in habitat suitability) leading to failure or poor survival of a year class. No detectable effect on populations within receivers or in LSA. No significant increase in mean concentration of a contaminant within fish that lie within the size range preferred by anglers.	Periodic (e.g., recurring) disruption of life history requirement or alteration of critical habitat(s) (e.g., decrease in habitat suitability) leading to year-class failure (e.g., poor spawning/survival of several age groups). Detectable changes in population dynamics (e.g., recruitment, population mortality and abundance) and/or compensatory responses (e.g., growth, maturation, fecundity). A significant increase in mean concentration of a contaminant within fish that lie within the size range preferred by anglers and attributed to the Project that does not increase health risk to consumers	Permanent disruption of life history requirement or alteration of habitat (e.g., destruction of critical habitat(s)), leading to high instability and risk of population decline within receiver or LSA. A significant increase in mean concentration of a contaminant within fish that lie within the size range preferred by anglers and attributed to the Project that increases health risk to consumers.

The significance assessment process focuses on evaluating potential impacts of Project effects on the environment and VECs, and the consideration of feasible mitigation measures that can be incorporated to control, reduce or eliminate the effect. The assessment recognizes the widest, reasonable range of potential effects without specific regard for their respective probability of occurrence. In this context, the probability of occurrence of an effect is not considered an assessment criterion.

The effects assessment follows a source-pathway-receptor approach. Project activities represent the source of a change, a measurable change to the environment represents a pathway and the VECs represent the receptors. In some cases, the VECs may act as both pathways and receptors.

Project effects may occur through direct or indirect interactions. A direct interaction occurs when the VEC is affected by a change resulting from a Project activity (e.g., dewatering of Mitta Lake). An indirect interaction occurs when the VEC is affected by a change in another VEC (e.g., reduction in watershed area affecting discharge of outlet stream).

The level of significance of an effect is assigned by assessing magnitude, geographic extent, frequency, duration, and degree of reversibility to identify an environmental consequence, as shown in Figure 3-1. Then the social and/or ecological importance of the VEC is considered to determine the overall significance of the effect.

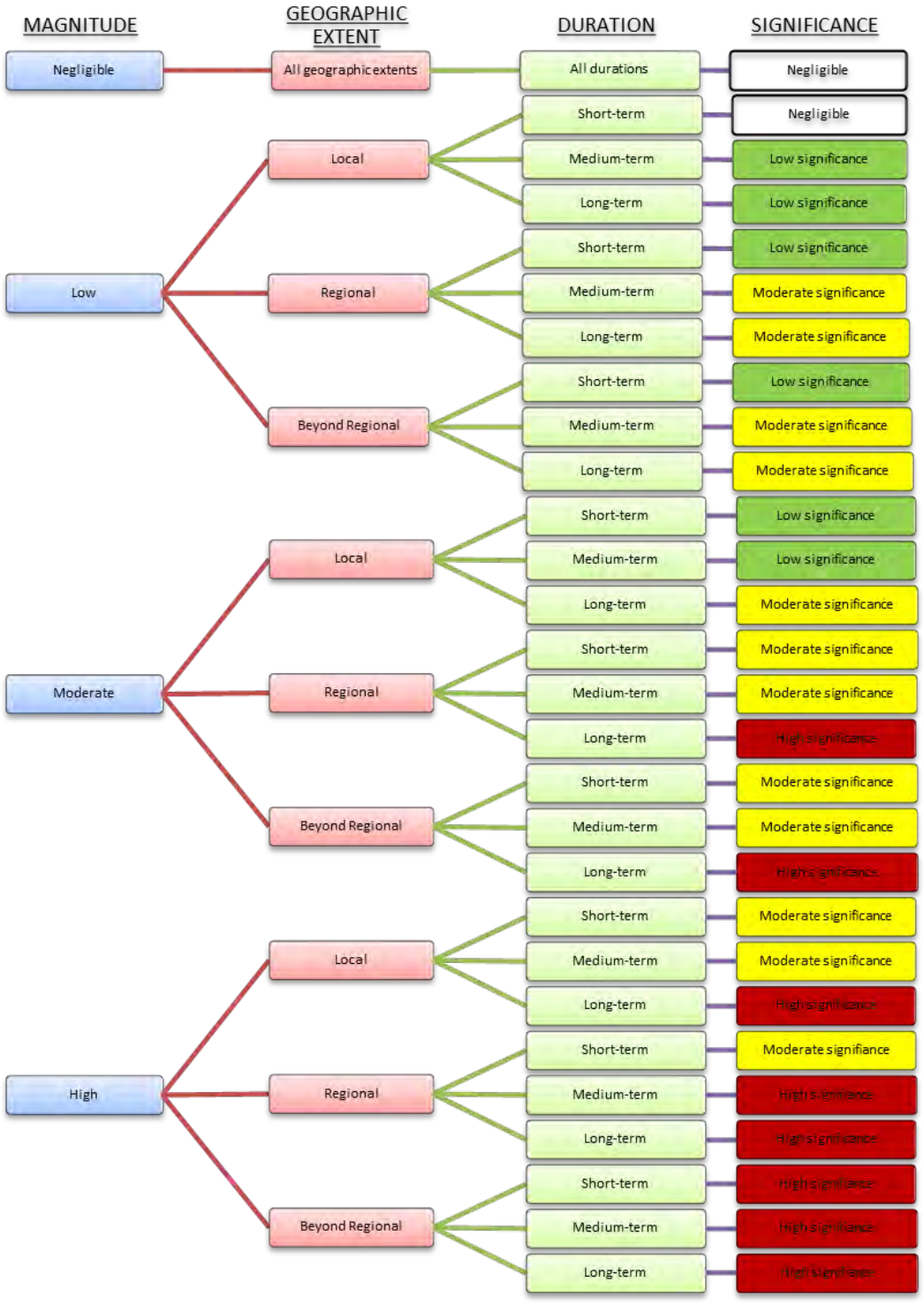


Figure 3-1: Decision Tree for Assigning Significance to Effects on Aquatic Environment

3.2 Determining Project Activity and Valued Ecosystem Components Interactions

Sections 3.2.1 through 3.2.4 identify the Project activities for each Project phase with the potential to have a direct and indirect interaction with the aquatic environment, as well as identifying which VEC may be affected. These interactions are highlighted in Appendix 3.I according to Project activity, VEC and API and are identified as either direct or indirect effects, for each of the life cycle stages of the Project. A summary is provided in Tables 3-3 and 3-4.

The *Fisheries Act* (the Act), administered by DFO prohibits the harmful alteration or disruption, or destruction, (HADD) of fish habitat, the destruction of fish and provides for fish passage except where authorized by the DFO. In cases where it is not possible to protect fish habitat by mitigation or project design, an Authorization may be issued under the Act. An Authorization allows a proponent to proceed under prescribed conditions, including the need to achieve "no net loss" of habitat by compensating for adverse effects on fish habitat. Habitat compensation is intended to improve physical, chemical, or biological factors that are limiting habitat capability. This includes replacing damaged habitat with newly created habitat, increasing the productive capacity of existing natural habitat, or least preferably, maintenance of fish production by artificial means. The amount of compensation must be determined based on the residual net loss of productive capacity of habitat. In the special instance of mining activities, where the deposition of a deleterious substance, for example mine tailings, into a fish bearing waterbody is proposed, a special regulation and Schedule 2 listing of the waterbody is required, along with an approved compensation plan (See Section 4.3).

A fish habitat accounting protocol and conceptual No Net Loss Plan (NNLP) was developed in consultation with the key regulatory agencies, including DFO and MNR, to assist in the preparation of a final NNLP for the Project, and also to support the effects assessment process in the environmental assessment (Appendix 2.III). The accounting protocol follows a widely accepted approach used for quantifying habitat called the Habitat Evaluation Procedure (HEP), which was modified based on more recent fish habitat preference/suitability studies in Canada (Minns et al. 2001; Minns 2010). HEP has been used as the basis for developing NNLPs and also environmental assessments within Canada. The approach uses a spreadsheet model to assess aquatic habitat as follows:

- Habitat area calculated as the surface area of a unit of habitat (m^2).
- For each species or guild present, a Habitat Suitability Index (HSI) score (0 to 1) is calculated for each habitat class (e.g., spawning, juvenile, adult, summer/winter refugia, migration) and averaged.
- A species specific rank or Habitat Unit (HU) score is the product of area and HSI.
- Total available habitat for the aquatic feature is the sum of the individual species HU scores.

Resultant number of HUs is linked to actual habitat area but generally considered to be a dimensionless value. The Habitat Suitability Index scoring was based on a subjective rating based upon detailed habitat mapping information collected during baseline studies and species specific habitat preference tables generated from scientific and technical literature (Appendix 2.III).

3.2.1 Construction Phase

During the construction phase, flows in watercourses within the Mine Study Area are expected to be altered from baseline conditions by changes in land cover, runoff diversion, runoff interception and lake dewatering. The majority of aquatic habitat alteration will take place during this phase of the Project and will be permanent. These changes are expected to occur during general construction of the overburden stockpile, WRMF, TMF, and Support and Ancillary Infrastructure. The construction of these facilities will eliminate some small watercourses, and will affect the headwaters of other watercourses.

Indirect effects include the reduction of downstream flows due to elimination of portions of catchments. Changes in the magnitude of flows in watercourses under normal, dry and wet hydrologic conditions as a result of runoff diversion and runoff collection are expected to be roughly proportional to changes in their tributary drainage areas at any given location. The entire catchment in which API #14 is located will be removed as Support and Ancillary Infrastructure, including the process plant collection pond (PPCP), is developed.

Upgrading of the access road (Hardtack/Sawbill), mine site road and construction of the project transmission line will be undertaken at the beginning of the construction phase to facilitate movement of equipment to the site. This will include the upgrading of existing, and construction of new water crossings along the access road (Hardtack/Sawbill) and the mine site road. New 'on-site' roads will be constructed around the perimeters of planned components of Project Site infrastructure (e.g., east and west pits, waste rock stockpile, buildings and access roads to the live ore stockpile, low-grade ore stockpile and overburden stockpile areas). APIs potentially directly impacted by water crossing construction include #20, #21, #22, #63, #64, #65, #66, #67 and #68 along the access road (Hardtack/Sawbill), APIs #1, #15 and #17 along the mine site road, and #11, #12, #14, #17 along various on-site roads. Only some of these crossings represent direct fish habitat; however, potential for downstream effects on habitat exist. APIs #11, #12 and #14 also will be impacted during the operations phase of the Project, as shown in Figure 3-2.

610000 620000 630000

5430000

5420000

N

LEGEND

- API's Potentially Impacted by the Project
- API's Not Impacted by the Project
- Raft Lake Cut Location
- Trail
- Road
- River/Stream
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREAS OF POTENTIAL IMPACT FOR THE PROJECT

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020		SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	
GIS	JO	11 Feb. 2013	
CHECK	BH	11 Feb. 2013	
REVIEW	GA	11 Feb. 2013	

FIGURE: 3-2

G:\Projects\2010\10-1118-0020_BretlResources_HammondReefGIS\MXDs\Draft\AquaticsTSD\Potential_Directly_Impacted_API.mxd

Potential impacts of water crossing construction on aquatic biota are well documented. Elevated total suspended solids (TSS) and accelerated bedload movement caused by erosion can affect water quality, as well as alter channel morphology and streambed composition. In addition, particles carried by water are abrasive and their movement can physically erode channels (Anderson et al. 1996). If TSS levels remain elevated for a prolonged duration (days or weeks) during certain periods of the year, primary productivity of a watercourse can be inhibited downstream of crossings. Depending on the amount and type of substrate affected, and the duration of the effect, bedload movement can reduce substrate porosity, pool depth and riffle area. All three aspects can have negative consequences for aquatic organisms living downstream of crossings. Reduced depth compromises a pool's ability to overwinter fish and can render it less suitable as a rearing and foraging habitat for juveniles and summer feeding and holding habitat for adults. Reduced riffle area results in a loss of oxygenated habitat suitable for benthic invertebrates, reduced diversity of benthic invertebrate communities downstream of the crossing, indirect loss of preferred prey for fish within the affected area, loss of spawning areas, loss of interstitial habitat for invertebrates and loss of interstitial nursery and rearing habitat for eggs and young fish. Elevation drops at the inlet or outlet can create physical barriers for many species. Fish species encountered in water courses intersected by the linear corridors have limited or no jumping capabilities. Water velocities can be too high to allow the upstream passage of fish or other organisms during the freshet or following periods of extensive precipitation. As stream-discharge increases, velocities within culverts increase correspondingly. Average velocities can easily exceed the prolonged swim speed of fish. For spring spawning fish species such as walleye and northern pike, the timing of movement is critical and temporary or seasonal barriers might seriously impact survival or reproduction within individual streams. Absence of a wetted, low-flow channel can result in water depths too shallow to allow passage for fish or other organisms.

Replacing the natural streambed and banks with an artificial crossing structure usually results in direct loss of habitat. Culverts provide very little habitat within the culvert. Some habitat can be provided if the culvert is sufficiently embedded with substrate that is similar to the natural streambed. Open-bottom or arch culverts and bridge crossings often maintain natural streambeds. Direct loss of habitat at each crossing location will be evaluated once crossing design specifications become available. Where required, HADDs associated with water crossings will be added to the NNLP.

To avoid HADDs, a number of strategies will be employed during construction of roads and water crossings including the design of crossings (e.g., to facilitate fish passage) and sound construction practices. Any equipment used in the stream will be clean and inspected for leaks. These procedures will minimize the potential for erosion, sediment releases, and introduction of contamination. All construction activities will be subject to a sediment control plan, and best management practices, that will include standard erosion and sediment control measures (e.g., erosion mats, silt curtains) to prevent surface runoff from disturbed banks and subsequent sediment delivery to the channel during the construction period; particular attention will be directed to controlling runoff along the road during high precipitation events. The MNR provides direction for managing environmental concerns associated with the construction, maintenance and decommissioning of roads and water crossings in the *Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales* (MNR 2010). Timing restrictions on in-water work and activities that may potentially cause sedimentation during periods of fish spawning, incubation and fry emergence are prescribed. Provincial authorization to conduct in-water work is granted under the *Lakes and Rivers Improvement Act* and it is through this permitting process that timing restrictions are applied. The MNR will consider mitigation and prescribe conditions on an individual basis for each water crossing. Where it can be demonstrated that all potential impacts will be mitigated during

construction (erosion and sediment control plans, best management practices), in-water work within the timing windows can be permitted. If there are sensitive habitat features (e.g., spawning habitats) near a crossing location, it may be more difficult to demonstrate 100% mitigation of potential effects. Generally, the zone of potential impact for any given water crossing is defined as 100 m downstream and 30 m upstream of each crossing (MNR 2010).

An emergency response and spill plan will be designed to minimize the likelihood of accidental spills, or if they do occur to quickly respond and clean-up any spills. During construction, hazardous materials and fuel will be stored according to regulatory requirements to protect the environment and workers and will be located a safe distance from watercourses. Individuals working on the construction activities and handling hazardous materials will be trained in the Transportation of Dangerous Goods. Emergency spill kits will be available near work areas. Construction objectives will include the following:

- Minimizing the time spent working in water.
- Using construction methods resulting in the least adverse effects.
- Avoiding construction during high risk periods within the life cycles of resident fish (i.e., abiding by seasonal timing restrictions).
- Minimizing the release of sediment or suspended solids.
- Minimizing disturbance and erosion of substrate and along banks.
- Using sediment control measures.
- Maintaining flows.
- Restoring riparian areas.
- Maintaining fish passage during construction.
- Maintaining hydraulic and hydrologic characteristics of water courses, to the extent practical.

During the construction phase, stockpile and laydown areas will be prepared for equipment and supplies that are brought to site. The site infrastructure, including a water supply pipeline, storage and maintenance areas, permanent support facilities, such as a paramedic station and offices, will be constructed. Clearing, grubbing, and site levelling will be undertaken where infrastructure is to be placed. The soils removed during opening of these areas will also be stockpiled for future use in rehabilitation. Site preparation will also necessitate removal of soils in some areas for site infrastructure. Removed soils will be stockpiled, and protected against erosion, for future use in reclamation. As vegetation and soils are removed, there may be potential for sediment to enter water courses at Sawbill and Lynxhead bays, which will be mitigated with erosion and sediment control plans. As part of the construction of buildings and parking areas for the Project Site, a retaining wall/sloping berm will be constructed adjacent to the shore of one of the small bays off Sawbill Bay along the peninsula. The toe of this wall/berm will cover a portion (less than 0.8 ha) of the drawdown zone of Upper Marmion Reservoir, above the low water mark. This area may provide seasonal habitat for baitfish, northern pike and possibly smallmouth bass, and represents a seasonal habitat loss.

The TMF, including a tailings containment area and tailings disposal pipeline, will be constructed. The pipeline will be constructed above ground, with drainage points and spill containment areas located at naturally occurring low points along the route. The pipeline will follow the existing on-site road alignments to the maximum extent possible: the road bed may need to be widened to accommodate the pipeline. Where the pipeline deviates from existing on-site roads, a construction access road will be constructed that will also be used as a service road for the pipeline during operations.

Erosion and sedimentation are two potential impacts of site preparation. Excess erosion can degrade stream habitats by increasing total suspended solids in the water negatively impacting invertebrates, fish eggs and fry by subjecting them to sediment and physical abrasion. Appropriate sediment and erosion control measures will be implemented to mitigate deposition of fine materials into water courses.

Mitta Lake (API #12) is located on top of the proposed west pit. The elimination of this lake is unavoidable. The draining of Mitta Lake will take place early in the construction phase. Water from the lake will be transferred into the Upper Marmion Reservoir and either discharged at an offshore location at the end of the Hammond Reef peninsula or pumped through the emergency spill pond, and then into Upper Marmion Reservoir, if sediment control is required. Baseline water quality data (Lake Water Quality TSD) show that water quality in Mitta Lake is similar to water quality in Sawbill Bay, and transfer of water will not result in adverse effects on Sawbill Bay water quality. The pump intake will be a floating intake located in the middle of Mitta Lake and will be appropriately screened to minimize impingement or entrainment of fish. As water levels in the lake are reduced, a fish salvage protocol will be implemented to minimize fish mortality. Live-captured fish will be transferred as they become stranded in isolated pools and basins and released into Sawbill Bay or other suitable waterbody, based on discussions with DFO and MNR. The dewatering will result in the mortality of all benthic invertebrate organisms entrained within the pump. The conveyance of water to the outflowing stream will cease early in the drawdown process. The fish salvage protocol will also be implemented in any isolated pools in the outflow. API #69 also will be eliminated as clearing and construction of the west pit proceeds. The process plant collection pond (PPCP) will be developed in API #13.

The entire catchments of each of these APIs will be permanently eliminated.

The starter perimeter dams within the TMF will be constructed near the southwest corner of the facility before commencement of operations and will have a crest elevation that provides sufficient tailings and reclaim water storage capacity for the first two years of operation. It is expected that flows in API #1 will be affected by construction of dams. This entire catchment will be contained within the TMF and thus eliminated.

Additional in-design measures to offset construction impacts include the following:

- Erosion and sediment control plans.
- Flagging/fencing construction footprints to prevent disturbance beyond construction areas.
- Observe fisheries timing windows when working in/near water.
- Implement fish rescue and salvage protocols in advance of construction activities and adjust construction phasing to facilitate rescue operation to minimize stress to fish.
- For surface water diversion construction: Construct diversion channel in the dry; manage pumping rates to the channel to minimize erosion.

- Implement silt controls and erosion controls on pump discharges; maintain buffers around/adjacent to waterbodies to be protected.
- Manage runoff/erosion of stockpiles.
- Stockpile logs, rootwads and wetland materials for use in habitat compensation.
- Road crossings: Use open bottom culverts where feasible; construct compensation measures in advance of road work.
- Use stabilizing vegetation and seeding as soon as possible post construction to minimize erosion.
- Implement stormwater management controls/facilities: Use ponds as temporary sediment controls during construction.

Table 3-3: Construction Phase Activities and Interaction with the Aquatic Environment

(X = potential direct interaction; y = potential indirect interaction) (Appendix 3.I)

Project Activities	Lower reaches	Sawbill/ Lynxhead Bay	Lizard Lake	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species
Linear Infrastructure							
Upgrading/construction of roads and water crossings	X			X	X		X
Support and Ancillary Infrastructure							
Clearing and grubbing of development areas	X, y	y					X, y
Stripping and stockpiling of topsoil	X, y	y					X, y
Ore Processing Facility							
Site grading	X, y	y					X,y
Mine							
Clearing and grubbing	X, y						X, y
Blasting and excavation of pre-strip material and haul to WRMF	X, y	y					X y
Stockpiles							
Clearing and grubbing	X, y	y					X y
Waste Rock Management Facility (WRMF)							
Clearing and grubbing	X, y			y			X, y

Table 3-3: Construction Phase Activities and Interaction with the Aquatic Environment (Continued)

Project Activities	Lower reaches	Sawbill/ Lynxhead Bay	Lizard Lake	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species
Tailings Management Facility (TMF)							
Clearing, grubbing and installation of temporary sediment control measures	X, y			X, y			X, y
Strip topsoil from dam foundations and truck to stockpile	X, y			X, y			X, y
Water Management System							
Dewatering of Mitta Lake including fish rescue and discharge of water to Upper Marmion Reservoir	X, y	Y					X, y

3.2.2 Operations Phase

During the operations phase, flows in watercourses will continue to be influenced by on-going changes in land cover, runoff interception, water taking and effluent discharge that commenced during the construction phase. Additional changes are expected as a result of increased runoff collection with the progressive expansion of the Mine, overburden stockpile, WRMF and TMF. The Project Site and the quantity of runoff intercepted by the water collection system, therefore, will increase over time.

An accommodation camp will be established where the exploration camp is currently located. Potable water will be removed from Sawbill Bay. Flows in Sawbill Creek will be affected by the discharge of treated sewage effluent from the accommodation camp located just upstream of the creek mouth. Changes in flows in the creek were evaluated by summing the expected discharge and selected flow statistics. The greatest percentage increase will be to low flows in the creek. This is expected to affect the lower reaches of the creek, between 50 m and 100 m upstream of the mouth. Discharge will be year-round. Changes in the magnitude of flows in Sawbill Creek are less than 1% of baseline flows. Changes in the duration and frequency of flows of a given magnitude will be correspondingly small. There will be no change to the timing of seasonal flows in the creek. Effluent quality will meet MOE guidelines. The sewage discharge location near the mouth of Sawbill Creek (API #20) is a seasonal migration route for walleye and other fast water spawning species (e.g., sucker species) that spawn further upstream in Sawbill Creek.

At the onset of the operations phase, the process of removing the ore (economically valuable material) through development of the open pits begins. Mine ramps will be advanced progressively through the operating life of the Mine using blasting. According to Wright and Hopky (1998) “the detonation of explosives in or adjacent to fish habitat has been demonstrated to cause disturbance, injury and/or death to fish and marine mammals, and/or the harmful alteration, disruption or destruction of their habitats, sometimes at a considerable distance from the point of detonation”. As noted, the detonation of explosives in or near water produces post-detonation compressive shock waves characterized by a rapid rise to a high peak pressure followed by a rapid decay to below ambient hydrostatic pressure. The latter pressure deficit causes most impacts on fish. The primary site of damage in fish is the swimbladder. The kidney, liver, spleen, and sinus venous also may rupture and haemorrhage. Fish eggs and larvae also may be killed or damaged (Wright 1982). Wright (1982) showed that an overpressure in excess of 100 kPa will result in these effects. The degree of damage is related to type of explosive, size and pattern of the charge(s), method of detonation, distance from the point of detonation, water depth, and species, size and life stage of fish. Fisheries and Oceans Canada (DFO) has established a set of guidelines for the use of explosives in or near Canadian fisheries waters (Wright and Hopky 1998). For instances were blasting is occurring near fisheries waters, collection of site specific data, to measure actual blast vibrations may be necessary to confirm the need for mitigation.

The intensity of blast vibrations is primarily influenced by the maximum explosive weight detonated per delay period within a blast and the distance between the blast and the receptor. The primary means of reducing the impact on the spawning beds and active fisheries are by increasing the distance to these environmental receptors or reducing the weight of explosive charge detonated per delay period. Ongoing blast monitoring will provide guidance as to when, if at all, blast designs should be altered to accommodate vibration levels at the nearest active spawning beds. Collection of data on the actual spawning species, locations and times will also provide important information regarding means to mitigate potential impact of blast-induced vibrations.

The mining process will generate waste rock (uneconomic material), which will be brought to surface and disposed of in the waste rock stockpile. The operation of the Mine will involve on-going transport of equipment and supplies to the site. Mining activities will be supported by facilities for fuelling and servicing equipment. Mined ore will be brought to surface uncrushed via truck haulage and placed directly into the gyratory crusher for immediate processing or placed into the live ore stockpile adjacent to the processing plant for processing in the future. The ore stockpiles will be protected with berms to control runoff. Seepage collection systems will be installed at the low points around the perimeter of the waste rock piles. This will allow the seepage water quality to be monitored.

In addition to the mine workings and the processing plant, the operating phase includes a number of facilities to support the mining operation. These include an accommodation camp, administration offices and laboratories, and facilities to support these functions, such as sewage treatment facilities, waste disposal, and potable water supply. Domestic sewage will be treated on-site at one of the sewage treatment facilities and discharged from the Project Site. Solid wastes will be disposed of in a licensed landfill.

Based on predicted flows and lake mixing characteristics, and in consideration for walleye spawning areas in Lynxhead Narrows, the south end of Sawbill Bay was identified as the optimum location for the discharge from the effluent treatment plant (ETP), providing the best mixing characteristics, avoiding sensitive aquatic habitats and within a reasonable distance from the ETP. Using average baseline Upper Marmion Reservoir water quality data, average site discharge concentration, steady-state climatic conditions, and average mixing for the operational scenario, the predicted average water quality in the south end of Sawbill Bay was calculated (Water and Sediment Quality TSD). All predicted concentrations during average site discharge conditions during operations are lower than both the PWQO and the provincial Municipal-Industrial Strategy for Abatement (MISA) criteria. In general, the predicted results are the same as, or marginally greater than, average Upper Marmion Reservoir baseline concentrations. Water quality was also predicted under worst case conditions (e.g., using average baseline data, maximum predicted lab data for site discharge, and low flow conditions). Resulting predicted concentrations are lower than both the PWQO and MISA criteria. In general, the predicted results are the same as or marginally greater than average Upper Marmion Reservoir baseline concentrations with the exception of copper, which showed a slight increase to predicted concentrations slightly above the CWQG and for free cyanide, which exceeded CWQG and PWQO. The potential effects of copper and free cyanide, therefore, are assessed in Section 3.4.

Operation of the TMF will include pumping of the tailings slurry from the Ore Processing Facility. Tailings will be contained by perimeter dams constructed of non-erodible waste rock around the perimeter of the TMF. The perimeter containment dams will be constructed in stages to provide sufficient tailings and reclaim water storage capacity at all times during operations. Process water transported to the TMF with the tailings as well as precipitation that comes in contact with tailings will be contained and collected in a reclaim pond within the TMF and pumped to the processing plant for reuse.

During operations, seepage water from the TMF will be collected in sumps at the toe of the TMF containment dam and pumped back into the TMF. However, it is anticipated that some seepage may bypass the collection system and drain to Lizard Lake. TMF seepage rates were based on a preliminary seepage analysis as described in the Site Water Quality TSD. All predicted concentrations of average case TMF seepage to Lizard Lake for the operational scenario are lower than the MISA criteria. In general, the predicted results are the same as or marginally greater than average Lizard Lake baseline concentrations for most parameters.

The results predict an increase in the concentration of free cyanide from 0.005 mg/L to a maximum of 0.009 mg/L in the southern basin of Lizard Lake. Water quality assessment in Lizard Lake showed that both mercury and selenium exceeded the CWQGs under baseline conditions, but water quality modelling results indicate that there was no increase predicted due to seepage from the TMF. Water quality also was predicted under worst case conditions (e.g., using average baseline data, maximum predicted lab data for site discharge, and low flow conditions). All predicted concentrations of upper bound TMF seepage to Lizard Lake during operations are lower than the MISA criteria. In general, the predicted results are the same as or marginally greater than average Lizard Lake baseline concentrations for most parameters with the exceptions are copper and free cyanide. Copper concentrations were predicted to increase to 0.0022 mg/L, which is slightly above the CWQG of 0.002 mg/L. Free cyanide concentrations were predicted to increase to a maximum of 0.014 mg/L, compared to the CWQG of 0.005 mg/L and could potentially affect aquatic life. The effects are assessed in Section 3.6.

As the TMF is expanded, changes in flows from baseline conditions are expected in Lumby Creek in the Trap-Turtle-Lynxhead Bay watershed. Changes in flows in Lumby Creek as a result of the interception of runoff from areas within the Project Site (e.g., TMF) by the water collection system will have limited effect on water levels in Lizard Lake and Upper Marmion Reservoir, since the Project Site is a small percentage of the total drainage area of these features. This interception of runoff will affect inflows to Lizard Lake and the lower reach of Lumby Creek between Lizard Lake and Turtle Bay. Potential changes in monthly mean flows in Lumby Creek obtained using hydrologic modelling, range from -7.7% to 0.0%, with the greatest changes generally occurring in the spring and the smallest changes occurring in the winter (see Hydrology TSD). Reductions in the magnitude of water levels in Lizard Lake under normal, wet and dry hydrologic conditions as a result of runoff collection in the TMF were estimated using hydrologic modelling. Potential changes in monthly mean water levels in Lizard Lake ranging from minus 2.7 cm (May) to 0 cm (December to March), with the greatest changes occurring during the spring and summer (April to September) and the smallest changes occurring during the winter/early spring (December to March). As a result of the reduction in tributary drainage area to the lake, shorter durations and lower frequencies of occurrence (return periods) of lake water levels of a given magnitude are also expected. Changes to the general timing of seasonal lake water levels are unlikely.

Permanent aquatic habitat alteration during the operations phase will include the infilling of API #11, within the WRMF, the deposition of tailings in API #2 in the TMF, and the containment and conversion of API #13, which will be used as the Mine Water Emergency Spill Pond and PPCP. Several other smaller APIs that will be affected will be addressed as part of the fish compensation No Net Loss Plan. A fish rescue and salvage plan will be implemented for the smaller waterbodies with transfer of fish to another waterbody approved by MNR/DFO.

The dewatering of API #2 will be carried out in a similar fashion to the dewatering of Mitta Lake. Water from API #2 will be transferred downstream into the outflowing watercourse. The pump intake will be a floating intake located in the middle of API #2 and will be appropriately screened to minimize impingement or entrainment. As water levels in API #2 are reduced a fish salvage protocol will be implemented to minimize fish mortality. Live-captured fish will be transferred as they become stranded in isolated pools and basins and released into API #8 or Lizard Lake or another waterbody approved by DFO/MNR. The dewatering will result in the mortality of all benthic invertebrate organisms entrained within the pump. The conveyance of water to the outflowing stream will continue until the lake is totally dewatered.

During the dewatering of API #2, flows into API#8 are expected to increase. Following the dewatering process, flow from API #2 into API #8 will cease completely. Reductions in the magnitude of water levels in API #8 during normal, wet and dry hydrologic conditions as a result of runoff collection in the TMF were predicted using hydraulic and hydrologic modelling. Potential changes in monthly mean water levels in API #8 range from minus 2.1 cm (May) to 0.0 cm (August), with the greatest changes occurring in the spring/summer/fall seasons and the smallest changes occurring in the winter season. As a result of the reduction in tributary drainage area to the lake, shorter durations and lower frequencies of occurrence (return periods) of lake water levels of a given magnitude are also expected. Changes to the general timing of seasonal lake water levels are unlikely. Flows into API #8 will be reduced by 2 cm as the upper portions of this catchment are dammed and converted into the TMF. This indirect effect will also affect flows and habitat within the stream that flows out of API #8 and reports to Lizard Lake. The mouth of this stream is API #39. All of the adjacent watershed, where APIs #6 and #7 are located, also will be removed by the TMF.

APIs #47 and #48 are located up gradient of the TMF and flow into API #1 in the northwest corner of the TMF. Portions of the outflowing streams will be eliminated as the TMF fills and the headwater features become isolated.

Water levels in the Upper Marmion Reservoir under normal, wet and dry hydrologic conditions may be affected by changes in inflows to the reservoir as a result of Project activities during the operations phase. Inflows to the reservoir are expected to be influenced by runoff interception, water taking, discharges of treated effluent, increased runoff due to changes in land cover, and Mine dewatering. The possible combined influence of all these Project activities was evaluated using single-year and continuous lake water balance models. Potential changes in water levels in the Upper Marmion Reservoir as a result of Project activities in the operations phase can be easily accommodated within the normal operating rules for the Raft Lake Dam. Potential changes in water levels, predicted based on single-year lake water balance modelling, range up to minus 9 cm in both dry and wet years, with return periods of 100 years. Potential changes in water levels, predicted using continuous lake water balance modelling range from minus 6.8 cm to minus 1.4 cm occurring in the 100-year dry and the 100-year wet water taking scenarios, respectively. These changes could be almost entirely negated if reservoir operation is changed to meet minimum outflow requirements, and target reservoir levels to compensate for the net reduction in inflows as a result of the Project.

Table 3-4: Operations Phase Activities and Interaction with the Aquatic Environment
(X = potential direct interaction; y = potential indirect interaction) (Appendix 3.I)

Project Activities	Lower reaches	Sawbill/ Lynxhead Bay	Lizard Lake	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species
Mine							
Ongoing removal and stockpile of topsoil and overburden	X	y					X
Tailings Management Facility (TMF)							
Filling of the TMF with tailings	y		y	y			y
Ongoing construction of tailings dams	y		y	y			y
Water Management System							
Operation of seepage collection ponds, pumping water to open pits until water is suitable for direct discharge		X, y	y	y	y	y	y
Diversion of surface runoff for makeup water	y	Y	Y	y			y
Water withdrawal from Upper Marmion Reservoir for makeup water		X,y		y	y	y	y
Discharge of effluent from Mine operations and sewage effluent from on-site infrastructure		y		y	y	y	y

3.2.3 Closure Phase

The closure phase includes activities designed to ensure that the Project Site is closed in a manner that reduces the potential impacts on the social and natural environment. In the closure phase, the mining activities are terminated, and dismantling and closure of the site begins. Closure involves the decommissioning of the Project Site through the removal of infrastructure that will not be needed in the post-closure phase, and the closing of waste management areas in an environmentally acceptable manner. During the closure phase, the storage, warehousing and maintenance areas are dismantled, potentially hazardous materials such as fuels, oils, lubricants, chemicals and reagents are removed from the Project Site by licensed contractors, and hydrocarbon contaminated soils are remediated or removed from the Project Site. Mine wastes will be stabilized in place. The infrastructure is demolished, and all inert demolition debris will be disposed of appropriately. Waste disposal areas, such as the sewage treatment facility, will be decommissioned. Upon completion of operations, the open pits will no longer be actively de-watered, and will naturally begin to fill from groundwater inflow, precipitation and runoff from nearby areas.

The surface of the Tailings Management Facility (TMF) will be graded to shed water and reduce infiltration and re-vegetated to prevent erosion. Ongoing runoff and seepage from the TMF will be monitored and managed as necessary during closure and post-closure. Soils from the overburden stockpile created during the construction phase will be used to support re-vegetation.

During the closure phase, lake water levels will continue to be altered by runoff diversion, runoff collection and treated sewage effluent discharge. However, the changes are expected to be smaller than during the operations phase. As portions of the Project Site are decommissioned, land occupied by these facilities will be reclaimed and pre-development flow directions restored where possible. In addition, water taking will cease. At the end of mining, the dewatering system will be taken out of service and natural infilling of the open pits will commence. Reclaim water, site runoff and seepage water from the processing plant area and the waste rock stockpile will be pumped to the open pits. When the water quality reaches an acceptable level for direct discharge, site runoff will no longer be pumped to the open pits, and at that time runoff and seepage water will be allowed to drain naturally to adjacent waterbodies.

There are no anticipated direct impacts from the closure activities on the aquatic environment VECs.

3.2.4 Post-closure Phase

During the post-closure phase, lake water levels will initially continue to be affected by the same Project activities as during the closure phase, with the exception that the discharge of treated sewage effluent from the Project Site will cease. Runoff collected from the TMF, waste rock stockpile, low-grade ore stockpile and overburden stockpile will be routed to the Mine to the open pits. However, when water quality improves to an acceptable quality (based on effects on aquatic life), runoff from these facilities will be allowed to discharge directly to the environment. Approximately 78 years after the operations phase is complete, the water in the flooded open pits will begin to overflow, and this overflow will be directed through a ditch into Upper Marmion Reservoir (Golder 2012b). Based on the post-closure flow model, it is estimated that about 253,000 m^3/yr will overflow from the open pits. After pit flooding is sufficiently advanced and prior to pit overflow, the water quality at the top of the flooded open pits will be evaluated, and a decision will be made regarding post-overflow treatment if required. It is expected that stratification of water in the flooded open pits will result in surficial water quality that is suitable for discharge to Upper Marmion Reservoir.

The TMF seepage collection system will continue to function passively in post-closure and seepage will be directed to the open pits, until monitoring has indicated that the water will be suitable for discharge. Water quality predictions of average case TMF seepage in Lizard Lake during the post-closure indicated concentrations of average/maximum mixing case TMF seepage to Lizard Lake for the post-closure scenario are lower than the MISA criteria and PWQOs/CWQGs with the exception of mercury and selenium (Water and Sediment Quality TSD). In general, the predicted results are the same as or marginally greater than average Lizard Lake baseline concentrations for all parameters. Concentrations of mercury and selenium are above CWQGs under baseline conditions, and discharge of seepage water during post-closure is not predicted to result in an increase in these elements in Lizard Lake.

There are no anticipated direct impacts from the post-closure activities on the aquatic environment VECs.

3.3 Assessment of Effects on Valued Ecosystem Components

Project activity-VEC interaction tables in the previous sections identified potential direct and indirect Project effects on VECs.

Project effects require mitigation to eliminate, reduce and/or minimize these effects on VECs. In general, the greatest remaining effects occur during the construction phase, when many features will be eliminated within the MSA and alterations in the local groundwater and surface water drainage patterns have the potential to affect VECs located “downstream” of the MSA. During the operations phase, the potential effects are largely indirect, again related to the continued altered drainage pattern, as well as water takings from Sawbill Bay to provide Mine process make up water, intermittent discharges to Sawbill Bay from the effluent treatment plant, discharges to Sawbill Creek from domestic sewage wastes associated with the accommodation camp and other infrastructure, seepage to ground and surface water from the TMF and WRMF, and lake water from Sawbill and Lynxhead bays into the open pits. Seepage issues will be managed by a pumping system that will address any effects.

At closure, removal of Mine infrastructure including their footprint, as well as revegetating the TMF will be completed, while managing any potential effects primarily with in-design mitigation measures. Continued mitigation of discharges to Sawbill Bay and any local seepage concerns will be accomplished by routing surface waters to the open pits. The effluent treatment plant will be decommissioned during the closure phase. Surface drainage from within the Mine will initially be directed to the open pits.

Post-closure effects will largely be passive as the revegetated areas become established (and other areas naturally revegetate) and surface water drainage to the open pits reaches the point where it meets background water quality or SSWQOs and can be rerouted into Sawbill Bay. Post-closure environmental monitoring programs will be in place to ensure that no effects persist over the post-closure period, particularly when the open pits overflow into Sawbill Bay. Mitigation measures will ensure that there is no further impact on Upper Marmion Reservoir water levels and that any seepage from the TMF or WRMF meets background water quality or SSWQOs where it discharges to surface water.

The construction phase of the Project, therefore, is where the majority of potential direct loss of habitat will occur. The primary measures of Project effects are fish habitat losses and loss of fish populations from APIs eliminated by the Project Site. Secondary measures of Project effects are fish habitat losses and predicted

population effects from indirect effects of surface water diversions, and indirect effects of effluent and seepage discharges, which tend to occur through the construction and operations phase of the Project.

Walleye do not inhabit any of the aquatic features that will be directly affected through elimination. There is also no indication that walleye use the lower reaches of the streams in which flow reductions due to drainage alteration will occur. Some impact on walleye habitat may occur during construction of stream crossings where walleye habitat has been identified. Since the disturbance will be limited to a small area, during non-critical periods, and will be of short duration, there is no significant impact predicted on walleye from this activity. Walleye habitat is not predicted to be affected by lake levels changes since these are minor. There are no direct effects on walleye or walleye habitat; Sewage effluent quality will meet MOE guidelines and effluent volumes will have a negligible effect on Sawbill Creek flows and the discharge is sited downstream of any walleye spawning areas. Effluent discharge from the Mine will also meet water quality guidelines. Smallmouth bass do not inhabit headwater ponds and streams within the Project Site. Smallmouth bass could potentially be affected at some of the stream crossings along the access road (Hardtack/Sawbill). Since the disturbance will be limited to a small area, during non-critical periods, and will be of short duration, there is no significant impact predicted on smallmouth bass from this activity. Smallmouth bass habitat is not predicted to be affected by lake levels changes since these are minor. There is potential for direct effects on smallmouth bass habitat associated with the construction of the west pit retaining wall in Sawbill Bay and by blasting activity.

Effects on northern pike, in API #2, will occur as a consequence of loss of habitat as the TMF is developed. A fish salvage plan will be implemented in this and other bodies of water that will be eliminated. As a result, direct loss of fish will be kept to a minimum, and it is expected that the effects on the local population will be minor. The loss of northern pike habitat has been included in the NNLP prepared for the Project. Northern pike habitat in the downstream reaches of the tributaries from the Project Site, used as spawning and rearing habitat, may also be affected due to flow reductions. There is some potential of direct effects on northern pike habitat associated with the construction of the west pit retaining wall in Sawbill Bay and by blasting activity.

Baitfish (small-bodied forage fish) will be affected by habitat loss through direct elimination of some habitats, and flow reductions in the lower reaches of some streams. Some habitats will be eliminated entirely, and the effects cannot be mitigated. The NNLP will address baitfish habitat loss. Reductions in flow in other habitats, particularly the downstream reaches of streams in which headwater areas have been eliminated also will experience some loss of habitat. These form part of the compensation plan as well, since there is no effective means of mitigating these impacts.

Finally, there is potential for direct Project effects on northern pike and baitfish species and their habitat associated with 15 road crossings along the proposed upgraded access road (Hardtack/Sawbill). There are no impacts to fish and fish habitat from the proposed project transmission line or the proposed fibre optic line.

3.4 Construction Phase Effects and Mitigation

The direct loss of habitat through the destruction of existing surface water features within the Project Site are summarized in Table 3-5 and shown in Figure 3-2. Indirect losses of aquatic habitat are summarized in Table 3-6.

Table 3-5: Aquatic APIs Potentially Directly Affected by the Osisko Hammond Reef Gold Project (Preferred Option)

Infrastructure Feature	Aquatic API	Description	Description of Potential Impact
Open Pit	■ Mitta Lake (API #12) and its outlet stream	■ 17.2737 ha headwater lake; approximately 0.0449 ha of lower reach - stream; empties into Sawbill Bay; supports white sucker (*Catostomus commersoni)*, ninespine stickleback (*Pungitius pungitius)*, brook stickleback (*Culaea inconstans*), fathead minnow (*Pimephales promelas)*, Iowa darter (*Etheostoma exile)*, mottled sculpin (*Cottus bairdii*) and finescale dace (*Phoxinus neogaeus)*.	■ Mitta Lake forms the active west pit. The destruction of Mitta Lake results in the loss of 396 HU of useable littoral habitat and 7,311 HU of useable open water habitat.
	■ API #14	■ Upper portions of approximately 0.1169 ha lower reach stream; empties into Sawbill Bay; supports brassy minnow (*Hybognathus hankinsoni),* finescale dace, northern redbelly dace (*Phoxinus eos)*, fathead minnow; juvenile common white sucker captured in lower reach.	■ API #14 will be removed for the construction of the Support and Ancillary Infrastructure near the east pit. Destruction of API #14 results in a loss of 45 HU of useable low gradient stream habitat and 119 HU of useable high gradient stream habitat.
	■ API #69	■ 0.9871 ha headwater pond and 0.0165 ha of headwater stream; pond supports white sucker, pearl dace, Iowa darter, brassy minnow, central mudminnow (*Umbra limi*), blacknose shiner, finescale dace and northern redbelly dace. No fish were found to exist within the outlet stream.	■ Headwater pond and upper reaches of API #69 will be destroyed through the construction of the west pit. Destruction of API #69 results in a loss of 224 HU of useable littoral habitat, 1080 HU of useable open water habitat.

Table 3-5: Aquatic APIs Potentially Directly Affected by the Osisko Hammond Reef Gold Project (Preferred Option) (Continued)

Infrastructure Feature	Aquatic API	Description	Description of Potential Impact
Other Mine Facilities	■ Sawbill Bay	■ Localized filling within the drawdown zone along Hammond Reef peninsula to provide adequate space for Mine buildings, parking, etc.; approximately 0.8 ha of seasonal habitat within the drawdown zone will be destroyed. Area provides seasonal nursery/foraging habitat for baitfish species, northern pike, smallmouth bass	■ About 0.8 ha of the drawdown zone along the Hammond Reef peninsula shoreline will be destroyed. Resulting loss of about 1200 HU of useable habitat destroyed.
Mine Water Spill Emergency Pond	■ API #13	■ 1.9375 ha headwater pond; approximately 0.0396 ha of headwater stream and 0.0476 ha of headwater beaver impoundments; both the pond and stream are fishless. Empties into Lynxhead Bay.	■ No useable habitat will be lost through the destruction of API #13 for purposes of Support and Ancillary Infrastructure development.
Waste Rock Stockpile	■ API #11	■ 2.7777 ha headwater pond; approximately 0.0787 ha of headwater stream including (several) 0.1030 ha of beaver impoundments; empties into Lynxhead Bay; supports finescale dace, northern redbelly dace, fathead minnow.	■ API#11 will be destroyed through the construction of the waste rock stockpile. 32 HU of useable low gradient stream, 13 m of useable high gradient stream, 58 HU of useable pond, 173 HU of useable littoral and 1701 HU of useable open water habitat will be lost.

Table 3-5: Aquatic APIs Potentially Directly Affected by the Osisko Hammond Reef Gold Project (Preferred Option) (Continued)

Infrastructure Feature	Aquatic API	Description	Description of Potential Impact
Tailings Management Facility	■ API #47	■ Approximately 0.0762 ha of lower reaches – Inlet stream and 2.9944 ha of beaver impoundments; supports finescale dace, pearl dace (*Margariscus margarita),* and northern redbelly dace.	■ The streams and beaver impoundments of API #47 will be impacted by the proposed Tailings Management Facility. This will result in a loss of 11 HU of useable low gradient habitat, 34 HU of useable high gradient habitat and 1824 m^2 of useable pond habitat.
	■ API #48	■ Approximately 0.0123 ha of headwater - ephemeral/seasonal stream, 0.0430 ha of headwater - permanent stream and several headwater beaver ponds (1.0198 ha total); approximately 0.2051 ha headwater pond; no hydraulic connection to downstream aquatic features. Finescale dace captured in one of the beaver ponds.	■ The outlet stream and associated beaver impoundments will be impacted by the proposed TMF. This will result in the loss of 239 HU of useable pond habitat.
	■ API #1	■ Approximately 0.0894 ha of lower reaches – inlet stream, including 0.5836 ha of beaver impoundments; empties into Sawbill Bay; upper sections support pearl dace, finescale dace and fathead minnow; juvenile and young-of-the-year (YOY) white sucker captured in lower sections.	■ API #1 is entirely contained within the footprint of the TMF and, thus, will be destroyed. This will result in the loss of 266 HU of useable low gradient habitat, 21 HU of useable high gradient habitat, and 2722 HU of useable pond habitat.
	■ API #7	■ 1.0962 ha headwater pond; partially in-filled; fishless; connected to API #6 by a series of small, headwater beaver ponds (approximately 0.0721 ha).	■ Though API #7 will be destroyed by the proposed TMF, no useable habitat will be eliminated since the feature is fishless and isolated from API #6.

Table 3-5: Aquatic APIs Potentially Directly Affected by the Osisko Hammond Reef Gold Project (Preferred Option) (Continued)

Infrastructure Feature	Aquatic API	Description	Description of Potential Impact
	■ API #6	■ 0.5385 ha pond, 0.0437 ha of lower reaches – inlet stream, and 0.1004 ha of lower reaches - ephemeral stream; empties into Lizard Lake; pond and ephemeral stream are fishless; white sucker and Iowa dater captured in lower segment of stream.	■ API #6 is contained within the footprint of the proposed TMF. This will result in the loss of 21 HU of useable low gradient stream habitat.
	■ API #2	■ 12.4351 ha headwater lake and 0.2217 ha of headwater stream and 0.3808 ha of headwater beaver impoundments; supports pumpkinseed (*Lepomis gibbosus)*, northern pike, yellow perch (*Perca flavescens)*, Iowa darter (*Etheostoma exile),* white sucker, blacknose shiner (*Notropis heterolepis)*.	■ The destruction of API #2 results in the loss of 632 HU of useable littoral habitat and 9476 HU of useable open water habitat.
Corridors	■ Water crossing locations along the access road (Hardtack/Sawbill), and mine site road (API 20-23 and 63-68)	■ 14 culvert locations; movement of fish between waterbodies located up/downstream of water crossings.	■ Impacts to surface water features contained within road crossing API include alteration of the stream channel at the location of the culvert. Potential for HADDs at each crossing will be assessed once culvert design specifications are developed

Notes:

* = Impacted habitat area calculated using ecotype weighted useable area following methods described in Fish Habitat Accounting Procedure: Hammond Reef Gold Project No Net Loss Plan (Golder 2012).

Table 3-5 presents the direct effects on aquatic habitat of the construction phase. In summary, the following habitat losses result for each of the habitat VECs:

- Receivers: There is 0.8 ha of seasonal habitat within the drawdown zone of Sawbill Bay lost, representing about 1200 HUs of seasonal habitat for baitfish, northern pike and smallmouth bass.
- Lower reaches: There are 3.9491 ha of inlet streams, 0 ha of lakes and 0.5385 ha of ponds that provide habitat for baitfish.
- Headwaters: There are 1.8635 ha of headwater streams, 29.7088 ha of lakes (API #12 and #2), and 3.7648 ha of ponds that provide habitat for baitfish and northern pike.
- There are 14 stream crossings or crossing upgrades on the proposed access road (Hardtack/Sawbill) that will result in the loss of habitat within the footprint of the culvert/bridge structure. This represents habitat for baitfish and northern pike.
- There are also several ephemeral streams and a number of fishless headwater ponds and headwater streams.

A fish Habitat NNLP was prepared to offset the effects of these habitat losses. A summary of the NNLP habitat offsets is presented in Section 3.8.

Table 3-6: Aquatic Areas of Potential Impact Potentially Indirectly Affected by the Osisko Hammond Reef Gold Project (Preferred Option)

Magnitude of Predicted Impact	Aquatic Area of Potential Impact	Description	Description of Potential Impact
10 to 25% drainage loss to footprint	■ API #8	■ 18.0619 ha lake and 0.0700 ha stream and beaver impoundments; supports pumpkinseed, white sucker, northern pike, walleye, smallmouth bass, Iowa darter, spottail shiner and yellow perch.	■ APIs #2, 3, 4, 5, 8 and 46 are contained within Catchment R; however, only API #8 is downstream of the portion of the catchment that is removed. The TMF is partially located within the southern portion of Catchment R and, thus, will result in a reduction in catchment area of 24.08%. This will reduce the amount of water flowing in and out of API #8 and impact the fish community in this catchment.
Less than 10% drainage loss to footprint	■ API #15	■ 0.4237 ha partially in-filled headwater beaver pond and 0.0150 ha ephemeral and 0.0265 ha permanent stream; stream supports yellow perch, walleye, northern pike and lake whitefish	■ API #15 is contained within Catchment H. The Support and Ancillary Infrastructure is partially contained within Catchment H and, thus, will result in a reduction in catchment area of 2.6 %.
	■ API #16	■ 0.6151 ha headwater pond and 0.0420 ha stream; does not support a fish community.	■ API #16 is contained within Catchment G. The Support and Ancillary Infrastructure is partially contained within Catchment G and thus will result in a reduction in catchment area of 0.14 % though no fish were found within the pond or stream.
	■ API #17	■ 1.6269 ha headwater lake; supports finescale dace and fathead minnow.	■ API #17 is contained within Catchment F. The Waste Rock Management Facility is partially contained within Catchment F and, thus, will result in a reduction in catchment area of 1.61 %.

3.5 Operations Phase Effects and Mitigation

The primary effects of the Project on aquatic habitat occur in the construction phase. During operations, there are a number of potential effects, as follows:

- **Water withdrawal from Sawbill Bay:** Since the available water from diversion of the surface catchments in the MSA is insufficient to meet Mine water use, water will also be withdrawn from Sawbill Bay. The combined effect of the surface water diversions and the Sawbill Bay withdrawal will result in a reduction in water levels in Upper Marmion Reservoir in the order of 5 to 7 cm (9 cm under extremely rare conditions).
- **Mine effluent discharge**: An effluent treatment plant is required to treat Mine wastewater. The discharge will be located at the end of the Hammond Reef peninsula and discharge into outer Sawbill Bay. The discharge will be intermittent.
- **Sewage discharge to Sawbill Creek**: An accommodation camp will be established at the current location of the exploration camp. The sewage treatment facilities will service the accommodation camp and other infrastructure and discharge into Sawbill Creek, just upstream of Sawbill Bay.
- **Operational blasting of the open pits**: Operational blasting of the east and west pits has the potential to affect fish habitat along the shoreline of the Hammond Reef peninsula.
- **Pit Inflows from Upper Marmion Reservoir**: As the open pits are excavated, there is potential for lake water to enter the pits through rock fissures potentially affecting Upper Marmion Reservoir water levels.
- **Seepage losses from the TMF and the WRMF**: There is potential for seepage from these sites to migrate to receivers – Sawbill Bay and Lizard Lake.
- **Atmospheric deposition of dust and contaminants**: There is potential for atmospheric deposition of contaminants from mining activities.

3.5.1 Water Withdrawal from Sawbill Bay

The combined water use at the Mine will require all of the surface water diverted from approximately 19 km^2 of the MSA and water withdrawal from Sawbill Bay. This will result in a lowering of water levels in Upper Marmion Reservoir by up to9 cm. As discussed previously, the current operating range of the Raft Lake Dam, which regulates water levels in Upper Marmion Reservoir is in the order of 2.5 m annually. Since approximately 46% of the drainage to Upper Marmion Reservoir is uncontrolled, and the dam is operated by removing/replacing stoplogs, the ability of the operation of the dam to follow the Raft Lake Dam rule curve is difficult and the focus of operation is largely based on anticipating the size of spring freshet flows to preserve sufficient water to maintain levels close to the rule curve for the remainder of the year. A lowering of Upper Marmion Reservoir by up to 9 cm can easily be accommodated within the current operating plan for the dam and, therefore, there are no anticipated effects on fish and fish habitat within Marmion Reservoir or downstream in the Seine River.

3.5.2 Mine Effluent Discharge

Discharge of effluent will be intermittent, such that during the majority of time there will be either no discharge, or only a minor discharge, which will meet the PWQOs/CWQGs under average conditions. Thus under average

operating conditions, there will be no chronic or acute effects on northern pike, walleye, smallmouth bass or baitfish.

Water quality was also predicted under worst case conditions (e.g., using average baseline data, maximum predicted lab data for site discharge and low flow conditions). Resulting predicted concentrations are lower than both the PWQO and MISA criteria for most parameters with the exception of copper and free cyanide, which were predicted to increase above the CWQG and PWQO. Site-specific water quality objectives (SSWQOs) that would be protective of aquatic life but that take into account the characteristics of surface waters in Upper Marmion Reservoir and Lizard Lake were developed for these two substances. The derivation of the SSWQOs is described in the Human Health and Ecological Risk Assessment TSD. Using the biotic ligand model approach that has been adopted by the U.S. EPA to develop guidelines for copper, a SSWQO for copper of 0.0079 mg/L was developed for Upper Marmion Reservoir. Since predicted copper concentrations are below this level, there is no predicted effect on aquatic life from copper.

Based on a review of toxicity data provided in the Human Health and Ecological Risk Assessment TSD, a SSWQO of 0.01 mg/L was developed for free cyanide. Under average operating conditions, free cyanide concentrations are predicted to be less than the SSWQO. Under worst case predictions (i.e., high discharge during low lake levels), concentrations of free cyanide could exceed the SSWQO. However, concentrations are predicted to be below effects levels for species that would likely be present. A review of cyanide toxicity data (recent data have been summarized in Gensemer et al 2007) provides chronic thresholds for warm water fish species and invertebrates. No effects concentrations (NOECs) for fathead minnow and bluegill were reported as 0.016 mg/L and 0.009 mg/L, respectively, and the lowest effects levels (LOECs) for these same species are reported as 0.02 mg/L. Chronic toxicity data were not available for other species of fish; however, other warm water species are likely to have similar thresholds and these species are considered as surrogates for bass and walleye.

Invertebrates appeared to be less sensitive, with reported NOECs and LOECs for amphipods of 0.016 mg/L and 0.021 mg/L, respectively. Reported NOECs and LOECs for isopods (*Asellus* sp.) were 0.029 mg/L and 0.04 mg/L, respectively. As a result, predicted worst case concentrations of free cyanide are not expected to have adverse effects on aquatic life. Furthermore, as noted in the Lake Water Quality TSD, there is no predicted discharge during dry years, which represents the modeled worst case conditions (i.e., highest discharge during lowest water levels). Since lowest water levels would occur only during dry years, it is unlikely that the predicted worst case condition would actually occur, since during dry years all excess water would be re-used and there would be no discharge.

The site of the effluent discharge pipe will be offshore in water depths of about 8 m in a well-mixed portion of outer Sawbill Bay. The pipe outlet will be elevated above the substrate (i.e., at mid-depth) and fitted with a diffuser discharge to promote rapid mixing. This location was chosen to minimize the exposure potential of fish to the mixing zone, by locating the outlet beyond the littoral zone and away from both the substrate and the water surface. This location represents an area that would be least used by most fish species, particularly northern pike, walleye and smallmouth bass. It is anticipated that in order for a potential chronic effect on fish to occur within this mixing zone, prolonged exposure (i.e., in the order of weeks) would be necessary to result in an impact on individual fish, which is unlikely. As a result, it is anticipated that there would be no measurable effect at the individual and/or population level on the target VECs.

3.5.3 Treated Sewage Effluent Discharge to Sawbill Bay

A sewage treatment facility will be constructed to meet the domestic sewage needs of an accommodation camp for the Mine. The system will be sized to meet MOE requirements for a discharge to a cool water stream. The discharge will meet the MOE regulatory criteria for sewage discharge and, as a result, there will be no impact on receiving waters or VECs.

3.5.4 Operational Blasting of the Open Pits

Vibration from blasting is a potential risk to fish in shoreline areas adjacent to the open pits. Blast effects will not be a concern during early years of Mine development due to the distance from the pit to the shoreline areas of Upper Marmion Reservoir (Sawbill Bay and Lynxhead Bay). However, in later years of pit development as the west pit is expanded and the margins of the west pit approach the shores of the reservoir, there is potential for adverse effects on sensitive life stages that may be present. Therefore, blast intensities and transmissivity will be monitored during initial pit development to assess potential for damaging vibrations to occur, and appropriate mitigation measures will be developed to mitigate any adverse effects on fish species when blasting occurs near the margins of the reservoir in later stages of pit development.

3.5.5 Pit Inflow from Upper Marmion Reservoir

As the open pits are excavated below the operating elevation of Upper Marmion Reservoir, there is potential for lake water to enter the pits through cracks and fissures in the bedrock, causing a loss of water from Upper Marmion Reservoir. A Mine water collection system will be constructed and operated to manage inflows into the pits and ensure that Upper Marmion Reservoir water levels will not be affected.

3.5.6 Seepage Losses from the Tailings Management Facility and the Waste Rock Management Facility

As the WRMF and the TMF are filled with material, there is potential for seepage of water through the groundwater system and into receivers including Sawbill Bay and Lizard Lake. A seepage collection system will be constructed and operated to manage seepage and ensure that seepage does not exit the MSA.

Water quality predictions indicate that under average conditions there will be no seepage losses from the TMF. However, under worst case assumptions, it is assumed that up to 10% of the seepage could by-pass the collection system and could migrate to Lizard Lake (Lake Water Quality TSD). Predicted worst case concentrations in Lizard Lake for free cyanide were 0.006 mg/L, which is slightly above the guideline of 0.005 mg/L and below the SSWQO of 0.01 mg/L. As a result there are no predicted effects on aquatic life due to free cyanide in Lizard Lake.

Seepage from the Waste Rock Management Facility will be collected by perimeter ditching and directed to the process plant collection pond. As a result, there is no predicted effect on aquatic life due to seepage from the WRMF.

3.5.7 Atmospheric deposition of dust and contaminants

There is potential for atmospheric deposition of contaminants from mining activities to affect aquatic habitats within the MSA and LSA. Atmospheric modeling studies were completed for all phases of the mine operation and concluded that there was no potential for contaminants to affect aquatic life (Atmospheric Environment TSD).

3.6 Closure Phase Effects and Mitigation

During the closure phase, all buildings and facilities will be removed, and the site will be re-graded and either revegetated using native materials, or allowed to naturally revegetate in order to reclaim the site. While the existing surface drainage collection system will be maintained, it will be modified with outlets to the open pits and to Sawbill Bay. Revegetation of the TMF will continue to eliminate offsite discharge of leachate.

Initially, it is anticipated that surface drainage will be transferred to the open pits, until such time as the surface runoff meets SWQOs, at which point it will be return to natural flow directions and, in the case of the TMF, directed for discharge to Sawbill Bay. At this time, the only source of inflow to the open pits will be precipitation and groundwater discharge. The pits will be allowed to fill over time and eventually overflow into Sawbill Bay.

Potential Project closure phase effects on aquatic habitats include the following:

- **Pit Inflow from Upper Marmion Reservoir**: As the open pits begin to fill, there is potential for lake water to enter the pits through rock fissures. Predictions of pit inflow are approximately 350 m^3/day. At this time, the water intake from Sawbill Bay will also be decommissioned and this potential water loss due to pit inflow from Sawbill Bay can easily be accommodated within the current operating plan for the dam; therefore, there are no anticipated effects on fish and fish habitat within Upper Marmion Reservoir or downstream in the Seine River.
- **Seepage losses from the TMF and the WRMF**: There is potential for seepage from these sites to migrate to receivers – Sawbill Bay and Lizard Lake. During the closure phase, the seepage collection system (i.e., perimeter ditches) will remain in place to ensure that contaminated seepage does not migrate to receivers. Any seepage will continue to discharge via the surface drainage system to the open pits. Monitoring of water quality will continue until water quality is similar to background or meets SSWQOs, at which point, it can be directed to the receivers.
- **Atmospheric deposition of dust and contaminants**: There is potential for atmospheric deposition of contaminants from closure activities. Modelling has predicted that there will be no contamination of aquatic habitats during closure activities (Human Health and Ecological Risk Assessment TSD).

3.7 Post-closure Phase Effects and Mitigation

Post-closure activities will see all active management and mitigation activities replaced by passive measures including restoration of natural drainage where practical, as the discharge of surface water from the MSA will meet SWQOs and can be discharged to Sawbill Bay. Water quality modeling predicts that seepage from the TMF and the WRMF will meet background concentrations or SSWQOs by the time it reaches receivers. Pit inflows from Upper Marmion Reservoir will be monitored during closure and if required a plan to manage water levels in Upper Marmion Reservoir will be developed to ensure there are no changes in water levels that could adversely affect aquatic habitats while the pit is filling. It is estimated that in about 78 years, the open pits will overflow into Sawbill Bay at which time any inflows to the pit would be balanced by pit overflows to Upper Marmion Reservoir. At that time, there will be a small increase in total runoff to Sawbill Bay as a result of reduced permeability of the overall Project Site. Discharge is in the order of 70 m^3/h = 20 l/s. While fish may gain access to the open pits, there will be no active program to restore the pit lakes as fish habitat. During filling of the pits, stratification of the water column is expected and bottom waters are predicted to become anoxic.

Benching and steep pit slopes will also preclude development of littoral habitat. Benthic production in this environment is expected to be low as a result. At the point of pit overflow, water quality will meet background or SWQOs and discharge to Sawbill Bay; however, under the post closure conditions of the pit, aquatic habitat conditions to support fish are low. In discussions with DFO (See Section 2.1.1), DFO indicated that the open pits would not be considered as potential for fish habitat compensation.

An environmental monitoring program will be implemented to ensure that there are no off-site effects of the Project, post-closure. This is discussed further in Section 4.

3.8 Additional Project Mitigation and Compensation Measures and Conceptual No Net Loss Plan

Additional mitigation and compensation measures are necessary to offset the direct and indirect effects of the construction and operations phases of the Project. These are described below.

To mitigate the potential impacts that are predicted to result from the proposed Project, habitat compensation measures have been developed that will be incorporated into the overall design of the Project and thus act to reduce the magnitude of the impact and limit residual effects. Most measures will be completed during the construction and operations phase of the Project, whereas some will be completed during the closure and post-closure.

Habitat losses and gains were calculated using a habitat accounting procedure based on the HEP suitability index approach, which is widely used in the evaluation of fish habitat. This procedure is detailed in the NNLP in Appendix 2.III.

The Habitat Evaluation Procedure (HEP) (USFW 1980) approach was used to determine the quantity and quality of fish habitat affected by mine construction, operation and closure including the open pits, the preferred Tailings Management and Waste Rock Storage Facilities and all other infrastructure (e.g., roads, transmission corridors, process facilities). While more recent methodologies have been developed, in particular Minns et al. (2001) and Minns (2010), the HEP approach was preferred for the following reasons:

- DFO and MNR have agreed with the application of this method, also used in the Meliadine Gold Project (Golder 2011).
- Golder has successfully demonstrated the use of HEP in a number of approved NNLPs and was familiar with the Meliadine project.
- The HEP approach, though more subjective, offered greater flexibility in terms of the range of habitat variables that could be used.
- The HEP approach can be applied using baseline data collected by Golder for this project.
- The final model used for the project is based on extensive consultation with DFO and MNR (see Section 2.2.1) and is described in Appendix 2.III.

In the end, the final model used the HEP approach, with modifications based on input from the Minns (2010) and Minns et al (2001) papers, as well as input from Dr. C.K. Minns.

HEP uses Habitat Units (HUs), a single dimensionless value that integrates habitat quantity and quality, where the HU is the product of habitat quantity measured as a unit area (typically square metres) (HA) and habitat quality expressed as a Habitat Suitability Index (HSI) (i.e. HU = HSI x HA). Minns et al (2001) use the term Weighted Useable Area (WUA) in place of HU as it more accurately reflects the fact that although the value is dimensionless, it is weighted based on the habitat preferences of the fish species present in each habitat unit and inherently linked to HA. The number of WUAs harmfully altered or disrupted, or destroyed through the construction, operations and post-closure phases of the Project was compared to the WUAs gained from habitat created or enhanced.

The key factors in calculating the Weighted Useable Area are the Species Weights and the Species Habitat Suitability Index Scores. These are summarized below and described in detail in Appendix 2.III

Fish Guilds and Species Weights

The assumption in designating guilds for the purpose of habitat accounting is that all member species share the same habitat requirements, vulnerabilities to habitat alteration and will benefit equally from proposed compensation measures.

To develop Species Habitat Weights (SHW), Minns et al (2001) grouped fish into "habitat groups" using thermal preference and feeding ecology (i.e., piscivorous and non-piscivorous species). Using a more rigorous statistical approach, Minns (2010) undertook a similar analyses and grouped fish into habitat groups using thermal preference and spawning habitat preference. A key rule of this weighting procedure is that the sum of the individual weights for all species recorded for the area must sum to 1.0. For the purpose of weighting/grouping fish, Golder has adapted the latter approach and grouped the species present into the categories developed by Minns (2010) (Table 3-7).

Table 3-7: Fish Habitat Groupings

Habitat Group	Description	Piscivore	Non-Piscivore
Cold + A1 (lake)[(a)]	lake stenotherms		**Group 1**: lake whitefish, cisco
Cold + A1 (stream)[(a)]	stream stenotherms	**Group 3**: burbot	**Group 2**: pearl dace
Cold +A2	stream salmon, lamprey	N/a	N/a
Cold + B	sculpins, sticklebacks		**Group 4**: brook stickleback, ninespine stickleback
Cool + A1	percids, redhorses, darters, dace	**Group 6**: northern pike, walleye	**Group 5**: longnose dace, brassy minnow, finescale dace, northern redbelly dace, golden shiner, iowa darter, yellow perch, white sucker
Cool + A2	nonguarding darters, chubs, lamprey	N/a	N/a
Cool + B	guarding darters, pomoxids	N/a	N/a

Table 3 7: Fish Habitat Groupings (Continued)

Habitat Group	Description	Piscivore	Non-Piscivore
Warm + A	shiners, moronids, gars, suckers		**Group 7**: blacknose shiner, central mudminnow, emerald shiner, spottail shiner
Warm + B	centrarchids, minnows, bullhead	**Group 9**: smallmouth bass	**Group 8**: fathead minnow, pumpkinseed

Note:
(a) This was one category in Minns (2010); however, it has been split into a lake versus stream grouping here.

This classification or grouping of fish resulted in 9 categories, which were assigned weights as follows:

- Piscivores (3 categories): 0.5 (combined score); and
- Non-piscivores (6 categories): 0.5 (combined score).

In this way, piscivores are given the same proportional weight as non-piscivores. In particular, northern pike, walleye and smallmouth bass were given the same weighting, based on MNR recommendations during the workshops. In addition, this approach also gives some consideration to relative abundance and biomass by assigning more weight to generally larger, though less abundant piscivores and less to non-piscivores. Minns (2010) also considered giving more weight to species considered to have "fishery potential" and well as "species richness". The former included species that were considered important as sportfish or commercial fish, which is also consistent with DFOs habitat priorities. Some adjustment in the weights for individual fish was also made to recognize their values to recreational and commercial fisheries. Final weights for each species are shown in Table 3-8.

Table 3-8 Species Habitat Weights (SHW) by Habitat Group

Group	Species	Weight
Group 1: Cold+A1-Lake: Non-Piscivore	lake whitefish	0.04
	cisco	0.04
Group 2: Cold+A1-Stream: Non-Piscivore	pearl dace	0.03
Group 3: Cold+A1-Stream: Piscivore	burbot	0.03
Group 4: Cold+B: Non-Piscivore	ninespine stickleback	0.013
	brook stickleback	0.013
	mottled sculpin	0.013
	brassy minnow	0.013
	finescale dace	0.03
	redbelly dace	0.03
	golden shiner	0.03
	longnose dace	0.013
	white sucker	0.03
	lowa darter	0.013
	yellow perch	0.03

Table 3 8 Species Habitat Weights (SHW) by Habitat Group (Continued)

Group	Species	Weight
Group 6: Cool+A1: Piscivore	walleye	0.17
	northern pike	0.17
Group 7: Warm+B: Non-Piscivore	blacknose shiner	0.013
	emerald shiner	0.03
	spottail shiner	0.03
	central mudminnow	0.013
Group 8: Warm+B: Non-Piscivore	fathead minnow	0.03
	pumpkinseed	0.013
Group 9: Warm+B: Piscivore	smallmouth bass	0.17
Total		**1.00**

These SHWs were used as multipliers to adjust the final calculation of WUA totals for each API in each ecotype. Within each ecotype, streams and lakes were tallied separately. The overall habitat value of each ecotype is dependent on the same list of fish species and will be inherently sensitive to the hierarchy of fisheries identified in the *Fisheries Act* (i.e., sport and commercial species, First Nations species, baitfish, etc.). With this weighting, ecotypes supporting piscivores generally will receive a higher ranking: For example, the habitat scores for receivers would receive a higher HU score because of the presence of walleye and smallmouth bass, compared to lakes and warmwater streams. Only fish that were captured within each ecotype were ranked in terms of the existing habitat; as such, fish that were not present did not contribute to the total weighted useable area.

Species Habitat Suitability Index Scores

The draft guidelines for the preparation of the Project EA requires that habitats for each potentially affected species be characterized as spawning, rearing/nursery, feeding, migratory corridor and overwintering/summer refuge habitats (Canadian Environmental Assessment Agency 2011). These habitat classes have been adopted for NNL Planning and are defined as follows:

- spawning habitat is used by fish for the specific act of reproduction;
- nursery/rearing habitat is used by developing embryos and YOY and sub-adult fish for foraging and refuge from predators;
- feeding habitat is used by adult fish for feeding or periods between feeding events;
- overwintering/summer refugia are used by YOY, sub-adult and adult fish to survive periods of hostile conditions (e.g., low dissolved oxygen, flows and water temperature extremes); and
- migratory corridors are used by fish to access important habitats described above.

A variety of sources were consulted to developed habitat preferences for each species and each species' life stage (Appendix 2.III). A conservative approach to classifying specific habitats was used. No specific studies to document spawning activity or overwintering locations were undertaken during baseline studies. For the purpose of habitat classification, it was assumed that stream or lake habitat segments possessing characteristics consistent with habitat requirements of fish species or guilds are used as spawning or overwintering habitats.

Habitats identified as one of the five types listed above were rated equally (i.e. no type(s) of habitat were valued higher than others). The Habitat Unit Score (HU score) is the unweighted average of the life stage specific HSI scores. The results of the Habitat Accounting procedure will be included in the final NNLP. Spreadsheets showing the detailed calculations and scores are included in Appendix 2.III.

Weighted Useable Area Calculation

For each affected watercourse segment and waterbody, multiplication of the habitat area (surface area in m^2) by the habitat quality (as represented by the HSI assignments) results in the derivation of WUAs. Based on the applied methods, the derived WUAs represent the overall value of the habitat for fish species that are present or could reasonably be expected to be present.

3.8.1 Fish Salvage and Rescue Protocols

A preliminary DRAFT fish salvage and rescue protocol will be developed to guide the transfer of fish from Mitta Lake and API #2. Consultation with Aboriginal groups is envisioned prior to finalizing the protocol. This protocol will describe the method of drawdown by stages and the staged rescue and transfer of fish from these waterbodies to Sawbill Bay or a number of fishless lakes that are part of the mitigation and compensation plan for the Project (subject to approval by MNR/DFO). In addition to this protocol, a similar protocol will be developed to salvage, rescue and transfer fish from other waterbodies that will be eliminated within the MSA.

3.8.2 Compensation Measures Selection

The development of the habitat compensation approach was based upon DFOs current priority of focusing compensation activities on valued fisheries, namely commercial, recreational and Aboriginal (CRA) fisheries and the fish that support them. In addition, this priority also gives consideration to the hierarchy of compensation preferences as outlined in DFO Policy for Management of Fish Habitat (DFO 1986) and the *Practitioners Guide to Habitat Compensation* for DFO Habitat Management Staff (DFO 2006).

Within the LSA, the key CRA fishery's that may be affected by the Project are as follows:

- Receiving waterbodies: Upper Marmion Reservoir, including Sawbill and Lynxhead Bay and Lizard Lake.
- Streams and lakes within the Project Site that may support fisheries within receiving waterbodies provide seasonal habitats for CRA species and that may provide potential baitfish opportunities.

In the context of the valued fisheries, the general preferences for habitat compensation can be summarized as follows, in order of priority:

- Creation of similar habitat at or near the Project Site within the same ecological unit; that is, replace natural habitat with the same type of habitat at or near the Project.
- Create similar habitat in a different ecological unit that supports the same stock or species.
- Increase the productive capacity of existing habitat at or near the development site and within the same ecological unit.
- Increase the productive capacity of a different ecological unit that supports the same stock or species.
- Increase the productivity capacity of existing habitat for a different species of fish either on or off-site.

Potential compensation options assessed included the following:

- Impoundment of former beaver ponds that have reverted to meadows to create pond habitat.
- Potential to introduce large and small bodied fish species into ponds/small lakes that were determined to be fishless, during baseline studies.
- Assessment of on-site APIs found to be fishless during baseline studies to determine their potential for fish introduction.
- Examine existing water crossings to determine if fish passage or adjacent habitat can be enhanced/ created.
- Several options for these forms of habitat enhancement have been identified on and off-site (Figure 3-2).

3.8.3 Compensation Calculations

Habitat losses were accounted for based on the species present, habitat unit types present within each API and their areas. Losses were calculated in a similar manner using the same weight for each characteristic (Table 3-5).

In the case of fishless lakes, it was assumed that the following species could successfully be stocked to establish self-sustaining populations: finescale dace, northern redbelly dace, white sucker, yellow perch, fathead minnow and pumpkinseed. This is consistent with the species supported in the catchments and in similar aquatic features where these fishless lakes are located and also consistent with the fish communities occupying features that were proposed for flooding to create additional habitat. In the case of features that may be impounded, the habitat areas calculated in Table 3-9 and shown in Figure 3-3 represent the net increase in habitat area (e.g., existing habitat in these features has been subtracted and is not accounted for in the overall compensation value).

Table 3-9: Preliminary WUA Calculation Showing Estimates of Habitat Gains for Specific Areas of Potential Impact

Total Area	Available Habitat Area (HA)	Number of Species Present	Total Weighted Useable Area (WUA)	Ecotype Weighted Useable Area (EWUA)
API # 10 (13,881 m^2)				
Littoral	6,763 m^2	7	936 HU	936 HU
Open Water	7,118 m^2	7	537 HU	537 HU
API # 16 (6,142 m^2)				
Littoral	5,032 m^2	7	696 HU	696 HU
Open Water	1,109 m^2	7	84 HU	84 HU
API # 44 (8,039 m^2)				
Littoral	3,652 m^2	7	505 HU	505 HU
Open Water	4,387 m^2	7	331 HU	331 HU

Table 3-9: Preliminary WUA Calculation Showing Estimates of Habitat Gains for Specific APIs (Continued)

Total Area	Available Habitat Area (HA)	Number of Species Present	Total Weighted Useable Area (WUA)	Ecotype Weighted Useable Area (EWUA)
API # 43 (28,954 m^2)				
Littoral	13,826 m^2	7	1,913 HU	1,913 HU
Open Water	15,125 m^2	7	1,140 HU	1,140 HU
API # 14 (33,163 m^2)				
Littoral	17,263 m^2	7	2,389 HU	2,389 HU
Open Water	15,900 m^2	7	1,198 HU	1,198 HU
BM #2 (75,125)				
Littoral	38,120 m^2	7	5,275 HU	5,275 HU
Open Water	37,000 m^2	7	2,789 HU	2,789 HU
BM # 1 (48,176)				
Littoral	24,176 m^2	7	3,345 HU	3,345 HU
Open Water	24,000 m^2	7	1,809 HU	1,809 HU
Total			***22,947 HU***	***22,947 HU***

610000 620000 630000

5430000

5420000

N

Serpent Lake

Cornell Lake

Sawbill Bay

Mitta Lake

Lynxhead Bay

Marmion Reservoir

Light Lake

Upper Seine Bay

Hawk Bay

LEGEND

- Pond Creation
- Fish Introduction
- Watercrossing Enhancement
- Trail
- Road
- River/Stream
- Raft Lake Cut Location
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
POTENTIAL FISH HABITAT COMPENSATION WORKS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008		
GIS	JO	15 Jan. 2013		
CHECK	BH	15 Jan. 2013		
REVIEW	GA	15 Jan. 2013		

FIGURE: 3-3

G:\Projects\2010\10-1118-0020_BrettResources_HammondReefGIS\MXDs\Draft\AquaticsTSD\Potential_Fish_Habitat_Compensation_Works.mxd

3.8.4 Additional Mitigation and Compensation Measures

The compensation measures described above provide partial compensation for the lost habitat. MNR indicated that they would be receptive to additional habitat enhancements to northern pike, walleye and smallmouth bass in Upper Marmion Reservoir, should additional on-site compensation be required. In addition, several other possible compensation measures have been developed as follows:

- Stream Crossings: a total of 15 stream crossings for the proposed access road (Hardtack/Sawbill) will be required, of which 14 are considered to impact fish habitat. For each of these, compensation for the lost habitat associated with culvert installation will be provided, using one of the following approaches:
  - Installation of an open bottomed culvert to preserve aquatic habitat.
  - Remediate existing barriers in the stream being crossed to provide access by fish to more habitat area (equal to or greater than the area of habitat occupied by the culvert).
  - Undertake a channel restoration associated with the culvert installation to increase stream area (by increasing channel length and/or width) and offset the habitat lost to the culvert.
- Creation of northern pike spawning habitat: to enhance northern pike spawning habitat, which is currently impacted by water level fluctuations in the Upper Marmion Reservoir, several areas can be excavated to create the appropriate depths within or adjacent to the zone of water level fluctuations. The following areas have been identified:
  - An area of low lying shore near the proposed Helipad to the east side of the shallow embayment at the mouth of Sawbill Creek. This area would be excavated to a depth equal to the lower limit of the water level fluctuation to create about 1.5 ha of spawning and nursery habitat.
  - A series of northern pike spawning channels would be excavated along the shoreline of Snail Bay and Turtle Bay equivalent to an area of about 3.0 ha of spawning and nursery habitat.
  - There are a number of other similar locations where northern pike spawning habitat could be created, for example, the mouth of API 1, representing another 3.0 ha of spawning and nursery habitat.
  - The segment of Lumby Creek between Turtle Bay and Lizard Lake would be improved to allow passage by northern pike, providing access to spawning habitat in Lizard Lake and to Upper Marmion Reservoir northern pike populations. This would provide access to a substantial length of stream/floodplain habitat with suitable spawning, nursery and adult habitat.
  - The stream connection between Trap Bay and Lynxhead Bay would be improved to enhance passage by northern pike, and improve access by Upper Marmion Reservoir northern pike into Trap Bay. This would provide access to a substantial length of stream/floodplain habitat with suitable spawning, nursery and adult habitat.
- Creation of walleye spawning habitat or access to spawning habitat:
  - Spawning habitat exists in Sawbill Creek (the creek adjacent to the Project Site Helipad); however, fish passage is an issue. Removal of barriers and improvement of spawning habitat (Inflow 1 and 2) will improve existing spawning areas for walleye and improve access by Upper Marmion Reservoir walleye

into Sawbill Creek. This would provide access to a substantial length of stream/floodplain habitat with suitable spawning, nursery and adult habitat. Spawning habitat exists in Lumby Creek between the mouth (in Lynxhead Bay) at the outlet of Lizard Lake; currently fish passage is limited for walleye in the Upper Marmion Reservoir.

Additional terrestrial studies (i.e. species at risk assessments) may be required where proposed compensation works entail the alteration of existing terrestrial habitats.

A quantitative monitoring program will be established for all compensation works, based upon existing conditions. The timing of monitoring activities will be linked to the rate of habitat change resulting from each compensation work. Monitoring events will measure compliance with the design of compensation works (i.e., the number of habitat units created) and physical and biological indicators of success (i.e., species utilization). For costing purposes, it has been assumed that all compensation works would be completed during the construction phase of the Project, and that five bi-annual surveys (a 10 year monitoring program) would be implemented to evaluate the success of the compensation.

The habitat compensation measures identified in Table 3-9 represent about 21 ha of surface water area and 22,947 HUs of like for like fish habitat. At this time, the conceptual NNLP would consist of the measures in Table 3-9, plus the following:

- Stream crossings
- Northern pike spawning habitat creation at the mouth of Sawbill Bay
- The fish salvage and rescue operations

These measures would offset the habitat effects from both the Schedule 2 MMER waterbodies as well as the other habitat effects of the project.

The other measures identified above represent other potential onsite alternatives.

3.8.5 Steep Rock Mine Habitat Compensation

Additional compensation works will be evaluated for the final NNLP. These may include off-site compensation. The Steep Rock Mine closed and was abandoned in 1979 and there is a high likelihood for the outflow from the two large pit lakes located on the Steep Rock Site to eventually impact downstream aquatic ecosystems. The development of a long-term rehabilitation plan for the Steep Rock Mine is currently underway. The rehabilitation plan will identify potential opportunities for site remediation, which may contribute to the protection of aquatic life in downstream waters and/or the rehabilitation of on-site fish habitat. In discussions with regulatory agencies (Section 2.2.1), MNR and DFO have expressed strong interest in pursuing an agreement with OHRG to provide funding for remediation activities at the Steep Rock Site rather than undertake on-site compensation, once the cost of the on-site compensation for the Project has been determined. This is in acknowledgement of the greater public, agency and Aboriginal interest in seeing the fisheries in the Steep Rock Site restored and mitigating risk to downstream fisheries.

The means of facilitating this off-site compensation would require an agreement between DFO, MNR and Osisko, for example by securing letters of credit toward reclamation of the Steep Rock Site.

3.9 Residual Effects

There are a number of potential residual effects of the Project as follows:

- Although the aquatic habitats lost within the MSA will be replaced by equivalent or more highly valued fish habitat that will enhance the valued fishery of Upper Marmion Reservoir, the contribution of these fish communities (in terms of genetic diversity and indirect fish habitat) to the lower reaches, Lizard Lake and Upper Marmion Reservoir will be lost. The indirect fish habitat component will be compensated for by the suite of habitat compensation measures implemented and genetic diversity will be partially maintained through the implementation of fish salvage protocols during which the majority of impacted fish will be released in other waterbodies in the area, including Lizard Lake, API #8 and Upper Marmion Reservoir. As a result, this residual effect is considered to be negligible.
- Post-closure, surface runoff from the MSA will increase slightly resulting in a discharge from the overflow from the pit lake in the order of 70 m^3/h. This discharge will meet SSWQOs and is considered to be a negligible effect.
- During Mine operations, the effluent discharge from the treatment plant may, on occasion, exceed guidelines for the protection of aquatic life and the SSWQOs. At this time, this is predicted to occur infrequently, only during “wet years”. This is predicted to be a less than 1 in 25 year occurrence. The resulting mixing zone at the end of the discharge will be small and located in an area of low fish use. As a result, the potential for exposure of fish to this area will be low and the concentration/duration of effect will be very low. As a result, there will be no effect of this discharge on fish populations in Upper Marmion Lake. No effects are expected on smallmouth bass, northern pike, walleye or baitfish populations in Upper Marmion Lake.
- During Mine operations, closure and post-closure, there is potential for “piping” of surface water in Upper Marmion Reservoir to move via cracks and fissures in the bedrock into the open pits. This amount has been predicted to be about 350 m^3/day. During the operations phase, a Mine water collection and pumping system will ensure that there is no impact on Upper Marmion Reservoir water levels. Once the Mine is closed and the Mine water intake from Sawbill Bay is decommissioned, this inflow of water to the open pits can easily be accommodated within the current operating regime for Upper Marmion Lake. As a result, there is no impact on Upper Marmion Reservoir water levels until the open pits reach the same elevation as the lake. As a result, the effect on VECs is considered negligible.

Based on the suite of in-design and other mitigation/compensation measures that are proposed to be implemented, no other residual effects of the Project on the aquatic environment are anticipated.

4.0 MONITORING PROGRAMS AND COMMITMENTS

4.1 Aquatic Monitoring Program

A monitoring program will be designed and implemented to confirm water quality, flow and water level alteration predictions generated during surface water modelling. If this program establishes that Project-related effects on the aquatic environment are greater than predicted, fish habitat suitability and utilization studies will be triggered on aquatic features (APIs) and/or specific VECs.

Details of water quality, hydrology and aquatic sediment monitoring are provided in the Water and Sediment Quality TSD, Hydrology TSD, Site Water Quality TSD and Lake Water TSD.

The environmental monitoring program will include the EEM program during operations through to include post closure, details of which will follow EC/MOE requirements, as identified below.

In addition to the regular monitoring required under the EEM program, MNR has identified an opportunity to incorporate long term fisheries monitoring of Lizard Lake and Sawbill/Lynxhead Bay into their District Fisheries Assessment program. This program has recently been initiated and MNR has indicated a willingness to work in partnership with Osisko on collection and sharing of methodologies and data for the life cycle of the Project.

4.2 Final No Net Loss Plan

A final NNLP plan to offset habitat losses attributed to the Project will be completed and submitted along with the Fisheries Act Authorization Request. It will include adequate compensation (e.g., creation of new habitat units) to fully offset all direct and indirect effects to habitat. It is expected that the final NNLP will be somewhat of a living document as it may require amendment periodically. New HADDs may be added to the list already generated in the conceptual NNLP, which will subsequently require compensation (e.g., if effects of a particular stream crossing cannot be completely mitigated). The final NNLP will include details of the timing and location of construction of compensation works, and a monitoring schedule for each form of compensation. Where monitoring determines that habitat gain objectives have not been met as planned, additional compensation measures will be designed and implemented. It is anticipated that a single final NNLP will be submitted to regulatory agencies to address requirements of Metal Mining Effluent Regulations (MMER) scheduling for API#2 and the other features within the TMF that are natural, fish-bearing waterbodies within the TMF/WRMF and all non-TMF related HADDs.

Bill C-38, passed in June 2012, amends the Fisheries Act to focus on the protection of fish that support commercial, recreational or Aboriginal fisheries and to more effectively manage activities that pose the greatest threat to these fisheries. It is unclear if/how amendments to the Act may affect current DFO policy. Habitat policy, including ‘no net loss’ is currently under review to ensure consistency with the Act’s focus on managing threats to recreational, commercial and Aboriginal fisheries. When new direction regarding habitat management policy becomes available, it may require the final NNLP be amended.

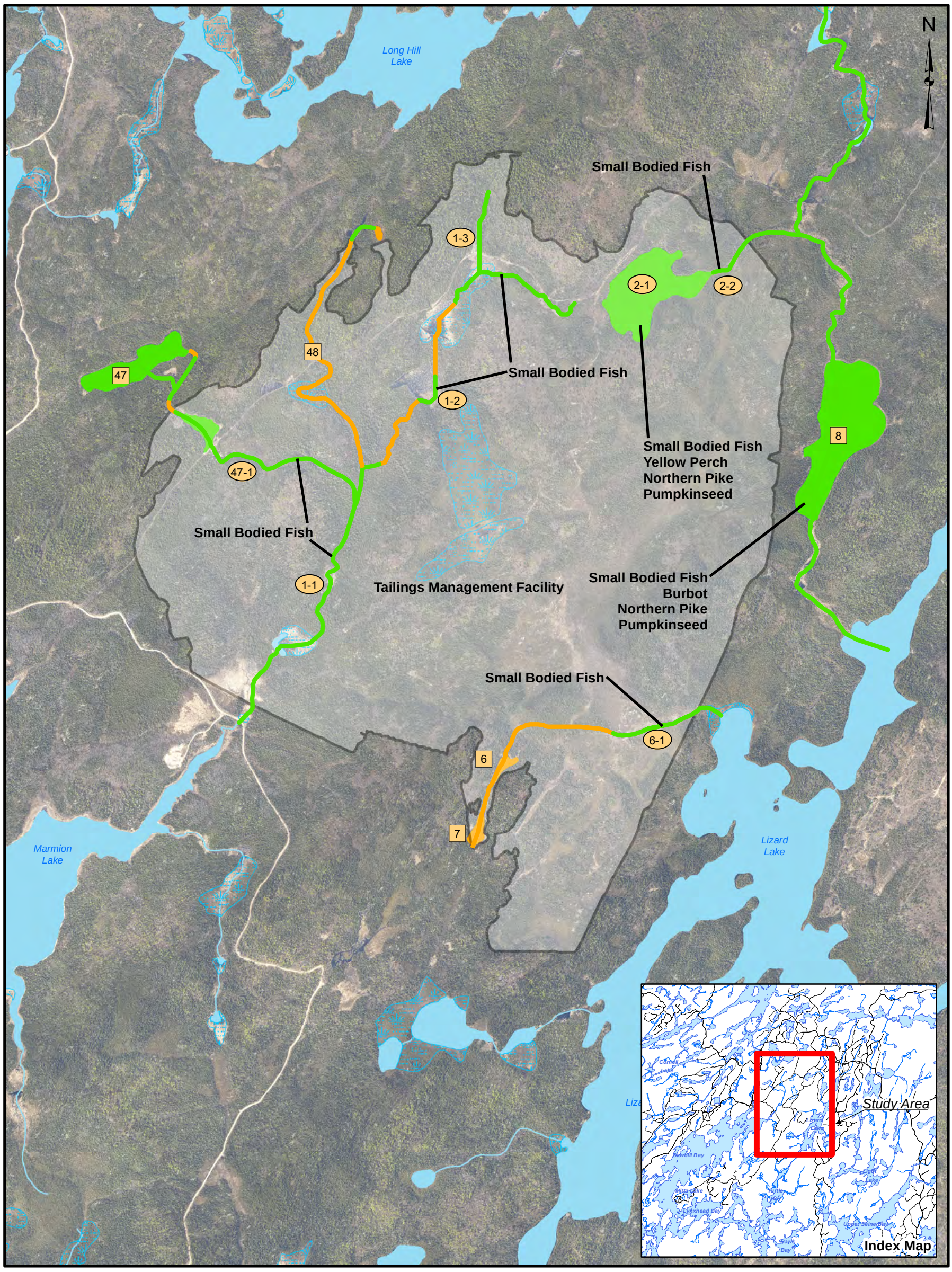
Additional compensation works will be evaluated for the final NNLP. These may include off-site compensation such as the Steep Rock work described previously. This is in acknowledgement of the greater public, agency

and aboriginal interest in seeing the fisheries in the Steep Rock Site restored and mitigating risk to downstream fisheries.

The NNLP will also include compliance and effectiveness monitoring programs to evaluate if the compensation measures function as proposed.

4.3 Scheduling of Waterbodies under Metal Mining Effluent Regulation

Using a natural water body frequented by fish for tailings disposal requires an amendment to the MMER, which is a federal legislative action. The MMER, enacted in 2002, were developed under subsections 34(2), 36(5) and 38(9) of the *Fisheries Act* to regulate the deposit of mine effluent, waste rock and tailings into natural waters frequented by fish. These regulations, administered by Environment Canada, apply to the TMF and the WRMF components of the Project. Environment Canada (2011) outlines a specific process that is required to utilize a natural water body for metal mine waste disposal. This process requires preparation of an assessment of alternatives for mine waste disposal for consideration (completed as part of the EA; Golder 2012), the preparation of a fish habitat compensation plan for consideration as part of the EA, and public and Aboriginal consultations on the EA, including on possible amendments to the MMER. OHRG will be required to submit all required documentation to Environment Canada and may be asked to provide additional background information necessary in the preparation of the regulatory amendment package. Within the TMF, APIs #1, #2, #6, #47 and #48 will likely require scheduling under the Regulations, as shown in Figure 4-1. API #11, within the WRMF will also require scheduling, as shown in Figure 4-2.



LEGEND

- API Reach
- Area of Potential Impact
- Fish Bearing Waters
- Non Fish Bearing Waters
- Waterbody
- Wetland
- Water Segment
- Tailings Management Facility

REFERENCE

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15

500 0 500
SCALE 1:20,000 METRES

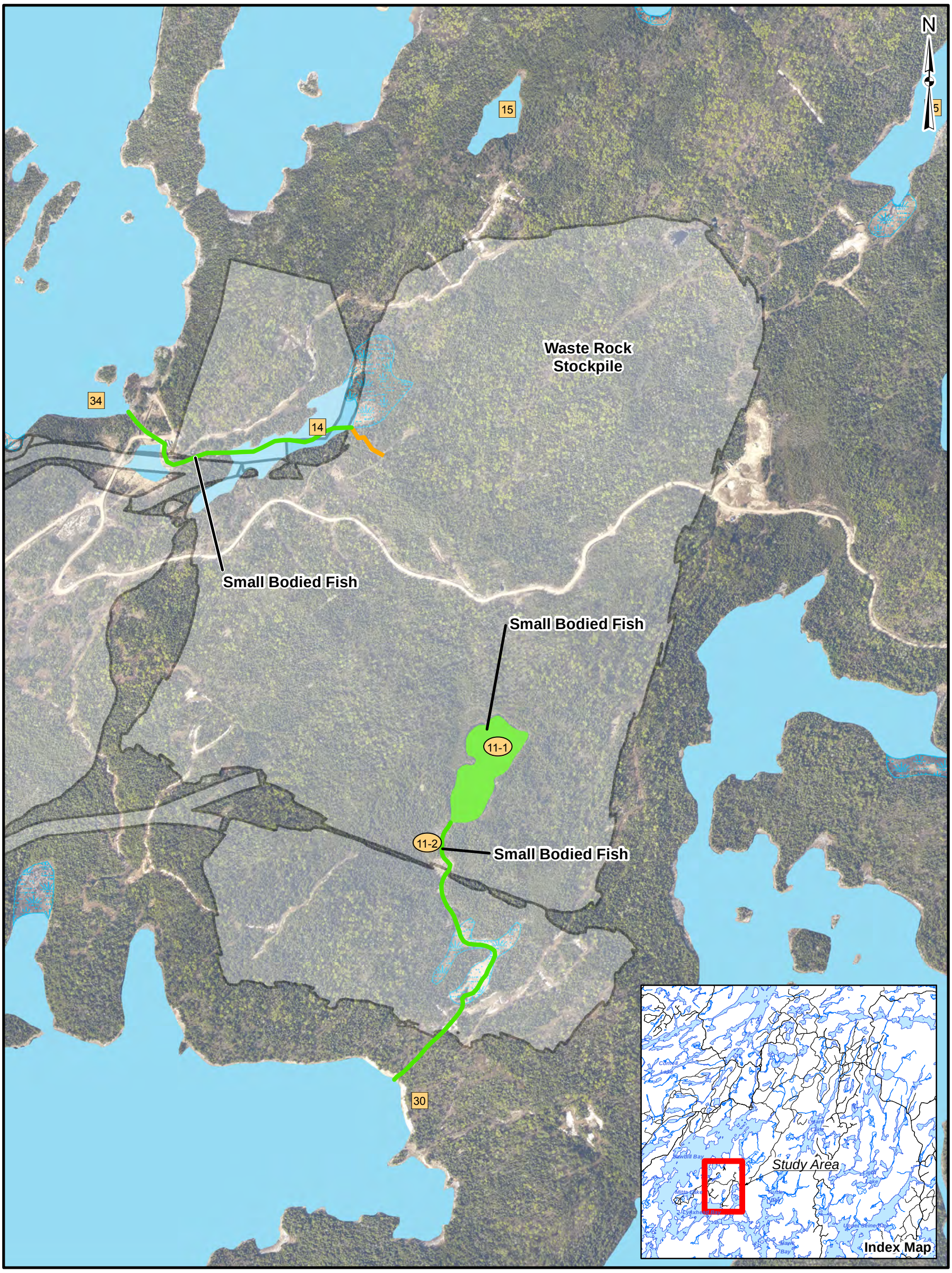
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREAS OF POTENTIAL IMPACT REQUIRING
METAL MINING EFFLUENT REGULATION LISTING

Golder Associates
Sudbury, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	RRD	Dec. 2010	FIGURE 4-1	
GIS	PJM	Nov. 2012		
CHECK	BH	11 Feb, 2013		
REVIEW	GA	11 Feb, 2013		

Path: N:\Active\GIS\Clients\OsiskoHammondReefGoldLtd\10-1118-0020\GIS\MXDs\Fish_Bearing_Waters\FishFrequentedWaters_BaseCase.mxd



LEGEND

- API Reach
- Area of Potential Impact
- Fish Bearing Waters
- Non Fish Bearing Waters
- Waste Rock Stockpile
- Waterbody
- Wetland

REFERENCE

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15

400 0 400

SCALE 1:10,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREAS OF POTENTIAL IMPACT REQUIRING METAL MINING EFFLUENT REGULATION LISTING

Golder Associates
Sudbury, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	RRD	Dec. 2010	FIGURE 4-2	
GIS	PJM	Nov. 2012		
CHECK	BH	11 Feb. 2013		
REVIEW	GA	11 Feb. 2013		

Path: N:\Active\GIS\Clients\OsiskoHammondReefGoldLtd\10-1118-0020\GIS\MXDs\Fish_Bearing_Waters\FishFrequentedWaters_Stockpile.mxd

4.4 Environmental Effects Monitoring (MMER)

The MMER under the Fisheries Act directs metal mines to conduct Environment Effects Monitoring (EEM) as a condition governing the authority to deposit effluent. EEM is a science-based performance measurement tool used to assess the adequacy of the regulations. EEM studies are designed to detect and measure changes in aquatic ecosystems (i.e., receiving environments). The metal mining EEM program is an iterative system of monitoring and interpretation phases that is used to assess the effectiveness of environmental management measures, by evaluating the effects of effluents on fish, fish habitat and the use of fisheries resources by humans. Long-term effects are assessed using regular cyclical monitoring and interpretation phases designed to investigate the impacts on the same parameters and locations. In this way, both a spatial and temporal characterization of potential effects to assess changes in receiving environments are obtained. Study elements include fish population and fish habitat assessments, benthic invertebrate surveys, fish tissue analyses, effluent characterization, sub-lethal toxicity and water quality monitoring.

The first EEM study design must be submitted not later than 12 months after the day on which the mine becomes subject to the Regulations. The first interpretative report must be submitted not later than 30 months after the date on which the mine becomes subject to the Regulations or not later than 42 months after the date on which it becomes subject to the Regulations, if the mine has submitted a report utilizing historical biological monitoring information. Subsequent interpretative reports are submitted 36 or 72 months after the day on which the most recent interpretative report was required to be submitted, depending on the results of the previous interpretative report.

4.5 Construction Monitoring

Field monitoring will be performed to ensure that the mitigation measures implemented during construction successfully minimize adverse environmental effects. Monitoring will focus on the effects of any sediment release and deposition during construction. Post-construction monitoring will be conducted in watercourses affected by the road culvert crossings to evaluate the effects of any sediment releases and deposition at crossing sites, and to evaluate fish passage potential (e.g., hydraulics) through culverts. The effectiveness of habitat reclamation following construction will also be evaluated. Monitoring will be adaptive in that, if changes to fish and fish habitat are detected, appropriate remedial actions will be implemented and subsequent monitoring programs adjusted to ensure the effectiveness of remedial actions and future operations.

A standardized monitoring procedure will be developed so that monitoring data can be used to validate impact predictions. Various environmental variables may be monitored during construction, depending on the concerns and crossing objectives:

- Suspended sediment load before, during and after construction to provide feedback to construction personnel and document the zone of influence and changes in water quality.
- Substrate composition before, during and after construction to document areas of sedimentation.
- Watercourse flows during construction to ensure that fish passage and minimum flows are maintained.
- Monitoring during blasting and diversion procedures.

- Confirm that specific crossing objectives have been achieved.
- Observe and document actual effects.
- Observe and document recovery.
- Determine the need for maintenance of structures and mitigation measures.
- Fulfil explicit mitigation and compensation requirements.

4.6 Blast Monitoring and Collection of Supplementary Fish Habitat Information (Sawbill Bay)

To assess potential for vibration impact as development of the open pits approaches the final pit design, blasting operations will be monitored during initial pit development to obtain site-specific data on the potential for damaging vibrations to affect adjacent aquatic habitats. Baseline studies on habitat use, specifically timing and locations of spawning, have not been completed. It is recommended that these studies be undertaken to effectively mitigate the effects of blast vibration on fish in Sawbill Bay. These data also will be useful in evaluating the effects of construction of the retaining wall adjacent to the west pit, on fish habitat. The fish and data from fish habitats studies will be combined with the site-specific blast monitoring data to develop guidance as to when, if at all, blast designs should be altered to accommodate vibration levels at the nearest active spawning beds and to assess the effectiveness of blast mitigation on fish.

5.0 SUMMARY OF FINDINGS

For the purposes of the Aquatic Environment TSD, the following study areas were established:

- Local Study Area (LSA): This includes all of Upper and Lower Marmion Reservoir and a 1 km corridor along the access road (Hardtack/Sawbill) and the project transmission line.
- Mine Study Area (MSA): This includes the area within the footprint of the Mine.
- Linear Infrastructure Study Area (LISA): This is part of the LSA and includes a 1 km corridor along the access road (Hardtack/Sawbill) and the project transmission line.
- Regional Study Area (RSA): This includes the Local Study Area, plus Raft Lake and the Raft Lake Dam.

The Project is located on the Hammond Reef peninsula, a large peninsula on Upper Marmion Reservoir, a reservoir within the Seine River watershed, which is managed for multiple uses. Fish populations in Upper Marmion Reservoir represent a valued fishery, both for Aboriginal and non-aboriginal people, with walleye, northern pike, smallmouth bass and baitfish representing the Valued Ecosystem Components. Several waterbodies or receivers, including Upper Marmion Reservoir, Lizard Lake, API #8 and the lower reaches of Hammond Peninsula tributaries, were also considered VECs because they support these valued fisheries. Within the Mine Study Area (MSA), there are many small headwater features, representing about 19 km^2 of drainage area that discharge to Sawbill Bay and Lynxhead Bay (Upper Marmion Reservoir) and to Lizard Lake (on Lumby Creek, a tributary of Upper Marmion Reservoir), which are considered the primary receivers.

The small headwater tributaries are typically isolated from the primary receivers by natural barriers (steep gradients, bedrock chutes, and stable beaver dams) and provide habitat mainly for baitfish and other small bodied fish. Walleye and smallmouth bass are not present, and northern pike only occur in a few small lakes. Typical habitats in these headwater tributaries are low gradient, meandering streams, interspersed by beaver ponds and occasional small lakes, typically blocked by beaver dams at their inlets and outlets. There are a number of headwater ponds and streams that are fishless, and also a number of small drainage features that are considered to be ephemeral.

The lower reaches of these headwater features within the MSA are accessible to the valued fishery of Upper Marmion Reservoir and Lizard Lake; however, they are only used by baitfish, other small bodied fish and northern pike. Habitat characteristics of these lower reaches tend to be somewhat steeper than the headwaters, with more typical pool riffle morphology and coarser substrates. Beaver ponds are also interspersed along the length of these features. Habitat conditions at the mouths of these features, where they meet Upper Marmion Reservoir and Lizard Lake are typically low gradient with soft sediments and some rooted aquatic macrophytes. While the mouths of these lower reaches offer nursery habitat for many species of fish, these habitats in Upper Marmion Reservoir are affected by the annual water level fluctuations, in the order of 2.5 m. The effect of these fluctuations is to reduce the productivity of these rivermouth areas for fish and, in some cases, reduce fish movement between the lake and these lower reaches.

The access road (Hardtack/Sawbill) and the mine site road will require upgrading of existing culverts or new culverts at 15 crossing locations. None of the watercourses at crossing locations support northern pike, smallmouth bass or walleye, but these species occur upstream or downstream of four crossings. Only six of the

watercourses crossed by the road support baitfish and other small bodied fish, and four of the watercourses are too steep to support fish. One location was found not to support fish.

An aquatic baseline study program was implemented over three years from 2010 to 2012, with three sampling seasons in each year. Multiple gears were used to sample 55 water bodies (APIs), on the peninsula, along the access road (Hardtack/Sawbill) and an alternate TMF location. The program included multiple visits to each API where field work included fish inventories, habitat mapping and assessment, bathymetry and flow characteristics, representative photographs and identification of habitat limitations (e.g., barriers). Aquatic invertebrate collections and sediment samples were collected from 15 locations to provide a baseline reference, and fish tissue samples were collected from primary receivers for walleye, white sucker and blacknose shiner for chemical analysis of chemicals of concern, primarily metals.

5.1 Key Baseline Conditions

Key findings of the field program are as follows:

- There were no coldwater fish species captured in the MSA, although lake whitefish, cisco and burbot are present in Upper Marmion Reservoir in the LSA.
- In some watercourses, sections of channel and flows are either seasonal (APIs #2, #15, #43, #48, #69), ephemeral (APIs #1, #10, #43, #44, #46, #47) or sub-surface (APIs #10, #16, #17, #47).
- Fishes from receiving waterbodies (i.e., Upper Marmion Reservoir and Lizard Lake) can access the lower reaches of several of the watercourses; however, this access is limited by upstream barriers and lake water level fluctuations:
  - This is evidenced by the capture of juvenile northern pike and white sucker and/or yellow perch (APIs #10, #40, #44, #49) in lower sections of streams.
  - Juvenile burbot were also captured in the lower reaches of two streams (APIs #2, #40).
  - No adult, young-of-year or juvenile walleye or smallmouth bass were captured in any of the streams.
  - Lower reaches of streams likely provide spawning and nursery habitats for some Upper Marmion Reservoir dwelling species, for example, northern pike, yellow perch and white sucker. Spawning activity for these species was not documented.
- Water level management in Upper Marmion Reservoir and low water conditions likely limit accessibility by fish to tributaries and backwater or flooded areas:
  - This regularly has a large impact on the suitability of mouths and lower reaches of many watercourses as nursery areas as evidenced by LiDAR imagery provided in Appendix 2.II.
  - Habitat suitability within embayments of the reservoir (i.e., Snail Bay) is a function of reservoir water levels and stream inflows.

- Exceptions are the watercourses that drain the Hammond Reef peninsula; here, steep cascades in lower reaches preclude reservoir dwelling fish from ascending streams. As a result, some of these watercourses do not support fish communities (APIs #11, #12 and #13).

- Flows in many watercourses appear to be flashy and/or seasonal.
- Channels upstream of the backwater effect caused by Upper Marmion Reservoir water level fluctuations, are generally very shallow and narrow, and as a result, offer little refugia for fish.
  - This is particularly the case for tributaries with small catchments/very small drainage areas.
  - Beaver ponds and headwater ponds likely serve as refugia and sources of fish to repopulate seasonal streams.
- Ponds in the MSA varied in size and depth. Shallow ponds may be subjected to freezing and/or anoxia, as indicated by summer dissolved oxygen profiling.
- All ponds inhabited by fish exhibited simple fish communities, usually dominated by cyprinids. There were also a number of “fishless” ponds.
- Several ponds are physically disconnected from downstream waterbodies seasonally by damming or flows that are ephemeral or subsurface (APIs #6, #7).
- Fish tissue concentrations of metals are highest in walleye for the majority of the metals tested.
- Fish tissue concentrations of total mercury exceed regulatory guidelines in walleye.
- Benthic community composition is generally similar across the study area. API #37 has a slightly healthier benthic community when comparing taxa richness values whereas API #69 appears to be the poorest in quality in terms of density of organisms and %EPT.
- Existing habitat was classified according to ecotype and homogenous habitat units within each ecotype for the purpose of habitat accounting. Results showed the following:
  - Receiver habitats represent by far the largest habitat component in terms of area of littoral and open water habitat.
  - Headwater Lakes and Beaver ponds are the next largest habitat type.
  - Low and high gradient streams represent a small portion of the total available habitat.

5.2 Potential Effects

5.2.1 Construction

During construction, the main effect of the Project will be habitat loss. There is no active discharge and no blasting since the mine has not begun operations.

The majority of habitat losses occur during the construction phase as follows:

- Receivers: There is 0.8 ha of seasonal habitat within the drawdown zone of Sawbill Bay lost, representing about 1,200 HUs of seasonal habitat for baitfish, northern pike and smallmouth bass.
- Lower Reaches: There are 3.9491 ha of inlet streams, 0 ha of lakes and 0.5385 ha of ponds that provide habitat for baitfish.
- Headwaters: there is 1.8635 ha of headwater streams, 29.7088 ha of lakes (API #12 and #2), and 3.7648 ha of ponds that provide habitat for baitfish and northern pike.
- There are 14 stream crossings or crossing upgrades on the proposed access road (Hardtack/Sawbill) that will result in the loss of habitat within the footprint of the culvert/bridge structure. This represents habitat for baitfish and northern pike.
- There are also several ephemeral streams and a number of fishless headwater ponds and headwater streams.
- In addition, to these effects, there is potential mortality of fish present in these waterbodies, unless a fish rescue plan is developed and implemented as part of the construction phase of the Project.
- Receivers: API #8 and Lizard Lake will have a reduction in their drainage areas of about 24% and 14%, respectively. This represents a reduction in lake levels in these waterbodies in the order of 2 to 3 cm (Hydrology TSD). This shallow area represents potential habitat for baitfish species; however, it is considered not suitable for walleye, smallmouth bass and northern pike.

All of these habitat losses will be offset by compensation projects outlined in the NNLP being prepared for the project, and as a result, there will be no residual effects from these losses.

5.2.2 Operations

During operations, there are a number of potential effects, as follows:

Water withdrawal from Sawbill Bay: Since the available water from diversion of the surface catchments in the MSA is insufficient to meet mine water use, water will also be withdrawn from Sawbill Bay. The combined effect of the surface water diversions and the Sawbill Bay withdrawal will result in a reduction in water levels in Upper Marmion Reservoir of about 9 cm, which is readily accommodated within the current operating regime of the reservoir. As a result there are no significant effects.

Mine effluent discharge: An effluent treatment plant is required to treat Mine waste water. The discharge will be located at the end of the Hammond Reef peninsula and discharge into outer Sawbill Bay. The discharge will be intermittent. Mine effluent is not predicted to exceed water quality guidelines or objectives (PWQOs or CWQGs) or site-specific water quality objectives. Therefore, there is no predicted effect on aquatic life and this impact is considered to be negligible.

Sewage discharge to Sawbill Creek: An accommodation camp will be established at the current location of the exploration camp. The sewage treatment facilities will service the accommodation camp and other infrastructure and discharge into Sawbill Creek, just upstream of Sawbill Bay. Discharge from this system will

meet MOE regulatory requirements, and, therefore, there will be no impact on the receiving waterbodies or VECs.

Operational blasting of the open pits: Operational blasting of the east and west pits has the potential to affect fish habitat along the shoreline of the Hammond Reef peninsula. A blast monitoring program and fish habitat characterization study will be implemented throughout the operational phase of the project to measure blast characteristics and ground vibrations. A mitigation management program will be implemented to ensure that DFO guidelines are met, and, therefore, there will be no impact on fish life cycle stages.

Pit Inflow from Upper Marmion Reservoir: As the open pits are excavated, there is potential for lake water to enter the pits through rock fissures. A Mine water collection system will be in place to ensure that water levels in Upper Marmion Reservoir are maintained. As a result, there will be no impact on water levels in Upper Marmion Reservoir.

Seepage losses from the TMF and the WRMF: There is potential for seepage from these sites to migrate to receivers – Sawbill Bay and Lizard Lake. Average seepage losses will meet SSWQO and worst case conditions are predicted to result in no adverse effects to these receivers.

Atmospheric deposition of dust and contaminants: There is potential for atmospheric deposition of contaminants from mining activities. Predictive modeling studies have concluded that the effects of atmospheric deposition of dust and contaminants on aquatic life will be negligible.

5.2.3 Closure and Post-closure

Potential Project closure phase effects on aquatic habitats include the following:

Pit Inflow from Upper Marmion Reservoir: As the open pits begin to fill, there is potential for lake water to enter the pits through rock fissures. The mine inflow estimate is approximately 350 m^3/day. During the closure phase, the Mine water inflow will be monitored and if required a plan to manage water levels in Upper Marmion Reservoir will be developed to ensure there are no changes in water levels that could adversely affect aquatic habitats while the filling. It is estimated that in about 78 years, the open pits will overflow into Sawbill Bay at which time any inflows to the pit would be balanced by pit overflows to Upper Marmion Reservoir. There will be no effect on Upper Marmion Reservoir water levels.

Seepage losses from the TMF and the WRMF: There is potential for seepage from these sites to migrate to receivers – Sawbill Bay and Lizard Lake. During the closure phase, the seepage collection system will remain in place to ensure that contaminated seepage does not migrate to receivers until such a time as monitoring shows that the seepage is acceptable for direct release.

Atmospheric deposition of dust and contaminants: There is potential for atmospheric deposition of contaminants from closure activities. Modeling has demonstrated that there will be no contamination of aquatic habitats during closure activities.

There are no anticipated post closure effects; there are, however, a number of potential residual effects of the Project as follows:

- Although the aquatic habitats lost within the MSA will be replaced by equivalent or more highly valued fish habitat that will enhance the valued fishery of Upper Marmion Reservoir, the contribution of these fish

communities (in terms of genetic diversity and indirect fish habitat) to the lower reaches, Lizard Lake and Upper Marmion Reservoir will be lost. The indirect fish habitat component will be offset by the suite of habitat compensation measures implemented and genetic diversity will be partially maintained through the implementation of fish salvage protocols during which the majority of impacted fish will be released in other waterbodies in the area, including Lizard Lake, API #8 and Upper Marmion Reservoir. In addition, fish salvaged from these operations will be used to stock a number of fishless lakes as part of the NNLP. As a result, this residual effect is considered to be negligible.

- Discharge from the sewage treatment facility will meet MOE guidelines and as a result there will be no effect on the receiver. Post-closure, surface runoff from the MSA will increase slightly resulting in a discharge from the overflow from the pit lakes in the order of 70 m^3/h. This discharge will meet SWQOs and is considered to be a negligible effect.
- During Mine operations, the effluent discharge from the treatment plant, may on occasion, exceed guidelines for the protection of aquatic life and the SWQOs. At this time, this is predicted to occur infrequently, only during “wet years”. This is predicted to be a less than 1 in 25 year occurrence. The resulting mixing zone at the end of the discharge will be small and located in an area of low fish use. As a result, the potential for exposure of fish to this area will be low and the concentration/duration of effect will be very low. As a result, there will be no effect of this discharge on fish populations in Upper Marmion Lake. No effects are expected on smallmouth bass, northern pike, walleye or baitfish populations in Upper Marmion Lake.
- During Mine operations, closure and post-closure, there is potential for “piping” of surface water in Upper Marmion Reservoir to move via cracks and fissures in the bedrock into the open pits. This amount has been predicted to be about 350 m^3/day. During the operations phase, a Mine water collection and pumping system will ensure that there is no impact on Upper Marmion Reservoir water levels. Once the Mine is closed and the Mine water intake from Sawbill Bay is decommissioned, this inflow of water to the pits can easily be accommodated within the current operating regime for Upper Marmion Lake. Once the pits are full and overflow into Upper Marmion Lake, there will be a small net increase in flow into Marmion Lake. As a result, there is no impact on Upper Marmion Reservoir water levels and the effect on VECs is considered negligible.
- Based on the suite of in-design and other mitigation/compensation measures that are proposed to be implemented, no other residual effects of the Project on the aquatic environment are anticipated.

5.3 Fish Habitat Compensation

The following is a summary of the compensation projects identified as part of the conceptual No Net Loss Plan:

- Fish salvage and rescue operations: during the construction phase.
- Stream restoration works at 15 culvert crossings
- Stocking of Four fishless headwater lakes/ponds.
- Constructing berms to create three new headwater ponds.

- Creating northern pike spawning habitat adjacent to the mouth of Sawbill Creek

These measures will offset project effects for both the MMER schedule 2 waterbodies as well as the other fish habitat effects of the project.

In addition to these, several alternative projects were identified as follows:

- Creating fish passage (northern pike and walleye) in Lumby and Sawbill Creeks.
- Creating northern pike spawning habitat in shallow bays of Sawbill Bay (including Snail Bay) and adjacent to the mouth of Sawbill Creek.
- Creating stream habitat/removing fish barriers as part of construction of 14 stream crossings.

An Environmental monitoring program to assess the performance of fish compensation measures will also be undertaken (five biannual studies).

An MMER Schedule 2 listing of a number of APIs will be required. Within the TMF, APIs #1, #2, #6, #47 and #48 will require scheduling under the Regulations. API #11, within the WRMF will also require scheduling.

In addition to monitoring of the compensation projects, a construction monitoring plan, an environmental effects monitoring (EEM) plan, and post-closure monitoring plan will be implemented. The construction monitoring program will focus on water quality monitoring and inspection of erosion and sediment control measures and occur for all aspects of construction, both during the construction phase and throughout the life of the Project. The EEM monitoring program will follow federal requirements and occur throughout the life of the operations phase of the project. The post-closure plan environmental monitoring program will focus on water quality and quantity monitoring and will continue until it is demonstrated that there is no guidelines exceedances off-site.

6.0 LIST OF REFERENCES

Anderson, P.G., B.R. Taylor and G.C. Balch. 1996. *Quantifying the Effects of Sediment Release on Fish and their Habitats.* Prepared for the Eastern B.C. Habitat Unit and Alberta Area Habitat Management Division, Department of Fisheries and Oceans. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2346. 110 p. + appendices.

Becker, G.C. 1983. *Fishes of Wisconsin*. University of Wisconsin Press, Madison, Wisconsin. 1052 pp.

Bradbury, C. M., M. Roberge and C.K. Minns. 1999. *Life History Characteristics of Freshwater Fishes Occurring in Newfoundland and Labrador, With Major Emphasis on Lake Habitat Characteristics*. Can. MS Rep. Fish. Aquat. Sci. 2485:vii+150 p.

Bodaly, R.A. 1980. *Pre- and post-spawning movements of walleye, Stizostedion vitreum, in southern Indian Lake, Manitoba*. Canadian Technical Report of Fisheries and Aquatic Sciences, 931: 30 p.

Boileau, D. 2004. 2004 – 1014 Seine River Water Management Plan. 199 p.

Casselman, J.M. and Lewis, C.A. 1996. *Habitat requirements of northern pike (Esox lucius)*. Canadian Journal of Fisheries and Aquatic Sciences, 53: 161-174.

CCME (Canadian Council of Ministers of the Environment). 2000. *Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota: Methylmercury.* In: Canadian environmental quality guidelines, 1999. Canadian Council of Ministers of the Environment, Winnipeg.

CEA Agency (Canadian Environmental Assessment Agency). 2011. *Guidelines for the Preparation of an Environmental Impact Statement Pursuant to the Canadian Environmental Assessment Act for the Hammond Reef Gold Mine Project.* Hammond Reef Gold Mine Project. CEA Agency File #004524. Toronto, ON. 78 p.

CEA Agency and MOE (Ontario Ministry of the Environment). 2004. *Canada-Ontario Agreement on Environmental Assessment Cooperation.* Available at http://www.ene.gov.on.ca/environment/en/resources/STD01_078849.html. Accessed: June 19, 2012.

Colby, P.J., R.E. McNicol and R.A. Ryder. 1979. *Synopsis of Biological Data on the Walleye, Stizostedion v. vitreum. FAO Fish. Synop.* (119): 139 p.

Corbett, B.W. and Powles, P.M. 1986. *Spawning and larva drift of sympatric walleyes and white suckers in an Ontario stream*. Transactions of the American Fisheries Society, 115: 41-46.

Eschmeyer, P.H. 1950. *The life history of the walleye, Stizostedion vitreum (Mitchill), in Michigan*. Bulletin of the Institute of Fisheries Resources Michigan Department of Conservation, No. 3: 99 p.

Evers, D.C., Wiener, J.G., Driscoll, C.T., Gay, D.A., Basu, N., Monson, B.A., Lambert, K.F., Morrison, H.A., Morgan, J.T., Williams, K.A., Soehl, A.G. 2011. *Great Lakes Mercury Connections: The Extent and Effects of Mercury Pollution in the Great Lakes Region*. Biodiversity Research Institute. Gorham, Maine. Report BRI 2011-18. 44 pp.

Falk, M.R., Gillman, D.V. and Read, C.J. 1980. *The walleye, Stizostedion vitreum (Mitchill) sport fishery on Mosquito Creek, Northwest Territories, 1973-78*. Canadian Manuscript Report of Fisheries and Aquatic Sciences 1559: 29 p.

Ford, B.S., Higgins, P.S., Lewis, A.F., Cooper, K.I., Watson, T.A., Gee, C.M., Ennis, G.L. and Sweeting, R.L. 1995. *Literature reviews of the life history, habitat requirements and mitigation/compensation strategies for thirteen sport fish species in the Peace, Liard and Columbia River drainages of British Columbia.* Canadian Manuscript Report of Fisheries and Aquatic Sciences, 2321: 342 p.

Golder. 2008. Fish Species Habitat Suitability Index Models for the Alberta Oil Sands Region. Prepared for Imperial Oil Resources Ventures Limited (Imperial Oil)

Harbicht, S.M and Franzin, W.G. 1988. *A survey of the fishes utilizing the major streams flowing into Dauphin Lake, Manitoba, 1982*. Canadian Manuscript Report of Fisheries and Aquatic Sciences, 1974: 72 p.

Hall-Armstrong, J, A.G. Harris and R.F. Foster. 1996. *Fish Use of Wetlands in Northwestern Ontario: a Literature Review and Bibliography.* Northwest Sci. & Technol., Ontario Ministry of Natural Resources, Thunder Bay, Ont. TR-90. 54 p.

Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling, and D. Stalker. 1999. *Cumulative Effects Assessment Practitioners Guide*. AXYS Environmental Consulting Ltd. and the CEA Working Group for the Canadian Environmental Assessment Agency.

Holland, L.E., and M.L. Huston. 1984. Relationship of young-of-the-year Northern Pike to Aquatic Vegetation Types in Backwaters of the Upper Mississippi River. North American Journal of Fisheries Management 4:514-522.

Holm, E., N.E. Mandrak and M.E. Burridge. 2009*. The ROM Field Guide to Freshwater Fishes of Ontario*. Royal Ontario Museum, Friesens Printers, Altona, MB. 462 p.

Inskip, P.D. 1982. Habitat Suitability Index Models: Northern Pike. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.17. 40 p.

Jackson, B. 1995. *1994 Index Netting Assessment of the Upper Floodwaters Area (Upper Marmion Lake*). Atikokan District, Ministry of Natural Resources.

Jackson, B. 1996. *1995 Upper Floodwaters Creel Census*. Atikokan District Ministry of Natural Resources.

Jackson, B. 2007a. *Lower Marmion Lake Walleye Telemetry Study. 2001 – 2004*. Fort Francis District, Ministry of Natural Resources.

Jackson, B. 2007b. *Status of Walleye Population in Lower Marmion Lake: 2007 Assessment and Management Options.* Fort Francis District, Ministry of Natural Resources.15 p.

Jessop, C.S. and Lilley, J.W. 1975. *An evaluation of the fish resources of the Mackenzie River valley based on 1974 data*. Canadian Fisheries Marine Services Technical Report. 96 p.

Jessop, C.S., Porter, T.R., Blouw, M., and Sopuck, R. 1973. *Fish resources of the Mackenzie River Valley Special Report: An intensive study of the fish resources of two main stem tributaries.* Fisheries Service Department of the Environment for the Environmental-Social Program Northern Pipelines. 148 p.

Johnston, T.A., Gaboury, M.N., Janusz, R.A, and Janusz, L.R. 1995. *Larval fish drift in the Valley River, Manitoba: influence of abiotic and biotic factors, and relationships with future year-class strengths*. Canadian Journal of Fisheries and Aquatic Sciences, 52: 2423-2431.

Jude, J.D. 1992. *Evidence for natural reproduction by stocked walleyes in the Saginaw River tributary system, Michigan.* North American Journal of Fisheries Management, 12: 386-395.

Krebs, Charles J. 1985. Ecology, *The Experimental Analysis of Distribution and Abundance*, 3rd edition. Harper & Row, New York.

Kerr, S.J., B.W. Corbett, N.J. Hutchinson, D. Kinsman, J.H. Leach, D. Puddister, L. Stanfield and N. Ward. 1997. *Walleye Habitat: A Synthesis of Current Knowledge with Guidelines for Conservation*. Percid Community Synthesis, Walleye Habitat Working Group, Ontario Ministry of Natural Resources, Peterborough, Ontario. 82 p.

Lane, J.A., C.B. Portt and C.K. Minns. 1996. *Spawning Habitat Characteristics of Great Lakes Fishes*. Can. MS Rep. Fish. Aquat. Sci. 2368: v + 48 p.

Lane, J.A., C.B. Portt and C.K. Minns. 1996. *Nursery Habitat Characteristics of Great Lakes Fishes*. Can. MS Rep. Fish. Aquat. Sci. 2338: v + 42 p.

Lane, J.A., C.B. Portt and C.K. Minns. 1996. *Adult Habitat Characteristics of Great Lakes Fishes*. Can. MS Rep. Fish. Aquat. Sci. 2358: v + 43 p.

Langhorne, A.L., m. Neufeld, G. Hoar, V. Bourhis, D.A. Fernet, and C.K. Minns. 2001. *Life History Characteristics of Freshwater Fishes Occurring in Manitoba, Saskatchewan, and Alberta, with Major Emphasis on Lake Habitat Requirements*. Can. MS Rep. Fish. Aquat. Sci. 2579:xii + 170 p.

Machniak, K. 1975a. *The effects of hydroelectric development on the biology of northern fishes(reproduction and population dynamics). 2. Northern pike Esox lucius (Linnaeus).* Canadian Fisheries Marine Services Technical Report. 82 p.

Machniak, K. 1975b. *The effects of hydroelectric development on the biology of northern fishes (reproduction and population dynamics)* 1. Lake whitefish Coregonus clupeaformis (Mitchill). Canadian Fisheries Marine Services Technical Report, 527: 67 p

Marshall, T.R. 1977. *Morphological, physiological, and ethological differences between walleye (Stizostedion vitreum vitreum) and pikeperch (S. lucioperca).* Journal of the Fisheries Research Board of Canada, 34: 1515-1523.

McMahon, T.E., J.W. Terrell, and P.C. Nelson. 1984. *Habitat Suitability Information: Walleye*. U.S. Fish Wildl. Serv. FWS/OBS-82/10.56. 43 p.

McPhail, J.D. and Lindsey, C.C. 1970. *Freshwater fishes of northwestern Canada and Alaska.* Fisheries Research Board of Canada Bulletin, 173: 381 p.

Mitro, M.G. and Parrish, D.L. 1997. *Temporal and spatial abundances of larval walleyes in two tributaries of Lake Champlain.* Transactions of the American Fisheries Society, 126: 273-287.

MNR (Ministry of Natural Resources). 1979. *Manual of Instructions Aquatic Habitat Inventory Surveys*. Ontario Ministry of Natural Resources Queens Park Printer for Ontario 1979. 212 p. + appendices.

MNR 1989. *Atikokan District Fisheries Management Plan 1988 - 2000*. Atikokan District Ministry of Natural Resources.

MNR. 2010. *Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales*. Toronto: Queen's Park Printer for Ontario. 211 p.

MOE (Ministry of the Environment). 2011. *Guide to Eating Ontario Sport Fish 2011-2012*. Queen's Printer for Ontario, 2011

Morgan, G.E., and Ed Snucins. 2005. *Manual of Instructions NORDIC Index Netting.* Ontario Ministry of Natural Resources. Queens Park Printer for Ontario. 2005. 32 p. + appendices.

NOAA (U.S. National Oceanic and Atmospheric Administration). 2012. *Glossary of Hydrologic Terms.* Available at: http://www.nws.noaa.gov/os/hod/SHManual/SHMan014_glossary.htm

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. 1989. *Rapid Bioassessment Protocols for Use in Streams and Rivers. Benthic Macroinvertebrates and Fish*. EPA 440-4-89-001. Office of Water Regulation and Standards, U.S. Environmental Protection Agency, Washington, D.C.

Portt, C.B., G. Coker and C.K. Minns. 1999. *Riverine Habitat Characteristics of Fishes of the Great Lakes Watershed*. Can. MS Rep. Fish. Aquat. Sci. 2481:vi + 62 p.

Rawson, D.S. 1957. *The life history and ecology of the yellow walleye, Stizostedion vitreum, in Lac la Ronge, Saskatchewan*. Transactions of the American Fisheries Society, 86: 15-36.

Richardson, E.S., J.D. Resit and C.K. Minns. 2001. *Life History Characteristics of Freshwater Fishes Occurring in the Northwest Territories and Nunavut, with Major Emphasis on Lake Habitat Characteristics*. Can. MS Rep. Fish. Aquat. Sci. 2569:vii + 146 p.

Roberge, M., T. Slaney and C.K. Minns. 2001. *Life History Characteristics of Freshwater Fishes Occurring in British Columbia with Major Emphasis on Lake Habitat Requirements*. Can. MS Rep. Fish. Aquat. Sci. 2574: i + 41 p.

Ryder, R.A. 1977. *Effects of ambient light variations of behavior of yearling, subadult and adult walleyes (Stizostedion vitreum vitreum).* Journal of the Fisheries Research Board of Canada, 34: 1481-1491

Sandstrom, S., M. Rawson and N. Lester. 2010. *Manual of Instructions for Broad-scale Fish Community Monitoring; Using Large Mesh Gillnets and Small Mesh Gillnets*. Ontario Ministry of Natural Resources. Peterborough, Ontario. Version 2010.1 34 p. + appendices.

Scott, W.B., and E. J. Crossman, 1973. *Freshwater Fishes of Canada*. Bulletin 184, Fisheries Research Board of Canada, Ottawa, ON. xviii + 966 p.

Scott, W. B. and E. J. Crossman. 1998. *Freshwater fishes of Canada*. Galt House Publications Ltd. Oakville, Ontario. 966 pp.

Smith and Wilson 1996. A consumers' guide to evenness indices. Oikos 76:70 – 82.

Twomey, K.A., K.L. Williamson and P.C. Nelson. 1984. *Habitat Suitability Index Models and Instream Flow Suitability Curves: White Sucker*. U.S. Fish Wildl. Serv. FWS/OBS-82/10.64. 56 p.

United Nations Conference on Environment and Development, 1992. *Rio Declaration on Environment and Development.* Available at http://www.unep.org/Documents.Multilingual/Default.asp?documentid=78&articleid=1163. Accessed: June 25, 2012.

USDA (United States Department of Agriculture). 2012. Natural Resources Conservation Service. *Glossary of Terms*. Available at http://soils.usda.gov/sqi/concepts/glossary.html#biology

U.S. Department of Interior (United States Department of Interior). 2012. *Bureau of Reclamation Glossary.* Bureau of Reclamation. Available at http://www.usbr.gov/projects/glossary.jsp

Wright, D.G. 1982. "A Discussion Paper on the Effects of Explosives on Fish and Marine Mammals in the Waters of the Northwest Territories". Can. Tech. Rep. Fish. Aquat. Sci. 1052: v + 16 p.

Wright, D. G., and G. E. Hopky. 1998. "Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters". Canadian Technical Report of Fisheries and Aquatic Sciences 2107: iv + 34 p.

7.0 GLOSSARY OF TERMS

Table 7-1: Glossary of Terms

Term	Definition
Acute	Occurring over a short period of time; used to describe brief exposures and effects that appear promptly after exposure. (U.S. Department of Interior 2012)
Ambient	Surrounding natural conditions or environment at a given place and time. Environmental or surrounding conditions. (U.S. Department of Interior 2012)
Anoxic (Anoxia)	Without oxygen. (U.S. Department of Interior 2012)
Anthropogenic	Generated by humans. Used to indicate soil conditions, disturbances, or stresses that are created by people. (USDA 2012)
Backwater	A small, generally shallow body of water with little or no current of its own. Stagnant water in a small stream or inlet. Water moved backward or held back by a dam, tide, etc. (U.S. Department of Interior 2012)
Basin	An area having a common outlet for its surface runoff. (NOAA 2012)
Benthic	Bottom of rivers, lakes, or oceans; organisms that live on the bottom of water bodies. Bottom- or depth-inhabiting. (U.S. Department of Interior 2012)
Catchment	See Basin
Culvert	A pipe or small bridge for drainage under a road or structure. A conduit for the free passage of surface drainage water under a highway, railroad, canal, or other embankment. (U.S. Department of Interior 2012)
Discharge	The release or extraction of water from an aquifer. Typical mechanisms of natural discharge are evapotranspiration by phreatophytes, springs, and drains to surface water bodies. Pumping is a man-caused discharge. (University of Idaho 2012)
Drawdown	The lowering of the surface elevation of a body of water, the water surface of a well, the water table, or the piezometric surface adjacent to the well, resulting from the withdrawal of water therefrom. (NOAA 2012)
Dredge	The scooping, or suction of underwater material from a harbor, or waterway. Dredging is one form of channel modification. Dredging is usually undertaken only on large rivers to maintain a navigation channel. (NOAA 2012)
Effluent	Partially or completely treated wastewater flowing out of a treatment facility, reservoir, or basin. (U.S. Department of Interior 2012)
Grouting	Filling cracks and crevices with a cement mixture. (U.S. Department of Interior 2012)
Grubbing	Removal of stumps, roots, and vegetable matter from the ground surface after clearing and prior to excavation. (U.S. Department of Interior 2012)
Headwater	The source and upper part of a stream; water upstream of a dam or powerhouse. (U.S. Department of Interior 2012)
Invertebrate	All animals without a vertebral column. (U.S. Department of Interior 2012)
Leachate	A liquid that results from water collecting contaminants as it trickles through wastes, agricultural pesticides or fertilizers. Leachate may occur in farming areas, feedlots, and landfills, and may result in hazardous substances entering surface water, ground water, or soil. (U.S. Department of Interior 2012)
Littoral	Pertaining to the shore. (U.S. Department of Interior 2012)

Table 7-1: Glossary of Terms (Continued)

Term	Definition
Loam	A soft, easily worked soil containing sand, silt, and clay. (U.S. Department of Interior 2012)
Macrophyte	A plant large enough to be seen by the naked eye. (U.S. Department of Interior 2012)
Mineralized (Mineralization)	The conversion of organic compounds into inorganic, plant-available compounds such as ammonium. This is accomplished by soil organisms as they consume organic matter and excrete wastes. (USDA 2012)
Precipitation	As used in hydrology, precipitation is the discharge of water, in a liquid or solid state, out of the atmosphere, generally onto a land or water surface. It is the common process by which atmospheric water becomes surface, or subsurface water. The term "precipitation" is also commonly used to designate the quantity of water that is precipitated. Precipitation includes rainfall, snow, hail, and sleet, and, therefore, is a more general term than rainfall. (NOAA 2012)
Riffle	A stretch of choppy water caused by an underlying rock shoal or sandbar. A run is a long riffle. (U.S. Department of Interior 2012)
Riparian	Living on or adjacent to a water supply such as a riverbank, lake, or pond. Of, on, or pertaining to the bank of a river, pond, or lake. (U.S. Department of Interior 2012)
Runoff	The portion of precipitation, snow melt, or irrigation that flows over the soil, eventually making its way to surface water supplies. Liquid water that travels over the surface of the Earth, moving downward due to the law of gravity; runoff is one way in which water that falls as precipitation returns to the ocean. (U.S. Department of Interior 2012)
Sedimentation	Deposition of waterborne sediments due to a decrease in velocity and corresponding reduction in the size and amount of sediment that can be carried. (U.S. Department of Interior 2012)
Seepage	The slow movement or percolation of water through soil or rock. Movement of water through soil without formation of definite channels. The movement of water into and through the soil from unlined canals, ditches, and water storage facilities. The slow movement or percolation of water through small cracks, pores, interstices, etc., from an embankment, abutment, or foundation. (U.S. Department of Interior 2012)
Slough	Movement of a soil mass downward along a slope because of a slope angle too great to support the soil, wetness reducing internal friction among particles, or seismic activity. It is also called a slope failure, usually a rather shallow failure. A wet place of deep mud or mire, or a temporary or permanent lake; ordinarily found on or at the edge of the flood plain or a river. Also refers to a creek or sluggish body of water in a bottomland. (U.S. Department of Interior 2012)
Sluiceway	An opening in a diversion dam used to discharge heavy floating debris safely past the dam. (U.S. Department of Interior 2012)
Stratification	Thermal layering of water in lakes and streams. Lakes usually have three zones of varying temperature, the epilimnion, the metalimnion, and the hypolimnion. The formation of separate layers (of temperature, plant, or animal life) in a lake or reservoir. (U.S. Department of Interior 2012)
Substrate	Surface on which a plant or animal grows or is attached. The base on which an organism lives; a substance acted upon. (U.S. Department of Interior 2012)

Table 7-1: Glossary of Terms (Continued)

Term	Definition
Sump	A pit or pool for draining, collecting, or storing water. A chamber located at the entrance to the pump which provides water to the pump. (U.S. Department of Interior 2012)
Surface Water	Water on the surface of the earth. An open body of water, such as a river, stream or lake. All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors which are directly influenced by surface water. (U.S. Department of Interior 2012)
Topsoil	The topmost layer of soil, usually containing organic matter. Usually refers to soil containing humus, which is capable of supporting plant growth. (U.S. Department of Interior 2012)
Transducer	A device that senses some varying condition and converts it to an electrical signal for transmission to some other device (a Receiver) for processing or decision making. (U.S. Department of Interior 2012)
Tributary	River or stream flowing into a larger river or stream. (U.S. Department of Interior 2012)
Trophic Levels	Levels of the food chain. The first trophic level includes photosynthesizers that get energy from the sun. Organisms that eat photosynthesizers make up the second trophic level. Third trophic level organisms eat those in the second level, and so on. It is a simplified way of thinking of the food web. In fact, some organisms eat members of several trophic levels. (USDA 2012)
Watercourse	Any surface flow such as a river, stream, or tributary. (NOAA 2012)
Watershed	Surface drainage area above a specified point on a stream. Area that drains into or past a point. A geographical portion of the Earth's surface from which water drains or runs off to a single place like a river. The area of land that drains its water into a stream or river. All the land and water within the confines of a certain drainage area. Vertically, it extends from the top of the vegetation to the underlying rock layers that confine water movement. An area of land that contributes runoff to one specific delivery point. (U.S. Department of Interior 2012)
Wetland	Lands including swamps, marshes, bogs, and similar areas such as wet meadows, river overflows, mudflats, and natural ponds. An area characterized by periodic inundation or saturation, hydric soils, and vegetation adapted for life in saturated soil conditions. Any number of tidal and nontidal areas characterized by saturated or nearly saturated soils most of the year that form an interface between terrestrial and aquatic environments; including freshwater marshes around ponds and channels, and brackish and salt marshes. (U.S. Department of Interior 2012)

8.0 LIST OF ABBREVIATIONS, ACRONYMS AND INITIALISMS

Table 8-1: List of Abbreviations, Acronyms and Initialisms

Acronym	Definition
ALS	ALS Laboratory Group
API	Areas of Potential Impact
BIC	Benthic Invertebrate Community
CCME	Canadian Council of Ministers of the Environment
CEA Agency	Canadian Environmental Assessment Agency
COC	Contaminants of Concern
CRA	Commercial, Residential and Aboriginal
DEM	Digital Elevation Model
DFO	Fisheries and Oceans Canada
EIS	Environmental Impact Statement
EPT	Ephemeroptera, Plecoptera, and Trichoptera
EWUA	Ecotype Weighted Useable Area
GPS	Global Positioning System
HA	Habitat Area
HU	Habitat Unit
ICP	Inductively Coupled Plasma mass spectrometry
IHO	International Hydrographic Organization
LISA	Linear Infrastructure Study Area
LSA	Local Study Area
MDL	Minimum Detection Limit
MISA	Municipal Industrial Strategy for Abatement
MMER	Metal Mining Effluent Regulation
MNR	Ontario Ministry of Natural Resources
MOE	Ontario Ministry of Environment
MSA	Mine Study Area
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
OHRG	Osisko Hammond Reef Gold Ltd.
PSQG	Provincial Sediment Quality Guidelines
PWQO	Provincial Water Quality Objectives
QA/QC	Quality Assurance/Quality Control
ROW	Right-of-way

Table 8-1: List of Abbreviations, Acronyms and Initialisms (Continued)

Acronym	Definition
RSA	Regional Study Area
SDI	Simpson's Diversity Index
SEI	Simpson's Evenness Index
SSWQO	Site-specific water quality objectives
TGS	Thermal Generating Station
TMF	Tailings Management Facility
TOC	Total Organic Carbon
TSD	Technical Support Document
VEC	Valued Ecosystem Component
VSC	Valued Social Component
WRMF	Waste Rock Management Facility
WUA	Weighted Usable Area
YOY	Young of the Year
ZEAS	Zaranko Environmental Assessment Services

9.0 LIST OF UNITS

Table 9-1: List of Units

Unit	Abbreviation
degrees Celsius	°C
centimetre	cm
cubic metres per hour	m^3/h
hectare	ha
hertz	Hz
Hounsfield unit	HU
kilohertz	kHz
kilometre	km
kilometres per hour	km/h
litre	L
litres per second	L/s
metre	m
Micrograms per gram	µg/g
micrometre	µm
milligrams per kilogram	mg/kg
milligrams per litre	mg/L
millimetre	mm
parts per million	ppm
square kilometre	km^2
square metre	m^2

AQUATIC ENVIRONMENT TSD
VERSION 1

APPENDIX 2.I

Definitions for Fish Habitat Mapping Variables

February 2013
Project No. 10-1118-0020
Hammond Reef Gold Project

Table of Contents

LAKE HABITAT MAPPING **1**

WATERCOURSE HABITAT MAPPING **2**

TABLES

Table C-1: List of Channel Units 3

Lake Habitat Mapping

Limnetic Zone: The open-water region of a lake that is too deep to support rooted aquatic vegetation.

Littoral Zone: The shallow area of a lake that extends from the waterline to the lakeward limit of rooted aquatic vegetation.

Macrophytes: Macrophytes are aquatic plants which are large enough to be seen with the unaided eye, as opposed to phytoplanktonic organisms. Macrophytes are specifically adapted to aquatic habitats, growing either in the water or along the margins of waterbodies. Flooded terrestrial vegetation does not qualify. There are two basic types of macrophytes which are distinguished when habitat mapping lakes; emergent and submergent macrophytes.

> ***Emergent Macrophytes:*** Macrophytes which grow in wet or boggy areas or which are rooted in water but extend above the water surface. Typical examples include Cattails, Bulrushes and Sedges.
>
> ***Submergent Macrophytes:*** Macrophytes which are rooted and which grow under the water. This includes floating-leaved aquatic plants and plants which may have flower stalks that extend above the surface. Typical examples include pondweeds, Coontail and water lily.

Pinnacle: A small, isolated point of lake bottom, which is exposed above the water line and surrounded by a shoal. Can be thought of as a very small island or a shoal which has a small portion above water.

Shelf: Frequently observed in deep lakes; it is the area of the bottom located near shore, between the waterline and the drop-off. The distance between these points can be highly variable. In areas of shallow bottom slope, the shelf may be extensive, whereas, in areas of steep bottom slope the shelf may not exist. In deep, clear lakes, the shelf is typically the primary area that is habitat mapped since the bottom is visible and characteristics of substrate, cover and vegetation can be recorded.

Shoal: A shallow but submerged area isolated from the shorelines of a lake. Can be composed of a variety of materials depending upon regional geology. May be “clean” (free of fines) if shallow enough to be affected by wave action and may have a significant potential to provide spawning habitat. Therefore, shoal areas in large, deep lakes receive particular attention during habitat mapping.

Slope: The change in vertical height relative to the change in horizontal distance. For lakes, this measurement describes the steepness of the shoreline above and below the water surface.

> ***Bottom Slope:*** The slope of the lakebed on a line perpendicular to shore, from the waterline to the lakeward side.
>
> ***Shore Slope:*** The slope of the lake shore immediately above the waterline.

Substrate: The material which comprises the bottom of a water body. Can be highly variable depending on regional geology, weathering, location within the lake, etc. Described by substrate particle size. Particle sizes include fines (clay, silt and sand), gravel, cobble, boulder and bedrock. Golder employs specific criteria for particle size classes which are defined in this document.

Substrate particle size classes used for both lake and watercourse mapping include:

- Organic material.
- Si – silt/clay (<0.06 mm in diameter).
- Sa – sand (0.06-2.0 mm).
- Gr – gravel (2-64 mm).
- Co – cobble (64-256 mm).
- Bo – boulder (>256 mm).
- Bd – bedrock.

Watercourse Habitat Mapping

Stream Pattern: Stream pattern describes the sinuosity of the channel or the degree to which the channel deviates from straightness. Sinuosity is the channels meander pattern which can range from straight to tortuously meandering. Sinuosity is expressed as the ratio of the length of channel between two points on the stream to the straight line distance between the same two points.

Substrate: Stream substrate is the material found on the bottom of the channel portion of the watercourse. It refers to the surficial deposits that can be seen when viewing the streambed. As part of the habitat evaluation process, the substrate is evaluated with respect to particle size composition. Particle size composition refers to the proportions of the substrate particles within each category from a series of size categories (Table C-1). These range from fine sediments (fines are particles <2 mm in size and include clay, silt and sand) through gravels, cobbles, boulders and bedrock. A substrate evaluation is conducted by visual observation. The observer estimates the percentage of the substrate particles, by surface area, in each of the size categories. Note: the term rubble is sometimes used for cobble sized particles – within this size class, cobble refers to rounded rock while rubble refers to angular rock.

Undercut Bank: An undercut bank is a bank that has been eroded at the base by flowing water, allowing water to be present underneath a portion of the bank. Although undercutting usually adds to bank instability, it may also provide cover for fish. If the overhanging portion of the bank provides and effective with >9 cm over water with a depth of >0.15 m, it provides a cover feature and the location and extent should be recorded on the habitat map.

Unstable Bank: A portion of the stream bank that is unstable in that it has, or has potential to, shed material into the stream. Instability may be due to various factors such as slumping, gullying, erosion or undercutting. Record the location and extent of unstable banks on the habitat map.

Wetted Width: The width of the water surface measured at right angles to the direction of flow. If an island(s) is present creating more than one channel, the total wetted width is the sum of the individual wetted widths. Wetted width is dependent on stream discharge and varies as water level varies.

Channel Unit (sometimes referred to as habitat type): Channel units are the hydraulic and morphological features of a stream channel. A channel unit is a section of channel which is homogeneous with respect to water depth, velocity and cover and is separated from other channel units by gradients in these parameters. Channel units are sometimes referred to as habitat types. The most common channel units are **pool**, **riffle** and **run**, although a total of 12 channel units have been defined (Table C-1).

Table C-1: List of Channel Units

Channel Unit	Description
Falls	Highest water velocity; involves water falling over a vertical drop; impassable to fish
Cascade	Extremely high gradient and velocity; extremely turbulent with entire water surface broken; may have short vertical sections but overall is passable to fish; armoured substrate; may be associated with chute
Chute	Area of channel constriction, usually due to bedrock intrusions; associated with channel deepening and increased velocity
Rapids	Extremely high velocity; deeper than riffle; substrate extremely coarse (large cobble/boulder); instream cover in pocket eddies and associated with substrate
Riffle	High velocity/gradient relative to run habitat; surface broken due to submerged or exposed bed material; shallow relative to other channel units; coarse substrate; usually limited instream or overhead cover for juvenile or adult fish (generally ≤0.5 m deep)
Run	Moderate to high velocity; surface largely unbroken; usually deeper than a riffle; substrate size dependent on specific hydraulics
Flat	Low gradient area characterized by low velocity and near-laminar flow; differentiated from pool habitat by high channel uniformity; more depositional than run habitat
Pool (Scour)	Discrete portion of channel featuring increased depth and reduced velocity relative to riffle/run habitats; formed by channel scour
Impoundment Pool	Includes pools which are formed behind dams; tend to accumulate sediment/organic debris more than scour pools; may have cover associated with damming structure; identify as Class 1, 2 or 3 as for scour pools; record dam type (e.g., debris, beaver, landslide)
Backwater	Discrete, localized area of variable size exhibiting reverse flow direction; generally produced by bank irregularities; velocities variable but lower than main flow; substrate similar to adjacent channel with higher percentage of fines – record large/significant backwater areas
Snye	Discrete section of non-flowing water connected to a flowing channel only at its downstream end; generally formed in a side-channel or behind a peninsula
Boulder Garden	Significant occurrence of large boulders providing significant instream cover; always in association with an overall channel unit such as a riffle or run

AQUATIC ENVIRONMENT TSD
VERSION 1

APPENDIX 2.II

Aquatic Existing Conditions Study Results

February 2013
Project No. 10-1118-0020
Hammond Reef Gold Project

February 2013

OSISKO HAMMOND REEF GOLD PROJECT

Fish and Fish Habitat Baseline Studies Interim Report – 2012 Update

DRAFT

Submitted to:
Osisko Hammond Reef Gold Project
155 University Avenue, Suite 1440
Toronto, ON M5H 3B7

REPORT

Report Number: 10-1118-0020 (5200)
Document No.: 2012-027 (Rev A)

Distribution:
1 e-copy - Osisko Hammond Reef Gold Ltd.
1 copy - Golder Associates Ltd.

Golder Associates

Table of Contents

Lizard Lake Factsheet 2012

Sawbill Bay and Lynxhead Bay Factsheet 2012

Stream Crossing Factsheets 2010 – 2012

Area of Potential Impact (API) Factsheet Updates – 2012 Update

Fish and Fish Habitat Baseline Studies Interim Report

DRAFT

AQUATIC ENVIRONMENT TSD
VERSION 1

LIZARD LAKE FACTSHEET

February 2013
Project No. 10-1118-0020
Hammond Reef Gold Project

LIZARD LAKE

Catchments R and Q drain to Lizard Lake, which is situated generally to the east of the proposed tailings area. A reduction in the size of these catchments will occur as portions of the upstream drainages are incorporated into the tailings containment area. As a result, a reduction in runoff to the drainage features and into Lizard Lake is anticipated. In the order of 200 – 250 ha of drainage area will be diverted, representing in the order of 10 – 15% of the drainage area of Lizard Lake.

Lizard Lake is a long narrow lake, consisting of two water bodies joined by a short, shallow, narrows (Figure 1). The upper portion of the lake is shallow with the majority of the area being less than 4 m and only a small area greater than 8 m. The lower portion is deeper with a relatively small area less than 4 m and a moderately large area with a moderately large area greater than 8 m and a maximum depth of over 20 m. This lower portion has fairly steeply sloping littoral areas, including a very steep drop off near the deepest part of the lake.

Despite its depth, it appears that the lake exhibits evidence of only a weak thermocline.

Only 2 inlets and the outlet of the lake were sampled for fish habitat; in addition 8 locations in the lake were sampled with catches shown in Table 1 (Figure 2):

Table 1: Lizard Lake, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (See Figure 2)	Date	Gear	Effort	Catch
L-1	August 2, 2010	boat electrofisher	1000 m^2	Northern Pike (5) Smallmouth Bass (3) Blacknose Shiner (47) Yellow Perch (19) Pumpkinseed (2)
L-2	August 21-22, 2010	nordic net	20 hrs.	Smallmouth Bass (1) Yellow Perch (15)
L-3	August 21-22, 2010	gillnet – experimental mesh	17 hrs.	Walleye (10) White Sucker (5) Cisco (14) Yellow Perch (1)
L-4	August 22, 2010	gillnet – experimental mesh	3 hrs.	Cisco (1)
L-5	August 21, 2010	nordic net	2 hrs.	Smallmouth Bass (1) Yellow Perch (1)
L-6	August 22, 2010	minnow traps (3)	15 trap hrs.	No catch
L-7	August 21, 2010	gillnet – experimental mesh	8 hrs.	Northern Pike (1) White Sucker (1) Cisco (1)
L-8	August 21, 2010	boat electrofisher	1000 m^2	Yellow Perch (246) Northern Pike (4) Smallmouth Bass (1) Iowa Darter (1) Pumpkinseed (1) Spottail Shiner (4)

LIZARD LAKE

Fish Effort Location (See Figure 2)	Date	Gear	Effort	Catch
L-9 (outlet)	12 May, 2011	backpack electrofisher	300 m	Burbot (3) Longnose Dace(40) Mottled Sculpin (1)

While netting was not completed in the deepest part of the lake, generally species such as walleye, white sucker and cisco were captured in deeper water near steep shorelines while most other species, such as smallmouth bass, yellow perch, northern pike and pumpkinseed were found in the shallower, backwater areas where rooted aquatic vegetation was present. No game fish were captured in the inlet and outlet streams sampled.

All of the inlets and the outlet to the lake are small with limited flows, suggesting that most spawning and nursery habitat for game species occurs in the Lake. Photos 1 to 3 show the lake and representative habitat.

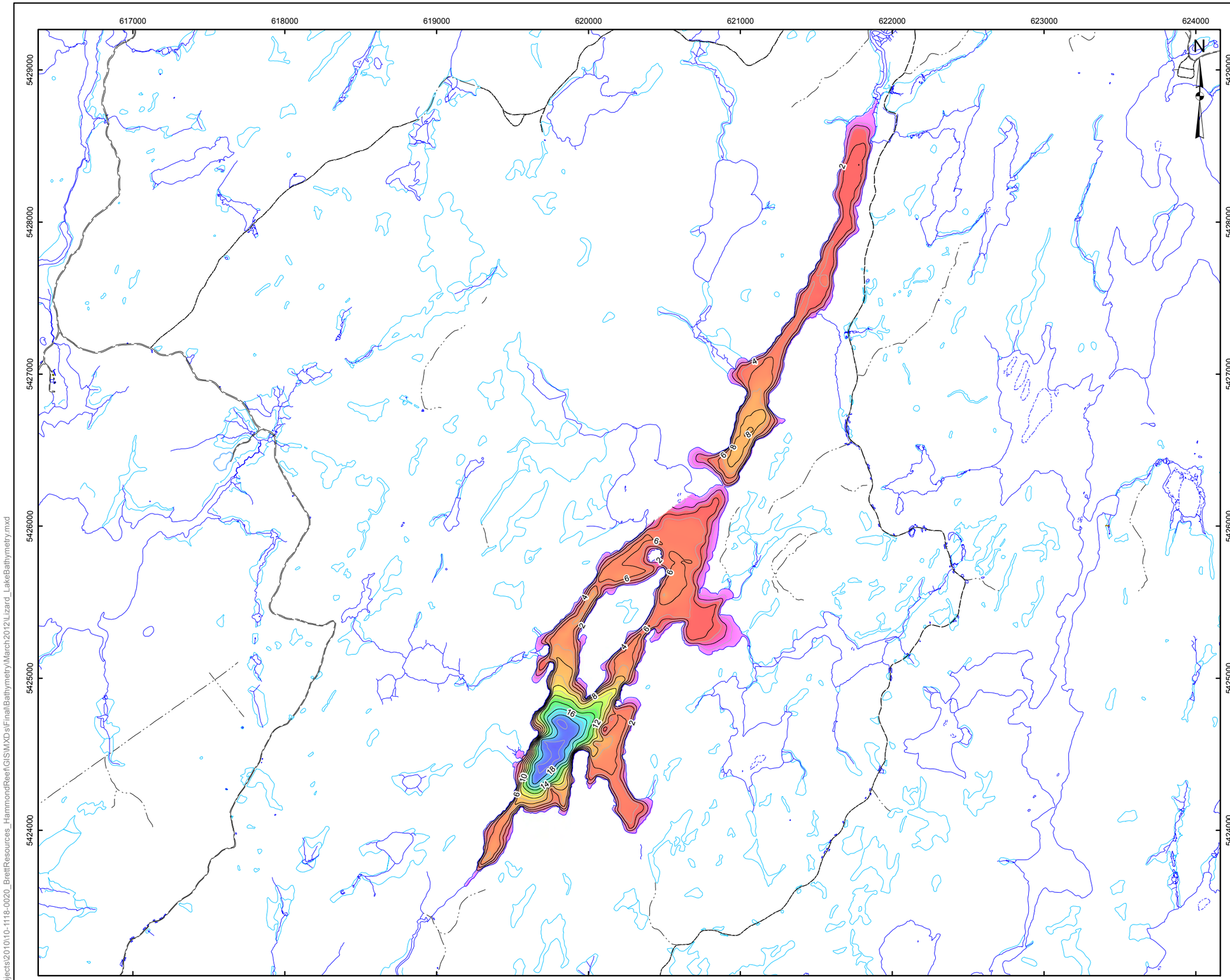
Photo 1: Aerial photo of Lizard Lake (in background)

LIZARD LAKE

Photo 2: Lizard Lake near minor tributary inflow

Photo 3: Lizard Lake looking toward main inlet to lake

n:\active\2010\1118\10-1118-0020 brett resources-hammond reef\005 environmental\5200 aquatic bio\reports\interim baseline report april 2012\lizard lake factsheet\lizard lake overview.docx



LEGEND

- Lake Bottom Contours - 2 m interval
- Lake Bottom Contours - 1 m interval
- Dirt Road - Double
- Dirt Road - Single
- Trail
- River/Stream
- Lake
- Wetland/Swamp

Depth of Lake Bottom (metres)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

NOTES:

1. Water level/Shoreline elevation used for Lizard Lake was 426.55 m (please refer to Table 1, Lake Level Elevation Data).
2. The contours were derived from a 20 metre cell size for the grid files. Minor contour errors exist at the shorelines where departures are at the scale of the grid dimension.

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010)
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

500 0 500 1,000
SCALE 1:25,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
CONTOURED DEPTH OF LAKE BOTTOM
LIZARD LAKE

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 0.0
DESIGN	CGE	14 Nov. 2008		
GIS	CGE	7 Mar. 2012		
CHECK	MMW	7 Mar. 2012		
REVIEW	SP	7 Mar. 2012		

FIGURE: 1

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\FinalBathymetry\March2012\Lizard_LakeBathymetry.mxd

618,400 619,000 619,600 620,200 620,800 621,400 622,000 622,600

5,428,400 5,427,800 5,427,200 5,426,600 5,426,000 5,425,400 5,424,800 5,424,200 5,423,600

N

API #8

FLOW

FLOW

L-8

L-3

L-7

LIZARD LAKE

API #6

L-1

L-4

L-5/L-6

L-2

FLOW

API #45

FLOW

L-9

820 0 820

SCALE 1:19,813 METRES

LEGEND

(#) Fish Effort Location

Shoreline Habitat Mapping

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

Lizard Lake
(Fish Community Assessment)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 1
DESIGN	AL	May 2012		
GIS	AL	May 2012		
CHECK	- -	May 2012		
REVIEW	- -	- / - / -		

FIGURE: 2

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\API_May_2012\Lizard_Lake.mxd

AQUATIC ENVIRONMENT TSD
VERSION 1

SAWBILL / LYNXHEAD BAY FACTSHEET

February 2013
Project No. 10-1118-0020
Hammond Reef Gold Project

SAWBILL / LYNXHEAD BAY OVERVIEW

Sawbill Bay and Lynxhead Bay (including Trap Bay) surround the Hammond Reef Peninsula and represent the lower portion of the Upper Floodwaters Area of Marmion Lake. Dominant flows from the Upper Seine River flow from Hawke Bay through the Lynxhead Narrows and past the southerly point of Hammond Reef Peninsula, then through the diversion dam into Finlayson Lake. In contrast, Sawbill Bay receives only minor tributary flows.

There are three deep basins: two in Sawbill Bay and one in Lynxhead Bay, with the one in upper Sawbill Bay and the one in Lynxhead Bay exceeding 25 m in depth, while the one in lower Sawbill Bay is generally less than 20 m in depth (Figure 1). Because of the difference in inflows, Sawbill Bay becomes thermally stratified, however only weak stratification occurs in Lynxhead Bay.

Water levels in the Upper Floodwaters are managed for energy production and other water uses and as a result, water levels in Sawbill Bay and Lynxhead Bay may fluctuate up to 3 m (this occurs primarily as a winter drawdown).

The shoreline of Hammond Reef Peninsula is predominantly steeply sloping and rocky, however there are several small, shallow embayments (generally less than 4 m deep) along the Sawbill Bay side, for example Snail Bay, and one in Lynxhead Bay. While these shallow embayments offer potential nursery habitat, their value is limited by the fluctuating water levels.

The available habitat around the Hammond Reef peninsula was extensively fished over a 2 year period using a variety of gear. A summary of species caught, gear type, effort and numbers of fish is provided in Tables 1 and 2. Yellow perch were the most common game fish captured, but catches also commonly included northern pike with lesser numbers of walleye, smallmouth bass and rarely Lake Ciscoe and Lake Whitefish. White suckers, blacknose dace, golden shiners and spottail shiners make up the rest of the catch.

There was not a strong distributional pattern to the catch data although catches, particularly of walleye and yellow perch, were somewhat higher in Sawbill Bay than Lynxhead Bay and catches were generally higher in embayments than along more exposed, steeper shorelines. Catches of Lake Ciscoe and Lake Whitefish appeared to be somewhat higher in Turtle Bay. Turtle Bay is another, somewhat smaller bay than Sawbill Bay, that is located off of the main flow path of the Seine River and has water depths generally less than 10 m (Figure 3), including a fairly extensive area that is less than 5 m in depth, that receives flows from Lizard Lake. Since the catch data was from late August to late September, it could be inferred from the data that fish communities may move into these large, more quiescent bays (Sawbill and Turtle Bays) in the late summer to forage, rather than in the areas where flow is more prominent.

Conversely, the shallow embayments within these bays may become largely inaccessible following the drawdown period and even when the water levels increase in spring, such areas may be less productive in terms of aquatic vegetation that they would be without this water level fluctuation.

Photos 1 – 10 show representative habitats in Sawbill and Lynxhead Bay. In general, there is more shallow protected shoreline with macrophyte growth along the Hammond Reef peninsula shoreline in Sawbill Bay than in Lynxhead Bay, including Trap Bay.

SAWBILL / LYNXHEAD BAY OVERVIEW

Table 1 - API: Sawbill Bay/Lynxhead Bay: Fishing Effort and catch Summary

Year	Primary Gear(s)	Total Catch
2010	Experimental gillnets	Northern Pike (49) Walleye (91) Yellow Perch (52) Smallmouth Bass (16) White Sucker (26) Lake Whitefish (17) Lake herring (24)
	Nordic nets	Smallmouth Bass (1) Northern Pike (28) Yellow Perch (42) Blacknose shiner (158)
	Boat electrofishing	Yellow Perch (308) Northern pike (9) Smallmouth Bass (4) White sucker (1) Blacknose shiner (634) Cyprinid spp (200)
2011	Broad-scale nets	Smallmouth Bass (3) Walleye (15) Yellow perch (368) Northern Pike (46) White Sucker (4) Lake whitefish (10) Golden shiner (1) Spottail Shiner (1)

Table 2: Sawbill Bay/Lynxhead Bay Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (API) (See Figure 2)	Date	Gear	Effort	Catch
Sawbill Bay				
1 (API 32)	September 23-24, 2011	Broad-scale small mesh gillnet	17.5 hrs	Spottail Shiner (1) Smallmouth Bass (1)
2 (API 32)	September 23-24, 2011	Broad-scale small mesh gillnet	17 hrs	No catch
3 (API 32)	September 23-24, 2011	Broad-scale large mesh gillnet	18 hrs	Walleye (2) Smallmouth Bass (1) White Sucker (1)
4 (API 34)	August 18-19, 2010	gillnet – experimental mesh	16 hrs	Northern Pike (7) Walleye (7)

SAWBILL / LYNXHEAD BAY OVERVIEW

Fish Effort Location (API) (See Figure 2)	Date	Gear	Effort	Catch
				Yellow Perch (1) Smallmouth Bass (2) White Sucker (4) Lake Whitefish (1)
5 (API 34)	August 20, 2010	gillnet – experimental mesh	7 hrs	Walleye (4) Smallmouth Bass (2) Northern Pike (1) White Sucker (1)
6 (API 34)	August 27-29, 2010	gillnet – experimental mesh	24.5 hrs	White Sucker (5) Northern Pike (5) Walleye (18) Yellow Perch (3) Smallmouth Bass (2) Lake Whitefish (3)
7 (API 34)	August 28-29, 2010	gillnet – experimental mesh	21 hrs	Walleye (22) Northern Pike (4) Smallmouth Bass (2) White Sucker (3)
8 (API 34)	August 26, 2010	boat electrofisher	600m	Yellow Perch (131) Smallmouth Bass (4)
9 (API 34)	September 22-23, 2011	Broad-scale small mesh gillnet	22.5	Yellow Perch (45) Northern Pike (2)
10 (API 34)	September 22-23, 2011	Broad-scale small mesh gillnet	22.5	Yellow Perch (177) Northern Pike (5) Walleye (1) Spottail Shiner (1)
11 (API 34)	September 22-23, 2011	Broad-scale large mesh gillnet	23.5	Smallmouth Bass (1) Walleye (3) White Sucker (1) Northern Pike (1) Lake Whitefish (2)
12 (API 37)	August 18, 2010	boat electrofisher	700 m	Northern Pike (8) Blacknose Shiner (330) Yellow Perch (20) White Sucker (1) Cyprinid sp. (~200)
13 (API 37)	August 21-22, 2010	minnow trap (1)	15 trap hrs	No catch
14 (API 37)	August 21-22, 2010	minnow trap (1)	15 trap hrs	No catch
15 (API 37)	August 21-22, 2010	minnow trap (1)	15 trap hrs	No catch

SAWBILL / LYNXHEAD BAY OVERVIEW

Fish Effort Location (API) (See Figure 2)	Date	Gear	Effort	Catch
16 (API 37)	August 21-22, 2010	minnow trap (1)	15 trap hrs	No catch
17 (API 49)	September 20-21, 2011	Broad-scale small mesh gillnet	23 hrs	Yellow perch (79) Northern Pike (7) Golden Shiner (1)
18 (API 49)	September 20-21, 2011	Broad-scale small mesh gillnet	22 hrs	Yellow Perch (13) Northern Pike (3)
19 (API 49)	September 20-21, 2011	Broad-scale large mesh gillnet	21.25	Lake Whitefish (1) Northern Pike (1)
Lynxhead Bay				
20 (API 30)	August 26, 2010	boat electrofisher	500m	Yellow Perch (10) Northern Pike (1)
21 (API 30)	September 24, 2011	Broad-scale small mesh gillnet	17.5 hrs	Walleye (2) Yellow Perch (15)
22 (API 30)	September 24, 2011	Broad-scale small mesh gillnet	17.5 hrs	Walleye (1) Northern Pike (1)
23 (API 30)	September 24, 2011	Broad-scale large mesh gillnet	17 hrs	Lake Whitefish (1) White Sucker (1) Northern Pike (1)
24 (API 69)	August 26, 2010	boat electrofisher	400 m 502 seconds	Yellow Perch (203) Northern Pike (1) Blacknose Shiner (3)
25 (API 69)	August 20, 2010	minnow traps (4)	96 trap hrs	No catch
26 (API 69)	August 26-27, 2010	gillnet – experimental mesh	14 hrs	Smallmouth Bass (2) Yellow Perch (2) Northern Pike (1) Walleye (10) White Sucker (1)
Snail Bay				
27 (API 35)	August 18, 2010	boat electrofisher	800 m	Yellow Perch (48) Blacknose Shiner (250)
28 (API 35)	September 20-21, 2011	broad-scale small mesh gillnet	22.5 hrs	Yellow Perch (9) Northern Pike (5)
29 (API 35)	September 20-21, 2011	broad-scale small mesh gillnet	22 hrs	Yellow Perch (15) Northern Pike (6)
30 (API 35)	September 20-21, 2011	broad-scale large mesh gillnet	22.5 hrs	Northern Pike (5) Lake Whitefish (5) Yellow Perch (6) Walleye (4)

SAWBILL / LYNXHEAD BAY OVERVIEW

Fish Effort Location (API) (See Figure 2)	Date	Gear	Effort	Catch
31 (API 35)	September 20-21, 2011	broad-scale small mesh gillnet	21 hrs	Northern Pike (4) Yellow Perch (8)
32 (API 35)	September 20-21, 2011	broad-scale large mesh gillnet	20 hrs	Northern Pike (5) Yellow Perch (1) Walleye (2) White Sucker (1) Lake Whitefish (1)
Turtle Bay				
33 (API 40)	August 25, 2010	boat electrofisher	600 m	Yellow Perch (72) Blacknose Shiner (54)
34 (API 41)	August 25, 2010	boat electrofisher	600 m	Yellow Perch (27)
35 (API 41)	August 24, 2010	nordic net	25 hrs	Smallmouth Bass (1) Northern Pike (5) Yellow Perch (8)
36 (API 41)	August 23, 2010	nordic net	29 hrs	Yellow Perch (14)
37 (API 41)	September 24, 2010	gillnet – experimental mesh	23 hrs	Yellow Perch (10) White Sucker (6) Cisco (12) Walleye (14) Northern Pike (1) Lake Whitefish (2)
38 (API 36)	August 24-25, 2010	gillnet – experimental mesh	23 hrs	Yellow Perch (3) Walleye (3) Northern Pike (15) Lake Whitefish (4) Smallmouth Bass (2)
39 (API 36)	August 25-26, 2010	gillnet – experimental mesh	23 hrs	Lake Whitefish (2) Northern Pike (1) White Sucker (1) Walleye (6) Yellow Perch (2) Smallmouth Bass (1)
40 (API 36)	August 23-24, 2010	gillnet – experimental mesh	25 hrs	Smallmouth Bass (5) Northern Pike (14) Walleye (3) Lake Whitefish (3) Yellow Perch (13)
41 (API 36)	August 23-24, 2010	nordic net	22 hrs	Yellow Perch (8) Northern Pike (3)
42 (API 36)	September 24-25, 2010	gillnet – experimental mesh	23 hrs	Yellow Perch (10) White Sucker (6)

SAWBILL / LYNXHEAD BAY OVERVIEW

Fish Effort Location (API) (See Figure 2)	Date	Gear	Effort	Catch
				Cisco (12) Walleye (14) Northern Pike (1) Lake Whitefish (2)
43 (API 36)	August 25, 2010	boat electrofisher	800 m	Yellow Perch (12) Blacknose Shiner (103) Northern Pike (2)
44 (API 36)	August 26, 2010	boat electrofisher	1000 m	Northern Pike (4) Yellow Perch (14) Blacknose Shiner (55)

\\mis1-s-filesrv1\data\active\2010\1118\10-1118-0020 brett resources-hammond reef\005 environmental\5200 aquatic bio\reports\interim baseline report april 2012\sawbill and lynxhead bay overview.docx

SAWBILL / LYNXHEAD BAY OVERVIEW

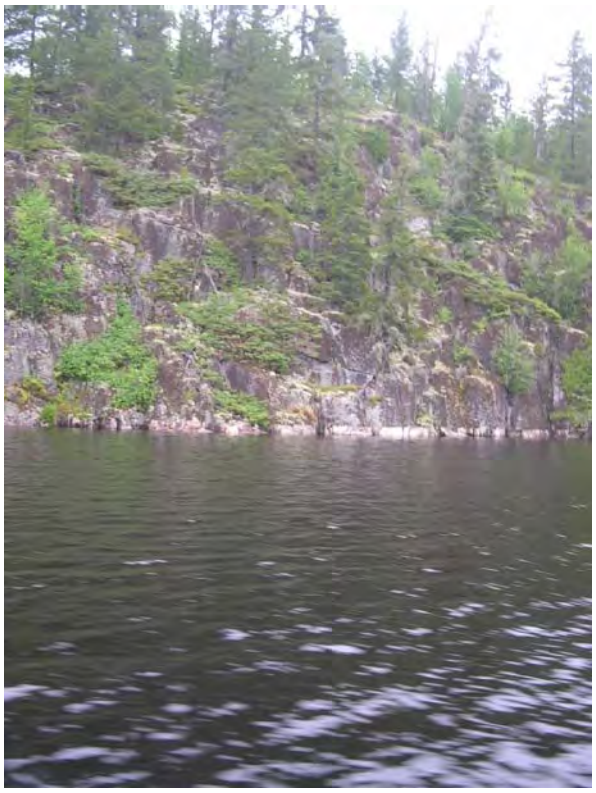


Photo 1: Steep shoreline in Upper Sawbill Bay along Hammond Reef peninsula

Photo 2: Shallow embayment shoreline in upper Sawbill Bay along Hammond Reef peninsula

SAWBILL / LYNXHEAD BAY OVERVIEW

Photo 3: Upper Snail Bay

Photo 4: Upper Snail Bay

SAWBILL / LYNXHEAD BAY OVERVIEW

Photo 5: Upper Snail Bay showing floating vegetation

Photo 6: Steep shoreline in lower Sawbill Bay near end of Hammond Reef peninsula

SAWBILL / LYNXHEAD BAY OVERVIEW

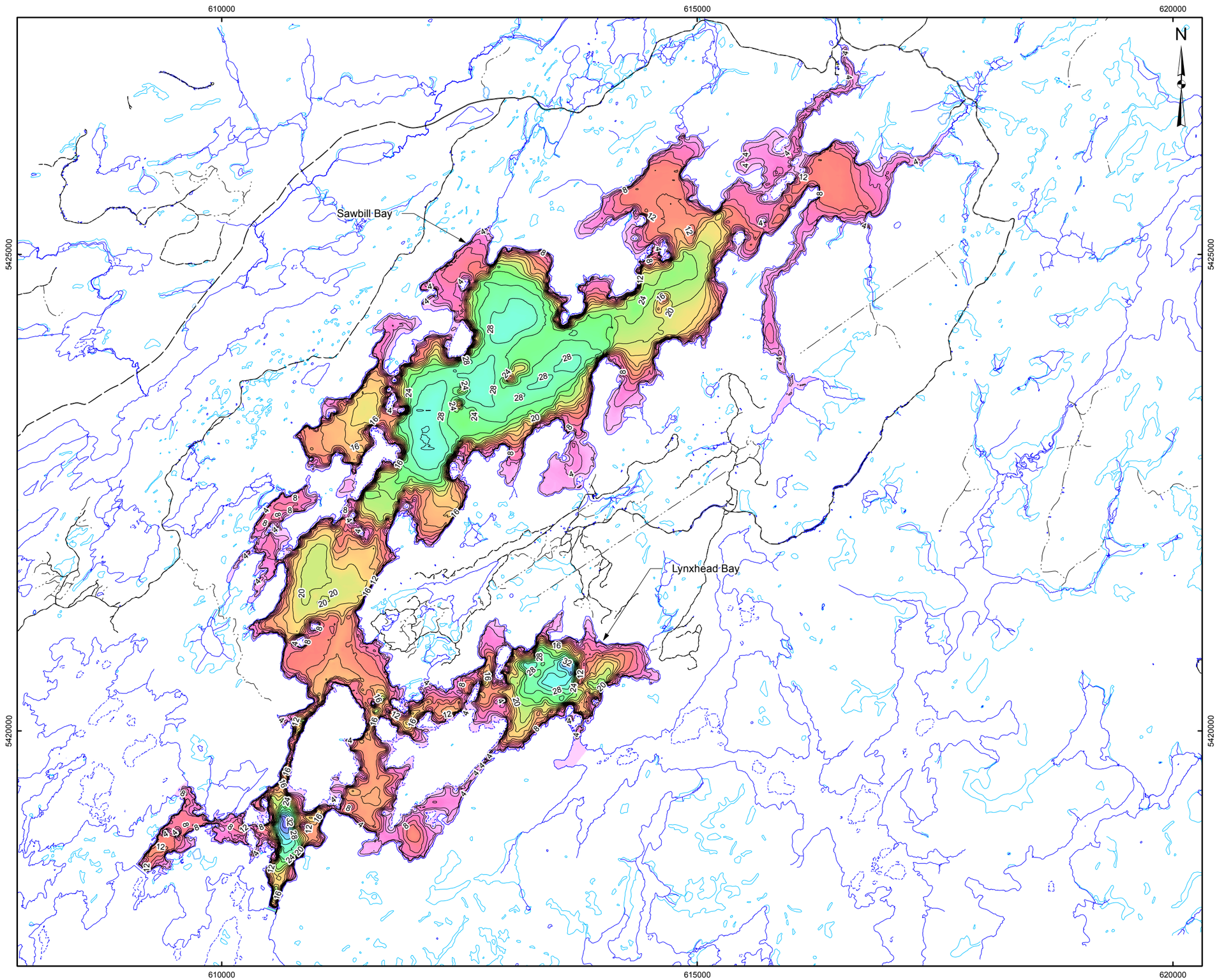
Photo 7: Steep shoreline in lower Sawbill Bay near end of Hammond Reef peninsula

Photo 8: Lynxhead Bay shoreline near end of Hammond Reef peninsula

SAWBILL / LYNXHEAD BAY OVERVIEW

Photo 9: Lynxhead Bay shoreline near Trap Bay

Photo 10: Trap Bay shoreline



LEGEND

- Lake Bottom Contours - 2 m interval
- Dirt Road - Double
- Dirt Road - Single
- Trail
- River/Stream
- Lake
- Wetland/Swamp

Depth of Lake Bottom (metres)

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38

NOTES:

1. Water level/Shoreline elevation used for Marmion Lake was 415.18 m (please refer to Table 1, Lake Level Elevation Data).
2. The contours were derived from a 20 metre cell size for the grid files. Minor contour errors exist at the shorelines where departures are at the scale of the grid dimension.

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010)
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000
SCALE 1:40,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

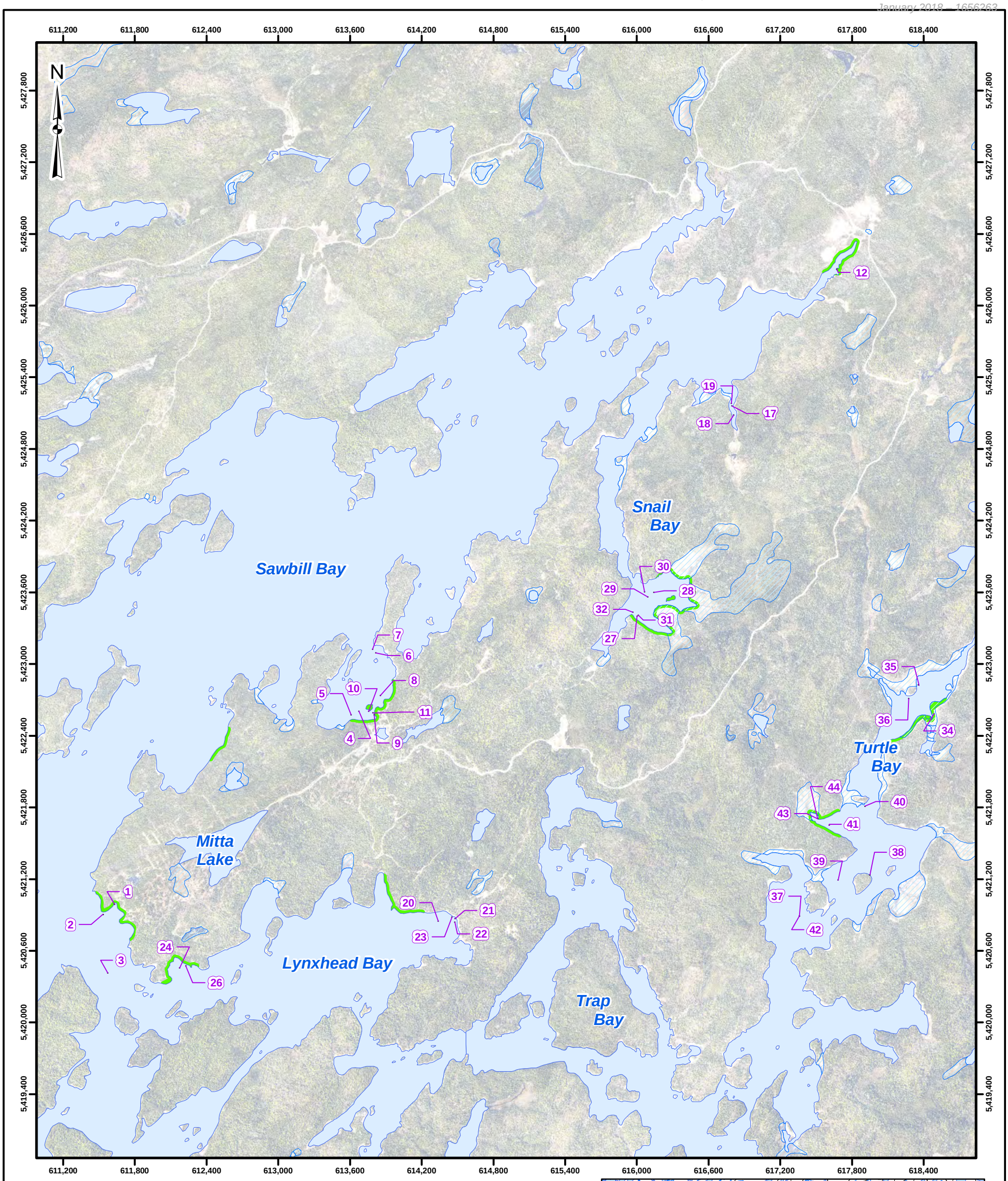
TITLE
CONTOURED DEPTH OF LAKE BOTTOM
SAWBILL BAY AND LYNXHEAD BAY

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 0.0
DESIGN	CGE	14 Nov. 2008		
GIS	CGE	7 Mar. 2012		
CHECK	MMW	7 Mar. 2012		
REVIEW	SP	7 Mar. 2012		

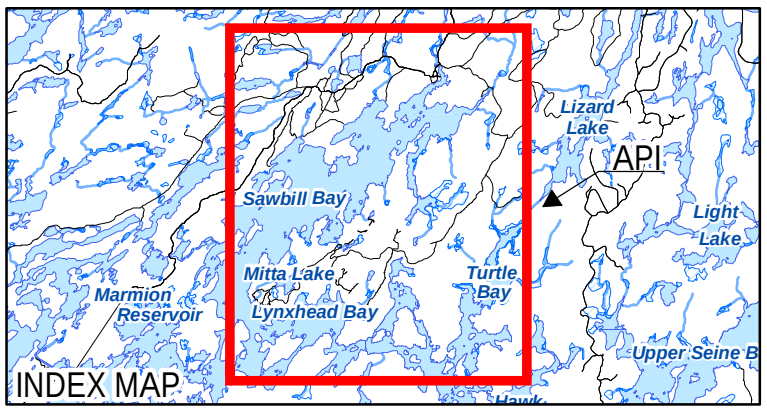
FIGURE: 1

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\FinalBathymetryMarch2012\Sawbill_LynxheadLakeBathymetry.mxd



1,300 0 1,300

SCALE 1:32,149 METRES



LEGEND

- # Fish Effort Location
- Shoreline Habitat Mapping

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

Sawbill Bay/Lynxhead Bay (Fish Community Assessment)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 1
DESIGN	AL	May 2012		
GIS	AL	May 2012		
CHECK	- -	May 2012		
REVIEW	- -	- / - / -		

FIGURE: 2

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\API_May_2012\Sawbill_Lynxhead_Bay.mxd

615000

620000

5420000

5415000

N

Turtle Bay

Trap Bay

Flood Bay

Hawk Bay

LEGEND

- Lake Bottom Contours - 5 m interval
- Lake Bottom Contours - 1 m interval
- Dirt Road - Double
- Dirt Road - Single
- Trail
- River/Stream
- Lake
- Wetland/Swamp

Depth of Lake Bottom (metres)

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38

NOTES:

1. Water level/Shoreline elevation used for Trap Bay was 415.18 m (please refer to Table 1, Lake Level Elevation Data).
2. Water level/Shoreline elevation used for Turtle Bay was 415.18 m (please refer to Table 1, Lake Level Elevation Data).
3. Water level/Shoreline elevation used for Flood Bay was 415.18 m (please refer to Table 1, Lake Level Elevation Data).
4. Water level/Shoreline elevation used for Hawk Bay was 415.18 m (please refer to Table 1, Lake Level Elevation Data).
5. The contours were derived from a 20 metre cell size for the grid files. Minor contour errors exist at the shorelines where departures are at the scale of the grid dimension.

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010)
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000
SCALE 1:35,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
CONTOURED DEPTH OF LAKE BOTTOM
TRAP BAY TO HAWK BAY
(TRAP, TURTLE, FLOOD AND HAWK BAYS)

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 0.0
DESIGN	CGE	14 Nov. 2008		
GIS	CGE	7 Mar. 2012		
CHECK	MMW	7 Mar. 2012		
REVIEW	SP	7 Mar. 2012		

FIGURE: 3

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\FinalBathymetry\March2012\TrapBay_HawkBayBathymetry.mxd

AQUATIC ENVIRONMENT TSD
VERSION 1

STREAM CROSSING FACTSHEETS

February 2013
Project No. 10-1118-0020
Hammond Reef Gold Project

API #20

The stream was mapped in August 2010. The stream consists of a defined channel extending approximately 70 m from an unnamed pond to the west to Sawbill Bay (Figure 20). The stream generally flows east-southeast. The road bisects the channel approximately 50 m downstream from the unnamed pond. The stream passes through a large (approximately 6 foot diameter) steel culvert under the roadway. All reaches of the stream are located in and drain coniferous forest.

The upper most reach of the stream is flat with low gradient and flow. The dominate substrate type is silt with boulders subdominating. Downstream of this reach the stream turn to a rapid, high velocity reach with boulder and cobble substrate. The remaining downstream portion of the stream that was mapped in August 2010 is low quality run habitat with boulder substrate dominating. The most significant physical feature of API#20 is a rocky cascade located to the east of the road crossing.

The channel width along the mapped reaches varies between 30 m at the upstream low gradient/flow reach (FL) to 7.5 m at R3. The maximum depth observed within the transect completed within the stream (with the exception of the FL reach) at the time of the mapping was 0.9 m at RA(1).

Aquatic vegetation within the stream was limited to 15% cover within the upper most reach mapped. No other portions of the stream contained aquatic vegetation. In August 2010, the discharge was calculated to be 1.13 m^3/s. Table 1 summarizes basic water chemistry data collected in the unnamed water body at the origin of the stream.

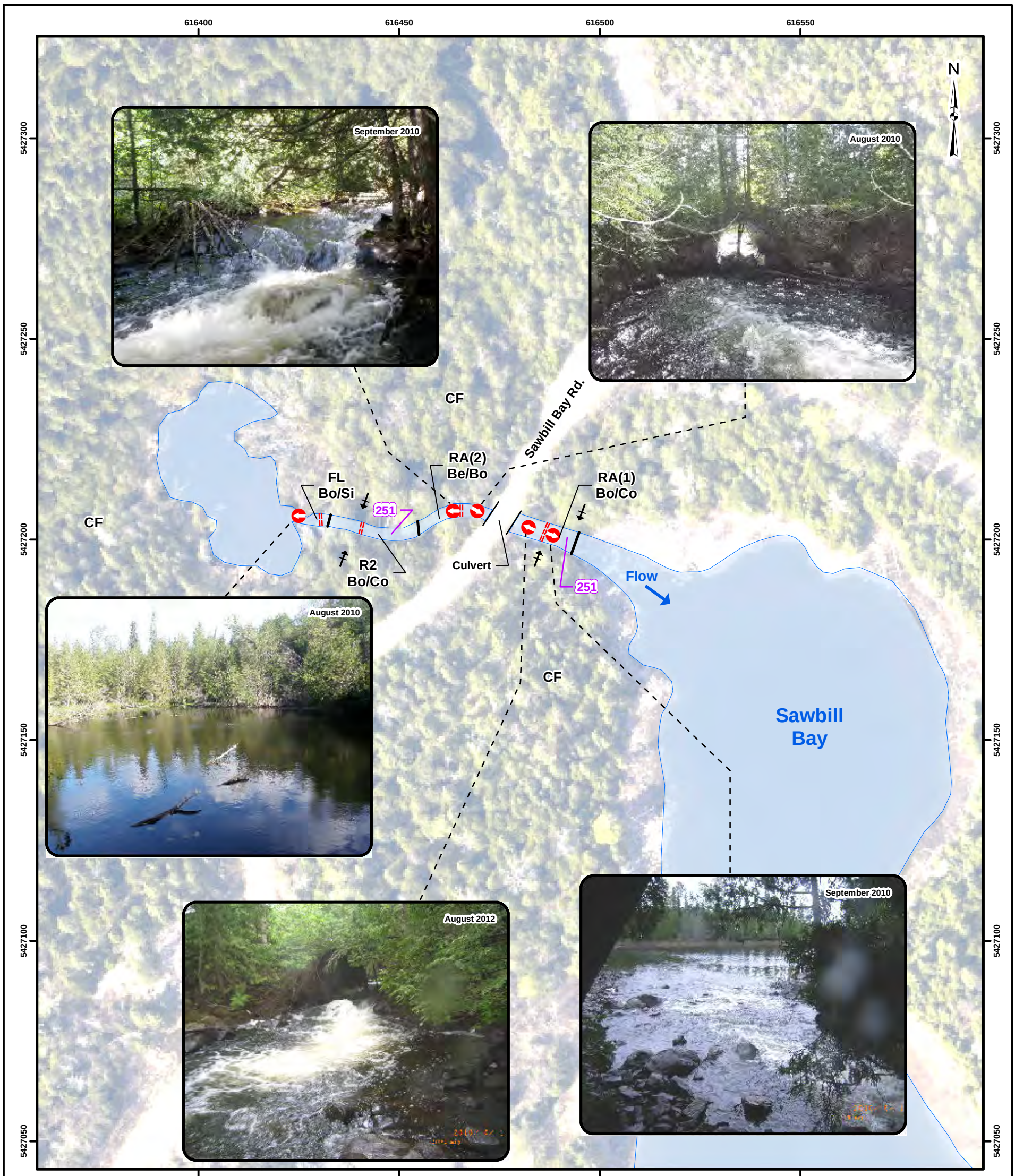
Table 1: API #20 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2010	18	61.63	6.70	41	7.13

Station 251, downstream of the road crossing, was electroshocked in August 2010 for a distance of 100 m (520 seconds). The most abundant species caught was the central mud minnow. Table 2 summarizes fish catches.

Table 2: API #20, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
251	August 5, 2010	backpack electrofisher	100 m (520s)	Central Mudminnow (9) White Sucker (1) Burbot (1)



Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
RA(1)	14	7.5	0.9	Bo	Co	0
RA(2)	20	8.79	0.75	Bo	Be	0
R2	25	11.75	0.85	Bo	Co	0
FL	5	30	-	Si	Bo	15

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)

Substrate Classification
- Si -Silt (0.06mm)
- Co -Cobble (64-256mm)
- Bo -Boulder (>256mm)
- Be -Bedrock

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass / Forbes

Channel Unit Type
- FL - Flat, Low Gradient, Low Velocity
- R3 - Lowest Quality Run Habitat
- RA - Rapid; High Velocity; Substrate Extremely Coarse

Bank Slope
- ← Shallow Slope (0 to 5%)
- ⇤ Steep Slope (31 to 70%)
- ⇠ Intermediate Slope (6 to 30%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 20

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 20	
GIS	AL	July 2012		
CHECK	JD	July 2012		
REVIEW	JS	July 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Working\API_20.mxd

API #21

The stream was mapped in August 2010. The stream consists of a defined channel extending approximately 120 m between two unnamed waterbodies (north and south) (Figure 21). The stream generally flows south from the northern most waterbody. The road bisects the channel approximately 45 m downstream of its origin in the north. The upper reaches, north of the road, are located in and drain coniferous forest. Downstream of road the stream drains coniferous forest to the west and low lying grass/forb area to the east. There are two beaver dams within the upper reaches of the stream. The upper most beaver damn is active and is 2.0 m in height while the downstream dam is inactive is 0.6 m in height. The active beaver dam is a barrier to fish movement.

North of the upper most beaver dam is an impoundment area. Substrate within this reach is predominantly silt. Downstream of this reach (between the upper and lower beaver dams) is a flat, low gradient, low flow reach. The substrate within this reach is also silt. Downstream of the second beaver damn the stream turns to lowest quality run habitat with bedrock and boulder substrate. The reach immediately before the road is low gradient and flow with silt substrate dominating. South of the road there is another run habitat reach with boulder and cobble substrate. This reach is approximately 31 m long and turns to a low flow and gradient reach with silt substrate downstream. The channel width along the mapped reaches varies between 1.48 m at the downstream low gradient/flow reach (FL(1)) to 6.52 m at FL(2). Within the impoundment reach the stream is 45 m wide. The maximum depth observed within the transect completed within the stream (with the exception of the impoundment) at the time of the mapping was 0.18 m at FL(3).

Aquatic vegetation within the stream was limited to 5% cover within the two lower reaches mapped and 15% and 20% cover in the upstream FL and impoundment reaches, respectively. In August 2010, the discharge was calculated to be 0.004 m^3/s. Table 1 summarizes basic water chemistry data collected in the unnamed water body at the origin of the stream.

Table 1: API #21 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2010	20	21.37	7.23	82	5.70

API #21

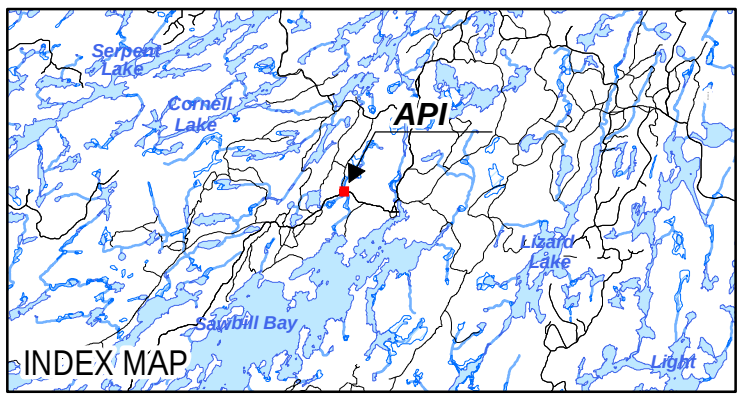
Station 350, downstream of the road crossing, was electroshocked in August 2010 for a total of 693 seconds (approximately 11.5 minutes). The most abundant species caught was the finescale dace. Table 2 summarizes fish catches.

Table 2: API #21, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
350	August 4, 2010	backpack electrofisher	693 seconds	Finescale Dace (115) Northern Redbelly Dace (15) Iowa Darter (19)

\\golder.gds\gal\mississauga\active\2010\1118\10-1118-0020 brett resources-hammond reef\005 environmental\1000 seia report\01 tsds\aquatic environment tsd\04 appendices\app 2.ii aquatic baseline\stream crossings\api 21.docx

Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	19	1.48	0.15	Si	-	5
R3(1)	31	1.72	0.06	Bo	Co	5
FL(2)	6	6.52	-	Si	-	0
R3(2)	15	1.61	0.08	Be	Bo	0
FL(3)	18	3.87	0.18	Si	Bo	15
IP2	10	45	-	Si	-	20



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Riparian Vegetation
CF - Coniferous Forest
GF - Grass / Forbes

Bank Slope
Shallow Slope (0 to 5%)
Steep Slope (31 to 70%)
Intermediate Slope (6 to 30%)

Bank Features
Be -Bedrock

Substrate Classification
Si -Silt (0.06mm)
Co -Cobble (64-256mm)
Bo -Boulder (>256mm)

Channel Unit Type
FL -flat, low gradient, low velocity
R3 -lowest quality run habitat
IP2 -Impoundment pool class 2

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 21

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 21	
GIS	AL	July 2012		
CHECK	JD	July 2012		
REVIEW	JS	July 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Working\API_21a.mxd

API #22

This stream consists of a defined channel extending approximately 100 m upstream of its origin in the unnamed waterbody to the west (Figure 22). The upper reaches, west of the road, are located in and drain coniferous forest. The uppermost reach is flat, with low gradient and flow. Downstream of this reach there is a 45 m stretch of lowest quality run habitat. The reach east of the road is located in and drains a low lying grass/forb area. This stream flows generally north/northeast and is segregated from any other channel in the area. Channel widths ranged between 3.25 m and 1.28 m at the transects and depths are less than 0.5 m along the entire length Within the low flow reached, the substrate is silt with some boulders (most downstream reach only). The run habitat substrate consists of cobble with boulder.

The stream is bisected by the road 22 m from the mouth. On either side of the road, due to a blocked/infilled culvert, the channel widens/pools to approximately 15 m in an easterly direction. The channel is very low gradient with a low to no flow. The upstream 25 m of the stream channel was dry at the time of the assessments. Approximately 40% coverage of aquatic vegetation exists in the downstream segment of the stream. In August 2010, the discharge was calculated to be 0.001 m^3/s. Table 1 summarizes basic water chemistry data collected in the unnamed water body at the mouth of the stream.

Table 1: API #23 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2010	20	22.17	7.05	82	6.81
June 2011	18.5	18.5	7.58	68	9.88

A total of 139 hours of netting and 60 minnow trap hours were completed between August 2010 and June 2011 within the pond at the mouth of the stream. Table 2 summarizes fish catches. The most abundant species were finescale dace and fathead minnow.

Table 2: API #22, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
613696 m E 5426523 m N	August 4-6, 2010	minnow trap (2)	78.5 trap hrs.	Finescale Dace (147) Northern Redbelly Dace (22)
258	June 4-5, 2011	nordic net	19 hours	Finescale Dace (1) White Sucker (34) Pearl Dace (14) Fathead Minnow (11)

DRAFT

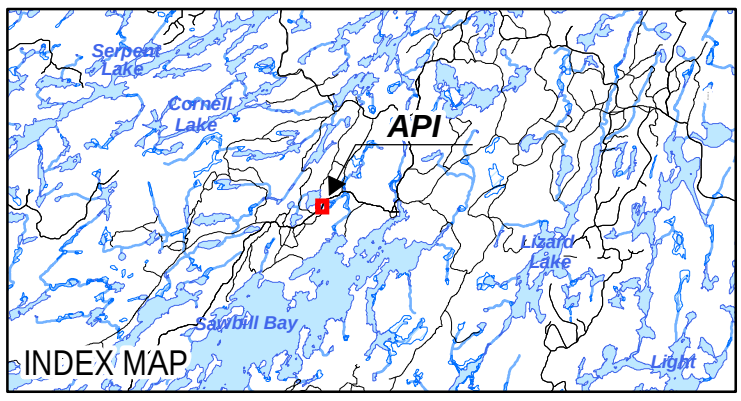
API #22

Table 2: API #22, Fish Community Assessment (Effort, Gear and Catch Summaries) (Continued)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
259	June 4-5, 2011	nordic net	21.5 hours	Finescale Dace (1) White Sucker (24) Pearl Dace (6) Fathead Minnow (8)
260	June 4-5, 2011	gill net-experimental mesh	20 hours	White Sucker (13)
261	June 4-5, 2011	minnow traps (3)	60 trap hrs.	Finescale Dace (147) Fathead Minnow (71)

\\golder.gds\gal\mississauga\active\2010\1118\10-1118-0020 brett resources-hammond reef\005 environmental\1000 seia report\01 tsds\aquatic environment tsd\04 appendices\app 2.ii aquatic baseline\stream crossings\api 22.docx

Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	50	3.25	0.5	Si	-	75
R3	45	1.28	0.04	Co	Bo	0
FL(2)	5	3.14	0.22	Si	Bo	20



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)

Substrate Classification
- Si -Silt (0.06mm)
- Co -Cobble (64-256mm)
- Bo -Boulder (>256mm)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass / Forbes

Channel Unit Type
- FL - Flat, Low Gradient, Low Velocity
- R3 - Lowest Quality Run Habitat

Bank Slope
- Shallow Slope (0 to 5%)
- Steep Slope (31 to 70%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 22

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 22	
GIS	AL	July 2012		
CHECK	JD	July 2012		
REVIEW	JS	July 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Working\API_21.mxd

API #23

This stream consists of a defined channel extending approximately 200 m upstream of its mouth in the unnamed waterbody to the north. It drains the forested (coniferous) area to the south of the water body and is segregated from any other channel in the area. Channel widths generally are less than 2.5 m and depths are less than 0.6 m along the entire length (Figure 23). Substrate consists of silt throughout the stream.

The stream is bisected by the road 22 m from the mouth. On either side of the road, due to a blocked/infilled culvert, the channel widens/pools to approximately 15 m in an easterly direction. The channel is very low gradient with a low to no flow. The upstream 25 m of the stream channel was dry at the time of the assessments. Approximately 40% coverage of aquatic vegetation exists in the downstream segment of the stream. Due to the lack of flow, discharge was not calculated. Table 1 summarizes basic water chemistry data collected in the unnamed water body at the mouth of the stream.

Table 1: API #23 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2010	22	22.60	6.45	96	3.84
June 2011	18.5	18.5	7.58	68	9.88

A total of 139 hours of netting and 60 minnow trap hours were completed between August 2010 and June 2011 within the pond at the mouth of the stream. Table 2 summarizes fish catches. The most abundant species were finescale dace and fathead minnow.

Table 2: API #23, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
613696 m E 5426523 m N	August 4-6, 2010	minnow trap (2)	78.5 trap hrs.	Finescale Dace (147) Northern Redbelly Dace (22)
258	June 4-5, 2011	nordic net	19 hours	Finescale Dace (1) White Sucker (34) Pearl Dace (14) Fathead Minnow (11)
259	June 4-5, 2011	nordic net	21.5 hours	Finescale Dace (1) White Sucker (24) Pearl Dace (6) Fathead Minnow (8)

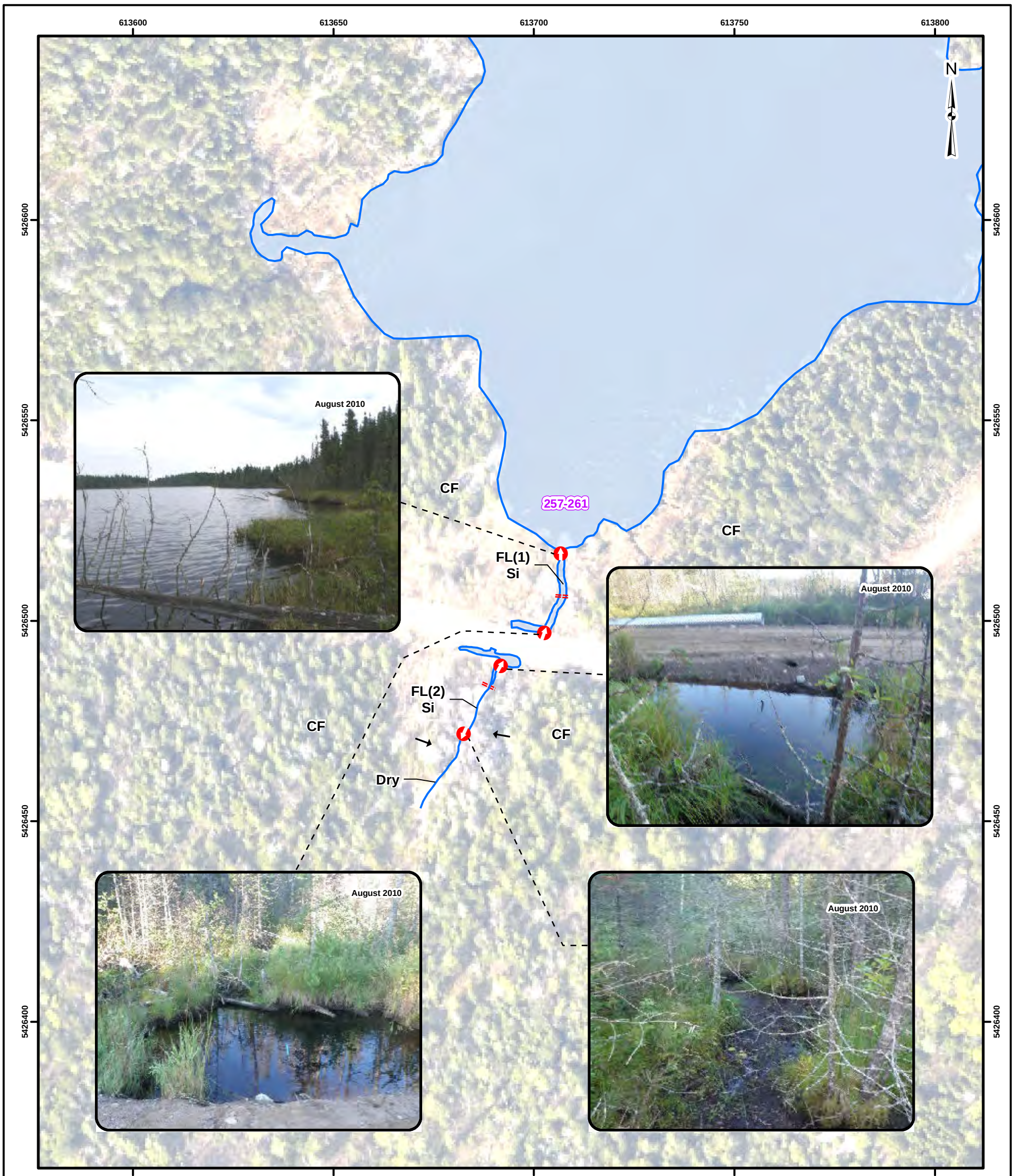
DRAFT

API #23

Table 2: API #23, Fish Community Assessment (Effort, Gear and Catch Summaries) (Continued)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
260	June 4-5, 2011	gill net-experimental mesh	20 hours	White Sucker (13)
261	June 4-5, 2011	minnow traps (3)	60 trap hrs.	Finescale Dace (147) Fathead Minnow (71)

\\golder.gds\gal\mississauga\active\2010\1118\10-1118-0020 brett resources-hammond reef\005 environmental\1000 seia report\01 tsds\aquatic environment tsd\04 appendices\app 2.ii aquatic baseline\stream crossings\api 23.docx



Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	22	2.2	0.56	Si	-	40
FL(2)	50	1.63	0.04	Si	-	0

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)

Substrate Classification
Si -Silt (0.06mm)
Co -Cobble (64-256mm)
Bo -Boulder (>256mm)

Bank Slope
Shallow Slope (0 to 5%)
Steep Slope (31 to 70%)

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
R3 - Lowest Quality Run Habitat

Riparian Vegetation
CF - Coniferous Forest
GF - Grass / Forbes

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 23

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 23	
GIS	AL	July 2012		
CHECK	JD	July 2012		
REVIEW	JS	July 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Working\API_23.mxd

API #63

The stream was mapped in May 2011. The stream consists of a defined channel extending approximately 300 m from Sawbill Road to Finlayson Lake. The mapped segment of stream extends approximately 110 m north of the road and 100 m south of the road (Figure 63). The stream generally flows south. At the road the stream passes through two, 1.5 m diameter steel culverts placed approximately 1.5 m apart. Within the upper and lower reaches, the stream is located in and drains grass/forb areas with some coniferous forests to the east.

The upper most reach of the stream, north of the road, is low quality run habitat. The dominate substrate type is gravel with silt/clay subdominating. Within the reach there are small islands and exposed gravel and cobble areas. South of the road the stream continues as low quality run habitat transitioning with sanding substrate to a high velocity/gradient riffle zone approximately 15 m south of the road. This riffle zone consists of cobble with some boulders. Downstream of the riffle zone the stream becomes a high quality run habitat with sandy substrate for approximately 7 m. Following this reach, the stream returns to a low quality run habitat with gravel substrate dominating. Within the lower reaches small islands are present mid channel. The most significant physical feature of API #63 is the high quality riffle zone south of the road.

The channel width along the mapped reaches varies between 2.8 m at the downstream reach to 13.8 m within the riffle zone. The maximum depth observed within the transects completed within the stream at the time of the mapping was 0.98 m within the riffle zone.

Aquatic vegetation within the stream was limited to 5% cover within the lower R3 reach mapped. No other portions of the stream contained aquatic vegetation. In May 2011, the discharge was calculated to be 0.27 m^3/s. Table 1 summarizes basic water chemistry data collected in the unnamed water body at the origin of the stream.

Table 1: API #63 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2011	19	9.56	7.0	36	11.42

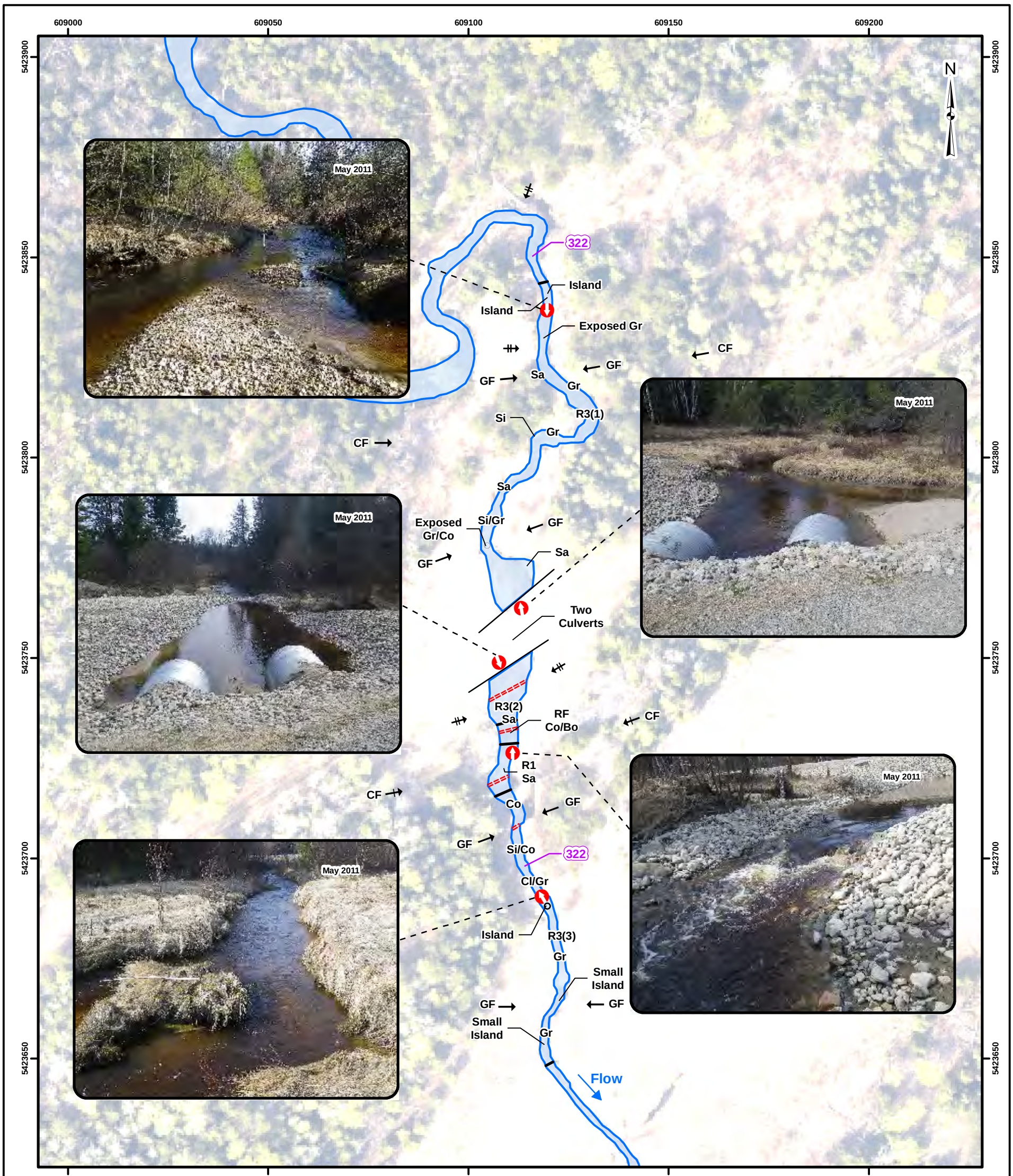
API #63

Station 322, downstream of the road crossing, was electroshocked in May 2011 for a distance of 200 m (2,302 seconds). The most abundant species caught was the white sucker. Table 2 summarizes fish catches.

Table 2: API #63, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
322	May 6, 2011	backpack electrofisher	200 m (2,302s)	White Sucker (7) Finescale Dace (5) Iowa Darter (1)

\\golder.gds\gal\mississauga\active\2010\1118\10-1118-0020 brett resources-hammond reef\005 environmental\1000 seia report\01 tsds\aquatic environment tsd\04 appendices\app 2.ii aquatic baseline\stream crossings\api 63.docx



Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
R3(1)	109	4.5	0.5	Gr	Si(Clay)	0
R3(2)	15	7.35	0.53	Sa	Co	0
RF	5	4	0.32	Co	Bo	0
R1	7	13.8	0.98	Sa	-	0
R3(3)	73	2.8	0.26	Gr	Si(Clay)	5

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects

Substrate Classification
- Si -Clay/Silt (0.06mm)
- Co -Cobble (64-256mm)
- Bo -Boulder (>256mm)
- Gr -Gravel (2064 mm)
- Sa -Sand (0.006-2 mm)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass / Forbes

Channel Unit Type
- FL - Flat, Low Gradient, Low Velocity
- R1 - Highest Quality Run Habitat >1.0m
- R3 - Lowest Quality Run Habitat
- RF - Riffle, High Velocity/Gradient Relative to Habitat

Bank Slope
- Shallow Slope (0 to 5%)
- Steep Slope (31 to 70%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 63

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 63	
GIS	AL	July 2012		
CHECK	JD	July 2012		
REVIEW	JS	July 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Working\API_63.mxd

API #64

The stream and associated pond and lake near the vicinity of API #64 were mapped in May 2011. The stream consists of a very narrow channel extending approximately 10 m from an unnamed pond at which point the water percolates through a cattail marsh to Finlayson Lake (Figure 64). The pond drains immediately under Sawbill Road through a 1.5 m diameter steel culvert. The unnamed pond drains mixed forest. The stream is located in and drains grass/forb areas to the west and east.

The stream south of the road crossing is riffle. The dominant substrate type is cobble with gravel subdominating. The channel is 0.8 m wide with a maximum depth of 0.4 m. Aquatic vegetation covers approximately 5% of the channel.

In May 2011, the discharge was calculated to be 0.008 m^3/s. Table 1 summarizes basic water chemistry data collected in the unnamed water body at the origin of the stream.

Table 1: API #64, Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2011 (stream)	18	14.2	7.48	119	11.24
May 2011 (fish effort location 324-326)	8	5.81	7.00	54	11.78
May 2011 (fish effort location 323, 327-328)	8	10.98	7.00	113	10.36

The stream portions of API #64 were not sampled for fish community composition. The unnamed pond was sampled for 146 hours using minnow traps and 47.5 hours using nets. Finlayson Lake was sampled for 120 hours using minnow trap and 28.5 hours using nets. The most abundant species caught in the unnamed pond was the finescale dace. The most abundant species caught in Finlayson Lake near API#64 was northern pike. Table 2 summarizes fish catches.

Table 2: API #64, Fish Community Assessment (Effort, Gear and Catch Summaries)

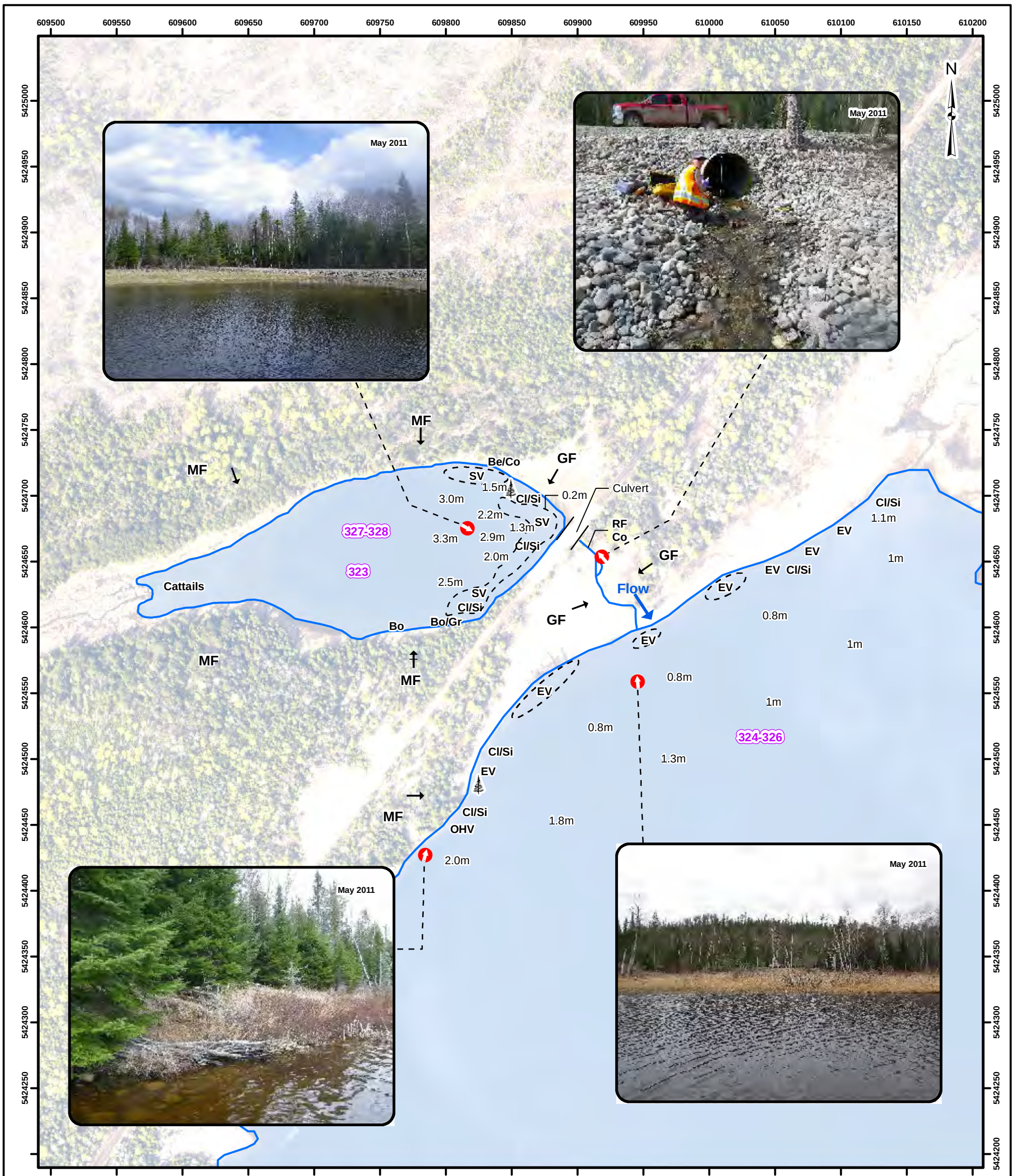
Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
323	May 6-7, 2011	minnow traps (6)	147 trap hrs.	Finescale Dace (23) Fathead Minnow (6)
324	May 6-7, 2011	minnow traps (6)	120 trap hrs.	No catch
325	May 6-7, 2011	nordic net	17.5 hrs.	Northern Pike (5) Lake Whitefish (2)

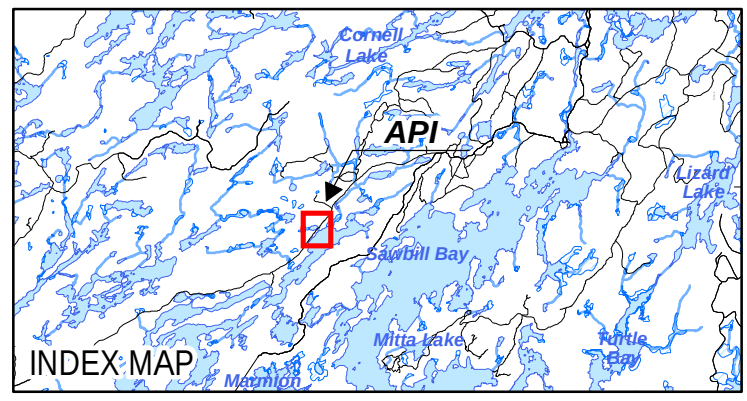
API #64

Table 2: API #64, Fish Community Assessment (Effort, Gear and Catch Summaries) (Continued)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
				White Sucker (3) Yellow Perch (1)
326	May 6-7, 2011	gillnet – experimental mesh	21 hrs.	Northern Pike (11) Lake Whitefish (7) White Sucker (1)
327	May 6-7, 2011	nordic net	24.5 hrs	Fathead Minnow (1) Finescale Dace (1)
328	May 6-7, 2011	gillnet – experimental mesh	23 hrs.	No catch

\\golder.gds\gal\mississauga\active\2010\1118\10-1118-0020 brett resources-hammond reef\005 environmental\1000 seia report\01 tsds\aquatic environment tsd\04 appendices\app 2.ii aquatic baseline\stream crossings\api 64.docx





Segment	Length (m)	Channel Width Transect (m)	Max. Depth a transect (m)	Substrate		In stream
				Dominant	Sub-dominant	Vegetation
RF	10	0.8	0.04	Co	Gr	5

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- OHV Overhanging Vegetation

Riparian Vegetation
- MF - Mixed Forest
- GF - Grass / Forbes

Bank Slope
- Shallow Slope (0 to 5%)
- Steep Slope (31 to 70%)
- Intermediate Slope (6 to 30%)

Channel Unit Type
- RF - Riffle, High Velocity/Gradient Relative to habitat

Substrate Classification
- Si -Clay/Silt (0.06mm)
- Co -Cobble (64-256mm)
- Bo -Boulder (>256mm)

Inundated Vegetation
- SV - Submergent Vegetation
- EV - Emergent Vegetation

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 64

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 64	
GIS	AL	July 2012		
CHECK	JD	July 2012		
REVIEW	JS	July 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Working\API_64.mxd

API #65

The stream of API #65 was mapped in May 2011. The stream consists of a defined narrow channel that flows generally south to a tributary of Detach Lake (Figure 65). The stream is located in and drains coniferous forest thorough length. Sawbill Road crosses the stream approximately 170 m north of the Detach Lake tributary. At the road, the stream passes through two, 1.35 m diameter steel culverts.

The mapped portion of the stream north of the road crossing is low quality run habitat (R3(1)). The dominate substrate is gravel with sand subdominating. Immediately south of the road, the stream becomes flat with low velocity and gradient for approximately 4 m. The substrate within this reach is dominated by sand with some gravel present. Downstream of this reach is a 5 m riffle zone with high velocity and gradient. The dominant substrate is cobble with some gravel present. Following the riffle zone the channel returns to low quality run with cobble as the dominate substrate type and gravel as the subdominant substrate type. This reach extends for 11 m at which point another riffle zone exists with cobble and gravel substrate. The last reach mapped extended 42 m and was characterised by low quality run habitat with gravel substrate and sand.

The maximum channel width observed at any transect was 4.5 m (FL). The maximum depth at any transect was 0.46 m (FL). No aquatic vegetation existed within any portion of the stream that was mapped. Throughout the mapped reaches there are a number of areas of woody debris within the channel.

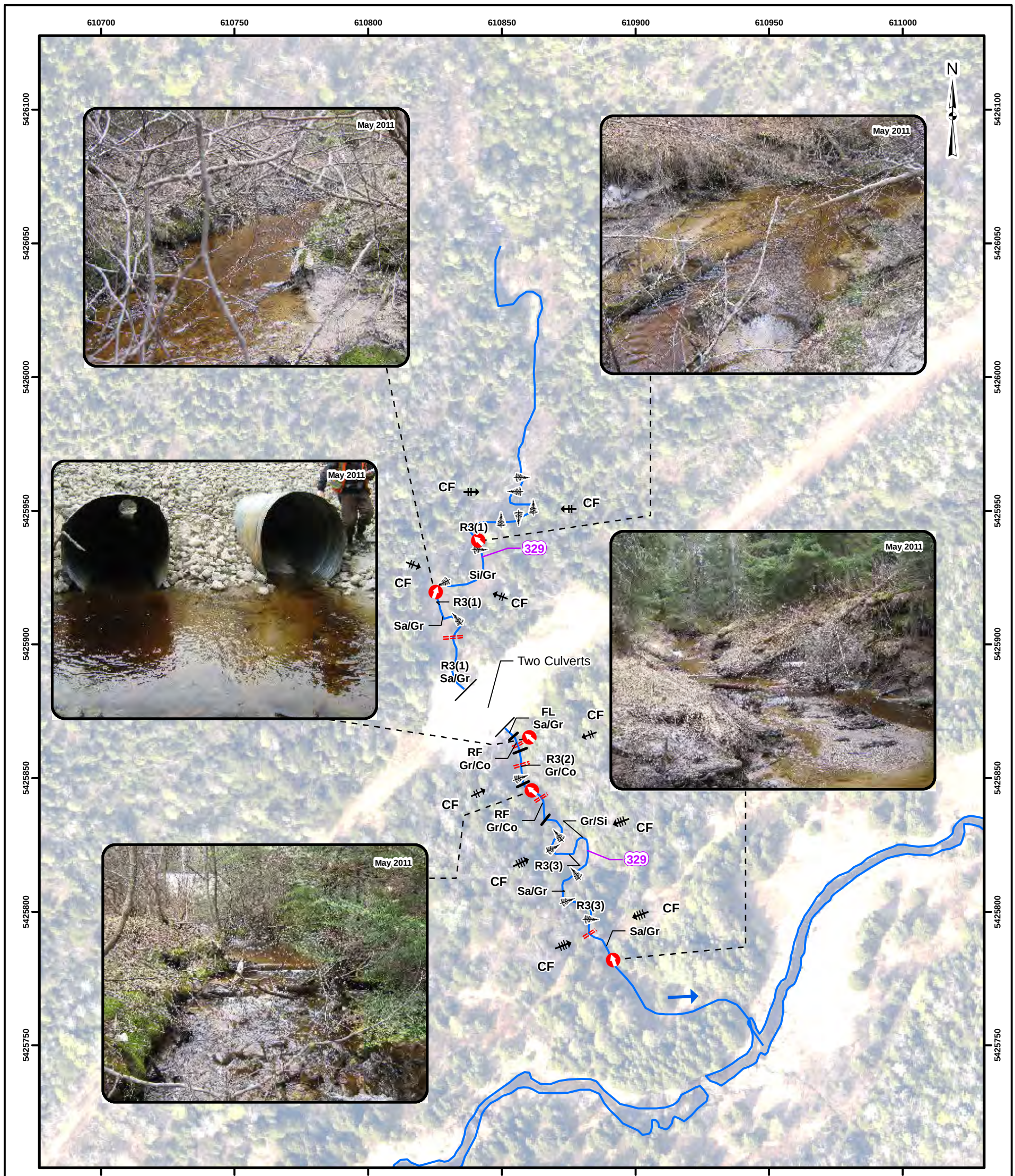
In May 2011, the discharge was calculated to be 0.064 m^3/s.

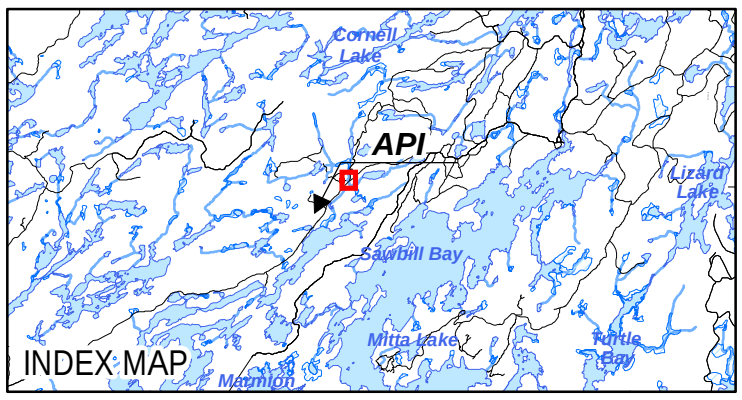
API #65 was electroshocked for 1,030 seconds (~17 min). Only two individual fish were caught, longnose dace and white sucker. Table 1 summarizes fish catches.

Table 1: API #65, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
329	May 12, 2011	backpack electrofisher	1030 seconds	Longnose Dace (1) White Sucker (1)

\\golder.gds\gal\mississauga\active\2010\1118\10-1118-0020 brett resources-hammond reef\005 environmental\1000 seia report\01 tsds\aquatic environment tsd\04 appendices\app 2.ii aquatic baseline\stream crossings\api 65.docx





Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
R3(1)	106	2.5	0.24	Gr	Sa	0
FL	4	4.5	0.46	Sa	Gr	0
RF	5	1.25	0.12	Co	Gr	0
R3(2)	11	2.1	0.24	Co	Gr	0
RF	15	2.3	-	Co	Gr	0
R3(3)	42	4.1	-	Gr	Sa	0

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass / Forbes

Substrate Classification
- Si -Silt (0.06mm)
- Co -Cobble (64-256mm)
- Bo -Boulder (>256mm)
- Gr -Gravel (2064mm)

Channel Unit Type
- FL - Flat, Low Gradient, Low Velocity
- R3 - Lowest Quality Run Habitat
- RF - Riffle, HighVelocity/Gradient Relative to habitat

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)
- Steep Slope (31 to 70%)
- Very Steep Slope (>70%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 65

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 65	
GIS	AL	July 2012		
CHECK	JD	July 2012		
REVIEW	JS	July 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Working\API_65.mxd

API #66

The stream was mapped in May 2011. The stream consists of a defined channel that acts as a tributary to Detach Lake. The mapped segment of stream extends approximately 110 m north of the road and 100 m south of the road (Figure 66). The stream generally flows south. At the road the stream passes through one, 1.5 m diameter steel culvert. Within the upper and lower reaches, the stream is located in and drains mixed forest.

The upper most reach of the stream mapped, north of the road, is moderate quality run habitat. The dominate substrate type is gravel with sand sub-dominating. Downstream of this reach is a cascade with bedrock substrate. Immediately north of the road the channel widens to become rapids with cobble substrate dominating and sand present. The reach immediately south of the road is a low quality pool habitat not suitable for overwintering. The dominant substrate type is sand with gravel sub-dominating. Downstream of the pool is a 20 m riffle zone with gravel and cobble substrate. Another pool is located immediately downstream of the riffle zone that contains sand and gravel substrate. The stream continues as low quality run habitat with gravel and cobble substrate for 37 m. Downstream of R3(1) the stream enters another riffle zone with high velocity and gradient and gravel/cobble substrate and then continues to a low quality run habitat reach.

The channel width along the mapped reaches varies between 4.3 m at the upstream reach (R2) to 11.1 m within pool reach P3(1). The maximum depth observed within the transects completed within the stream at the time of the mapping was 1.06 m within pool reach P3(2).

There is no aquatic vegetation within the stream within any portion mapped. In May 2011, the discharge was calculated to be 0.917 m^3/s. Table 1 summarizes basic water chemistry data collected in the unnamed water body at the origin of the stream.

Table 1: API #66, Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2011	4	4.40	6.02	27	12.69

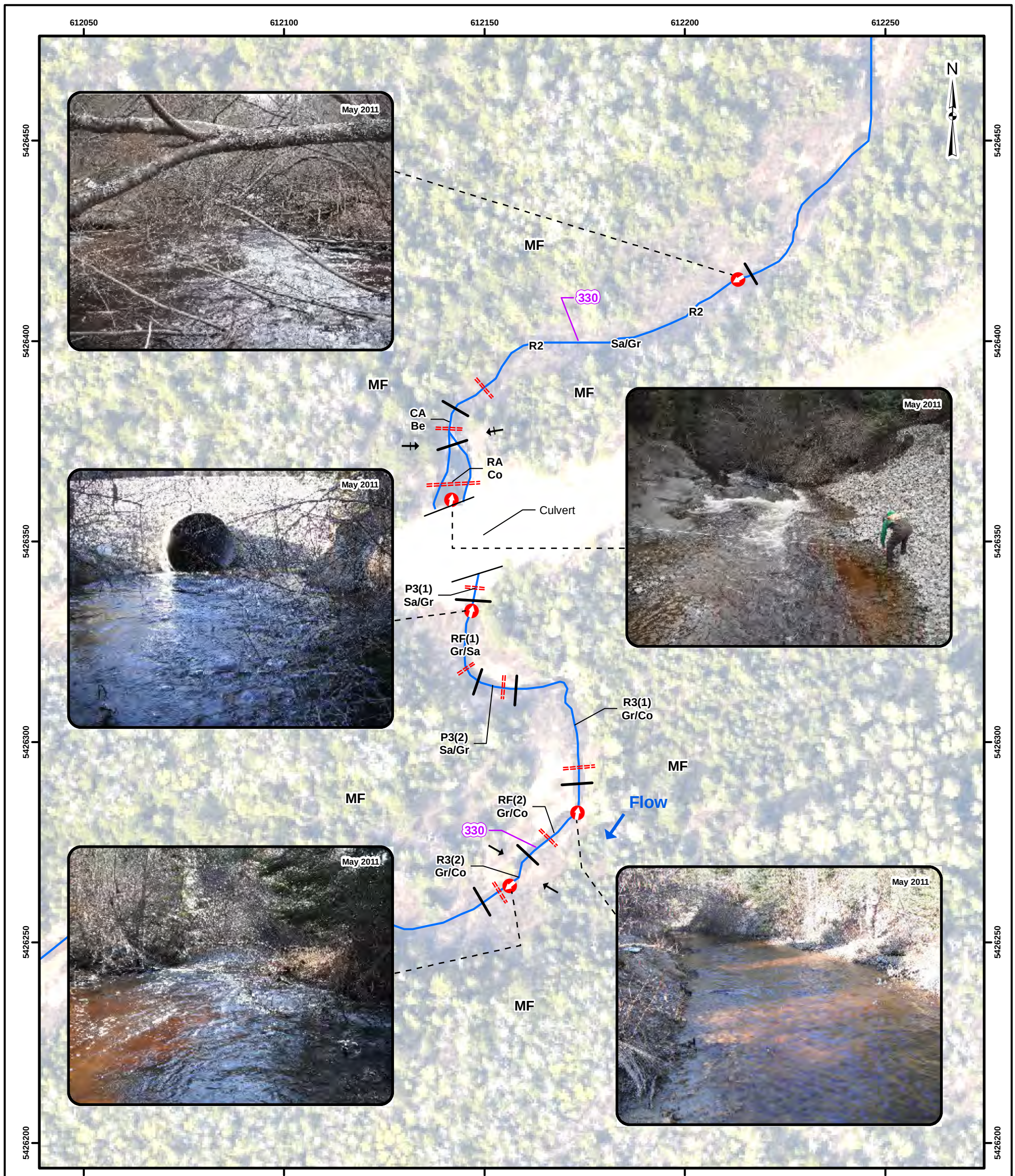
API #66

API #66 was electroshocked for a total of 300 m or 1,419 sec in May 2011. The most abundant species caught was longnose dace. Table 2 summarizes fish catches.

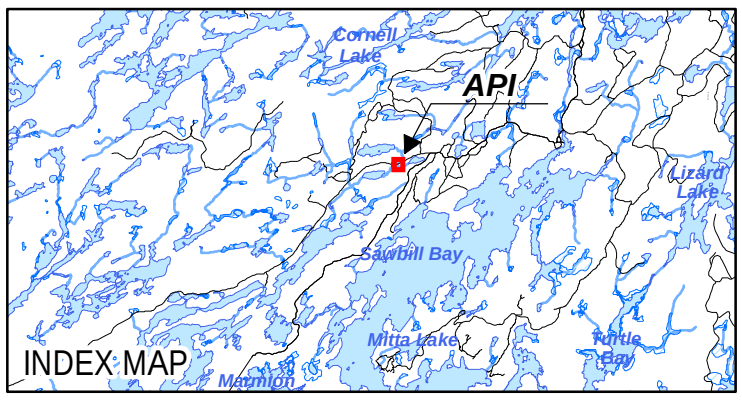
Table 2: API #66, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
330	2 May, 2011	backpack electrofisher	300 m (1419s)	Northern Pike (2) Longnose Dace (5) White Sucker (2) Dace sp. (1)

\\golder.gds\gal\mississauga\active\2010\1118\10-1118-0020 brett resources-hammond reef\005 environmental\1000 seia report\01 tsds\aquatic environment tsd\04 appendices\app 2.ii aquatic baseline\stream crossings\api 66.docx



Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
R2	82	4.3	0.7	Gr	Sa	0
CA	7	5	-	Be	-	0
RA	11	7.35	0.36	Co	Sa	0
P3(1)	5	11.1	0.7	Sa	Gr	0
RF(1)	20	8.5	0.34	Gr	Co	0
P3(2)	8	9.35	1.06	Sa	Gr	0
R3(1)	37	9	0.44	Gr	Co	0
RF(2)	22	9.9	0.48	Gr	Sa	0
R3(2)	13	5.75	-	Gr	Co	0



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)

Riparian Vegetation
MF - Mixed Forest
GF - Grass / Forbes

Substrate Classification
Si -Silt (0.06mm)
Co -Cobble (64-256mm)
Bo -Boulder (>256mm)
Gr -Gravel (2064mm)

Channel Unit Type
CA - Cascade; Extremely High Gradient and Velocity
RA - Rapid; High Velocity; Substrate extremely coarse
R2 - Moderate Quality Run Habitat 0.75 - 1.0m
R3 - Lowest Quality Run Habitat
RF - Riffle, HighVelocity/Gradient Relative to habitat
P3 - Low Quality Pool Habitat, not suitable for overwintering

Bank Slope
Shallow Slope (0 to 5%)
Intermediate Slope (6 to 30%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 66

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 66	
GIS	AL	July 2012		
CHECK	JD	July 2012		
REVIEW	JS	July 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Working\API_66.mxd

API #67

Due to the lack of a separate defined channel, no stream mapping was conducted at API #67. This API consists of a large cascade feature that drains a small pond to the west into Finlayson Lake. The flow is in a south east direction. The small pond to the west is located in a mixed forest.

The dominate substrate type within the cascade is bedrock. There is no aquatic vegetation present however there are is woody debris within the cascade. The cascade is approximately 1 m wide and 0.1 cm deep.

Table 1 summarizes basic water chemistry data collected in the unnamed water body at the top of the cascade.

Table 1: API #67 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
September 2011	18	14.1	7.40	62	8

API #67 was sampled using broad-scale small gillnets for a total of 152.25 hours in September 2011. The most abundant species caught was the yellow perch. Table 2 summarizes fish catches.

Table 2: API #67, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
331	September 26-27, 2011	Broad-scale small mesh gillnet	25 hrs	Yellow Perch (22) Northern Pike (1)
332	September 26-27, 2011	Broad-scale large mesh gillnet	25 hrs	Northern Pike (3) White Sucker (1)
333	September 26-27, 2011	Broad-scale large mesh gillnet	25.5 hrs	Lake Whitefish (3) Northern Pike (3)
334	September 26-27, 2011	Broad-scale large mesh gillnet	25.5 hrs	Lake Whitefish (3) Northern Pike (3)
335	September 26-27, 2011	Broad-scale small mesh gillnet	25.75 hrs	Yellow Perch (12) Northern Pike (2)
336	September 26-27, 2011	Broad-scale large mesh gillnet	25.5 hrs	No catch

API #68

Due to the lack of a separate defined channel, no stream mapping was conducted at API #68. This API consists of a large cascade feature that drains a small pond to the west into Finlayson Lake (Figure 68). The flow is in a south east direction. The small pond to the west is located in mixed forest.

The dominate substrate type is bedrock. There is no aquatic vegetation present within the cascade. The cascade is approximately 1 m wide and 0.1 cm deep.

Table 1 summarizes basic water chemistry data collected in the unnamed water body at the top of the cascade.

Table 1: API #68 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
September 2011	18	14.1	7.40	62	8

API #68 was sampled using broad-scale small gillnets for a total of 126.75 hours in September 2011. The most abundant species caught was yellow perch and walleye. Table 2 summarizes fish catches.

Table 2: API #68, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
337	September 26-27, 2011	Broad-scale small mesh gillnet	18 hrs	Yellow Perch (18) Walleye (1) Lake Whitefish (1)
338	September 26-27, 2011	Broad-scale small mesh gillnet	18 hrs	Yellow Perch (17) Lake Whitefish (2)
339	September 26-27, 2011	Broad-scale large mesh gillnet	18 hrs	Lake Whitefish (1)
340	September 26-27, 2011	Broad-scale large mesh gillnet	18 hrs	Walleye (6) Smallmouth Bass (1) Lake Whitefish (1)
341	September 26-27, 2011	Broad-scale large mesh gillnet	18.25 hrs	Walleye (1)
342	September 26-27, 2011	Broad-scale large mesh gillnet	18 hrs	Lake Whitefish (4) Walleye (5) Northern Pike (1)

API #68

Table 2: API #68, Fish Community Assessment (Effort, Gear and Catch Summaries) (Continued)

343	September 26-27, 2011	Broad-scale large mesh gillnet	18.5 hrs	Walleye (9) White Sucker (1) Lake Whitefish (2) Northern Pike (1)

\\golder.gds\gal\mississauga\active\2010\1118\10-1118-0020 brett resources-hammond reef\005 environmental\1000 seia report\01 tsds\aquatic environment tsd\04 appendices\app 2.ii aquatic baseline\stream crossings\api 68.docx

AQUATIC ENVIRONMENT TSD
APPENDIX 2.II
VERSION 1

2012 UPDATES

February 2013
Project No. 10-1118-0020
Hammond Reef Gold Project

Table of Contents

API #2 (HEADWATER LAKE) **1**
API #6 (POND) **5**
API #8 (LAKE) **7**
API #10 (HEADWATER POND) **10**
API #13 (HEADWATER POND) **12**
API #16 (HEADWATER POND) **14**
API #43 (HEADWATER LAKE) **16**
API #44 (HEADWATER POND) **18**
API #47 (HEADWATER LAKE) **20**
API #47 (STREAM) **22**
API #48 (STREAM) **23**

TABLES

Table 1: API #2 (lake), Basic Water Chemistry Parameter Data 1
Table 2: API #2 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries) 2
Table 3: API #6 Fish Species List 5
Table 4: API #6 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries) 6
Table 5: API #8 (lake), Basic Water Chemistry Parameter Data 7
Table 6: API #8 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries) 8
Table 7: API #10 (pond), Basic Water Chemistry Parameter Data 10
Table 8: API #10 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries) 11
Table 9: API #13 (pond), Basic Water Chemistry Parameter Data 12
Table 10: API #13 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries) 12
Table 11: API #16 (pond), Basic Water Chemistry Parameter Data 14
Table 12: API #16 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries) 15
Table 13: API #43, Basic Water Chemistry Parameter Data 16
Table 14: API #43, Fish Community Assessment (Effort, Gear and Catch Summaries) 16
Table 15: API #44 (pond), Basic Water Chemistry Parameter Data 18
Table 16: API #44 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries) 19

Table 17: API #47 (lake), Basic Water Chemistry Parameter Data 20
Table 18: API #47 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries) 21
Table 19: API #47 (beaver impoundment), Basic Water Chemistry Parameter Data 22
Table 20: API #47 (beaver impoundment), Fish Community Assessment (Effort, Gear and Catch Summaries) 22
Table 21: API #48 (beaver impoundment), Fish Community Assessment (Effort, Gear and Catch Summaries) 23

The following updated summaries for a number of Areas of Potential Impact were prepared following the 2012 field sampling program in order to incorporate 2012 sampling results. The photographs and other references are included in the original API summaries in the body of the Baseline Report.

API #2 (HEADWATER LAKE)

API #2 has a total surface area of 122,228 m^2. The shoreline is generally steep and contained by thick coniferous forest and exposed bedrock outcrops (Figure 2-1). A narrow band of alders and grasses and aquatic vegetation rings most of the lake's perimeter. There are no shoals or islands on the lake. Side scan bathymetry mapping indicates that there is a single, 5 m deep basin on the southeast side of the lake, adjacent to a steep bedrock shoreline (Figure 2-2). The lake bottom in the littoral zone is mix of fine and coarse substrates and bedrock. Within the lake basin, substrate consists of fine sediment (Figure 2-3). The lake bottom consists of a mixture of fine and coarse substrate with interspersed boulders.

There is no inflow to the lake, and a single outflow located at the northeast corner. An active beaver lodge was documented on the lake and 0.4 m high dam is located at the outflow, at the end of a narrow, weedy bay.

A temperature-dissolved oxygen profile was completed in October 2010 and September 2012 at the deepest location in the lake (Table 1). High dissolved oxygen levels were present throughout the water column. The lake had mixed at the time the profile was completed. It is not known if the lake stratifies fully during the summer months.

Table 1: API #2 (lake), Basic Water Chemistry Parameter Data

Date/Depth (m)	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
October 2010				
Surface	10.7	6.6	43	10.6
1	10.7	6.7	43	10.2
2	10.7	6.6	43	10.2
3	10.7	6.6	43	10.2
4	10.4	6.6	43	10.0
5	10.4	6.3	44	9.6
June 2011	15.2	7.5	54	10.0
September 2012				
0	16.84	6.19	44	9.18
1	16.16	6.19	44	9.05
2	15.90	6.19	43	8.95
3	14.82	6.19	43	8.73
4	14.67	6.19	43	8.66
5	14.61	6.19	43	8.51

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

The lake was fished in 2010, 2011, and 2012 (Table 2). Six fish species were identified in the lake, including pumpkinseed, and northern pike. The forage base consists of yellow perch, Iowa darter and blacknose shiner.

Table 2: API #2 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 2-1)	Date	Gear	Effort	Catch
83	October 15-16, 2010	minnow traps (1)	23 trap hrs.	no catch
84	October 15-16, 2010	minnow traps (1)	23 trap hrs.	pumpkinseed (1 juvenile, 3 YOY)
85	October 15-16, 2010	nordic net	22 hrs.	yellow perch (1 adult, 4 juvenile) northern pike (5 adult, 3 juvenile) white sucker (2 adult, 1 juvenile)
85	October 15-16, 2010	gillnet - experimental mesh	20 hrs.	white sucker (6 adult) northern pike (8 adult, 4 juvenile)
87	May 30-31, 2011	minnow traps (5)	90 trap hrs.	no catch
88	May 30-June1, 2011	nordic net	41 hrs.	yellow perch (6 adult, 8 juvenile) northern pike (7 adult) Iowa darter (2 adult) blacknose shiner (2 adult) white sucker (1 adult, 1 juvenile)
89	May 30-June1, 2011	nordic net	40 hrs.	yellow perch (5 adult) northern pike (3 adult) white sucker (1 adult, 1 juvenile)
90	May 30-June1, 2011	gillnet - experimental mesh	41.5 hrs.	northern pike (11 adult, 5 juvenile) white sucker (2 adult, 1 juvenile)
91	May 30-June1, 2011	gillnet - experimental mesh	41.5 hrs.	northern pike (8 adult) white sucker (7 adult, 2 juvenile)

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

Table 2: API #2 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries) (Continued)

Fish Effort Location (see Figure 2-1)	Date	Gear	Effort	Catch
345	September 14-15 2012	Broad-scale large/small mesh gillnet	18.2 hrs.	Yellow Perch (3) Northern Pike (7) White Sucker (3)
346	September 14-15, 2012	Broad-scale small mesh gill net	18.5 hrs.	Northern Pike (3) Yellow Perch (6)
347	September 14-15, 2012	Broad-scale small mesh gill net	18.6 hrs.	Yellow Perch (5)
348	September 14-15, 2012	Broad-scale large/small mesh gillnet	18.6 hrs.	Northern Pike (3) Yellow Perch (5)
349	September 14-15, 2012	Broad-scale large mesh gillnet	18.9 hrs.	White Sucker (1) Northern Pike (2)
350	September 14-15, 2012	Broad-scale small mesh gill net	18.9 hrs.	Yellow Perch (8) Northern Pike (1) Pumpkinseed (1)
351	September 14-15, 2012	Broad-scale large mesh gillnet	19 hrs.	White Sucker (1) Northern Pike (4)
352	September 14-15, 2012	Broad-scale large/small mesh gillnet	19.1 hrs.	Yellow Perch (10) Northern Pike (3)
353	September 14-15, 2012	Broad-scale large mesh gillnet	19.15 hrs.	Northern Pike (4)
354	September 15-16, 2012	Broad-scale small mesh gill net	19.6 hrs.	No catch
355	September 15-16, 2012	Broad-scale small mesh gill net	19.5 hrs.	Yellow Perch (5) Northern Pike (5)
356	September 15-16, 2012	Broad-scale small mesh gill net	19.8 hrs.	Northern Pike (1) Yellow Perch (2) Pumpkinseed (1)
357	September 15-16, 2012	Broad-scale large/small mesh gillnet	17 hrs.	Yellow Perch (5) Northern Pike (3)
358	September 15-16, 2012	Broad-scale large/small mesh gillnet	17.6 hrs.	Yellow Perch (5)
359	September 15-16, 2012	Broad-scale large/small mesh gillnet	17.7 hrs.	Yellow Perch (5) Northern Pike (1) White Sucker (1)
360	September 15-16, 2012	Broad-scale large mesh gillnet	19 hrs.	Northern Pike (1)

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

Table 2: API #2 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries) (Continued)

Fish Effort Location (see Figure 2-1)	Date	Gear	Effort	Catch
361	September 15-16, 2012	Broad-scale large mesh gillnet	18.9 hrs.	White sucker (3) Northern Pike (4)
362	September 15-16, 2012	Broad-scale large mesh gillnet	19.1 hrs.	Northern Pike (2)
363	September 14-15, 2012	minnow traps (2)	19.6 trap hrs.	No catch
364	September 14-15, 2012	minnow traps (1)	19.5 trap hrs.	No catch
365	September 14-15, 2012	minnow traps (1)	19.6 trap hrs.	Pumpkinseed (10)
366	September 15-16, 2012	minnow traps (1)	21.4 trap hrs.	Pumpkinseed (2)
367	September 15-16, 2012	minnow traps (1)	21.4 trap hrs.	Pumpkinseed (2)
368	September 15-16, 2012	minnow traps (1)	21.4 trap hrs.	No catch
369 (outflow)	September 17, 2012	backpack electrofisher	118 m (132s)	Finescale dace (7)

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

API #6 (POND)

The total surface area of API #6 is 5,572 m^2. A significant portion of this area is occupied by mats of grasses and forbs (Photo 1). Its maximum depth is 0.8 m (Figure 6-1). Substrate is entirely silt. Extensive woody debris (i.e., branches, blow down) litters the pond bottom. An occupied beaver lodge is located in the northern end of the pond. The shoreline is ringed by dense coniferous forest. Seepage from upstream beaver ponds provides the only inflow. Water elevation in the pond is controlled by two 2.0 m high beaver dams at the northern edge of the pond. Seepage through the northwest dam was evident (Photo 2). This was the only source of outflowing water.

Water in the pond is neutral and very dark coloured (Table 3).

Table 3: API #6 Fish Species List

Family/Subfamily	Species Common Name	Species Scientific Name
Coregoninae	Lake Whitefish Cisco	*Coregonus clupeaformis* *Coregonus artedi*
Umbridae	Central Mudminnow	*Umbra limi*
Esocidae	Northern Pike	*Esox lucius*
Cyprinidae	Longnose Dace Eastern Blacknose Dace Northern Redbelly Dace Finescale Dace Pearl Dace Fathead Minnow Spottail Shiner Blacknose Shiner Brassy Minnow Golder Shiner	*Rhinichthys cataractae* *Rhinichthys atratulus* *Phoxinus eos* *Phoxinus neogaeus* *Margariscus margarita* *Pimephales promelas* *Notropis hudsonius* *Notropis heterolepis* *Hybognathus hankinsoni* *Notemigonus crysoleucas*
Catostomidae	Common White Sucker	*Catostomus commersoni*
Gadidae	Burbot	*Lota lota*
Gasterosteidae	Ninespine Stickleback Brook Stickleback	*Pungitius pungitius* *Culaea inconstans*
Centrarchidae	Smallmouth Bass Pumpkinseed	*Micropterus dolomieu* *Lepomis gibbosus*
Percidae	Walleye Yellow Perch Iowa Darter	*Sander vitreus* *Perca flavescens* *Etheostoma exile*
Cottidae	Mottled Sculpin	*Cottus bairdii*

API #6 pond was fished on four occasions. No fish have been captured or observed during the field studies (Table 4). The outflow was sampled September 2012. White sucker was the only species captured.

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

Table 4: API #6 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 6-1)	Date	Gear	Effort	Catch
115	October 16-17, 2010	minnow traps (1)	19.75 trap hrs.	No catch
116	October 16-17, 2010	minnow traps (1)	20 trap hrs.	No catch
117	May 8-9, 2011	nordic net	22.5 hrs.	No catch
118	May 8-9, 2011	minnow traps (4)	92 trap hrs.	No catch
119	August 25-26, 2011	minnow traps (3)	79.5 trap hrs.	No catch
120	August 25-26, 2011	broad-scale large mesh (1)	14.75 hrs.	No catch
121	August 25-26, 2011	broad-scale small mesh (1)	14.75 hrs.	No catch
370	August 27-28, 2012	Minnow traps (3)	22.6 trap hrs.	No catch
371	August 27-28, 2012	Gillnet-experimental	22.4 hrs.	No catch
372	August 27-28, 2012	Gillnet-experimental	22.2 hrs.	No catch
373 (outflow)	September 19, 2012	Backpack electrofisher	95 m (294s)	White Sucker (1)
374 (outflow)	September 19, 2012	Backpack electrofisher	126 m (291s)	White Sucker (1)

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

API #8 (LAKE)

This lake has a surface area of 180,619 square meters and a maximum depth of 7.0 m (Figure 8-1). Shoreline substrate is predominately boulder and cobble except for an extensive sandy section along the northeast shore. The inflow, API #2, is flat and wide where it empties into the lake (Figure 8-2, Photo 1). The outflow is much narrower and is impounded downstream by beaver dams in several locations downstream although the backwater effect does not extend to the mouth of the lake's outflow. The pond is surrounded by a broad band of wetland habitat consisting of grasses and alders. Emergent vegetation is abundant at both the inflow and the outflow and along much of the shoreline. pH in the lake was slightly acidic. Dissolved oxygen was high throughout the water column (Table 5).

Table 5: API #8 (lake), Basic Water Chemistry Parameter Data

Depth (m)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
October 2010				
Surface	10.0	6.7	53	9.1
1	9.9	—	53	8.9
2	9.9	—	53	8.8
3	9.8	—	53	8.7
4	9.8	—	53	8.7
5	9.7	—	53	8.7
6	9.5	—	53	8.6
7	—	—	—	—
September 2012				
Surface	15.02	6.90	54	8.07
1	15.04	6.91	54	8.01
2	15.01	6.88	54	7.97
3	14.98	6.84	54	7.87
4	14.62	6.59	55	6.62
5	14.56	6.41	55	6.04
6.5	—	—	—	—

The lake supports populations of northern pike, pumpkinseed, common white suckers and burbot (Table 6). Although no small bodied fish were captured, finescale dace, golden shiner, and northern redbelly dace were captured in APIs located upstream of the lake.

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

Table 6: API #8 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 8-1)	Date	Gear	Effort	Catch
134	October 17-18, 2010	minnow traps (2)	44 trap hrs.	pumpkinseed (3 YOY)
135	October 17-18, 2010	minnow traps (1)	22 trap hrs.	no catch
136	October 17-18, 2010	gillnet - experimental mesh	22 hrs	white sucker (2 adults) northern pike (1 adult, 1 juvenile)
137	October 17-18, 2010	gillnet - experimental mesh	21 hrs.	white sucker (4 adults) northern pike (1 adult, 3 juvenile) burbot (1 juvenile)
370	September 16-17, 2012	Broad-scale large mesh gillnet	19.3 hrs.	White Sucker (2) Northern Pike (1)
371	September 16-17, 2012	Broad-scale large mesh gillnet	19.3 hrs.	Northern Pike (1) Pumpkinseed (1) White Sucker (1)
372	September 16-17, 2012	Broad-scale small mesh gillnet	19.4 hrs.	Northern Pike (1)
373	September 16-17, 2012	Broad-scale small mesh gillnet	19.3 hrs.	Golden Shiner (1) Northern Pike (1) Yellow Perch (1)
374	September 16-17, 2012	Broad-scale large/small mesh gillnet	20.6 hrs.	Northern Pike (1)
375	September 16-17, 2012	Broad-scale large/small mesh gillnet	19.9 hrs.	White Sucker (4) Yellow Perch (2) Northern Pike (1)
376	September 16-17, 2012	Broad-scale large/small mesh gillnet	19.3 hrs.	White Sucker (3) Northern Pike (1)
377	September 17-18, 2012	Broad-scale large mesh gillnet	23.4 hrs.	Northern Pike (1)
378	September 17-18, 2012	Broad-scale large mesh gillnet	23.4 hrs.	Northern Pike (3)
379	September 17-18, 2012	Broad-scale small mesh gillnet	23.6 hrs.	Yellow Perch (4) Northern Pike (1)

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

Table 6: API #8 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries) (Continued)

Fish Effort Location (see Figure 8-1)	Date	Gear	Effort	Catch
380	September 17-18, 2012	Broad-scale small mesh gillnet	24 hrs.	Pumpkinseed (1)
381	September 17-18, 2012	Broad-scale large/small mesh gillnet	22.5 hrs.	White Sucker (4) Northern Pike (3) Yellow Perch (2) Pumpkinseed (1)
382	September 17-18, 2012	Broad-scale large/small mesh gillnet	21.9 hrs.	Northern Pike (1) Yellow Perch (1) Pumpkinseed (1)
383	September 17-18, 2012	Broad-scale large/small mesh gillnet	23.5 hrs.	No catch
384	September 16-18, 2012	minnow traps (1)	42.4 hrs.	No catch
385	September 16-18, 2012	minnow traps (1)	43.3 hrs.	No catch
386	September 16-18, 2012	minnow traps (1)	43.1 hrs.	No catch
387	September 16-18, 2012	Broad-scale small mesh gill net	40.7 hrs.	Northern Pike (7)
388	September 16-18, 2012	Broad-scale large mesh gill net	42.3 hrs.	White Sucker (2) Northern Pike (6)
389 (upstream of lake)	September 17, 2012	Backpack electrofisher	240 m (940s)	Northern Pike (2) White Sucker (1) Finescale Dace (15)
390 (upstream of lake)	September 17, 2012	Backpack electrofisher	228 m (372s)	Finescale Dace (81)
391 (upstream of lake)	September 18, 2012	Backpack electrofisher	80 m (920s)	Northern Pike (2)
392 (upstream of lake)	September 18, 2012	Backpack electrofisher	358 m (951s)	Northern Pike (1) Golden Shiner (1)

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

API #10 (HEADWATER POND)

This pond has a surface area of 13,797 square meters and a maximum depth of 10.0 m (Figure 10-1). At its widest point, the pond is approximately 125 m wide and 200 m in length. The shoreline consists mostly of grasses and shrubs and bedrock outcrops (Photo 1). There is an extensive wetland area surrounding most of the pond. Bottom substrate is primarily silt with some boulders located near the outflow. There is no inflow to the pond although there is a small partially infilled depression located immediately west of API #10 (Photo 2). A large beaver dam is located at the south end of the pond (Photo 3). There is some seepage of water through the dam but water escaping the pond infiltrates the ground immediately downstream of the dam. Water in the pond is slightly acidic (Table 7). Conductivity is low.

Table 7: API #10 (pond), Basic Water Chemistry Parameter Data

Date/Depth (m)	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
Sept. 29, 30, 2010	11.0	6.1	12	8.1
Aug. 26, 27, 2011	22.8	6.1	14	7.0
September 2012 Profile				
0	20.82	5.63	23	7.14
1	18.34	5.33	24	2.67
2	13.5	4.85	23	<1.0
3	8.43	4.72	23	<1.0
4	—	—	—	—
5	—	—	—	—
6	—	—	—	—
7	—	—	—	—
8	—	—	—	—
9	4.06	2.68	39	<1.0
10	—	—	—	—

Notes:
"—" = No data available.

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

The pond was fished in September 2010, August 2011, and September 2012 (Table 8). No fish were captured.

Table 8: API #10 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 10-1)	Date	Gear	Effort	Catch
209	September 29-30, 2010	minnow traps (1)	18 trap hrs.	No catch
210	September 29-30, 2010	minnow traps (1)	18 trap hrs.	No catch
211	September 29-30, 2010	gillnet - experimental mesh	18.5 hrs.	No catch
212	September 29-30, 2010	nordic net	18 hrs.	No catch
213	August 26-27, 2011	broad-scale large mesh (2)	44 hrs.	No catch
214	August 26-27, 2011	broad-scale small mesh (2)	44 hrs.	No catch
215	August 26-27, 2011	minnow traps (3)	60 trap hrs.	No catch
393	September 26-27, 2012	Broad-scale large/small mesh gillnet	16.8	No catch
394	September 26-27, 2012	Broad-scale small mesh gillnet	16.8	No catch
395	September 26-27, 2012	Broad-scale large/small mesh gillnet	16.6	No catch
396	September 26-27, 2012	Broad-scale large mesh gillnet	16.6	No catch
397	September 26-27, 2012	Minnow traps (2)	16.4	No catch
398	September 26-27, 2012	Minnow traps (2)	16.7	No catch

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

API #13 (HEADWATER POND)

API #13 is a headwater pond with a total surface area of 19,375 square meters (Figure 13-1). The pond is approximately 160 m in length and 140 m at its widest point. Maximum depth is 5.5 m. Bottom substrate is entirely silt. Vegetation consists of wetland along most its shoreline and dense coniferous forest along the southern and southwestern shorelines (Figure 13-2; Photo 1). There is no inflow to the pond. A single outflow is located at its northern end (Photo 2). Water elevation in the pond is controlled by a beaver dam near its outflow. Table 9 summarizes water chemistry data collected in the pond.

Table 9: API #13 (pond), Basic Water Chemistry Parameter Data

Date/Depth (m)	Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
September 26, 2010				
Surface	12.5	7.0	36	12.4
1	11.4	7.0	36	11.4
2	10.4	6.9	36	10.5
3	10.4	6.9	36	10.4
4	10.0	6.9	36	10.0
5	9.0	—	—	—
May 8, 2011	6.8	7.0	52	9.0
August 27, 2011	22.6	7.3	50	7.0
September 27, 2012	20.76	6.59	71	8.20

Notes:
"—" = No data available .

The pond was fished on four occasions. No fish were captured (Table 10).

Table 10: API #13 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 13-1)	Date	Gear	Effort	Catch
22	September 26–27, 2010	gillnet - experimental mesh	16 hrs	No catch
23	September 26–27, 2010	gillnet - experimental mesh	16 hrs	No catch
24	September 26-27, 2010	minnow traps (2)	34 trap hrs	No catch

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

Table 10: API #13 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries) (Continued)

Fish Effort Location (see Figure 13-1)	Date	Gear	Effort	Catch
25	May 8-9, 2011	gillnet – experimental mesh	17 hrs	No catch
26	May 8-9, 2011	nordic net	16.5 hrs	No catch
27	May 8-9, 2011	minnow traps (4)	70 trap hrs	No catch
28	August 27-28, 2011	minnow traps (3)	48 trap hrs	No catch
29a	August 27-28, 2011	broad-scale large mesh	16 hrs	No catch
29b	August 27-28, 2011	broad-scale large mesh	16 hrs	No catch
29c	August 27-28, 2011	broad-scale large mesh	16 hrs	No catch
30	August 27-28, 2011	broad-scale small mesh (1)	16 hrs	No catch
399	September 27-28, 2012	Minnow traps (2)	17.8 trap hrs.	No catch
400	September 27-28, 2012	Broad-scale large/small mesh gillnet	17.2 hrs.	No catch
401	September 27-28, 2012	Broad-scale large/small mesh gillnet	17.2 hrs.	No catch
402	September 27-28, 2012	Broad-scale small mesh gillnet	17 hrs.	No catch
403	September 27-28, 2012	Broad-scale large mesh gillnet	17.15 hrs.	No catch
404	September 27-28, 2012	Broad-scale large mesh gillnet	17 hrs.	No catch
405	September 27-28, 2012	Broad-scale large/small mesh gillnet	16.8 hrs.	No catch

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

API #16 (HEADWATER POND)

This pond is situated in the middle of a large wetland area and has a total surface area of 6,151 m^2. It is circular and has a small 5 m deep basin in its centre (Figure 16-1). The pond is 75 m to 90 m in diameter. The perimeter of the pond is very shallow. Aquatic vegetation is abundant around the shoreline. A temperature-dissolved oxygen profile was completed in August 2010 and August 2012. Water temperatures and oxygen levels were similar throughout the water column (Table 11). pH in the pond was slightly alkaline. Substrate throughout the pond was silt. There are no defined inflows to the pond and a single seasonal outflow along its northwest shoreline. The outflow is not dammed but a beaver dam exists approximately 100 m below the outflow.

Table 11: API #16 (pond), Basic Water Chemistry Parameter Data

Date/Depth (m)	Surface Water Temperature (°C)	pH[(a)]	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2010				
Surface	12.0	7.3	64	8.9
1	11.0	7.2	62	8.6
2	10.7	7.2	62	8.5
3	10.5	7.3	62	8.4
4	8.0	7.3	62	8.0
5	7.0	7.2	62	7.0
August 2012				
Surface	22.62	—	104	8.10
1	20.80	—	103	4.02
2	19.90	—	108	4.02
3	13.57	—	164	1.28
4.5	22.62	—	104	8.10

Notes:
(a) "—"indicates pH probe was inoperable at time of sampling.

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

Fishing effort was expended in September 2010 and August 2012 (Table 12). No fish were captured.

Table 12: API #16 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 16-1)	Date	Gear	Effort	Catch
236	September 26 – 27, 2010	minnow trap (2)	40 trap hrs.	No catch
237	September 26 – 27, 2010	nordic net	20 hrs.	No catch
407	August 28-29, 2012	Minnow traps (3)	23.2 hrs.	No catch
408	August 28-29, 2012	Broad-scale large/small mesh gillnet	22.6 hrs.	No catch
409	August 28-29, 2012	Broad-scale large/small mesh gillnet	22.6 hrs.	No catch
410	August 28-29, 2012	Broad-scale small mesh gillnet	22.6 hrs.	No catch
411	August 28-29, 2012	Broad-scale large mesh gillnet	22.6 hrs.	No catch

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

API #43 (HEADWATER LAKE)

This lake has a surface area of 28,822 square meters and a maximum depth of 6.0 m (Figure 43-1). The dimensions of the lake are approximately 250 m wide and 200 m in length. The shoreline is tightly contained by a bedrock outcrop on its western shore and thick coniferous forest along its eastern shore. Substrate is predominately silt. There are no inflows to the lake, and one outflow at the south end (Figure 43-2). Water in the pond is slightly acidic and dissolved oxygen low at its deepest point (Table 13). The water was very dark. Secchi depth was less than 1 m.

Table 13: API #43, Basic Water Chemistry Parameter Data

Depth (m)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2011				
Surface	15.1	6.8	16	9.8
1	15.0	—	16	9.3
2	14.9	—	16	9.3
3	8.2	—	17	10.1
4	5.3	—	18	5.4
5	4.5	—	18	4.7
6	4.3	—	18	2.5
August 2012				
Surface	22.83	—	17	8.65
1	22.76	—	17	8.22
2	20.04	—	18	8.10
3	17.28	—	18	5.14
4	13.12	—	18	2.73
5	9.32	—	19	<1.0
6.5	—	—	—	—

Notes:
"—" = No data available.

No fish were captured during the May 2011 or August 2012 assessments (Table 14).

Table 14: API #43, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 43-1)	Date	Gear	Effort	Catch
169	May 27-28, 2011	minnow traps (3)	56 trap hrs.	no catch
170	May 27-28, 2011	nordic net	19 hrs.	no catch

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

Table 14: API #43, Fish Community Assessment (Effort, Gear and Catch Summaries) (Continued)

Fish Effort Location (see Figure 43-1)	Date	Gear	Effort	Catch
171	May 27-28, 2011	gillnet – experimental mesh	19 hrs.	no catch
412	August 26-27, 2012	Broad-scale large mesh gillnet	22.3 hrs.	no catch
413	August 26-27, 2012	Broad-scale large/small mesh gillnet	22.3 hrs.	no catch
414	August 26-27, 2012	Broad-scale small mesh gillnet	22.4 hrs.	no catch
415	August 26-27, 2012	Broad-scale large/small mesh gillnet	22.1 hrs.	no catch
416	August 26-27, 2012	Minnow traps (2)	23 trap hrs.	no catch
417	August 26-27, 2012	Minnow traps (1)	22.8 trap hrs.	no catch

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

API #44 (HEADWATER POND)

This lake has a surface area of 7,971 square meters and a maximum depth of 8 m (Figure 44-1). The deepest location is a discrete area in the immediate centre of the pond. The dimensions of the pond are approximately 120 m wide and 80 m in length. The shoreline is surrounded by a narrow band of grasses and shrubs. Substrate is predominately silt. There are no discernible inflows or outflows. Water in the pond is slightly acidic and dissolved oxygen was low at its deepest point (Table 15). The water was very dark. Secchi depth was less than 1 m.

Table 15: API #44 (pond), Basic Water Chemistry Parameter Data

Depth (m)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2011				
Surface	14.8	6.7	16	8.9
1	14.8	—	16	8.9
2	10.6	—	17	9.6
3	5.3	—	20	4.3
4	4.4	—	20	2.6
5	4.0	—	20	2.1
6	4.0	—	25	1.0
7	4.0	—	27	0.8
8	4.0	—	32	0.8
August 2012				
Surface	21.59	5.24	17	7.78
1	21.08	5.06	17	7.2
2	16.52	2.47[(a)]	18	1.52
3	11.50	<1.0[(a)]	16	0.52
4	7.38	<1.0[(a)]	22	0.65
5	Ended profile readings due to low oxygen levels			
6				
7				

Notes:

[(a)] Low pH may be due to low conductivity causes problems with metre. pH taken at surface with Hannah pen = 5.97.

"—" = No data available.

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

No fish were captured during the May 2011 or August 2012 assessments (Table 16).

Table 16: API #44 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 43-1)	Date	Gear	Effort	Catch
173	May 27-28, 2011	minnow traps (4)	56 trap hrs.	no catch
174	May 27-28, 2011	nordic net	16 hrs.	no catch
418	August 25-26, 2012	Minnow traps (2)	18 trap hrs.	no catch
419	August 25-26, 2012	Broad-scale small mesh gillnet	18.3 hrs.	no catch
420	August 25-26, 2012	Broad-scaled large/small mesh gillnet	18.1 hrs.	no catch
421	August 25-26, 2012	Broad-scale large mesh gillnet	17.8 hrs.	no catch
422	August 25-26, 2012	Broad-scale large/small mesh gillnet	17.9 hrs.	no catch

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

API #47 (HEADWATER LAKE)

This pond has a surface area of 60,016 square meters and a maximum depth of 11.0 m (Figure 47-1). The lake shoreline consists primarily of boulder and bedrock and has very little wetland habitat around its perimeter (Photo 1). Bottom substrate along the shoreline is primarily boulders and silt. Aquatic vegetation is sparse. There is no inflow to the lake and two permanent outflows located near its northeast corner, which converge into a single stream channel (Photos 2 and 3). Discharge was measured at 0.005 m^3/s in May 2011. Littoral zone cover is provided by large boulders and extensive woody debris, fallen timber, along the lake shoreline (Photo 4).

Table 17 summarizes basic water chemistry and the temperature-dissolved oxygen profile data collected in May 2011 and August 2012. The lake was visited too early in the year to determine whether or not it thermally stratifies. Low oxygen levels were recorded below a depth of 5 m. Water in the lake was very clear. Secchi depth was 4.5 m.

Table 17: API #47 (lake), Basic Water Chemistry Parameter Data

Depth (m)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2011				
Surface	10.1	7.4	59	10.4
1	10.0	—	59	10.4
2	10.0	—	59	10.2
3	7.7	—	59	9.2
4	6.4	—	61	8.2
5	5.7	—	64	6.0
6	5.1	—	75	2.3
7	4.9	—	84	0.8
8	—	—	—	0.5
9	—	—	—	—
August 2012				
Surface	21.54	7.3	62	8.92
1	21.20	7.45	62	8.83
2	21.07	7.44	62	9.01
3	20.58	7.25	62	8.45
4	18.84	6.86	63	6.81
5	15.17	6.15	68	2.41
6	10.86	4.86	74	<1.0
7	8.39	4.33	76	<1.0
8	—	—	—	—
9	7.44	4.31	120	<1.0
10	—	—	—	—

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

API #47 was fished on a single occasion. It is inhabited by finescale and pearl dace (Table 18).

Table 18: API #47 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 47-1)	Date	Gear	Effort	Catch
76	May 9-10, 2011	nordic net	16 hrs.	finescale dace (503 adults) pearl dace (5 adults)
77	May 9-10, 2011	nordic net	18 hrs.	finescale dace (423 adults) pearl dace (13 adults)
78	May 9-10, 2011	gillnet – experimental mesh	17 hrs.	no catch
79	May 9-10, 2011	minnow traps (4)	68 trap hrs.	finescale dace (72 adults) pearl dace (2 adults)
428	August 28-29, 2012	Minnow traps (2)	16.2 trap hrs.	Finescale Dace (208) Pearl Dace (1)
429	August 28-29, 2012	Minnow traps (2)	15.6 trap hrs.	Finescale Dace (110)
430	August 28-29, 2012	Broad-scale Large mesh gillnet	17.2 hrs.	No catch
431	August 28-29, 2012	Broad-scale large/small mesh gillnet	17.2 hrs.	Finescale Dace (10) Pearl Dace (86)
432	August 28-29, 2012	Broad-scale large/small mesh gillnet	17.6 hrs.	Pearl Dace (43) Finescale Dace (8)
433	August 28-29, 2012	Broad-scale small mesh gillnet	17.7 hrs.	Pearl Dace (46) Finescale Dace (13)

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

API #47 (STREAM)

The stream draining API #47 flows through a heavily forested area immediately downstream of the pond. The channel is difficult to distinguish in the upper 450 m. Approximately 817 m downstream of its origin, the stream channel becomes indistinguishable, and the drainage becomes wetted forest (Figure 47-2). The stream is ephemeral beyond this point. A large, shallow (i.e., less than 1 m deep) beaver impoundment and an abandoned road bed impedes downstream flow into the forested area (Figure 47-3).

The beaver pond was assessed in August 2012. Table 19 summarizes basic water chemistry of the impoundment in August 2012.

Table 19: API #47 (beaver impoundment), Basic Water Chemistry Parameter Data

Date	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2012	22.67	7.55	89	8.01

The beaver impoundment downstream of API #47 was fished on a single occasion. It is inhabited by finescale dace, northern redbelly dace, and pearl dace (Table 20).

Table 20: API #47 (beaver impoundment), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 47-2)	Date	Gear	Effort	Catch
423	August 29-31, 2012	Minnow trap (2)	17.1 hrs.	Finescale Dace (175) Northern Redbelly Dace (28) Pearl Dace (6)
424	August 29-31, 2012	Minnow trap (2)	17.8 hrs.	Finescale Dace (238) Northern Redbelly Dace (347)
425	August 29-30, 2012	Broad-scale large/small mesh gillnet	18.5 hrs.	Finescale Dace (3) Pearl Dace (4) Painted turtle (4)
426	August 29-30, 2012	Broad-scale small mesh gillnet	18.5 hrs.	Pearl Dace (13) Finescale Dace (17)
427	August 29-30, 2012	Broad-scale large mesh gillnet	17.2 hrs.	No catch

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

API #48 (STREAM)

This stream was mapped in May 2011. The upper reach of this stream consists of a flat, narrow channel that flows into a series of large, shallow beaver impoundments (Figure 48-2; Photos 1, 2 and 3). This series of pond is approximately 375 m in length. The ponds have a controlling effect on stream flow. Downstream of the ponds, the stream becomes a series of run segments interspersed with moderately steep cascades and wetted forest. Very little flow was evident during mapping. One segment of lower stream was completely dry (Figure 48-3). The stream ends at an abandoned forest access road which acts as a dam (Photo 4). The stream system is cut off from the rest of the catchment beyond this location. The south side of the road was dense forest. There is no identifiable culvert in the road base and there was no evidence of flow from the upstream pond through (i.e., sand, gravel in the forested area south of the road) or over (i.e., erosion of road base) the road. No standing water and no stream channel was detected on the south side of the road.

The pond immediately above the road was electrofished in May 2011 and September 2012 (Table 21). Finescale dace was the only species observed. No fish were observed anywhere along the stream when mapping was completed.

Table 21: API #48 (beaver impoundment), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 47-2)	Date	Gear	Effort	Catch
80b	May 2011	Backpack electrofisher	90 m (183 s)	No catch
434	September 9, 2012	Backpack electrofisher	40 m (131 s)	Finescale Dace (4)

Please see original API description in Fish and Fish Habitat Baseline Studies Interim Report dated July 3, 2012 for Figures and Photos referenced in this report.

AQUATIC ENVIRONMENT TSD
VERSION 1

FISH AND FISH HABITAT BASELINE STUDIES INTERIM REPORT

February 2013
Project No. 10-1118-0020
Hammond Reef Gold Project

July 3, 2012

OSISKO HAMMOND REEF GOLD PROJECT

Fish and Fish Habitat Baseline Studies Interim Report

DRAFT

Submitted to:
Osisko Hammond Reef Gold Project
155 University Avenue, Suite 1440
Toronto, ON M5H 3B7

REPORT

Report Number: 10-1118-0020 (5200)
Document No.: 2012-027 (Rev D)

Distribution:
1 e-copy - Osisko Hammond Reef Gold Ltd.
1 copy - Golder Associates Ltd.

Golder Associates

Table of Contents

1.0 INTRODUCTION 3

2.0 PROJECT OVERVIEW 3

3.0 STUDY OBJECTIVES 4

4.0 STUDY AREAS 4

5.0 METHODS 11

5.1 Regulatory Consultation 11

5.2 Aboriginal Engagement 11

5.3 Secondary Data Review 12

5.4 Primary Data Collection 12

5.4.1 Fish Community Assessment 12

5.4.2 Fish Habitat Mapping 14

5.4.3 Fish Tissues Analysis 15

5.4.4 Benthic Community Assessment 16

D2.2 Data Analysis 16

5.4.5 Sediment Sampling 17

6.0 RESULTS 17

6.1 Fish Community Assessment and Habitat Mapping 17

6.2 Fish Tissue Analysis 18

6.2.1 Trace Metals 18

6.2.2 Total Mercury 20

6.3 Sediment Analysis 21

6.4 Benthic Community Assessment 21

6.4.1 Benthic Invertebrate Density 21

6.4.2 Benthic Invertebrate Richness 22

6.4.3 Simpson's Diversity Index 22

6.4.4 Evenness 23

6.4.5 %EPT 23

6.5 Benthic Community Composition 23

DRAFT

7.0 ADDITIONAL BASELINE STUDIES 25

8.0 SUMMARY AND CONCLUSIONS 25

9.0 REFERENCES 29

TABLES

Table 1: Summary of Field Program Dates 12

Table 2: Habitat Features and Variables Measured During Baseline Studies 15

Table 3: Fish Species Captured During Baseline Studies 17

Table 4: Selected Fish Tissue Trace Metal Results Summary (mg/kg wwt) 19

Table 5: Total Mercury Levels in Fish Tissue Samples (µg/g, Detection Limit 0.050 µg/g) 20

Table 6: Sediment Grainsize and Total Organic Content Analysis Results 21

Table 7: Water quality conditions at benthic monitoring stations 22

Table 8: Fish species assemblages in APIs (watercourses) assessed during Aquatic Baseline Program. 25

Table 9: Fish species assemblages in APIs (ponds) assessed during Aquatic Baseline Program 26

FIGURES

Figure 1: Project Site Layout 6

Figure 2: Project Footprint & APIs 7

Figure 3: Site Watershed Boundaries 8

Figure 4: Benthic Invertebrate and Fish Tissue Collection Locations 2010-2011 9

Figure 5: Alternative Infrastructure Corridors 10

Figure 6: Benthic Invertebrate Community Major Taxonomic Groups Relative Abundance 24

APPENDICES

APPENDIX A
Aquatic Baseline Study Results

APPENDIX B
Habitat Preference Tables

APPENDIX C
Definitions for Fish Habitat Mapping Variables

APPENDIX D
Fish Tissue and Benthic Community Results

DRAFT

1.0 INTRODUCTION

This report contains a summary of aquatic baseline studies conducted in 2010 and 2011 at the proposed Mine Site (the Site), including the footprints of the open pit, Tailings Management Facility (TMF) and waste rock management alternatives and associated mine site infrastructure. These studies were also conducted at aquatic features located up and downstream of the Site footprint. Assessment of aquatic features was also conducted along access road/transmission corridor alternatives illustrated in Figure 1. The results of the corridor assessments will be presented in the final aquatic baseline study report which will be completed in late spring 2012. This information will serve as the primary reference for aquatic studies in support of the Technical Support Document and the Environmental Assessment Report.

Results of aquatic baseline studies are presented in the form of data summaries for each aquatic feature assessed. Aquatic features have been termed areas of potential impact (APIs). APIs include a number of permanent streams and associated beaver (*Castor canadensis*) impoundments as well as several small lakes, the largest of which is Mitta Lake. Figure 2 illustrates the locations of APIs assessed relative to the Project footprint. Data summaries are organized by catchment areas (i.e. sub-watersheds) which have also been assigned a unique identifying letter (Figure 3). For each aquatic feature, potential impacts of the Project are described in general terms. Detailed engineering and a surface water management plan have not been completed for the Project so impacts (i.e. how and where surface water will be conveyed/diverted) cannot be described in detail at this time. These impacts will be described and fully assessed within the EA. Biological, fish and fish habitat data, are presented for each feature and an overall interpretation of data is summarized for each catchment in Appendix A. In addition, for each species found within the study area, a compilation of habitat preferences was also assembled and is presented in Appendix B. This habitat preference data will be used to classify the relative importance of various habitats identified as part of the baseline aquatic surveys presented in Appendix A and will serve to guide the overall impact assessment and development of mitigation and fish habitat compensation plans.

Locations of fish sampling and habitat assessment locations are noted within the API figures in Appendix A; Figure 4 shows locations where fish tissue, benthic invertebrates and aquatic sediments were collected.

2.0 PROJECT OVERVIEW

The Hammond Reef property is located within the Thunder Bay Mining District in northwestern Ontario. The property is approximately 170 km west of Thunder Bay, Ontario and approximately 30 km northeast of the town of Atikokan, Ontario. Atikokan is located 3 km north of Highway 11 and has a population of approximately 3,400.

Access to the Hammond Reef property is presently via two routes: the Premier Lake Road, a gravel road that intersects Highway 623 near Sapawe and the Hardtack-Sawbill Road, a gravel road that intersects Highway 622 northwest of the Town of Atikokan (Figure 5). The exploration camp is located at the northern end of Sawbill Bay in Upper Marmion Reservoir. The property is also accessible by water from the southwest end of the Marmion Reservoir at its access point from Highway 622. The existing Hardtack-Sawbill road located to the north of Finlayson Lake has been upgraded to provide an improved and more direct linkage to the site in support of the expanded exploration program.

The Hammond Reef deposit is located mainly on a peninsula of land extending into the north end of the Upper Marmion Reservoir. The peninsula containing the deposit is surrounded by the Marmion Reservoir on three

DRAFT

sides with Sawbill Bay to the northwest and Lynxhead Bay to the southeast. The property also contains a number of smaller lakes. Mitta Lake is a small, steep-sided waterbody located atop mineralized zones of the deposit. Due to its location, the planned open pit mine and secondary pit areas will encompass Mitta Lake.

3.0 STUDY OBJECTIVES

Baseline data was collected to meet the requirements of the EA and to be consistent with provincial and federal legislative requirements. The fish and fish habitat baseline study will be interpreted to identify, within the defined study areas:

- Fish habitat use as spawning, rearing/nursery, feeding, migratory corridor and over wintering/summer refuge;
- Fish habitat by watercourse reach and/or type within the local watershed, including measures such as direction of flow, length of stream, surface area and/or mean bank full width, depths, monthly/seasonal/annual discharge volumes/velocities and natural or anthropogenic barriers to fish passage;
- For each potentially affected lake, measures of; total surface area, water elevation above mean sea level, shoal area, surface area of submerged and emergent aquatic vegetation, maximum and mean depths and water quality parameters (e.g., profiles of water temperature, turbidity, pH, dissolved oxygen);
- Distribution, abundance and characterization of fish by species and life stages;
- Existing metal levels in fish tissue in areas that may be impacted by effluent or seepage from the mine; and
- Fish and fish habitat along existing roads and the transmission line right of way.

4.0 STUDY AREAS

The study areas can be defined as the geographic range over which potential effects are anticipated to occur as a result of the Project. Because the magnitude of an impact depends in part on the geographic extent of the impact, the impact assessment will be considered with respect to specific areas. For the purposes of this report, existing environment is described at three scales, as described below.

- **The Mine Study Area**: this is the area containing the mine infrastructure, the deposit, and associated servicing and maintenance areas. Due to the local topography, the mine area is linear, since the mine and associated infrastructure are confined to the peninsula upon which the deposit occurs;
- **The Local Study Area (LSA)**: this area includes the Mine Area, and an area around the mine where impacts could be expected. The LSA includes portions of the Upper Marmion reservoir (upper floodwaters area) and the Seine River including Sawbill Bay, Lynxhead Bay, Trap Bay, Turtle Bay, Light Bay and Lizard Lake;
- **The Regional Study Area (RSA)**: this includes both of the above areas, and extends beyond the Local Study Area, and will encompass the maximum geographic area that impacts from the Project are anticipated. RSA boundaries are dictated by the extent of potential downstream effects of the Project

DRAFT

and the potential for mobile organisms (e.g. fish species) to be exposed to potential effects. This includes aquatic organisms in Upper Seine Bay and Marmion Lake

DRAFT

610000
620000
630000
5430000
5420000

Serpent Lake
Cornell Lake
Sawbill Bay
Lynxhead Bay
Mora Bay
Light Lake
Upper Seine Bay
Hawk Bay
Marmion Reservoir

TAILINGS MANAGEMENT FACILITY ALTERNATIVE 1
TAILINGS MANAGEMENT FACILITY BASE CASE
TAILINGS MANAGEMENT FACILITY ALTERNATIVE 2
CONSTRUCTION CAMP
EXPLORATION CAMP
HELIPAD
WATER RETENTION POND
TMF ROADWAY AREAS (PIPELINES TO FOLLOW)
OFFICE/ TRUCK SHOP/ FUEL BAY/ PARKING LOT
HELIPAD 1
PROCESS FACILITY
SUBSTATION
MINE WATER SPILL EMERGENCY POND
EXPLOSIVES PLANT AND AREA
WASTE ROCK STOCKPILE
OPEN PIT
STOCKPILE (UNKNOWN)
STOCKPILE (OVERBURDEN)
LOW GRADE STOCKPILE AREA

N

LEGEND

- Raft Lake Cut Location
- Potential Discharge Location
- Weather Station
- Helipad Location
- Trail
- Road
- Proposed Site Access Road
- Hardtack / Sawbill Access Road Alternative 1
- Raft Lake Access Road Alternative 2
- Proposed Raft Lake Powerline Alternative
- Proposed Hardtack Powerline Alternative
- River/Stream
- Lake
- Wetland
- Low Grade Stockpile Area
- Mine Water Spill Emergency Pond
- TMF Roadway Area (Pipeline to Follow Roadway)
- Water Retention Pond Area
- Construction Camp and Exploration Camp
- Explosives Plant Area
- Explosives Plant
- Office and Truck Shop and Processing Plant
- Open Pit
- Stockpiles (Overburden and Unknown)
- Waste Stockpile
- Tailings Management Facility Base Case
- Tailings Management Facility Alternative 1
- Tailings Management Facility Alternative 2
- Project Location

DRAFT

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
SCALE 1:80,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
PROPOSED SITE DEVELOPMENT
FOR THE OHRG PROJECT

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 2.0
DESIGN	CGE	14 Nov. 2008		
GIS	CGE	13 Apr. 2012		
CHECK	SP	13 Apr. 2012		
REVIEW	RJ	13 Apr. 2012		

FIGURE: 1

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXD\Draft\Aquatics\SiteLayout_30March2012.mxd

610000 620000 630000

5430000 5420000

N

Serpent Lake
Cornell Lake
Sawbill Bay
Mitta Lake
Lynxhead Bay
Marmion Reservoir
Light Lake
Upper Seine Bay
Hawk Bay

TAILINGS MANAGEMENT FACILITY ALTERNATIVE 1
TAILINGS MANAGEMENT FACILITY BASE CASE
TAILINGS MANAGEMENT FACILITY ALTERNATIVE 2
CONSTRUCTION CAMP
EXPLORATION CAMP
HELIPAD
WATER RETENTION POND
TMF ROADWAY AREAS (PIPELINES TO FOLLOW)
OFFICE/ TRUCK SHOP/ FUEL BAY/ PARKING LOT
HELIPAD 1
PROCESS FACILITY
SUBSTATION
MINE WATER SPILL EMERGENCY POND
OPEN PIT
WASTE ROCK STOCKPILE
STOCKPILE (UNKNOWN)
STOCKPILE (OVERBURDEN)
LOW GRADE STOCKPILE AREA
EXPLOSIVES PLANT AND AREA

LEGEND

- Raft Lake Cut Location
- Weather Station
- Helipad Location
- Trail
- Road
- Proposed Site Access Road
- Hardtack / Sawbill Access Road Alternative 1
- Raft Lake Access Road Alternative 2
- Proposed Raft Lake Powerline Alternative
- Proposed Hardtack Powerline Alternative
- River/Stream
- Lake
- Wetland
- Project Footprint
- Project Location

DRAFT

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
SCALE 1:80,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
PROJECT FOOTPRINT AND AQUATIC APIS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 2.0
DESIGN	CGE	14 Nov. 2008	FIGURE: 2	
GIS	CGE	13 Apr. 2012		
CHECK	SP	13 Apr. 2012		
REVIEW	RJ	13 Apr. 2012		

G:\Projects\2010\10-1118-0020_BrettResources_HammondReefGIS\MXD\sl\Draft\Aquatics\SiteLayout_30March2012.mxd

610000

620000

5430000

5420000

Serpent Lake

Cornell Lake

Sawbill Bay

Mitta Lake

Lynxhead Bay

Lizard Lake

Light Lake

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z AA AB AC AD AF AG AH AI

N

LEGEND

- Trail
- Road
- Contour - 20m Interval
- Contour - 10m Interval
- River/Stream
- Lake
- Wetland
- Site Watershed Boundary
- Project Facilities
- Project Location

WATERSHED AREAS

Name	Area (ha)
A	590.00
AA	73.34
AB	51.99
AC	29.24
AD	29.91
AF	77.52
AG	34.18
AH	60.02
AI	10.17
B	609.82
C	134.96
D	104.31
E	122.80
F	78.00
G	30.53
H	27.27
I	85.24
J	25.56
K	89.03
L	70.53
M	111.72
N	158.55
O	38.76
P	124.90
Q	272.96
R	623.45
S	230.85
T	336.68
U	200.68
V	106.27
W	66.90
X	82.32
Y	45.66
Z	74.75

DRAFT

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000
SCALE 1:50,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
SITE WATERSHED BOUNDARIES

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 2.0
DESIGN	CGE	14 Nov. 2008	FIGURE: 3	
GIS	RRD	Mar 2012		
CHECK	JD	Mar 2012		
REVIEW	JS	Mar 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\SiteWatershedMap.mxd

610000 620000 630000

5430000 5420000

N

TAILINGS MANAGEMENT FACILITY ALTERNATIVE 1
TAILINGS MANAGEMENT FACILITY BASE CASE
TAILINGS MANAGEMENT FACILITY ALTERNATIVE 2
CONSTRUCTION CAMP
EXPLORATION CAMP
HELIPAD
WATER RETENTION POND
TMF ROADWAY AREAS (PIPELINES TO FOLLOW)
OFFICE/ TRUCK SHOP/ FUEL BAY/ PARKING LOT
HELIPAD 1
PROCESS FACILITY
SUBSTATION
MINE WATER SPILL EMERGENCY POND
OPEN PIT
WASTE ROCK STOCKPILE
STOCKPILE (UNKNOWN)
STOCKPILE (OVERBURDEN)
LOW GRADE STOCKPILE AREA
EXPLOSIVES PLANT AND AREA

Serpent Lake
Cornell Lake
Sawbill Bay
Mitta Lake
Lynxhead Bay
Marmion Reservoir
Light Lake
Upper Seine Bay
Hawk Bay

LEGEND

- BIC Sampling Location
- Fish Tissue Sampling Location
- Raft Lake Cut Location
- Weather Station
- Helipad Location
- Trail
- Road
- Proposed Site Access Road
- Hardtack / Sawbill Access Road Alternative 1
- Raft Lake Access Road Alternative 2
- Proposed Raft Lake Powerline Alternative
- Proposed Hardtack Powerline Alternative
- River/Stream
- Lake
- Wetland
- Project Footprint
- Project Location

DRAFT

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
SCALE 1:80,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
BENTHIC INVERTEBRATE AND FISH TISSUE COLLECTION LOCATIONS (2010-2011)

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 2.0
DESIGN	CGE	14 Nov. 2008	FIGURE: 4	
GIS	CGE	8 May. 2012		
CHECK	SP	8 May. 2012		
REVIEW	RJ	8 May. 2012		

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXD\Draft\Aquatics\BenthicInvertebrate_FishTissueLocations_2010_2011.mxd

590000 600000 610000 620000 630000

5430000 5420000 5410000 5400000

N

Serpent Lake
Cornell Lake
TAILINGS MANAGEMENT FACILITY ALTERNATIVE 1
TAILINGS MANAGEMENT FACILITY BASE CASE
Sawbill Bay
MINE SITE LOCATION
Light Lake
TAILINGS MANAGEMENT FACILITY ALTERNATIVE 2
Lynxhead Bay
Upper Seine Bay
Finlayson Lake
RAFT LAKE CUT
Hawk Bay
Highway 622
Marmion Lake
Atikokan
Highway 11

LEGEND

- City/Town
- Existing Power Transmission Station
- Transport Canada identified Non-Navigable Waterways
- Raft Lake Cut Location
- Trail
- Road
- Provincial Highway
- Existing Railway
- Existing Power Transmission Line
- River/Stream
- Lake
- Wetland
- Proposed Site Access Road
- Hardtack / Sawbill Access Road Alternative 1
- Raft Lake Access Road Alternative 2
- Existing Premier Lake Access Road
- Proposed Raft Lake Powerline Alternative
- Proposed Hardtack Powerline Alternative
- Tailings Management Facility Base Case
- Tailings Management Facility Alternative 1
- Tailings Management Facility Alternative 2
- Project Location

DRAFT

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Transport Canada identified Non-Navigable Waterways - Provided by Transport Canada Marine, February 2010 (File Numbers 8200-09-6539, 8200-09-6538 and 8200-09-6536)
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2,500 0 2,500 5,000 7,500
SCALE 1:150,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
ALTERNATIVE INFRASTRUCTURE CORRIDORS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 2.0
DESIGN	CGE	16 Nov. 2010	FIGURE: 5	
GIS	CGE	8 May. 2012		
CHECK	BH	8 May. 2012		
REVIEW	SP	8 May. 2012		

G:\Projects\2010\10-1118-0020_BrettResources_HammondReefGIS\MXDs\Draft\Aquatics\AlternativeInfrastructureCorridors_30March2012.mxd

5.0 METHODS

Golder completed aquatic field studies in 2010 and 2011. They included the characterization of aquatic habitat, collection of basic surface water quality data (e.g. pH, dissolved oxygen, conductivity), benthic invertebrate community (BIC) and fish community assessment and the analysis of metals burdens in fish muscle tissue. Data was collected and archived using the field methods outlined in Golder's technical procedures (TPs).

5.1 Regulatory Consultation

The Ontario Ministry of Natural Resources (MNR) and Fisheries and Oceans Canada (DFO) have requested an opportunity to review baseline information, particularly fish and fish habitat information, in order to identify locations where additional aquatic information may be required to support the Environmental Assessment (EA) and permitting processes, including fish habitat compensation planning. It is anticipated that, following MNR and DFO review, data gaps will be discussed with the agencies and that additional field studies required to address deficiencies in the baseline will be conducted in 2012, if deemed appropriate.

A series of meetings/workshops were held with regulatory agencies to review/discuss a number of issues including field scope, approach to habitat assessment, regulatory requirements/approach to mitigation/ compensation and data completeness. The following meetings have been held to date:

- April 13, 2011 (Thunder Bay)
- July 12, 2011 (Atikokan)
- September 14, 2011 (Atikokan)
- February 29, 2012 (Thunder Bay)

5.2 Aboriginal Engagement

Osisko has engaged with identified Aboriginal communities throughout the EA process, including soliciting feedback on valued ecosystem components. First Nation Monitors also participated in Project baseline field data collection programs by accompanying the Golder technical staff as follows:

- Bathymetry: July 4 - 8, 2011
- Terrestrial Biology: July 18 - 22, 2011 and August 22 – 26, 2011
- Aquatic Biology: August 22- September 2, 2011
- Archaeology: October 17 - 23, 2011

Information related to each technical discipline will be included in the EA Report. For the aquatic biology component of the EA, this includes information related to fish spawning sites, fisheries and fish species of cultural significance.

DRAFT

5.3 Secondary Data Review

Marmion Lake reservoir was first constructed in 1926 (Boileau 2004) and the 3 block dams and the Raft Lake Dam were constructed in 1943 as part of the Seine River diversion. The 3 block dams include a spillway that effectively isolates lower Marmion Lake from upper Marmion reservoir also known as the upper floodwaters area. Water levels in upper floodwaters area are managed for multiple water uses including sustaining walleye spawning flows, storage for water power production and maintaining minimum water levels in lower Marmion Lake for the Atikokan TGS. Operation of the various dams and spillways is managed according to the Seine River Water Management Plan (Boileau 2004). In general, the dams controlling the upper floodwaters area allow for a winter drawdown of about 2.5 m, followed by rising water levels from April 15 to June 15 to accommodate walleye spawning.

The Marmion Reservoir has been a focus of MNR fisheries management over the past two decades and in particular, MNR has been interested in potential impacts on the walleye sports fishery, which was closed in the late 1990's in response to estimates of population declines (MNR, various; Jackson 2007). MNR identified a reduction of spawning success related to the Atikokan TGS, and a walleye spawning shoal was constructed at the inlet to Abie Lake to enhance spawning habitat. Monitoring of this spawning shoal and subsequent population assessments indicate that the walleye population is showing signs of recovery. As part of their past assessment work, MNR have identified Lynxhead Bay Narrows as a potential walleye spawning area in the upper floodwaters area of Marmion reservoir.

5.4 Primary Data Collection

Aquatic baseline data were collected in both 2010 and 2011, with approximate dates as outlined below. Most of the API's, beaver ponds and tributaries were visited on at least 2 occasions over the two year sampling program, with a number of key features being sampled in both sampling years (Table 1).

Table 1: Summary of Field Program Dates

Field Data Collected	2010	2011
Fish and Aquatic Habitat	May, August, September, October	May, August, September
Fish Tissue	August	September
Benthic Invertebrates	October	
Aquatic Sediments	October	

5.4.1 Fish Community Assessment

The objectives of fish community assessment studies were to establish what fish species were present in each aquatic feature, verify the presence of various life history stages present, identify fish frequented waters and non-fish bearing waters relative to the preliminary Project footprint provided by Osisko and collect samples to determine baseline concentrations of metals in fish muscle tissue. A variety of gears and techniques were utilized to confirm fish presence and fish community composition. Stationary fishing gears were set for 18 to 24 hour periods and at variety of depths in ponds and small lakes and in a variety of habitat in watercourses. Because of the nature of gillnetting gear (e.g. tangling gear) and the duration of sets, a large proportion of fish captured in gillnets were mortalities. Fishing gears included:

DRAFT

- **Nordic Nets:** The Nordic net is an internationally adopted netting gear used to characterize fish assemblages and assess fish community diversity in a variety of Scandinavian countries and within the Province of Ontario (Morgan and Snucins, 2005). Nordic nets consist of 30 m long, 1.5 m high gangs of 12 different 2.5 m long panels of 10 mm to 55 mm nylon mesh.
- **Standard Experimental Gill Net Gangs:** The standard experimental gang was adopted by the MNR in the late 1970s as the standard gear used to determine fish community composition for the Province's lake and river assessment program (MNR 1979). Experimental gangs consist of eight, 1.5 m high, 15.2 m long panels of 38 mm, 51 mm, 64 mm, 76 mm, 89 mm, 102 mm, 114 mm and 127 mm stretched, multifilament mesh.
- **Large and Small Mesh Broadscale Monitoring Nets:** The large mesh gillnet has been proposed by the American Fisheries Society as a North American standard for sampling angler harvested freshwater species. The small mesh gillnet is a new standard, developed in Ontario (Sandstrom et al. 2010). Jointly, the large and small mesh gillnets span a mesh size range that is similar to the Nordic gang. Large mesh broadscale nets are 49.6 m long and are comprised of eight, 3.1 m panels consisting of 38 mm, 51 mm, 64 mm, 76 mm, 102 mm, 114 mm and 127 mm stretched, monofilament mesh. Small mesh broadscale nets are 25.0 m long and are comprised of 1.8 m high panels of 13 mm, 19 mm, 25 mm, 32 mm and 38 mm stretched, monofilament mesh.
- **Minnow Traps:** a minnow trap is a small metal cylinder with narrow openings at either end that is typically used by anglers to collect baitfish. It can be baited with different baits, such as bread, meat scraps, to attract different small-bodied fish, and is usually used as a scientific apparatus to collect small, benthic fish or young-of-the-year fish.
- **Seine Netting:** A 15.2 m bag seine consisting of 6 mm, nylon mesh was used to capture fish in shallow habitats where bottom consisted of hard, relatively flat substrates with minimal organic debris (e.g. sunken branches). Seining effort is presented as area seined (m^2).
- **Backpack Electroshocking:** a backpack electrofisher is a device that consists of an anode (usually designed as a dipnet) and cathode (usually designed as a trailing metal wire or "rat tail") that creates an electric field around the operator. The operator walks in wadable waters, such as small streams, and fish are momentally rendered immobile by the electric field and can be captured on the anode or by a second person with a dipnet. Fish generally recover quickly and can be released.
- **Boat Electroshocking:** a boat electrofisher is a larger version of a backpack electrofisher that is set up on a boat. The cathode is generally a series of wires suspended from the sides of the boat and the anodes are on two booms that are placed off the front of the boat. One person operates the boat and one or two staff man dipnets in order to retrieve fish immobilized by the electric field. A boat electrofisher is designed to sample larger rivers or the littoral areas of lakes, and was used primarily in receiving bays of Marmion Reservoir and Lizard Lake.
- **Visual observations** in streams too narrow to electroshock or set other gears.

Data recorded on catch records included location [Global Positioning System (GPS) coordinates] at each end of stationary gear, start and end locations for electrofishing, time, date, gear type, depth, effort (square metres seined, meters of stream electroshocked or hours fished), numbers and life history stage (young-of-the-year,

DRAFT

juvenile and adults) of all fish species captured by species. Each location where fishing effort was expended has been assigned a unique number and these numbers appear in catch tables and on fish habitat maps.

5.4.2 Fish Habitat Mapping

Fish habitat was mapped to provide an inventory of the available habitats and to show the locations of habitats that are of importance to fish, such as spawning and rearing habitats. Table 2 contains a summary of data/variables measured during habitat mapping. These variables are defined in Appendix C. Some variables (e.g. substrate) are further broken down to classes (e.g. size ranges of gravel or cobble substrate) for the purpose of habitat mapping. Physical features, their locations and/or distribution were measured and recorded on data sheets and field maps by field crews who walked or navigated each aquatic feature. GPS referenced digital photos illustrating channel/shoreline characteristics were collected for each aquatic feature. Habitat maps for the Project were created by overlaying Light Detection and Ranging (LiDAR) images of aquatic features with field data. Lidar imagery, produced in June, 2010, was provided to Golder by Osisko (See Appendix A).

For Mitta Lake and API #2, both of which may be destroyed as a result of the Project, side scan sonar imaging was conducted to map bathymetry and bottom substrate. A differential GPS was used for positioning, to sub-metre accuracy. Navigation data was merged in real time with the bathymetry and side scan sonar data and collected using the Chesapeake software system SonarWiz. The SonarWiz software allows for surveying along pre-plotted survey lines with an off-track indicator but also supports ad-hoc survey requirements around shoals and along shorelines.

The survey was completed to generate an accurate DEM for the bathymetry within the water bodies noted above for use during fish habitat no net loss planning. Data was acquired at a rate of 5 Hz with a survey vessel speed of 10 km/hr to yield data along the survey track lines at a separation of approximately 0.5 m. The survey line data was acquired with two lines around the perimeter of the survey area – 25 m out from the shore and at 50 m out from the shoreline and with line spacings of 50 m or 75 m depending on the area of the water bodies and the water bottom relief and with crossing lines at 100 m intervals for additional data and Quality Assurance/Quality Control (QA/QC).

Bathymetry data was collected on all of the sidescan sonar transects, using a single beam automated hydrographic system (Odom Hydrotrack). This system provides digital output to the navigation computer and also prints a continuous profile of the lake bed on a thermal graphic recorder. The complete system produces accurate depth measurements (IHO standards) at a rate up to five soundings per second. The depth range is from 0.25 m to 600 m and the system supports the use of different frequency transducers selectable for the water bottom conditions. A “bar check” was completed in each of the main water bodies for calibrating the sound velocity in water.

Acoustic images of the lake floor were acquired using a 500 kHz side scan sonar system (GeoAcoustics). The survey transects were collected to provide 125 percent coverage of the lake bottom. Data was recorded and reviewed in real-time on the navigation computer (SonarWiz) and a full backup was recorded onto a Sony DAT, 16 channel tape recorder. The sidescan tow fish was towed from the stern or off the bow of the survey vessel.

The results are presented on a series of maps that include:

- bathymetric contour maps (0.5 m contours) and digital DEM; and

- surficial features maps based on interpretation of the sidescan sonar.

In beaver ponds, littoral zone habitat was mapped. Spot depths and bottom grabs were collected in order to determine general bathymetric and substrate characteristics. Habitat characteristics including maximum depth, temperature, dissolved oxygen and substrate characteristics were recorded.

Table 2: Habitat Features and Variables Measured During Baseline Studies

Habitat Features (Waterbodies)	Channel Units (Watercourses)	Habitat Features (Watercourses)	Substrate Types
Littoral/limnetic zones	Falls	Shoal	organic material
Shelf	Cascade	Slough	clay/silt
Shoals	Chute	Log jam	Sand
Bottom slope	Rapids	Undercut banks	Gravel
Submerged vegetation	Riffle	Unstable banks	Cobble
Emergent vegetation	Run	Inundated vegetation	Boulder
Depth	Flat	Beaver dam	Bedrock
Water Quality Parameters	Pool	Exposed bar	**Channel Unit Measures**
	Impoundment pool	Islands	Wetted width
Dissolved oxygen	Backwater	Bank/riparian vegetation	Channel width
Water temperature	Snye	Bank slope	Channel unit length
pH	Boulder garden	Gradient	Channel profile (depth)
Conductivity		Overhead cover	Velocity
		Instream cover	

Notes:
Definitions for habitat variables can be found in Appendix B.

Note that habitat maps have been prepared using several different scales.

5.4.3 Fish Tissues Analysis

Tissue samples were collected from fish species captured in potential receiving waterbodies using minnow traps, small mesh Nordic nets and experimental gill nets and analyzed to determine the baseline levels of bioaccumulation of metals and other potential contaminants. Samples of tissues (e.g., muscle) from a minimum of 5 individuals representing various trophic levels (e.g. planktivorous, benthic grazer and piscivorous species) and whole body samples of a small body fish species (e.g. cyprinids) were collected and analyzed to determine the existing levels of bioaccumulation of heavy metals (e.g. ICP-metal scan including total mercury) that may pose risks for human health and fish eating biota

Sample collection and storage followed Golder's Fish Health Assessment technical procedures (Golder 1997). Samples were preserved (frozen) on site and delivered to ALS Laboratory Group in Thunder Bay, Ontario. Analytical results provide a baseline for future conditions and results will be interpreted using existing sport fish consumption guidelines and Canadian Tissue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota (Canadian Council of Ministers of the Environment 1999) in the TSD to follow.

DRAFT

The heavy metals analyzed included: total silver, total aluminum, total arsenic, total barium, total beryllium, total bismuth, total boron, total calcium, total cadmium, total cerium, total cobalt, total chromium, total cesium, total copper, total europium, total iron, total gallium, total mercury, total lanthanum, total lithium, total magnesium, total manganese, total molybdenum, total niobium, total nickel, total lead, total rubidium, total antimony, total scandium, total selenium, total tin, total strontium, total thorium, total titanium, total thallium, total uranium, total vanadium, total tungsten, total yttrium, total zinc and total zirconium. Averages were calculated using the detection limit for non-detect values.

5.4.4 Benthic Community Assessment

A benthic community assessment was conducted in October 2010 in the lower reaches of APIs (Figure 4). Sample locations were selected above the influence of the receiving water bodies (i.e. Marmion Reservoir, Lizard Lake). At each station, five replicate samples were collected. Benthic samples were collected using a standard petite ponar dredge measuring 15 centimetres by 15 centimetres square. Samples were washed through a 500-µm sieve bag to remove fine particulates. Samples were transferred to labelled 1 Litre (L) sample bottles and preserved with 10% buffered formalin. All containers were also labelled internally with project number, date, and station information. All sieves and containers were rinsed with ambient water to ensure that all organisms were collected. Additional site specific data was also collected in support of the benthic sampling.

Benthic samples were submitted to Zaranko Environmental Assessment Services (ZEAS) for identification and enumeration. Benthic invertebrates were identified to the lowest practical taxonomic level, typically genus and species for most taxa, and family or order for specimens that could not be identified to a lower level.

Data quality was assessed visually in a spreadsheet format to identify potential data entry errors. Non-benthic organisms were removed from the data (round worms, springtails, indeterminate species of the order Diptera, and the phantom midge *Chaoborus favicans).* Pupae of benthic invertebrates were also not included in the data analysis.

D2.2 Data Analysis

Five benthic invertebrate community descriptors were calculated for each of the 6 sampling stations.

- Mean density, expressed as number of invertebrates per m².
- Mean taxa richness, the number of taxa (families) present at each station.
- Mean Simpsons Diversity index (SDI) value, based on the formula provided by Krebs (1985):

D = 1 – ∑ (pi)2, where D = Simpson's Diversity Index, pi = the proportion of the ith taxa at the station

- Mean Simpsons Evenness Index (SEI), evenness is calculated following Smith and Wilson (1996):

  $E = 1/\sum (p_i)^2/S$, where E = Simpson's Evenness Index, pi = the proportion of the ith taxa at the station, S = the total number of taxa at the station

- %EPT, total percentage of the orders Ephemeroptera, Plecoptera, and Trichoptera
- Community composition, the percent representation (relative abundance) of major taxonomic groups at each station.

DRAFT

Mean values for density, richness, SDI, SEI, and percent relative abundance were derived from the five replicate samples collected at each station in 2010.

5.4.5 Sediment Sampling

Sediment samples were collected concurrently with the benthic invertebrate sampling program in October 2010. All grab samples corresponded to the benthic sample locations. One sediment sample from each station was shipped on ice (along with a completed chain of custody form) to ALS Environmental in Thunder Bay, Ontario, for analysis of total organic carbon (TOC), and particle size.

6.0 RESULTS

6.1 Fish Community Assessment and Habitat Mapping

A total of 23 fish species, listed in Table 3 were captured during aquatic baseline studies for the Project.

Table 3: Fish Species Captured During Baseline Studies

Family/Subfamily	Species Common Name	Species Scientific Name
Coregoninae	Lake Whitefish Cisco	*Coregonus clupeaformis* *Coregonus artedi*
Umbridae	Central Mudminnow	*Umbra limi*
Esocidae	Northern Pike	*Esox lucius*
Cyprinidae	Longnose Dace Eastern Blacknose Dace Northern Redbelly Dace Finescale Dace Pearl Dace Fathead Minnow Spottail Shiner Blacknose Shiner Brassy Minnow Golder Shiner	*Rhinichthys cataractae* *Rhinichthys atratulus* *Phoxinus eos* *Phoxinus neogaeus* *Margariscus margarita* *Pimephales promelas* *Notropis hudsonius* *Notropis heterolepis* *Hybognathus hankinsoni* *Notemigonus crysoleucas*
Catostomidae	Common White Sucker	*Catostomus commersoni*
Gadidae	Burbot	*Lota lota*
Gasterosteidae	Ninespine Stickleback Brook Stickleback	*Pungitius pungitius* *Culaea inconstans*
Centrarchidae	Smallmouth Bass Pumpkinseed	*Micropterus dolomieu* *Lepomis gibbosus*
Percidae	Walleye Yellow Perch Iowa Darter	*Sander vitreus* *Perca flavescens* *Etheostoma exile*
Cottidae	Mottled Sculpin	*Cottus bairdii*

This list incorporates fish community sampling results from watercourses and water bodies which may be directly altered by the Project (e.g. the open pit, waste rock stockpile and TMF footprints) also includes fish species captured in water courses and water bodies located immediately up and downstream of the Project footprint (e.g. Marmion Reservoir and Lizard Lake) as fish inhabiting these features may utilize habitat within the

DRAFT

Project footprint seasonally (e.g. accessing water courses in order to reproduce). Fish community composition varies between catchments potentially affected by the project. Fish habitat and fish community data are presented for each aquatic feature, for each catchment in Appendix A.

The API factsheets describe the waterbodies physical and general chemical characteristics, fish community, sampling gear and locations, key habitat features/locations, representative photos, as well as key habitat features and fish use in both inflow and outflow tributaries. The factsheet also notes the relationship of the waterbody in its watershed and to the upper floodwaters area, and notes barriers to fish movement and describes the fish community at the discharge point to the upper floodwaters area, in this case Lynxhead Bay.

For each of the 23 fish species present in the study area, a life history/habitat preference table was prepared which summarizes key habitat use for each species (Appendix B). These habitat preference tables can be used in conjunction with the habitat maps to identify critical habitats for both individual species and selected fish communities or guilds in order to assess potential impacts from the project on aquatic resources. This approach can also be used to quantify available habitats for various species and to develop mitigation and compensation strategies consistent with DFO's no net loss policies.

6.2 Fish Tissue Analysis

A total of 88 tissue samples were collected and analyzed from Lizard lake, Sawbill Bay and Turtle Bay.

A total of five species were analysed for heavy metal content within their tissues (Cisco, White Sucker, Walleye, Lake Whitefish, and Blacknose Shiner). Table 4 provides a summary of the results. Appendix D contains the laboratory results.

6.2.1 Trace Metals

Table 4 summarizes the trace metal results of the fish tissue analysis. Blacknose Shiner specimens contained the highest calcium and zinc tissue concentrations (7970 mg/kg and 53 mg/kg, respectively). A Cisco specimen contained the highest concentration of bismuth (2.3 mg/kg). White suckers specimens contained the highest concentration of boron and copper (8.3 mg/kg and 1.2 mg/kg, respectively). Lake Whitefish specimens contained the highest concentrations of arsenic, zirconium and antimony (1.3 mg/kg, 1.2 mg/kg, and 1.1 mg/kg respectively. Walleye specimens accounted for the highest observed values for the eleven other metals tested. However, it should be noted that one specimen was responsible for 90% of the maximum levels observed for the species (OHR11FSBWALL010) (Appendix D).

DRAFT

Table 4: Selected Fish Tissue Trace Metal Results Summary (mg/kg wwt)

		Blacknose Shiner (n=2)			Lake Whitefish (n=22)			White Sucker (n=22)			Cisco (n=8)			Walleye (n=34)		
Parameter	**MDL**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**
Aluminum (Al)	*5.0*	24.2	33.7	14.7	10.2	40.2	2.5	14.9	49.1	2.5	21.1	32.9	6.1	15.6	55.6	2.5
Antimony (Sb)	*1.0*	<1.0	<1.0	<1.0	0.53	1.10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic (As)	*1.0*	<1.0	<1.0	<1.0	0.54	1.30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Barium (Ba)	*1.0*	0.90	1.30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beryllium (Be)	*0.20*	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2
Bismuth (Bi)	*1.0*	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.73	2.30	<1.0	0.5	1.9	<1.0
Boron (B)	*5.0*	<5.0	<5.0	<5.0	2.65	5.9	<5.0	2.8	8.3	2.5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium (Cd)	*0.20*	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2
Chromium (Cr)	*1.0*	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cobalt (Co)	*1.0*	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper (Cu)	*1.0*	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.53	1.20	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Lead (Pb)	*1.0*	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.56	1.80	<1.0	<1.0	<1.0	<1.0	0.5	2.0	<1.0
Magnesium (Mg)	*20*	278.0	285.0	271.0	252.2	330.0	183.0	255.2	319.0	187.0	289.5	338.0	227.0	346.9	2270.0	206.0
Silver (Ag)	*0.20*	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2
Tin (Sn)	*1.0*	1.50	1.70	1.30	1.16	2.30	<1.0	1.33	2.00	<1.0	1.05	1.80	<1.0	1.30	12.20	<1.0
Titanium (Ti)	*5.0*	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U)	*5.0*	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Vanadium (V)	*1.0*	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc (Zn)	*10*	46.50	53.00	40.00	<10	<10	<10	<10	<10	<10	<10	<10	<10	6.1	37.0	<10

DRAFT

6.2.2 Total Mercury

Total mercury content for fish tissue samples from Lizard Lake, Sawbill Bay and Turtle Bay are provided in Table 5.

Table 5: Total Mercury Levels in Fish Tissue Samples (µg/g, Detection Limit 0.050 µg/g)

Water Body	Species	Average	Maximum	Minimum
Turtle Bay	Blacknose Shiner (n= 1)	0.083	0.083	0.083
	Lake Whitefish (n=8)	0.241	0.329	0.135
	Walleye(n=8)	0.461	0.935	0.267
	White Sucker(n= 5)	0.185	0.301	0.072
Sawbill Bay	Blacknose Shiner (n=1)	0.066	0.066	0.066
	Lake Whitefish (n=14)	0.214	0.335	0.102
	Walleye (n=18)	0.523	1.660	0.232
	White Sucker (n= 11)	0.244	0.374	0.124
Lizard Lake	Cisco (n=8)	0.155	0.178	0.140
	Walleye (n= 8)	1.210	1.730	0.796
	White Sucker (n= 6)	0.239	0.408	0.140

Analytical results were compared to existing sport fish consumption guidelines and Canadian Tissue Guidelines for the Protection of wildlife Consumers of Aquatic Biota (Canadian Council of Ministers of the Environment 1999).

“Mercury is attracted to particles in the water and settles to the bottom sediments where it can be converted by microorganisms into methyl mercury. Methyl mercury is rapidly absorbed by a fish either directly from water passing over its gills or ingested with its diet. Since fish eliminate mercury at a very slow rate, concentrations of this substance gradually accumulate. For women of child-bearing age and children under 15, consumption restrictions for sport fish containing mercury begin at levels of 0.26 parts per million with total restriction advised for levels above 0.52 parts per million. For the general population, consumption restrictions begin at levels above 0.61 parts per million with total restriction advised for levels above 1.84 parts per million” (MOE 2011).

Based on these guidelines, 97 percent of the Walleye analyzed exceeded the consumption restrictions for sportfish containing mercury for women of child-bearing age and children under 15. Thirty-two percent of White suckers sampled and 27 percent of Lake Whitefish sampled also exceeded this guideline. Forty-one percent of Walleye samples analyzed exceeded the total restriction advised for sportfish containing mercury for women of child-bearing age and children under 15 while 35% exceeded the general population consumption restriction level of 0.61 ppm. No fish sampled exceeded the total restriction for the general population of 1.84 ppm.

DRAFT

6.3 Sediment Analysis

Sediments at each benthic community sampling station were analyzed for total organic carbon (TOC) content and grain size (Table 6). Sediment grain size ranged between sand to silty clay loam with TOC percentages between 0.94 and 35.6.

Table 6: Sediment Grainsize and Total Organic Content Analysis Results

	Sand (2.0 mm - 0.05 mm)	Silt (0.05 mm - 2 um)	Clay (<2 um)	Texture	Total Organic Carbon
Units	***%***	***%***	***%***	***-***	***%***
DI[a]	***0.1***	***0.1***	***0.1***	***-***	***0.1***
R1	92.7	7.06	0.24	Sand	1.44
R2*	55.7	42.6	1.65	Sandy loam	**32.1**
R4	46.2	41	12.8	Loam	0.94
R5	60.2	29.8	9.99	Sandy loam	1.64
R6	18.2	66.3	15.5	Silt loam	**12.4**
R7	24.6	47.9	27.5	Loam/Clay loam	**19.6**
R8	5.1	82.1	12.8	Silt loam	5.76
R9	48.3	41.2	10.5	Loam	**13.9**
R10	8	62.3	29.7	Silty clay loam	**27.4**
R11	17.3	67.4	15.3	Silt loam	7.38
R12	22.5	51.6	25.8	Silt loam	**23.1**
R13	37.1	47	15.9	Loam	8.91
R14	5.29	77.4	17.3	Silt loam	**35.6**
R15	70.5	23.4	6.09	Sandy loam	1.19

[a] detection limit

*Results unreliable. Insufficient soil for analysis

BOLD: indicates TOC values exceed Provincial Sediment Quality Guidelines (PSQG) of 10%.

A number of TOC values exceeded the PSQG of 10%, however these higher values are typical of highly organic sediments in wetland-dominated natural systems, such as those found in the study area.

6.4 Benthic Community Assessment

6.4.1 Benthic Invertebrate Density

Benthic invertebrate densities are naturally variable, reflecting change caused by a variety of both natural and anthropogenic influences. Response to anthropogenic influences can result in either an increase or decrease in benthic invertebrate density depending on the nature of the influence. Influences such as increased nutrient inputs from anthropogenic sources may benefit certain taxonomic groups resulting in an overall increase in density, while inputs of toxic substances can have an acute effect reducing invertebrate densities.

DRAFT

Average benthic invertebrate density varied greatly across the Study Area (Appendix D). The highest density (66,495 invertebrates per m^2) was observed at station R10 located on the shores of Lynxhead Bay. The lowest density (4,577 m^2) was observed at station R4 in Turtle Bay.

Densities at R10 were significantly higher ($p<0.05$) than all other stations with the exception of stations R5, R8, R11, R13 and R14; this is mainly attributable to numbers of *Microtenpidea (*midges; Chironomidae) and *Bivalvia* (bivales) found at this station. At R10, the dominance of fine sediments and high TOC concentrations may be the cause of the persistence of the disturbance-tolerant benthos (Table 8). The higher density at R10 suggests increased organic content. A relatively low dissolved oxygen concentration (5.65 mg/L) was also noted at this station, which may suggest a high biological oxygen demand (Table 7).

Table 7: Water quality conditions at benthic monitoring stations

Station	Dissolved Oxygen (mg/L)	Conductivity (mS/cm)	pH	Temperature (degrees Celsius)
R1	6.8	0.05	5.01	6.5
R2	5.06	0.023	4.2	3.71
R4	8.48	0.036	5.9	7.61
R5	12.11	0.034	5.77	9.47
R6	3.82	0.036	3.72	5.34
R7	11.24	0.021	3.84	7.18
R8	7.47	0.026	5.87	3.7
R9	9.48	0.068	4.48	7.32
R10	5.65	0.05	5.73	9.36
R11	7.61	0.063	4.85	7.52
R12	11.12	0.046	6.05	8.51
R13	8.61	0.156	6.61	7.35
R14	6.37	0.027	5.44	7.91
R15	11.16	0.059	6.31	7.56

6.4.2 Benthic Invertebrate Richness

Benthic invertebrate richness indicates the health of the community through its effects on diversity and increases with increasing habitat diversity, suitability, and water quality (Plafkin et al, 1989). The healthier the community is the greater number of taxa found within that community.

Average taxa richness varied slightly between stations with a low of 4 at stations R2 and R12 and a high of 11 at station R15 (Appendix D). Station R15 had significantly ($p<0.05$) higher taxa richness than R2, R6, R8, and R12.

6.4.3 Simpson's Diversity Index

SDI values range between 0 and 1 with higher values indicating greater diversity and lower values indicating lower diversity. Increasing diversity is positively correlated to overall community health.

Average SDI values ranged between 0.35 at station R9 and 0.71 at station R11 (Appendix D).

DRAFT

Though statistical analysis shows that the data sampled were not from populations with the same mean SDI values, no one station was significantly different from the others. The relatively low SDI scores at R9 are reflective of a combination of moderate taxa richness combined with low evenness (a representation of the relative abundance of the taxa present). Chironomidae (order Diptera) accounted for 84.18% of the species collected indicating that though the diversity at R9 is low, the water quality at this station would appear to be high due to the high abundance of the Chironomidae species (Figure 6).

6.4.4 Evenness

Evenness index values range between 0 and 1 with increasing numbers indicating increasing evenness. Healthier communities generally exhibit a more even distribution (higher evenness value) while lower evenness values generally indicate decreased health, with community structure favouring a few taxa.

Evenness values ranged from an average low of 0.30 at station R5 to a high at station R6 of 0.62 (Appendix D). Though statistical analysis shows that the data sampled were not from populations with the same mean SDI values, no one station was significantly different from the others. The relatively low evenness value observed at station R5 reflects the high percentage of *Tubificidae* worms (class Oligochaeta) and *Chironomidae* found at this station. These worms account for an average of 20% of the community structure, the second highest percentage of all stations sampled (R8 had an average 38% *Tubificidae* worms) (Figure 6).

6.4.5 %EPT

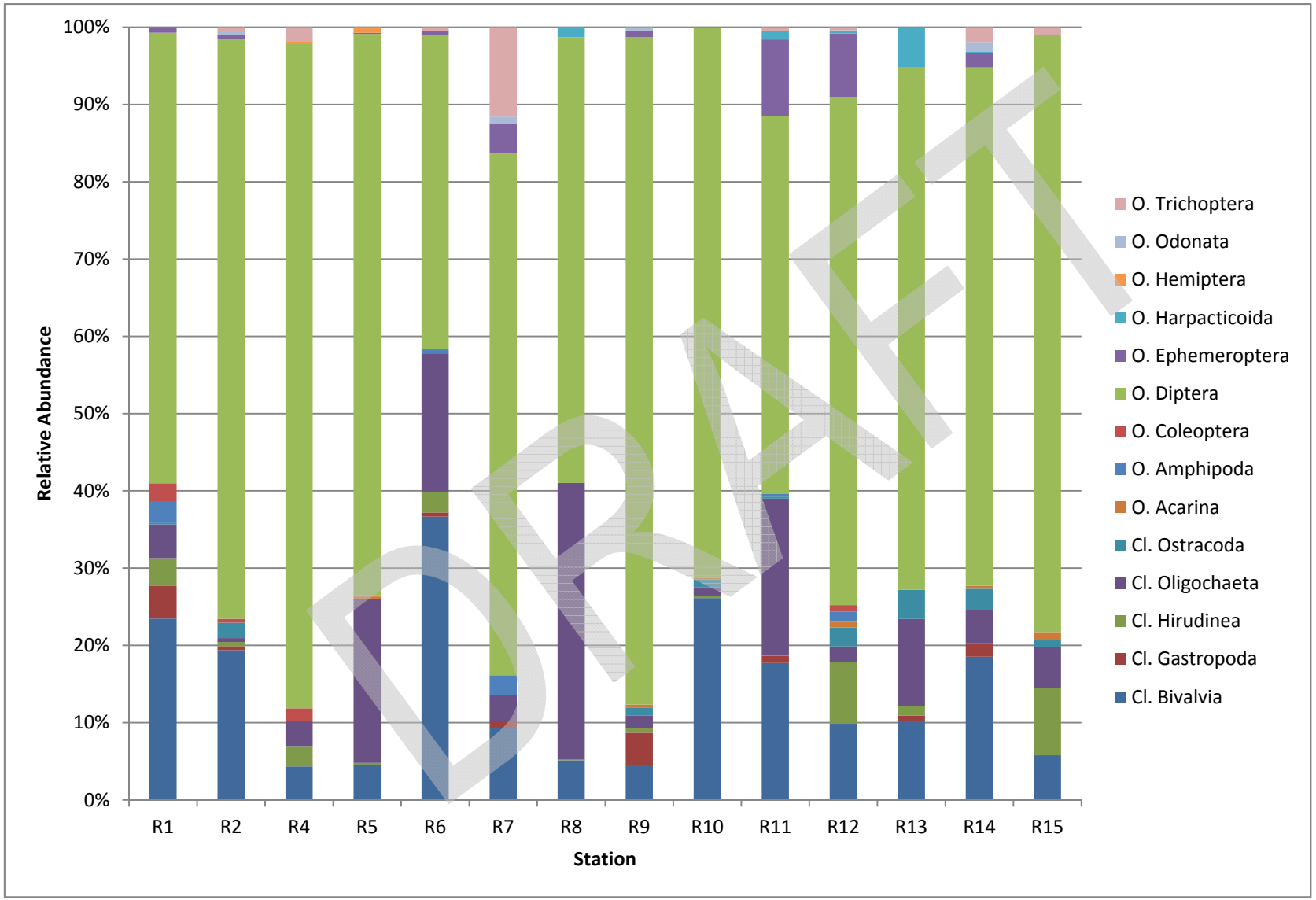
The percentage of the total abundance comprising Ephemeroptera, Placoptera, and Trichoptera taxa (%EPT) is a useful measure of richness of river and stream water quality. %EPT reflects the diversity of the aquatic assemblage. This measure is expected to decrease with increased disturbance.

The %EPT values ranged from an average low of 0% at stations R10 and R8 to a high of 14.82% at station R7 (Appendix D). The next highest average %EPT was observed at station R11 (9.64%). Station R7 had significantly higher %EPT than all other stations with the exception of R11, R13, and R15.

6.5 Benthic Community Composition

Benthic organisms were classified into dominant orders/groups and percent order/group was calculated (Figure 6). The most dominate family across all station was *Chironomidae (*non-biting midges). The second most dominant family was *Sphaeriidae* (fingernail clams, order Bivalvia).

DRAFT



DRAFT

Figure 6: Benthic Invertebrate Community Major Taxonomic Groups Relative Abundance

7.0 ADDITIONAL BASELINE STUDIES

Assessment of aquatic features was also conducted along access road/transmission corridor alternatives illustrated in Figure 1. The results of these assessments will be presented in the final aquatic baseline study report.

Surface water quality and hydrological studies have also been completed at the Site. The methods employed to collect this data and results of these studies will be analyzed and provided within the technical support document issued in support of the Project EA.

8.0 SUMMARY AND CONCLUSIONS

The aquatic baseline studies have been completed over two years, 2010 and 2011. Each of the API's potentially impacted by Project related effects was visited and assessed on multiple occasions, including fish community and habitat sampling, general chemistry. This interim report provides a detailed summary of this information for each API in the study area, as well as aquatic data collection in the upper floodwaters area. In addition, the review of secondary data sources indicates that MNR has actively conducted fisheries assessments of Marmion Lake since the early 1990's with particular emphasis on walleye, an important sport fish. Marmion Lake and the upper floodwaters area are part of a regulated system of dams, spillways and hydropower generators that are governed by the Seine River Water Management Plan (2004), a multi-stakeholder plan that manages water levels and flows for multi-use purposes. Collectively this comprehensive baseline of aquatics information will provide the basis for the completion of the Aquatic Technical Support Document and Project Environmental Assessment Report.

A summary of fish community assemblages present in the API's, both tributaries and ponds (respectively), are provided in Tables 8 and 9.

Table 8: Fish species assemblages in APIs (watercourses) assessed during Aquatic Baseline Program.

API #	Fish Species Assemblage												
	Finescale dace	Northern redbelly dace	Fathead minnow	Pearl dace	Blacknose dace	Brassy minnow	Iowa darter	Common white sucker	Northern pike	Yellow perch	Burbot	Central Mudminnow	Total species
1	X		X					X			X		4
4	X												1
5	X	X											2
6							X	X	X				3
8	No fish community												
9			X									X	2
10								X	X	X			3
11	X	X											2
12 (Mitta)	X	X	X					X					4

DRAFT

API #	Fish Species Assemblage												
	Finescale dace	Northern redbelly dace	Fathead minnow	Pearl dace	Blacknose dace	Brassy minnow	Iowa darter	Common white sucker	Northern pike	Yellow perch	Burbot	Central Mudminnow	Total species
14	X	X	X			X		X					5
16	No fish community												
40					X			X	X	X	X		5
41									X				1
42	X [2.]												1
44							X	X		X			3
46	X			X									2
47	X[1.]			X[1.]									2
48	No fish community												
49					X		X	X	X	X			5
69	No fish community												
Total	9	4	4	2	2	1	3	8	5	4	2	1	

1. Inferred; assemblage based upon fish community in upstream lake
2. Fish captured in one isolated pool near mouth/adjacent stream (API# 44)

Table 9: Fish species assemblages in APIs (ponds) assessed during Aquatic Baseline Program.

API #	SA (ha)	Max. Depth (m)	Fish Species Assemblage					
			fine scale dace	north. redbelly dace	fathead minnow	common white sucker	northern pike	Total
3	6.06	1.2	X	X		X	X	4
4	5.10	1.0	X	X				2
5	15.40	4.8	X	X				2
6	5.57	0.8	No fish community					
7	10.32	1.0	No fish community					
10	13.80	10.0	No fish community					
11	26.75	5.5	X	X	X			3
13	19.38	5.5	No fish community					
15	4.24	2.5	No fish community					
16	6.15	5.0	No fish community					
17	16.27	7.5	X	X	X			3

DRAFT

43	28.82	6.0	No fish community					
44	7.97	8.0	No fish community					
48	2.18	7.0	No fish community					
69	9.87	2.0	X	X				2
Total	-	-	6	6	2	1	1	_

Key findings of the baseline study are as follows:

- There were no coldwater fish species captured in the vicinity of the mine site. Watercourse temperatures tended to be very warm during summer months, except where subsurface flows resurfaced or where heavy forest provided shading.
- There were no coldwater seeps discovered at any of the APIs.
- Generally the watercourses are low gradient and highly influenced by beaver dams.
- Beaver activity has a pronounced effect on flows and connectivity of ponds and represent impediments to fish movement.
- In some watercourses, sections of channel and flows are either seasonal (API's 2, 15, 43, 48, 69), ephemeral (API's 1, 10, 43, 44, 46, 47) or sub-surface (API's 10, 16, 17, 47).
- Fishes from receiving waterbodies (i.e. upper Marmion reservoir and Lizard lake) can access the lower reaches of several of the watercourses, however this access is limited but upstream barriers:
  - This is evidenced by the capture of juvenile northern pike and common white suckers and/or yellow perch (API's 10, 40, 44, 49) in lower sections of streams;
  - Juvenile burbot were also captured in the lower reaches of 2 streams (API's 2, 40);
  - No adult, young-of-year or juvenile walleye or smallmouth bass were captured in any of the streams;
  - Streams likely provide spawning and nursery habitats for some reservoir dwelling species, for example northern pike, yellow perch and common white sucker. Spawning activity for these species was not documented.
- Water level management in reservoir and low water conditions likely limit accessibility by fish to tributaries and backwater or flooded areas:
  - This periodically, has a large impact on the suitability of mouths and lower reaches of many watercourses as nursery areas as evidenced by LiDAR imagery provided in Appendix 1.
  - Habitat suitability within embayments of the reservoir (i.e. Snail Bay) are a function of reservoir water levels and stream inflows.

DRAFT

  - Exceptions are the watercourses that drain the Hammond Peninsula; here, steep cascades in lower reaches preclude reservoir dwelling fish from ascending streams. As a result, some of these watercourses do not support fish communities (11, 12, 13).
- Flows in many watercourses appear to be very flashy and/or seasonal.
- Channels upstream of the backwater effect caused by reservoir water level fluctuations, are generally very shallow and narrow, and as a result offer very little refugia for fish
  - This is particularly the case for tributaries with small catchments/very small drainage areas;
  - Beaver ponds and headwater ponds likely serve as refugia and sources of fish to repopulate seasonal streams.
- Ponds in the study area varied in size and depth. Shallow ponds may be subjected to freezing and/or anoxia, as indicated by summer dissolved oxygen profiling.
- All ponds exhibited simple fish communities, usually dominated by cyprinids.
- Large bodied fishes were captured in a single pond (API 3), likely originated from a natural lake (API 8) located immediately downstream.
- Several ponds are physically disconnected from downstream waterbodies seasonally by damming or flows that are ephemeral or subsurface (API's 6, 7)
- Fish tissue concentrations of metals are highest in Walleye for the majority of the metals tested.
- Fish tissue concentrations of total mercury exceed regulatory guidelines in walleye.
- The metrics calculated for each waterbody indicates a uniform system when comparing benthic community composition or fish tissue metal concentrations which will provide a good aquatic baseline against which to measure future potential project effects.
- Benthic communities composition is relatively even across the study area. It would appear that R15 has a slightly healthier benthic community when comparing taxa richness values while R10 appears to be the poorest in quality when comparing density.

DRAFT

9.0 REFERENCES

Bradbury, C. M., M. Roberge and C.K. Minns. 1999. Life history characteristics of freshwater fishes occurring in Newfoundland and Labrador, with major emphasis on lake habitat characteristics. Can. MS Rep. Fish. Aquat. Sci. 2485:vii+150p.

Boileau, D. 2004. 2014 – 1014 Seine River Water Management Plan. 199 pp.

Canadian Council of Ministers of the Environment. 2000. Canadian tissue residue guidelines for the protection of wildlife consumers of aquatic biota: Methylmercury. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Colby, P.J., R.E. McNicol and R.A. Ryder. 1979. FAO Fish. Synop. Synopsis of biological data on the walleye, *Stizostedion v. vitreum* (119): 139 p.

Fish Species Habitat Suitability Index Models for the Alberta Oil Sands Region (Golder 2008).

Holland, L.E. and M.L. Huston. 1984. Relationship of young-of-the-year Northern Pike to aquatic vegetation types in backwaters of the upper Mississippi River. North American Journal of Fisheries Management 4:514-522.

Hall-Armstrong, J, A.G. Harris and R.F. Foster. 1996. Fish use of wetlands in Northwestern Ontario: a literature review and bibliography. Northwest Sci. & Technol., Ont. Min. Natur. Resour., Thunder Bay, Ont. TR-90. 54 pp+.

Holm, E., N.E. Mandrak and M.E. Burridge. 2009. The ROM field guide to freshwater fishes of Ontario. Royal Ontario Museum, Friesens Printers , Altona, MB. 462p.

Inskip, P.D. 1982. Habitat suitability index models: Northern Pike. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.17. 40 p.

Jackson, B. 2007. Status of Walleye Population in Lower Marmion Lake: 2007 Assessment and Management Options. 15 pp.

Kerr, S.J., B.W. Corbett, N.J. Hutchinson, D. Kinsman, J.H. Leach, D. Puddister, L. Stanfield and N. Ward. 1997. Walleye habitat: A synthesis of current knowledge with guidelines for conservation. Pecid Community Synthesis, Walleye Habitat Working Group, Ontario Ministry of Natural Resources, Peterborough, Ontario. 82 p.

McMahon, T.E., J.W. Terrell, and P.C. Nelson. 1984. Habitat suitability information: Walleye. U.S. Fish Wildl. Serv. FWS/OBS-82/10.56. 43 pp.

Ministry of Natural Resources. 1979. Manual of Instructions Aquatic Habitat Inventory Surveys. Ontario Ministry of Natural Resources Queens Park Printer for Ontario 1979. 212p + appendices.

Ministry of the Environment (MOE). 2011. Guide to Eating Ontario Sport Fish 2011-2012 Queen's Printer for Ontario, 2011

DRAFT

Morgan, G.E. and Ed Snucins. 2005. Manual of Instructions NORDIC Index Netting. Ontario Ministry of Natural Resources. Queens Park Printer for Ontario. 2005. 32p + appendices.

Lane, J.A., C.B. Portt and C.K. Minns. 1996. Spawning habitat characteristics of Great Lakes fishes. Can. MS Rep. Fish. Aquat. Sci. 2368: v+48p.

Lane, J.A., C.B. Portt and C.K. Minns. 1996. Nursery habitat characteristics of Great Lakes fishes. Can. MS Rep. Fis. Aquat. Sci. 2338: v+42p.

Lane, J.A., C.B. Portt and C.K. Minns. 1996. Adult habitat characteristics of Great Lakes fishes. Can. MS Rep. Fis. Aquat. Sci. 2358: v+43p.

Langhorne, A.L., M. Neufeld, G. Hoar, V. Bourhis, D.A. Fernet, and C.K. Minns. 2001. Life history characteristics of freshwater fishes occuring in Manitoba, Saskatchewan, and Alberta, with major emphasis on lake habitat requirements. Can. MS Rpt. Fish. Aquat. Sci. 2579:xii+170p.

Portt, C.B., G. Coker and C.K. Minns. 1999. Riverine habitat characteristics of fishes of the Great Lakes watershed. Can. MS Rpt. Fish. Aquat. Sci. 2481:vi+62p.

Richardson, E.S., J.D. Resit and C.K. Minns. 2001. Life history characteristics of freshwater fishes occurring in the Northwest Territories and Nunavut, with major emphasis on lake habitat characteristics. Can. MS Rep. Fish. Aquat. Sci. 2569:vii+146p.

Roberge, M., T. Slaney and C.K. Minns. 2001. Life history characteristics of freshwater fishes occurring in British Columbia with major emphasis on lake habitat requirements. Can. MS Rpt. Fish. Aquat. Sci. 2574: i + 41 p.

Twomey, K.A., K.L. Williamson and P.C. Nelson. 1984. Habitat suitability index models and instream flow suitability curves: White Sucker. U.S. Fish Wildl. Serv. FWS/OBS-82/10.64. 56 pp.

Sandstrom, S, M. Rawson and N. Lester. 2010. Manual of Instructions for Broad-scale Fish Community Monitoring; using Large Mesh Gillnets and Small Mesh Gillnets. Ontario Ministry of Natural Resources. Peterborough, Ontario. Version 2010.1 34 p. + appendices.

Scott, W.B. and E. J. Crossman, 1973. Freshwater fishes of Canada. Bulletin 184, Fisheries Research Board of Canada, Ottawa, ON. xviii + 966p.

DRAFT

Report Signature Page

GOLDER ASSOCIATES LTD.

DRAFT

John Seyler
Associate, Aquatics Component Leader

JS/KAB/ls/sv

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

\\golder.gds\gal\mississauga\active\2010\1118\10-1118-0020 brett resources-hammond reef\005 environmental\1000 seia report\01 tsds\aquatic environment tsd\04 appendices\app 2.ii aquatic baseline\6_hammond reef aquatic interim baseline_revd_03jul2012.docx

DRAFT

APPENDIX A

Aquatic Baseline Study Results

DRAFT

July 3, 2012
Report No. 10-1118-0020 **(5200)**

Golder Associates

Catchment B

CATCHMENT B

Catchment B is overlapped by the proposed base case TMF and TMF Alternative 1 (Figures 1 and 2). The catchment area is 609.8 hectares. Aquatic features within the catchment include a headwater lake (APIs #47) and a headwater pond (API #48) both of which located outside of the TMF, and a beaver pond system (API #1). Although streams from APIs #47 and #48 appear on maps to converge into a single stream channel, API #1, these features are actually disconnected from one another. API #1 flows southwards through the TMF eventually emptying into the northeast portion of Sawbill Bay (Figure 2). Should either the base case TMF or TMF Alternative 2 be selected, portions of the outflow streams associated with APIs #47 and #48 would be destroyed. Large sections of API #1 would also be destroyed and contained within the TMF. Flows in the lower section of API #1, where it flows into upper Sawbill Bay, may potentially be altered.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment b overview.docx

API #47 (HEADWATER LAKE)

This pond has a surface area of 60,016 square meters and a maximum depth of 11.0 m (Figure 47-1). The lake shoreline consists primarily of boulder and bedrock and has very little wetland habitat around its perimeter (Photo 1). Bottom substrate along the shoreline is primarily boulders and silt. Aquatic vegetation is sparse. There is no inflow to the lake and two permanent outflows located near its northeast corner, which converge into a single stream channel (Photos 2 and 3). Discharge was measured at 0.005 m^3/s in May 2011. Littoral zone cover is provided by large boulders and extensive woody debris, fallen timber, along the lake shoreline (Photo 4).

Table 1 summarizes basic water chemistry and the temperature- dissolved oxygen profile data collected in May 2011. The lake was visited too early in the year to determine whether or not it thermally stratifies. Low oxygen levels were recorded below a depth of 5 m. Water in the lake was very clear. Secchi depth was 4.5 m.

Table 1: API #47 (lake), Basic Water Chemistry Parameter Data (May 2011)

Depth (m)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
Surface	10.1	7.4	59	10.4
1	10.0	-	59	10.4
2	10.0	-	59	10.2
3	7.7	-	59	9.2
4	6.4	-	61	8.2
5	5.7	-	64	6.0
6	5.1	-	75	2.3
7	4.9	-	84	0.8
8	-	-	-	0.5
9	-	-	-	-

API #47 was fished on a single occasion. It is inhabited by finescale and pearl dace (Table 2).

Table 2: API #47 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 47-1)	Date	Gear	Effor	Catch
76	May 9-10, 2011	nordic net	16 hrs.	finescale dace (503 adults) pearl dace (5 adults)
77	May 9-10, 2011	nordic net	18 hrs.	finescale dace (423 adults) pearl dace (13 adults)

API #47 (HEADWATER LAKE)

Fish Effort Location (see Figure 47-1)	Date	Gear	Effor	Catch
78	May 9-10, 2011	gillnet – experimental mesh	17 hrs.	no catch
79	May 9-10, 2011	minnow traps (4)	68 trap hrs.	finescale dace (72 adults) pearl dace (2 adults)

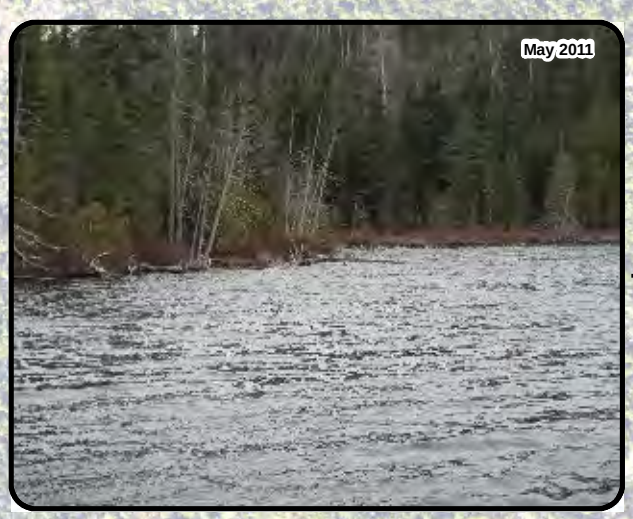
n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 47\api 47 headwater lake.docx

617200 617400 617600

5428800 5428600 5428400 5428200

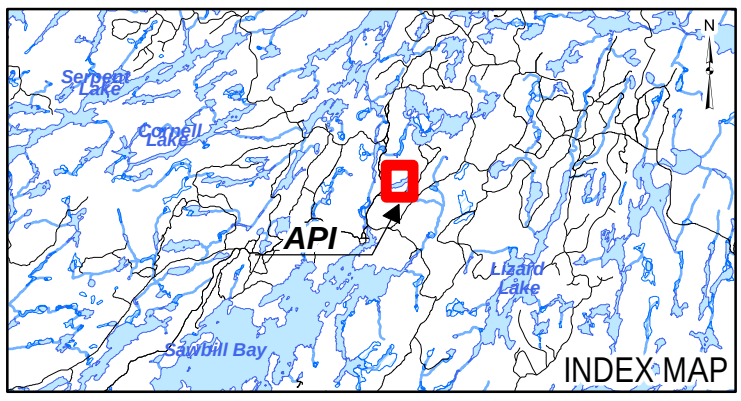
N

Si
Bo/Si
CF
77
2.5m
Bo/Si
CF
Bo/Si
79
Outflow
Co/Si
Bo/Si
Be
Be
Bo/Si
79
Be/Bo
Bo
Outflow
CF
79
CF
10.0m
78
Bo/Si
11.0m
Bo/Be
Si
76
2.5m
CF
CF
Bo/Si
Bo/Si
Bo
79
Be



617200 617400 617600

75 0 75 150
SCALE 1:3,000 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)
- Steep Slope (31 to 70%)

Riparian Vegetation
CF - Coniferous Forest

Substrate Classification
Be -Bedrock
Bo -Boulder
Co -Silt
Si -Silt

Bank Features
Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 47
(HEADWATER LAKE)

Golder Associates
Mississauga, Ontario

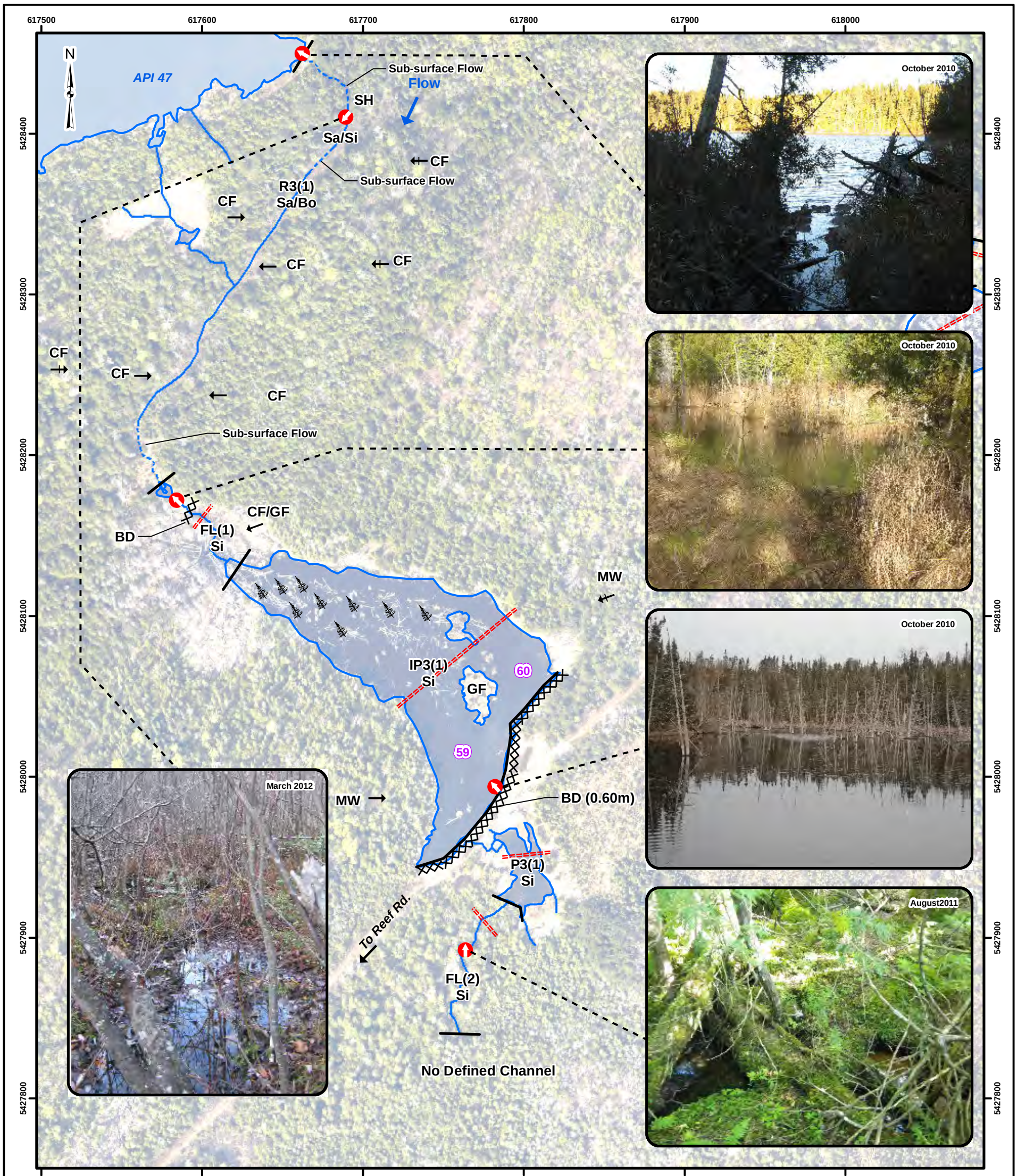
PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 47-1	
GIS	DM	11 Apr. 2012		
CHECK	JD	11 Apr. 2012		
REVIEW	JS	11 Apr. 2012		

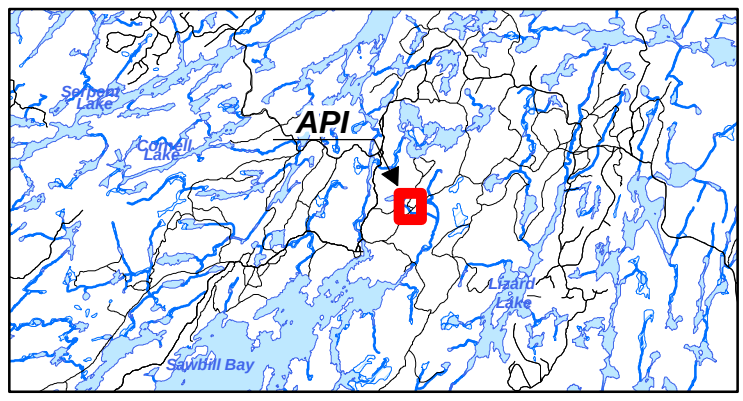
Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_47.mxd

API #47 (STREAM)

The stream draining API #47 flows through a heavily forested area immediately downstream of the pond. The channel is difficult to distinguish in the upper 450 m. Approximately 817 m downstream of its origin, the stream channel becomes indistinguishable, and the drainage becomes wetted forest (Figure 47-2). The stream is ephemeral beyond this point. A large, shallow (i.e. less than 1 m deep) beaver impoundment and an abandoned road bed impedes downstream flow into the forested area (Figure 47-3). The stream was not fished. It is assumed that the beaver impoundment is capable of supporting the cyprinid fish species which occupy the upstream pond.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 47\api 47 stream.docx





Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
R3(1)	333.68	6.4	-	Sa	Bo	0
FL(1)	90.69	1.16	0.26	Si	-	0
IP3(1)	224.77	105	1	Si	-	60
P3(1)	64.53	29	0.6	Si	-	20
FL(2)	103.47	1.3	-	Si	-	30

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
- FL - Flat, Low Gradient, Low Velocity
- IP3 - Impoundment Pool: Class 3
- P3 - Lowest Quality Pool Habitat (not suitable for overwintering)
- R3 - Lowest Quality Run Habitat

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)

Substrate Classification
- Bo -Boulder
- Sa -Sand
- Si -Silt

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- MW -Mixed Wood Forest
- SH - Shrub

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

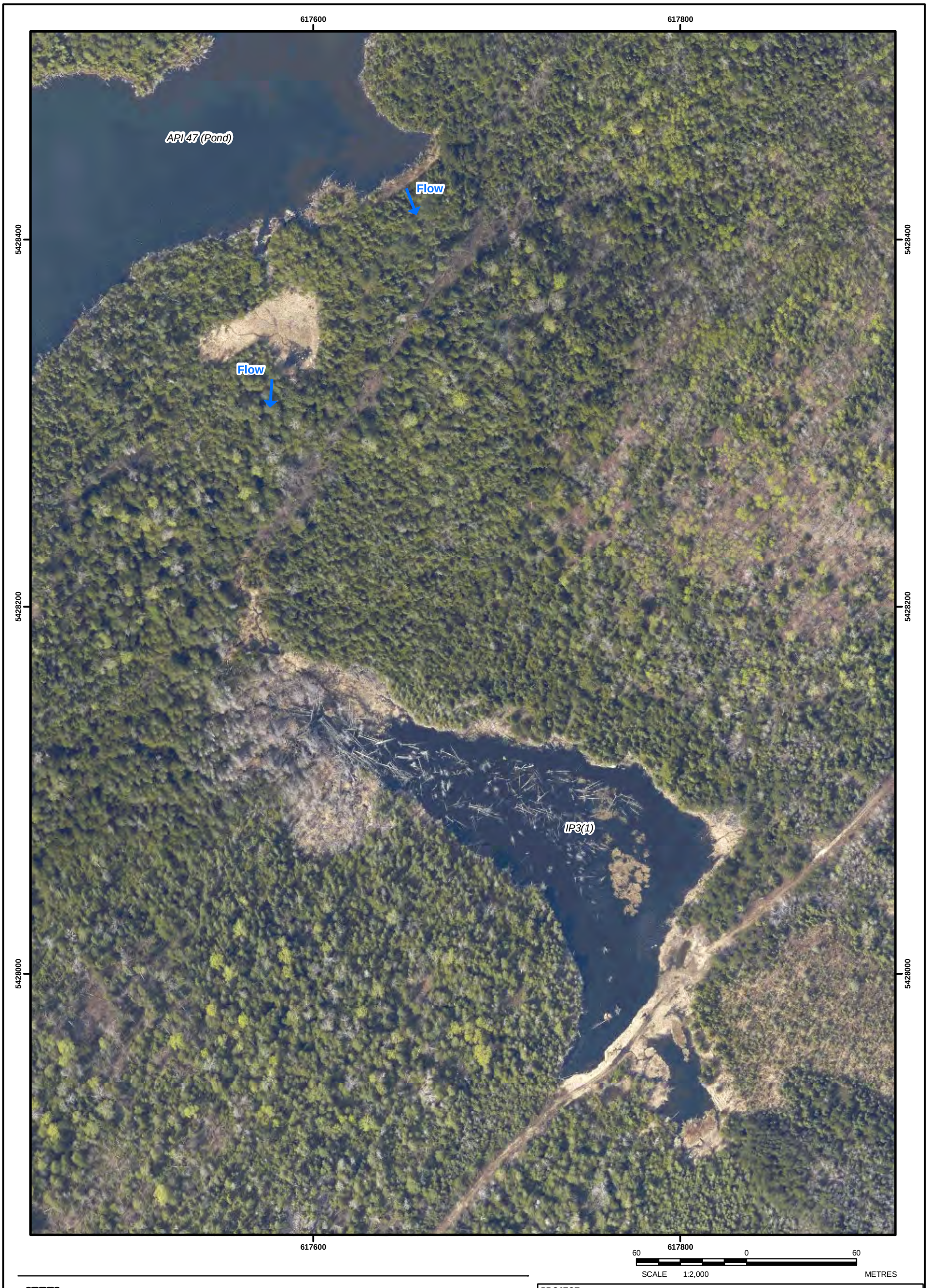
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 47 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 47-2	
GIS	DM	05 April 2012		
CHECK	JD	09 April 2012		
REVIEW	JS	15 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_47b.mxd



Beaver Dam

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 47 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 47-3	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #47 PHOTO LOG

Photo 1: Looking southwest (outflow along lower left shoreline).

Photo 2: Looking towards outflow on northeast shoreline.

API #47 PHOTO LOG

Photo 3: Outflowing channel.

Photo 4: Shoreline.

API #48 (POND)

This pond has a surface area of 2,175 square meters and a maximum depth of 7.0 m (Figure 48-1). The pond is approximately 20 m wide and 40 m in length. The shoreline consists entirely of grasses and shrubs. Bottom substrate is silt. Aquatic vegetation is extensive. There is no inflow to the pond and a single, permanent outflow located near its southwest corner. The outflowing channel is not dammed, but empties into a series of beaver impoundments approximately 55 m downstream of the pond. There is no backwater effect from the downstream beaver pond, upon API #48. Discharge at the outflow was measured at 0.00 m^3/s in May 2011.

Table 1 summarizes basic water chemistry and the temperature-oxygen profile data collected in May 2011. Low oxygen levels were recorded below a depth of 3 m. The pond's water was very dark and visibility was poor.

Table 1: API #48 (pond), Basic Water Chemistry Parameter Data (May 2011)

Depth (m)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
Surface	15.9	6.9	61	7.3
1	13.2			6.5
2	8.1			3.8
3	5.1			5.4
4	3.6			1.8
5	3.6			0.7
6	3.6		144	0.5
7	-			-

The pond was fished in May, 2011 (Table 2). No fish were captured.

Table 2: API #48 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (See Figure 48-1)	Date	Gear	Effort	Catch
80	May 29-30, 2011	minnow traps (3)	69 trap hrs.	no catch
81	May 29-30, 2011	minnow traps (2)	48 trap hrs.	no catch
82	May 29-30, 2011	nordic net	24 hrs.	no catch

618550 618575 618600 618625 618650

5429100 5429075 5429050 5429025 5429000

N

Si 3.0m GF

80

81

82 3.6m

CF

Outflow

Si

Si

7.0m

CF

GF

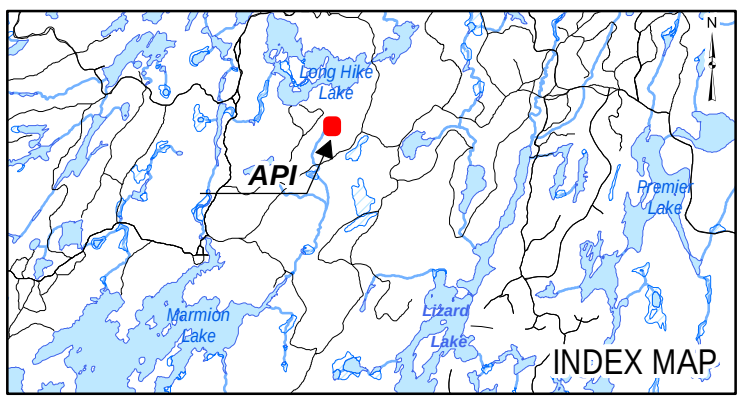
CF

Si

GF

10 0 10 20

SCALE 1:500 METRES



LEGEND: Legend features may not occur on every map

Photo Location & Direction
Fish Effort Location
Woody Debris
XXXX BD Beaver Dam (height m)
Beaver Lodge

Bank Slope
Shallow Slope (0 to 5%)

Substrate Classification
Si -Silt

Riparian Vegetation
CF - Coniferous Forest
GF - Grass and Forbs

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 48
(HEADWATER POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 48-1	
GIS	DM	11 Apr. 2012		
CHECK	JD	11 Apr. 2012		
REVIEW	JS	11 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_48.mxd

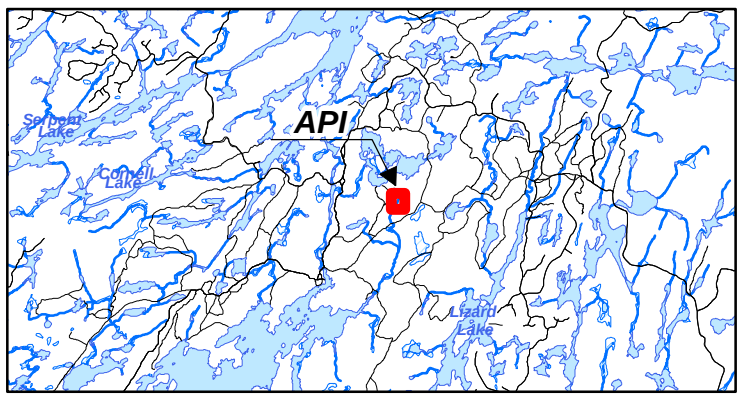
API #48 (STREAM)

This stream was mapped in May 2011. The upper reach of this stream consists of a flat, narrow channel that flows into a series of large, shallow beaver impoundments (Figure 48-2; Photos 1, 2 and 3). This series of pond is approximately 375 m in length. The ponds have a controlling effect on stream flow. Downstream of the ponds, the stream becomes a series of run segments interspersed with moderately steep cascades and wetted forest. Very little flow was evident during mapping. One segment of lower stream was completely dry (Figure 48-3). The stream ends at an abandoned forest access road which acts as a dam (Photo 4). The stream system is cut off from the rest of the catchment beyond this location. The south side of the road was dense forest. There is no identifiable culvert in the road base and there was no evidence of flow from the upstream pond through (i.e. sand, gravel in the forested area south of the road) or over (i.e. erosion of road base) the road. No standing water and no stream channel was detected on the south side of the road. The pond immediately above the road was electrofished. No fish were captured. No fish were observed anywhere along the stream when mapping was completed.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 48\api 48 stream.docx

SCALE 1:1,500 (60 0 60 METRES)

Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
R3(1)	33.80	1.4	-	Si	Bo	0
IP3(1)	359.80	40	-	Si	-	5
FL(1)	55.20	0.95	-	Si	-	0



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment Pool: Class 3
R3 - Lowest Quality Run Habitat

Substrate Classification
Bo -Boulder
Si -Silt

Riparian Vegetation
CF - Coniferous Forest
GF - Grass and Forbs
SH - Shrub

Bank Slope
← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

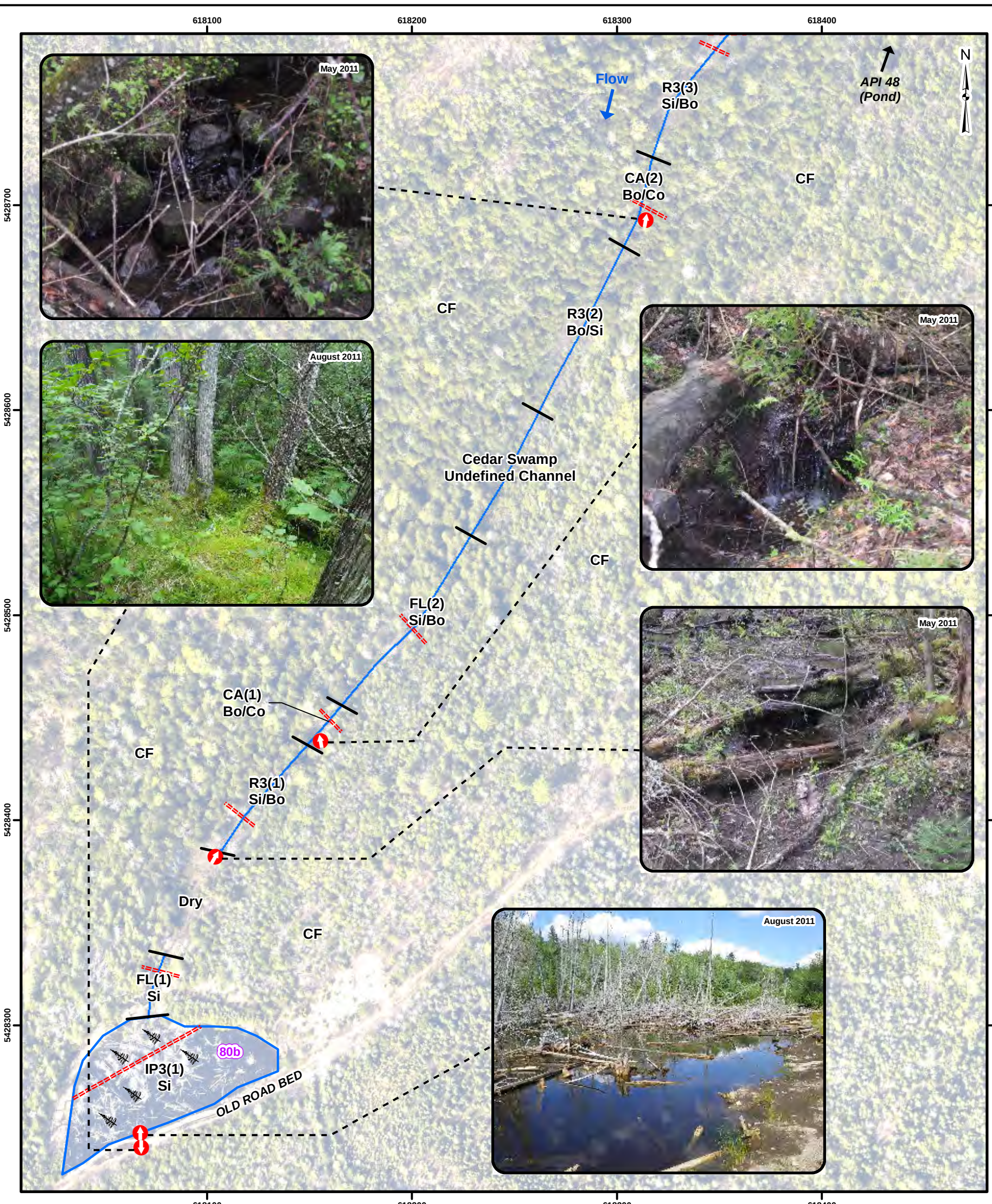
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 48 (STREAM)
(1 OF 2)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 48-2	
GIS	DM	13 Apr. 2012		
CHECK	JD	13 Apr. 2012		
REVIEW	JS	13 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_48c.mxd

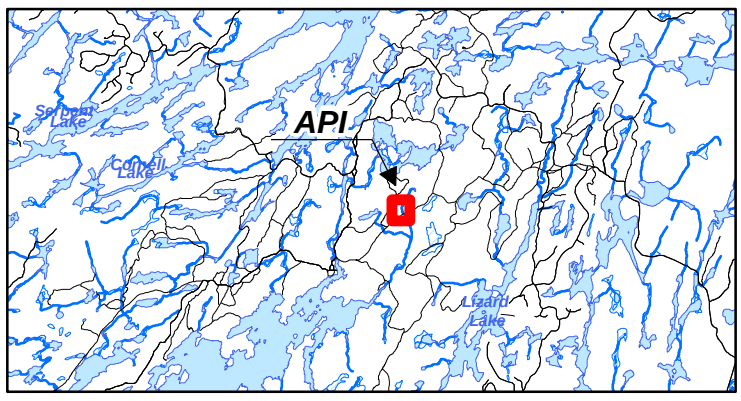


618100 618200 618300 618400

80 0 80

SCALE 1:2,000 METRES

Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
IP3(1)	57.20	60	0.68	Si	-	5
FL(1)	30.00	6.4	0.56	Si	-	0
N/A (dry)	54.00	N/A	N/A	N/A	N/A	N/A
R3(1)	67.00	1.9	0.13	Si	Bo	0
CA(1)	24.00	1.45	0.04	Bo	Co	0
FL(2)	101.00	1.2	-	Si	Bo	0
N/A (treed swamp)	69.00	N/A	N/A	N/A	N/A	N/A
R3(2)	91.00	-	-	Bo	Si	5
CA(2)	45.00	1.35	-	Bo	Co	0
R3(3)	71.77	1.4	-	Si	Bo	0



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
- CA - Cascade: Extremely High Gradient and Velocity
- FL - Flat, Low Gradient, Low Velocity
- IP3 - Impoundment Pool: Class 3
- R3 - Lowest Quality Run Habitat

Substrate Classification
- Bo -Boulder
- Co -Cobble
- Si -Silt

Riparian Vegetation
- CF - Coniferous Forest

Bank Slope
- ← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 48 (STREAM)
(2 OF 2)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 48-3	
GIS	DM	04 April 2012		
CHECK	JD	15 April 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_48b.mxd

API #48 PHOTO LOG

Photo 1: Aerial view of beaver dams.

Photo 2: Beaver dam located downstream of headwater pond.

API #48 PHOTO LOG

Photo 3: Beaver impoundments.

Photo 4: Abandoned forest access road and termination of API #48 stream.

API #1 (STREAM)

This stream system flows through approximately 2,690 m of dense forest. The upper section of the stream system is comprised of shallow beaver dams, connected to one another by wetted forest (i.e. lowlying areas of cedar swamp where water pools) or by ephemeral drainage. Table 1, summarizes water chemistry parameters measured in API #1, in the field.

Table 1: API #1 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2011	16.0	15.0	4.9	49	5.0

The uppermost portion of the stream consists of a shallow beaver pond connected by with a surface area of approximately 420 m^2. A stream channel, approximately 323 m in length flows through an open meadow and drains into the pond. Channel width varies between 1 m and 2 m. Stream substrate is silt. Beyond 323 m, the channel is undefined, draining a dense forested area (Figures 1-1 and 1-2). The ponds and upstream channel were fished in June and August 2011 (Table 2, fishing locations #65 and #66). This upper portion of API #1 supports finescale dace and fathead minnow populations.

Table 2: API #2 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 1-1, 1-3, 1-4, 1-5)	Date	Gear	Effort	Catch
65	August 30, 2011	minnow traps (2)	40 trap hrs.	finescale dace (42 adult, 8 juvenile) fathead minnow (29 adult, 14 juvenile)
66	August 30, 2011	backpack electrofisher	216 m	finescale dace (93 adult, 115 juvenile) fathead minnow (4 adult, 2 juvenile)
349	June 1, 2011	minnow traps (3)	66 trap hrs.	finescale dace (59 adults) fathead minnow (6 adults)
350	June 1, 2011	minnow traps (3)	63 trap hrs.	finescale dace (13 adults) fathead minnow (9 adults)

API #1 (STREAM)

61a	August 29, 2011	backpack electrofisher	845 m	common white sucker (4 juvenile) finescale dace (9 adult, 3 juvenile) fathead minnow (4 juvenile)
61b	August 29, 2011	backpack electrofisher	268 m	common white sucker (1 juvenile, 11 YOY) finescale dace (20 adult, 11 juvenile) fathead minnow (1 adult)
61c	August 29, 2011	backpack electrofisher	300 m	common white sucker (8 juvenile, 24 YOY) finescale dace (40 adult, 13 juvenile) fathead minnow (1 adult, 2 juvenile)
70	August 4, 2011	backpack electrofisher	180 m	common white sucker (4 juvenile, 12 YOY) finescale dace (72 adult, 4 juvenile) burbot (1 juvenile)
69	May 12, 2011	backpack electrofisher	250 m	common white sucker (20 juvenile) finescale dace (24 adult, 22 unk.)

Downstream of the first beaver pond, the stream flows through a flooded cedar swamp. No identifiable channel or feature is evident for approximately 220 m where a second, shallow beaver pond exists (Photo 1). T his pond has a surface area of approximately 2,250 m^2. It is inhabited by finescale dace and fathead minnows (Table 2, fishing location #349). There is no defined outflow nor any channel downstream of this second pond for approximately 112 m where a third, isolated beaver pond exists in a lowlying area of dense cedar (Figure 1-3). This pond is also inhabited by finescale dace and fathead minnows (Table 2, fishing location #350). There is no defined stream channel below this pond for approximately 385 m where the stream channel then emerges from the cedar swamp. The stream becomes permanent at this location.

This section of stream is a low gradient flat. It was electroshocked in August 2011. Juvenile common white suckers were captured in this stream reach. Below this flat channel segment the stream channel consists of a series of beaver impoundments (Figure 1-4). Juvenile and young-of-the-year

API #1 (STREAM)

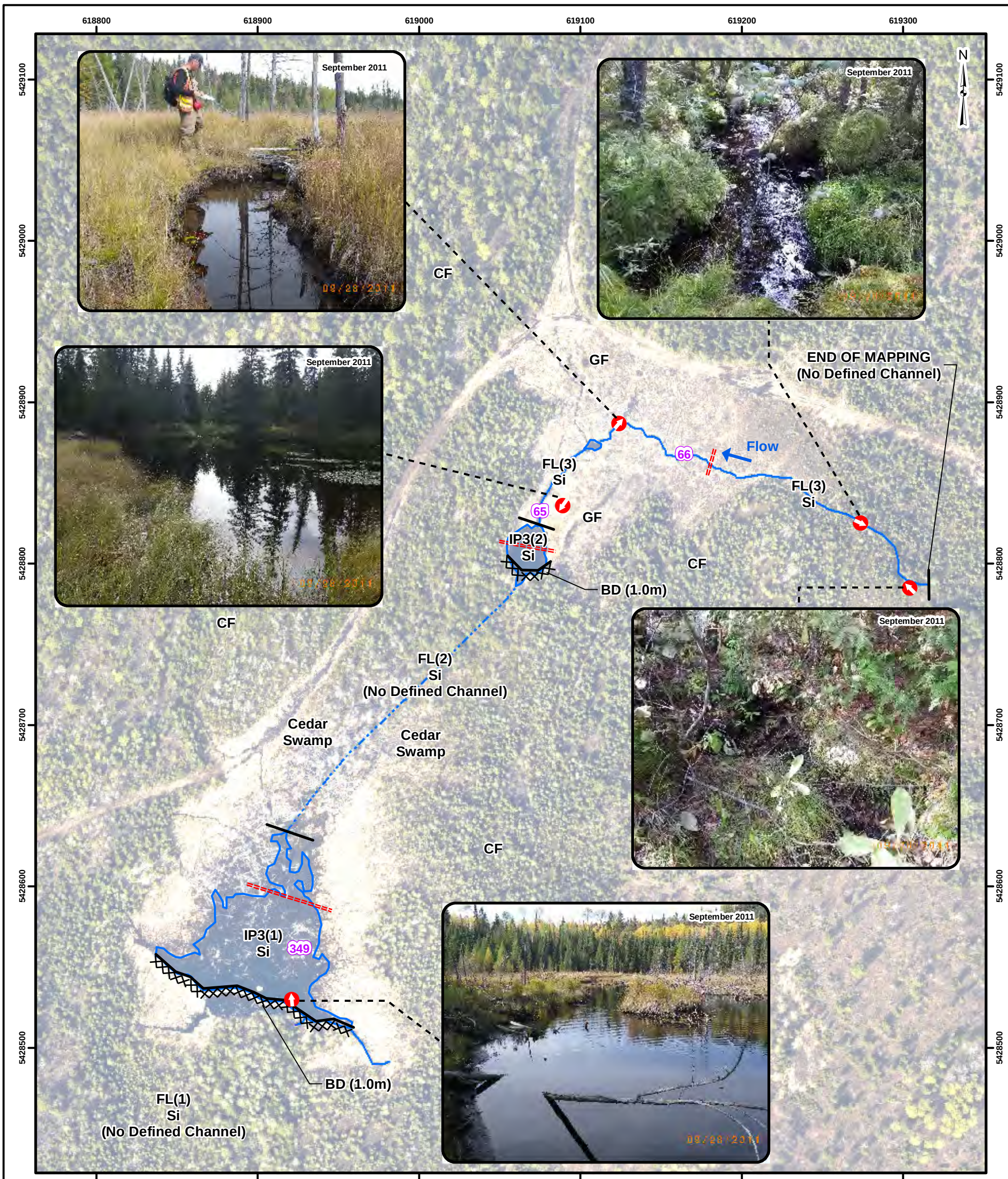
common white suckers were captured throughout these channel segments in addition to the cyprinid species captured at all upstream sampling locations.

The lower 150 m of the stream, north of the Hammond Reef access road consists of 6 m to 7 m wide flat and swifter flow run channel segments that flow through a wide meadow (Figure 1-5, Figure 1-6; Photo 2). Finescale dace, common white suckers and a juvenile burbot were captured north of the road (Table 2, fishing location #70).

There are three culverts located on the Hammond Reef road. Flows in the lower section of the stream are very flashy (Photos 3 and 4). Discharge calculated downstream of the Hammond Road in October 2010 and May 2011 was 0.009 m^3/s and 0.136m^3/s, respectively. It is possible that the area immediately below the culverts is used as spawning habitat for common white suckers. During high flow conditions fish are able to move upstream past the culverts on the Reef Road.

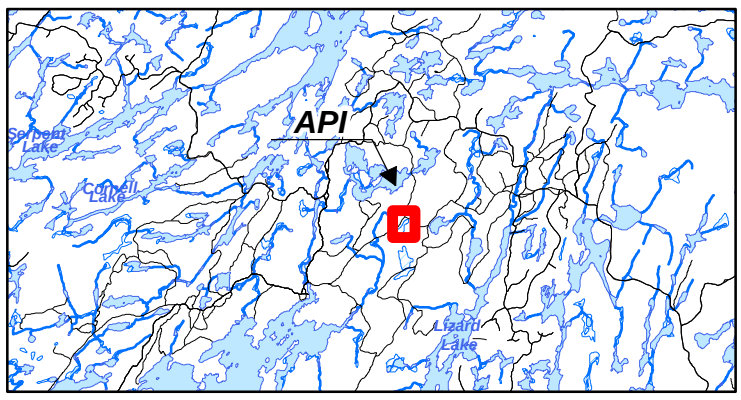
API #1 empties into a long, heavily vegetated meandering inlet (Photos 5). This lower reach may represent important spawning habitat for northern pike and nursery habitat for many of the fish species inhabiting the reservoir. Access from Marmion reservoir into the lower reaches of API #1 is dependent upon water levels in the reservoir (Photo 6).

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 1\api 1 stream.docx



100 0 100
SCALE 1:2,500 METRES

Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	112.71	-	-	Si	-	0
IP3(1)	105.81	25	<1	Si	-	0
FL(2)	218.96	-	-	Si	-	0
IP3(2)	29.65	25	<1	Si	-	0
FL(3)	323.82	1.2	0.3	Si	-	0



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment Pool: Class 3

Bank Slope
Shallow Slope (0 to 5%)

Substrate Classification
Si -Silt

Riparian Vegetation
CF - Coniferous Forest
GF - Grass and Forbs

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 1 (STREAM)
(MAP 1 OF 4)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 1-1	
GIS	DM	11 April 2012		
CHECK	JD	12 April 2012		
REVIEW	JS	16 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_1e.mxd

XXXX **Beaver Dam**

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

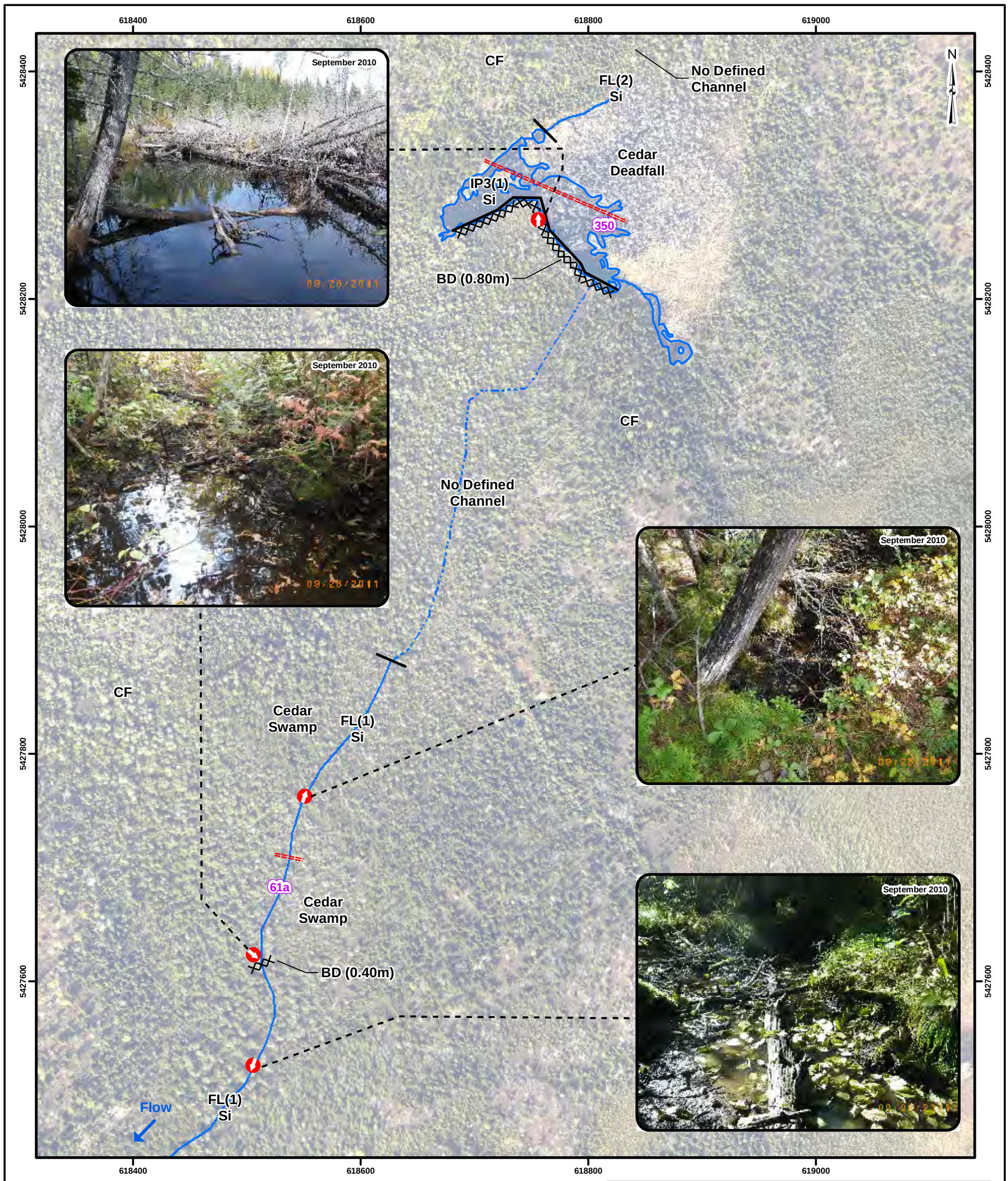
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

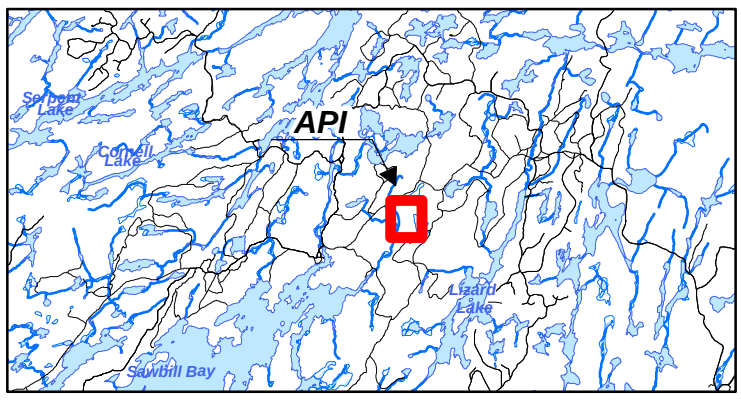
TITLE
AREA OF POTENTIAL IMPACT 1 (STREAM)
(UPPER REACH)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 1-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LIDAR_Figures.mxd





Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	483.91	1.3	<1	Si	-	5
IP3(1)	57.04	100	<1	Si		
FL(2)	123.69	-	-	Si	-	5

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment Pool: Class 3

Bank Slope
Shallow Slope (0 to 5%)

Substrate Classification
Si -Silt

Riparian Vegetation
CF - Coniferous Forest
MW - Mixed Wood

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT: HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

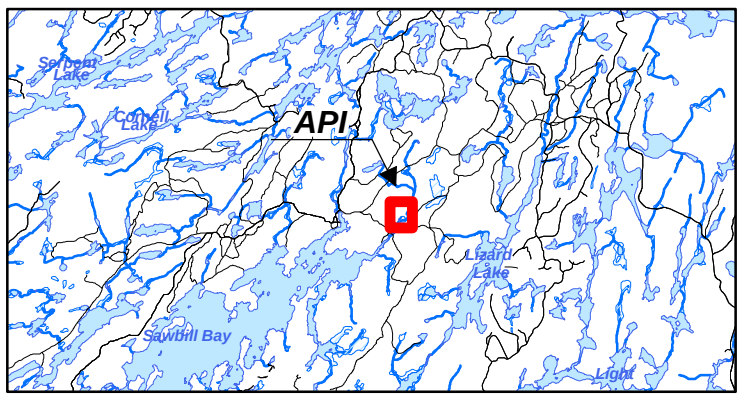
TITLE: AREA OF POTENTIAL IMPACT 1 (STREAM) (MAP 2 OF 4)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 1-3	
GIS	DM	10 April 2012		
CHECK	JD	11 April 2012		
REVIEW	JS	16 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_1d.mxd

Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	308.78	1.16	-	Si	Sa	-
IP3(1)	64.50	80	1.3	Si	Be	15
FL(2)	33.00	1.8	0.09	Si	-	5
CA(1)	3.00	0.76	-	Si	Bo	0
FL(3)	174.86	1.64	-	Si	-	5
IP3(2)	71.41	-	-	Si	-	-
FL(4)	224.73	-	-	Si	-	5



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
CA - Cascade: Extremely High Gradient and Velocity
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment Pool: Class 3

Bank Slope
← Shallow Slope (0 to 5%)

Substrate Classification
Co -Cobble
Gr -Gravel
Sa -Sand
Si -Silt

Riparian Vegetation
CF - Coniferous Forest
MW - Mixed Wood

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 1 (STREAM)
(MAP 3 OF 4)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 1-4	
GIS	DM	10 April 2012		
CHECK	JD	11 April 2012		
REVIEW	JS	16 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_1c.mxd

Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	145.62	7	-	Si	Co	30
RF(1)	5.00	5.97	-	Co	Gr	0
culvert	7.00	-	-	-	-	-
R3(1)	157.00	1.44	0.26	Si	-	5
FL(2)	42.43	2.95	0.1	Si	-	0

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
R3 - Lowest Quality Run Habitat
RF - Riffle, High Velocity/Gradient Relative to Habitat

Bank Slope
← Shallow Slope (0 to 5%)

Substrate Classification
Co -Cobble
Gr -Gravel
Si -Silt

Riparian Vegetation
CF - Coniferous Forest
MW - Mixed Wood

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT: HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE: AREA OF POTENTIAL IMPACT 1 (STREAM) (MAP 4 OF 4)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 1-5	
GIS	DM	09 April 2012		
CHECK	JD	10 April 2012		
REVIEW	JS	12 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_1b.mxd

XXXX **Beaver Dam**

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 1 (STREAM)
(LOWER REACH)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 1-6	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #1 PHOTO LOG

Photo 1: Isolated beaver impoundment located in the upper section of API #1.

Photo 2: Upstream view of API #1 from the Hammond Reef road (June 2010).

API #1 PHOTO LOG

Photo 3: Upstream view of Hammond Reef road from the lower reach of API #1 (June 2010).

Photo 4: Lower channel of API #1 (June 2010).

API #1 PHOTO LOG

Photo 5: Lower reach of API #1 (August 2010).

API #1 PHOTO LOG

Photo 6: Lower reach of API #1 (June 2010).

INTERPRETATION OF CATCHMENT B AQUATICS BASELINE

API #47 supports several cyprinid species. There is no fish community in API #48. Both of these systems are physically isolated from API #1 which flows southwards through the center of the catchment and the base case TMF and TMF Alternative 1. The upper sections of API #1 consist of a series of isolated beaver ponds. All of the ponds contain cyprinid species. Approximately 1.5 km upstream of the Hammond Reef Road, the stream channel becomes permanent. Juvenile and young-of-the-year common white suckers were found throughout this section of API #1 in addition to the cyprinid species that were captured in the upstream beaver ponds. Adult suckers are capable of ascending the stream from the reservoir and moving through the culverts on the Hammond Reef Road at high flows. No adult suckers have been captured or observed in API #1. The flat, slow flowing and fine substrate characteristics of this stream observed during habitat mapping are not consistent with the spawning habitat preferences of fast water spawning species such as common white sucker. However, it is probable that fast flowing conditions may exist, in the lower sections of stream for short periods in the spring. Construction of the TMF Base Case of TMF Alternative #1 will result in the destruction of API #1.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment b interpretation.docx

Catchment D

CATCHMENT D

The total area of Catchment D is 104.3 hectares (Figure 3). The only aquatic feature within this catchment is small stream (API #49) which flows off of the Hammond Peninsula in a northern direction, emptying into the north end of Sawbill Bay (Figure 2). This stream will not be impacted by the Project.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment d overview.docx

API #49 (STREAM)

API #49 is a low gradient stream consisting of a series of connected beaver ponds (Figure 49-1). All of the dams are low head and were partially breached or overflowing at the time the stream was mapped in May 2011. The stream is approximately 325 m in length. The origin of the stream is a large wet meadow (Figure 49-2) and the stream flows through narrow meadow over its entire length. The most significant feature of the stream is a large beaver pond near its upper end. The pond is more than 40 m wide and 1 m to 2 m deep (Photo 1). Below this pond, the stream channel is narrow and deeply incised (Photo 2). The stream channel is less than 1 m in depth. Substrate consists of sand and silt. Table 1 summarizes basic water chemistry parameters measured in the field. Stream discharge was calculated to be 0.017 m^3/s in May 2011.

Table 1: API #49 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2011	6.0	9.9	6.2	34	5.0
September 2011	14.0	15.0	7.5	35	8.0

Near the mouth of API #49, aquatic vegetation is abundant (Photo 3). The stream empties into a narrow, weedy, inlet of Sawbill Bay (Photo 4). At high water fish should be able to move freely from Sawbill Bay to the base of the large beaver impoundment upstream.

The stream was electroshocked in May and September, 2011 (Table 2). Three adult northern pike were observed spawning near the mouth on May 9, 2011 and young-of-the-year northern pike were captured near the mouth of the stream in September. All fish were captured in the stream were below the large beaver dam.

Table 2: API #49 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 49-1)	Date	Gear	Effort	Catch
193	May 12, 2011	backpack electrofisher	215 m	blacknose shiner (27 adult, 58 juvenile, 73 unk.) white sucker (12 juvenile) Iowa darter (1 unk.)
194	September 20, 2011	backpack electrofisher	95 m	yellow perch (5 juvenile) northern pike (2 YOY)

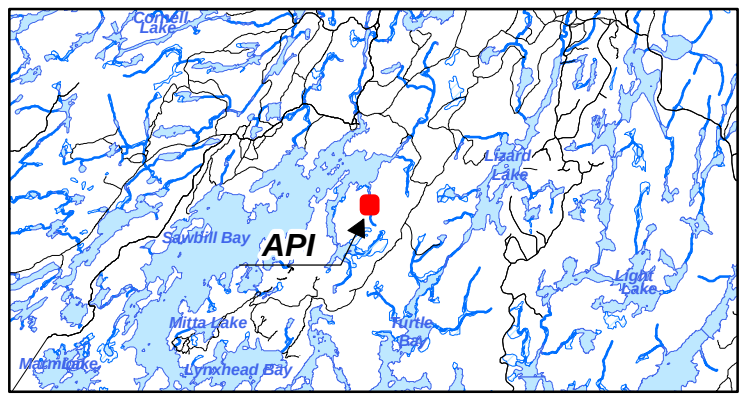
API #49 (STREAM)

Nets were also set near the mouth of API #49 in September 2011 (Table 3). A number of juvenile northern pike and yellow perch were captured. A single golden shiner was captured, the only one captured during baseline studies.

Table 3: API #49 (inlet of Sawbill Bay), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location	Date	Gear	Effort	Catch
195	September 20-21, 2011	Broad-scale small mesh gillnet	23 hrs.	yellow perch (2 adult, 77 juvenile) northern pike (4 adult, 3 juvenile) golden shiner (1 adult)
196	September 20-21, 2011	Broad-scale small mesh gillnet	22 hrs.	yellow perch (13 juvenile) northern pike (3 juvenile)
197	September 20-21, 2011	Broad-scale large mesh gillnet	21.25 hrs.	lake whitefish (1 adult) northern pike (1 adult)

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 49\api 49 stream.docx



Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	154.08	0.8	0.35	Sa	Si	10
IP3(1)	53.32	>40	>1	N/A	N/A	75
FL(2)	65.47	5.1	0.36	Si	-	80

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- BW Backwater

- SV Submergent Vegetation
- OHV Overhanging Vegetation

Channel Unit Type
- FL - Flat, Low Gradient, Low Velocity
- IP2 - Impoundment Pool: Class 2

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- SH - Shrub

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Gr -Gravel
- Si -Silt

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)
- Very Steep Slope (>70%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 49 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 49-1	
GIS	DM	30 Mar. 2012		
CHECK	JD	30 Mar. 2012		
REVIEW	JS	15 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_49b.mxd

XXXX **Beaver Dam**

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 49 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 49-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #49 PHOTO LOG

Photo 1: Large beaver dam, upper portion of API #49.

Photo 2: Channel segment downstream of beaver dam.

API #49 PHOTO LOG

Photo 3: Mouth of API #49, looking upstream.

Photo 4: Mouth of API #49; narrow inlet looking towards Sawbill Bay.

INTERPRETATION OF CATCHMENT D AQUATICS BASELINE

The extensive aquatic vegetation near the mouth and in the lower reaches of API #49 make it ideal spawning and nursery habitat for northern pike. Juvenile northern pike, yellow perch and common white suckers were captured in the stream or near its mouth. The partially breached dams in the lower sections of the stream create short fast flowing sections and common white suckers may spawn at these locations. There is no longer any overlap between the Project footprint and this stream.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment d interpretation.docx

Catchment E

CATCHMENT E

The total area of Catchment E is 122.8 hectares (Figure 3). The only aquatic feature within Catchment E is small stream which flows off the Hammond Peninsula in a southwest direction, emptying into Snail Bay (Figure 2). This stream will not be impacted by the Project.

Snail Bay has a drainage are of approximately 312 hectares made up of four small catchments including catchment E (Figure 3). The Bay is extremely shallow and aquatic vegetation is extensive throughout the Bay (Figures 35-1 and 35-2). Substrate consists entirely of silt. The Bay likely serves an important function to species such as northern pike, that rely upon aquatic vegetation to spawn, and as nursery habitat for a variety of other warmwater fish species. Habitat suitability in the Bay is closely linked to water elevation in the reservoir due to its shallowness. No evidence of small mouth bass nesting was found in Snail Bay.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment e overview.docx

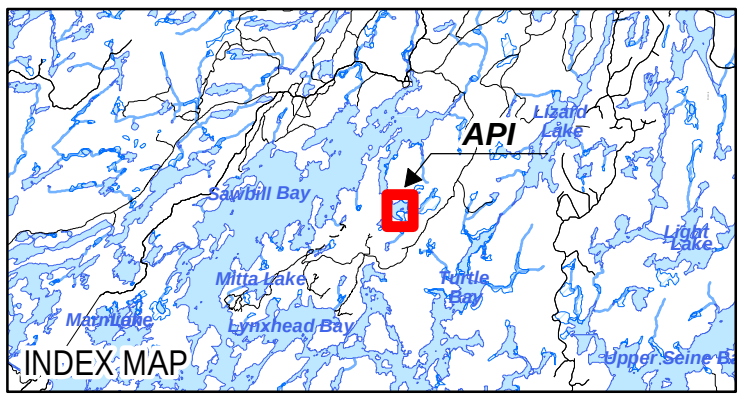
615900 616000 616100 616200 616300 616400 616500

5423900 5423800 5423700 5423600 5423500 5423400 5423300 5423200 5423100

N

CF
Catchment AG
Dead Trees
EV
(Cattails)
CF
1.7m
1.3m
1.6m
201-203
200
EV/Si
(Tapegrass)
EV
(Cattails)
1.1m
EV/Si
(Tapegrass)
Be
Catchment E
Standing Snags
204-205
API-50
198-199
Root Wads/Fallen Logs
Si/Co
1.0m
Catchment AF
1.2m
1.6m
EV
(Cattails)
EV
(Cattails/Tapegrass)
Stumps / Standing Snags
Si/Bo
(Tapegrass)
EV
Channel
CF
CF
EV/Si
(Tapegrass)
Channel
Catchment F
API-17
CF

75 0 75 150
SCALE 1:3,000 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Riparian Vegetation
CF - Coniferous Forest

Substrate Classification
Be -Bedrock
Bo -Boulder
Si -Silt

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 35
(Snail Bay)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 35-1	
GIS	DM	12 April 2012		
CHECK	JD	13 April 2012		
REVIEW	JS	15 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_35.mxd

Beaver Dam

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 35 (SNAIL BAY)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 35-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #50 (STREAM)

This stream consists of a single channel segment, 305 m in length (Figures 50-1 and 50-2). The stream drains a low lying, forested area. The stream was less than 1 m deep and channel width, where a defined channel was distinguishable, varied between 2 m and 3 m. The channel is low gradient and there are no barriers to fish movement to and from Snail Bay. Aquatic vegetation is abundant and there are extensive areas of flooded terrestrial vegetation in the upper portion of the channel (Photo 1). At high water, the flooding effect of the reservoir likely inundates a significant portion of the lower stream. The mouth of the stream is bordered by an extensive area of emergent vegetation and cat tail marsh (Photo 2). Stream discharge was calculated to be 0.032 m^3/s in May 2011. Table 1 summarizes basic water chemistry parameters measured in the field. The stream was electroshocked in May and September 2011. Juvenile common white suckers and a young-of-the-year northern pike were captured in the lower stream, near its mouth (Table 2).

Table 1: API #50 (stream), Basic Water Chemistry Parameter Data

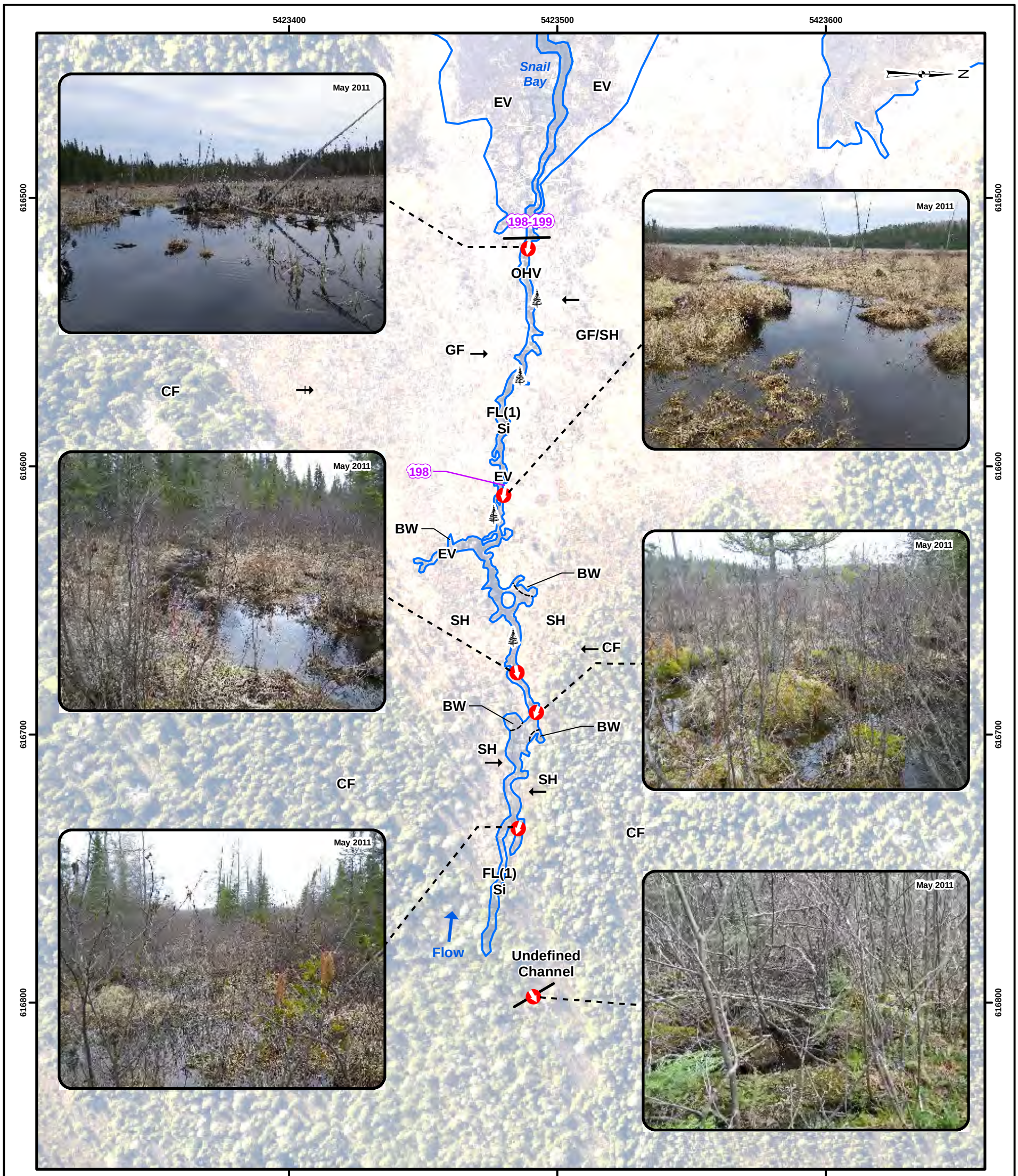
Date	Air Temperature (°C)	Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2011	17.0	3.9	5.9	70	9.8
September 2011	14.0	15.0	7.4	41	7.0

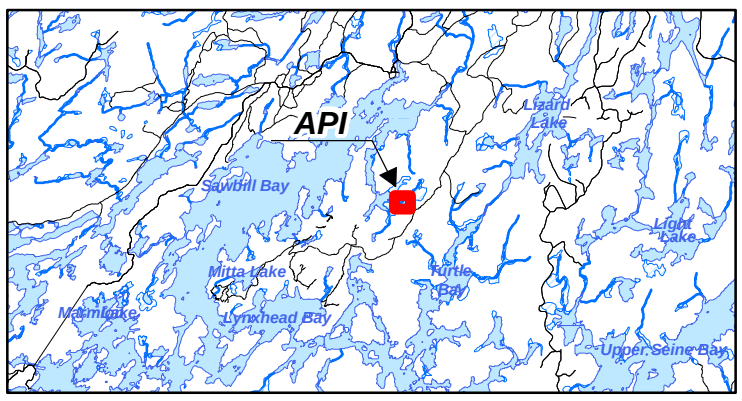
Table 2: API #50 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 50-1_	Date	Gear	Effort	Catch
198	May 9, 2011	backpack electrofisher	260 m	white sucker (4 juvenile)
199	September 20, 2011	backpack electrofisher	150 m	northern pike (1 YOY)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 50\api 50 stream.docx





Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL	305.01	2.25	0.46	Si	-	20

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

BW Backwater
EV Emergent Vegetation
OHV Overhanging Vegetation

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)

Substrate Classification
Si -Silt

Riparian Vegetation
CF - Coniferous Forest
GF - Grass and Forbs
SH - Shrub

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 50 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 50-1	
GIS	DM	05 April 2012		
CHECK	JD	09 April 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_50b.mxd

XXXX **Beaver Dam**

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 50 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 50-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #50 PHOTO LOG

Photo 1: API #50 inside its mouth, looking upstream.

Photo 2: Mouth of API #50, looking towards Snail Bay.

INTERPRETATION OF CATCHMENT E AQUATICS BASELINE

The origin of this stream is thick, wet, wooded area. Fish are able to move freely between the stream and Snail Bay. The stream provides nursery habitat to several species of fish. Northern pike may spawn in the stream but there were no fast water areas consistent with spawning habitat requirements for species like common white sucker or walleye. As a result of revisions to the site plan for the project, there is no longer any overlap between the Project footprint and this stream. No project related impacts to Snail Bay are anticipated.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment e interpretation.docx

Catchment F

CATCHMENT F

Catchment F has a drainage area of 78.0 hectares. A single aquatic feature is located within the catchment, a small, isolated headwater lake, API#17 (Figure 3). An outflowing stream channel, illustrated on some map layers, connecting API #17 to Snail Bay does not exist. It appears that surface water may infiltrate the overburden and reach Snail Bay via sub-surface flow. There is a small inlet on Snail Bay (Figures 35-1 and 35-2) that some maps illustrate as the mouth of a stream connecting API #17 to the bay.

In preliminary site plans a waste rock storage option overlapped with this catchment. Revisions to the Project site plan have sited the explosives plant and area adjacent to the lake (Figure 1). However, no Project-related impacts are anticipated.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment f overview.docx

API #17 (HEADWATER LAKE)

The lake has a surface area of 16,269 square meters. The lake shoreline is tightly contained by mature coniferous forest. Substrate around the perimeter of the lake is predominately boulder (Figure 17-1). The bottom slopes rapidly from the shoreline. Maximum depth is 7.5 m. The lake is slightly acidic and conductivity is very low (Table 1). The water is very dark coloured. There are no inflows to the lake. Despite appearing on available map layers, there is no defined outflow or channel joining API #17 to Snail Bay (Figure 2).

Table 1: API #17 (lake), Basic Water Chemistry Parameter Data

Date	Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
September 28-29, 2010	11.6	6.6	8	9.0
May 9-10, 2011	11.8	6.5	14	10.0
August 26-27, 2011	24.0	6.5	6	8.0

API #17 was fished on three different occasions. Three fish species, fathead minnow, finescale dace and northern redbelly dace were captured in the Lake (Table 2).

Table 2: API #17 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 17-1)	Date	Gear	Effort	Catch
183	September 28–29, 2010	minnow trap (1)	24 trap hrs.	no catch
184	September 28-29, 2010	minnow trap (1)	24 trap hrs.	finescale dace (144 adult) fathead minnow (7 adult)
185	September 28–29, 2010	gillnet - experimental mesh	23 hrs.	no catch
186	September 28–29, 2010	gillnet - single panel (38 mm mesh)	23 hrs.	no catch
187	May 9-10, 2011	gillnet - experimental mesh	24 hrs.	no catch
188	May 9-10, 2011	nordic net	24 hrs.	finescale dace (4 adult)
189	May 9-10, 2011	minnow traps (4)	79 trap	finescale dace

DRAFT

API #17 (HEADWATER LAKE)

Fish Effort Location (see Figure 17-1)	Date	Gear	Effort	Catch
			hrs.	(10 adult) northern redbelly dace (1 adult)
190	August 26-27, 2011	minnow traps (3)	49.5 trap hrs.	finescale dace (172 adult) northern redbelly dace (38 adult)
191	August 26-27, 2011	broad-scale large mesh (3)	48 hrs.	no catch
192	August 26-27, 2011	broad-scale small mesh (2)	33 hrs.	finescale dace (12 adult) northern redbelly dace (75 adult) fathead minnow (7 adult)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 17\api 17 lake.docx

616000

5422500

N

Skidder Trail

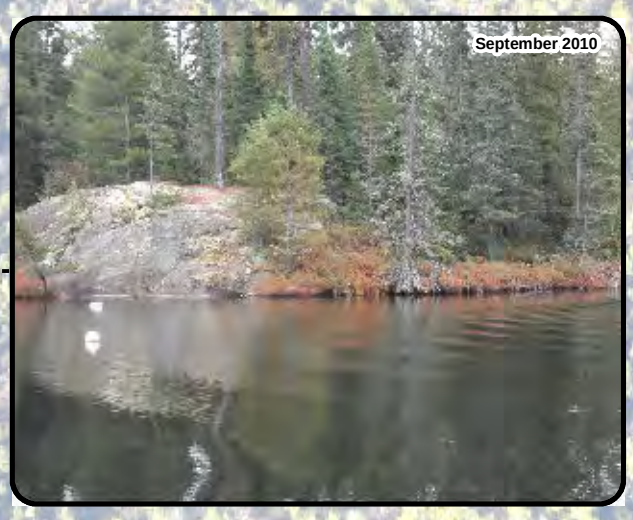
Si
Be
Bo
Bo
Bo
Bo
Bo
Be
Si
Bo
Bo
SH
Bo
Be
Be/Bo
Be
Be
Be
Bo
CF
Bo/Co
Bo/Si
Be
Be
SV
CF

7.5m
7.0m
5.5m
3.5m
2.0m

183
191
191
186
192
185
188
184
191
192
187
189

September 2010

September 2010



September 2010

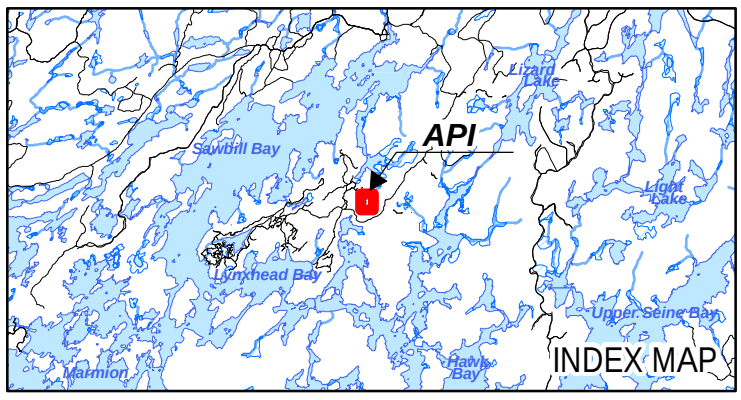
September 2010

September 2010

616000

5422500

30 0 30 60
SCALE 1:1,500 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- EV Emergent Vegetation
- SV Submergent Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Steep Slope (6 to 30%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- SH - Shrubs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 17 (POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 17-1	
GIS	DM	10 Apr. 2012		
CHECK	JD	10 Apr. 2012		
REVIEW	JS	10 Apr. 2012		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\PondAPI\API_17.mxd

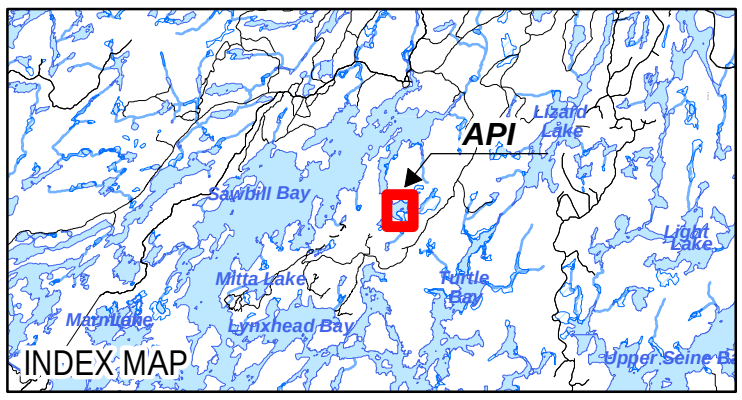
615900 616000 616100 616200 616300 616400 616500

5423900 5423800 5423700 5423600 5423500 5423400 5423300 5423200 5423100

N

CF
Catchment AG
Dead Trees
EV
(Cattails)
CF
1.7m
1.3m
1.6m
201-203
200
EV/Si
(Tapegrass)
EV
(Cattails)
1.1m
EV/Si
(Tapegrass)
Be
Catchment E
Standing Snags
204-205
API-50
198-199
Root Wads/Fallen Logs
Si/Co
1.0m
Catchment AF
1.2m
1.6m
EV
(Cattails)
EV
(Cattails/Tapegrass)
Stumps / Standing Snags
Si/Bo
(Tapegrass)
EV
Channel
CF
CF
EV/Si
(Tapegrass)
Channel
Catchment F
API-17
CF

75 0 75 150
SCALE 1:3,000 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Riparian Vegetation
CF - Coniferous Forest

Substrate Classification
Be -Bedrock
Bo -Boulder
Si -Silt

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 35
(Snail Bay)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 35-1	
GIS	DM	12 April 2012		
CHECK	JD	13 April 2012		
REVIEW	JS	15 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_35.mxd

Beaver Dam

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 35 (SNAIL BAY)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 35-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

INTERPRETATION OF CATCHMENT F AQUATICS BASELINE

API #17 supports a fish community consisting of cyprinid species. The lake is physically isolated from Snail Bay. No direct project related impacts on API #17 are anticipated.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment f interpretation.docx

Catchment G

CATCHMENT G

Catchment G has a total surface area of 30.53 hectares (Figure 3). There is a small headwater (API #16) pond and its outflowing stream within the catchment (Figure 2). The stream empties into Sawbill Bay. The site plan for the project does not overlap with API #16. No project related impacts to these aquatic features are anticipated.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment g overview.docx

API #16 (HEADWATER POND)

This pond is situated in the middle of a large wetland area and has a total surface area of 6,151m^2. It is circular and has a small 5 m deep basin in its centre (Figure 16-1). The pond is 75 m to 90 m in diameter. The perimeter of the pond is very shallow. Aquatic vegetation is abundant around the shoreline. A temperature-dissolved oxygen profile was completed in August 2010. Water temperatures and oxygen levels were similar throughout the water column (Table 1). pH in the pond was slightly alkaline. Substrate throughout the pond was silt. There are no defined inflows to the pond and a single seasonal outflow along its northwest shoreline. The outflow is not dammed but a beaver dam exists approximately 100 m below the outflow.

Table 1: API #16 (pond), Basic Water Chemistry Parameter Data

Date/Depth (m)	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2010				
Surface	12.0	7.3	64	8.9
1	11.0	7.2	62	8.6
2	10.7	7.2	62	8.5
3	10.5	7.3	62	8.4
4	8.0	7.3	62	8.0
5	7.0	7.2	62	7.0

Fishing effort was expended in September, 2010 (Table 2). No fish were captured.

Table 2: API #16 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 16-1)	Date	Gear	Effort	Catch
236	September 26 – 27, 2010	minnow trap (2)	40 trap hrs.	No catch
237	September 26 – 27, 2010	nordic net	20 hrs.	No catch

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 16\api 16 headwater pond.docx

615050 615100 615150 615200

5423700 5423650 5423600 5423550 5423500 5423450

N

CF

GF

Outflow

Si

1.5m

Si

GF

236

Si

237

Si

1.5m

5.0m

1.5m

CF

Be

Wild Celery
Aquatic Moss

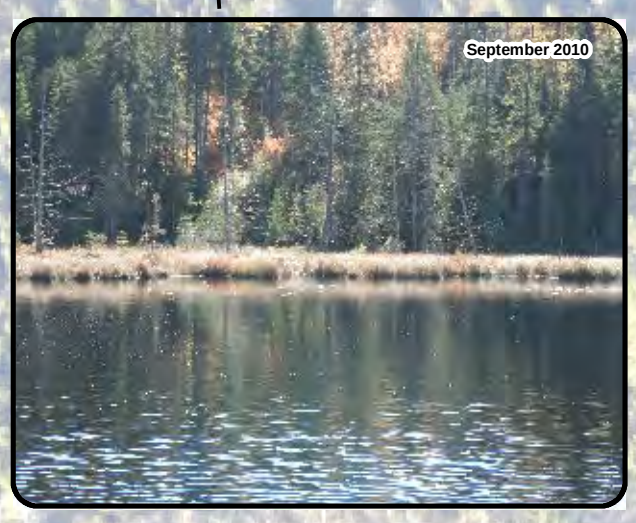
SV

CF

FV

1.5m

GF

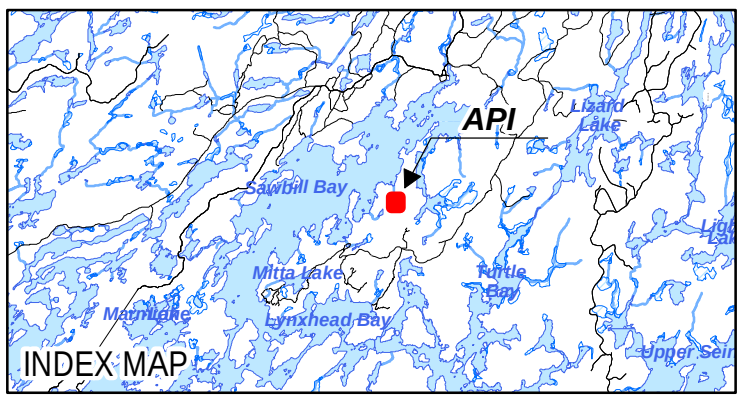


CF

615050 615100 615150 615200

25 0 25 50

SCALE 1:1,000 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Inundated Vegetation
SV - Submergent Vegetation
FV - Floating Vegetation

Bank Slope
Shallow Slope (0 to 5%)
Steep Slope (31 to 70%)

Riparian Vegetation
CF - Coniferous Forest
GF - Grass / Forbes

Substrate Classification
Si -Silt

Bank Features
Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 16
(Headwater Lake)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 16-1	
GIS	DM	12 April 2012		
CHECK	JD	13 April 2012		
REVIEW	JS	16 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_16.mxd

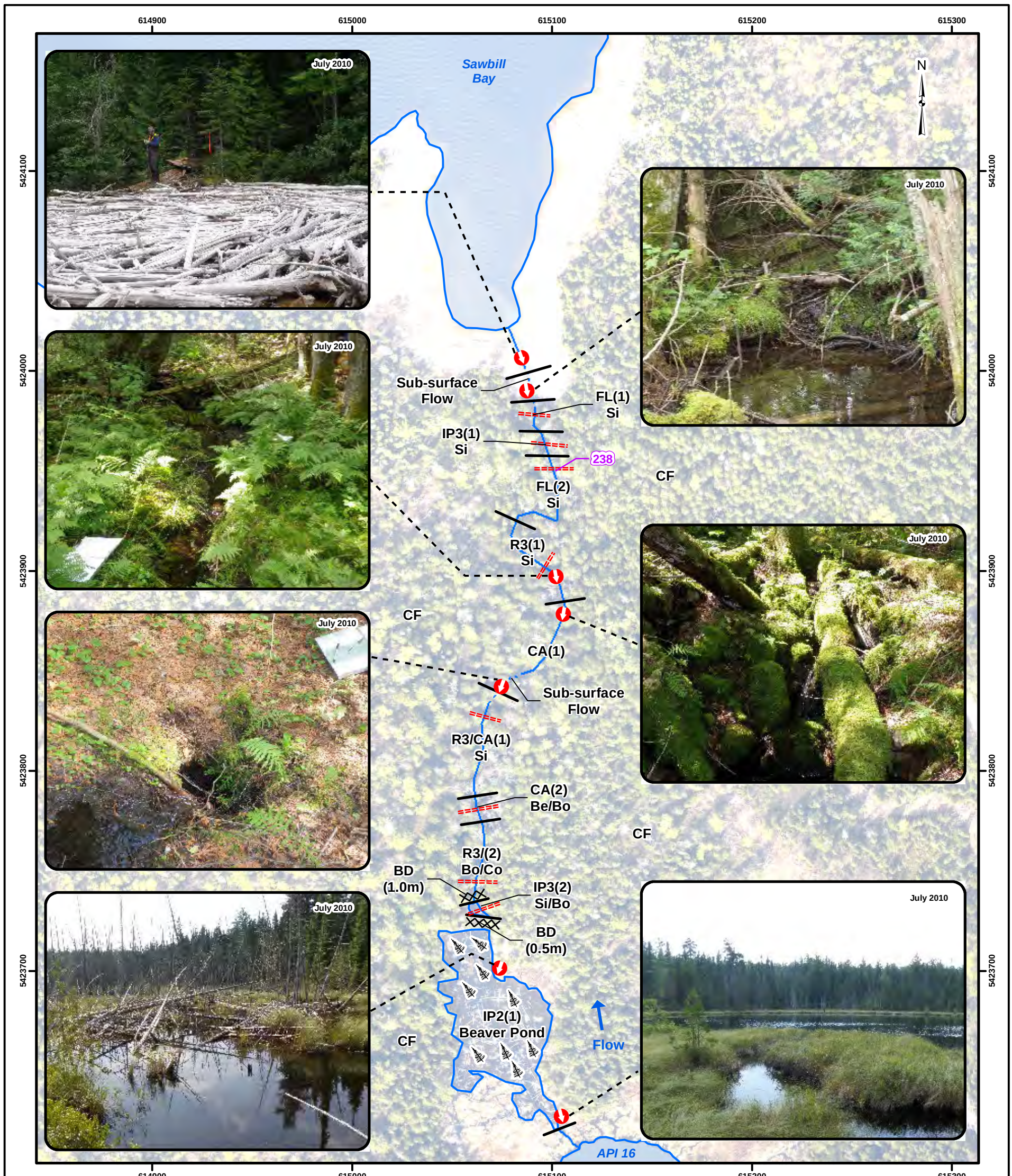
API #16 (OUTFLOW STREAM)

This stream is 420 m in length. The upper segments are impounded by beaver dams (Figure 16-2). The impounded areas are less than 1 m in depth. The stream channel throughout the middle portion of the stream is moderate to high gradient and less than 1 m in width. Substrate is predominantly silt. There is no aquatic vegetation. The stream channel flattens out in its lower segments and flows underground before emptying into Sawbill Bay. The mouth of the stream is impeded by a large log jam. pH in the stream was 6.36. The lower 100 m of the stream was electroshocked in 2010 (Table 1). No fish were captured. No fish were observed in the upper portions of the stream.

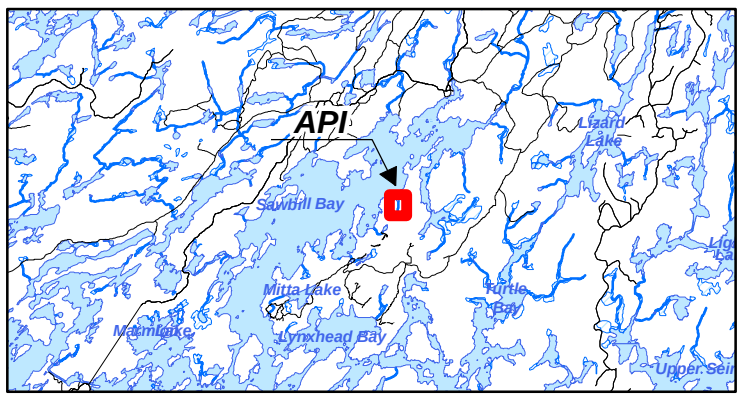
Table 1: API #16 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 16-2	Date	Gear	Effort	Catch
238	July 3, 2010	backpack electrofisher	100 m	No catch

DRAFT



Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
underground	14.00	-	-	-	-	-
FL(1)	11.00	1.66	-	Si	-	0
IP3(1)	10.50	4.64	0.45	Si	-	0
FL(2)	55.41	3.3	0.12	Si	-	0
R3(1)	50.33	0.83	0.06	Si	-	0
CA(1)	63.91	-	-	-	-	-
R3/CA(1)	54.65	0.86	0.1	Si	-	5
CA(2)	14.00	0.76	0.06	Be	Bo	0
R3(2)	37.65	1.86	0.06	Bo	Co	0
IP3(2)	5.60	14.5	0.2	Si	Bo	10
IP2(1)	114.89	-	-	-	-	-



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
- CA - Cascade
- FL - Flat, Low Gradient, Low Velocity
- IP2 - Impoundment Pool: Class 2
- IP3 - Impoundment Pool: Class 3
- R3 - Lowest Quality Run Habitat

Substrate Classification
- Bo -Boulder
- Co -Cobble
- Si -Silt

Bank Slope
- ← Shallow Slope (0 to 5%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 16 (STREAM)
(MAP 2 OF 2)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 16-2	
GIS	DM	12 April 2012		
CHECK	JD	14 April 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_16b.mxd

INTERPRETATION OF CATCHMENT G AQUATICS BASELINE

Neither the headwater pond nor its outflowing stream support fish communities. Sections of the stream including the lower reach flow underground. Fish from Sawbill Bay cannot access this inflowing stream due to the subsurface flow. No project related impacts to the pond or the stream are anticipated.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment g interpretation.docx

Catchment H

CATCHMENT H

Catchment H has a surface area of 27.27 hectares (Figure 3). There is a headwater pond (API #15) and a stream connecting the pond to Sawbill Bay, in the catchment. The pond is located north of the Waste Rock Stockpile (Figures 1 and 2). No project related impacts to these aquatic features are anticipated.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment h overview.docx

API #15 (HEADWATER POND)

API #15 is a partially infilled beaver pond (Figure 15-1). It has a total surface area of 4,237 m^2. Only the southern portion of the pond consists of open water. Maximum depth in the pond is 2.5 m. The outflow is controlled by a 2 m high, abandoned beaver dam. Aquatic vegetation is abundant along the shoreline and in the northern portions of the pond. The shoreline in the southern end of the pond is predominately bedrock. Bottom substrate is silt.

The pond was assessed on three occasions. Table 1 summarizes water quality parameters measured in the field. No fish have been captured or observed in the pond (Table 2).

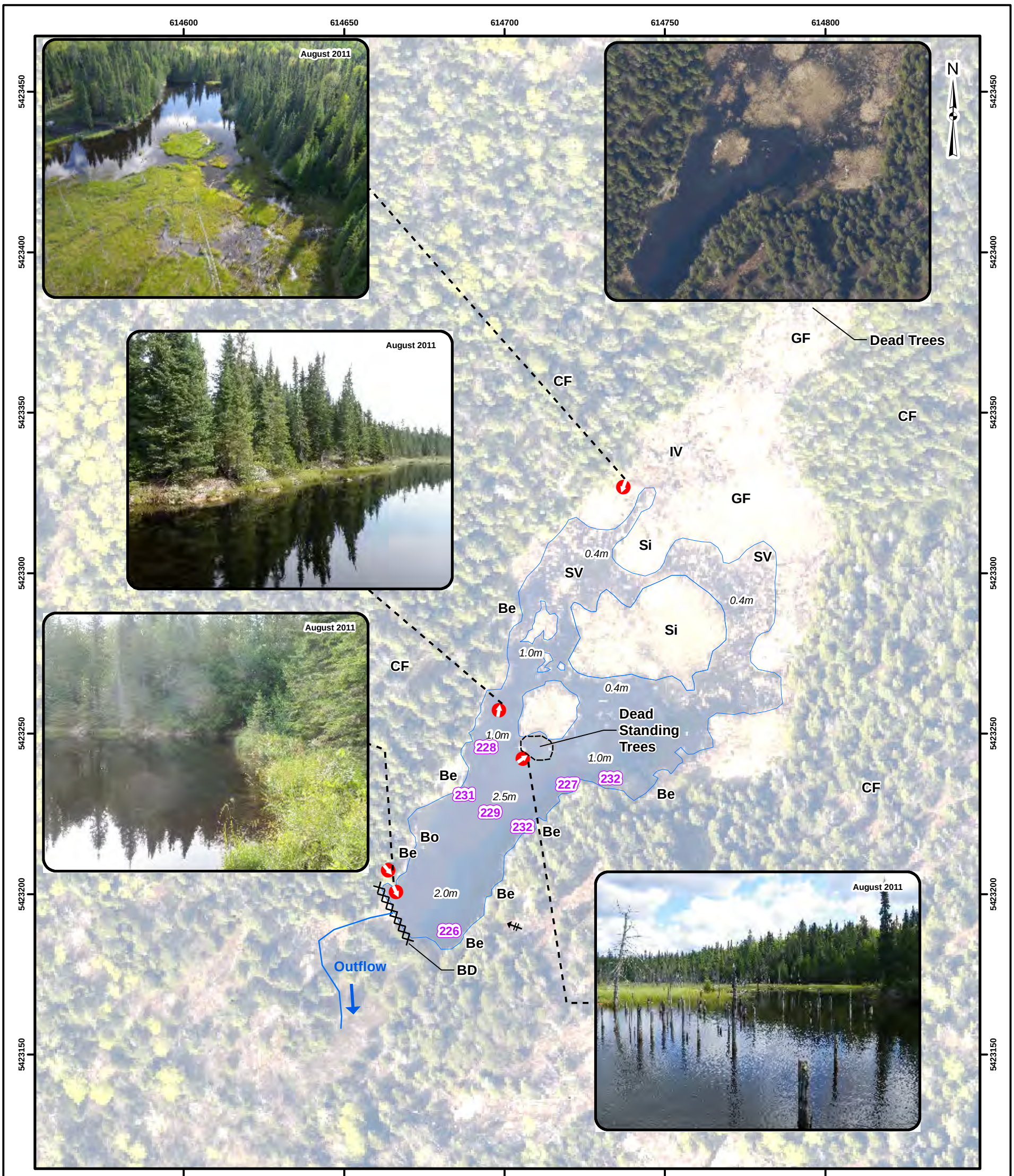
Table 1: API #15 (pond), Basic Water Chemistry Parameter Data

Date (m)	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
September 2011	10.2	7.4	46	10.0
August 2011	21.1	7.4	75	7.0
September 2011	13.5	7.5	38	8.0

Table 2: API #15 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

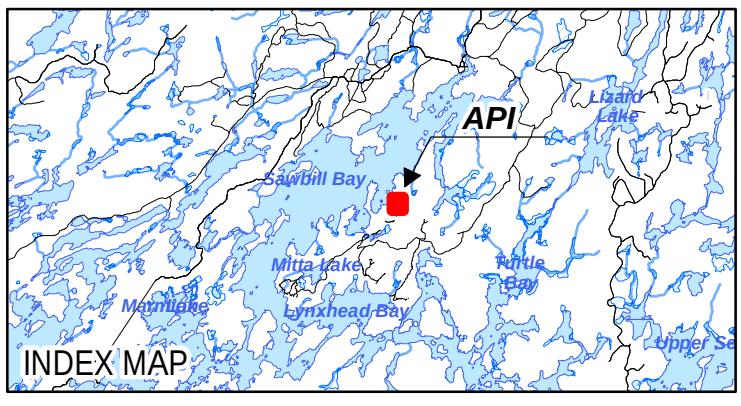
Fish Effort Location (See Figure 15-1)	Date	Gear	Effort	Catch
226	August 2-3, 2010	minnow traps (3)	40 trap hrs.	no catch
227	September 27-28, 2010	minnow traps (1)	20 trap hrs.	no catch
228	September 27-28, 2010	minnow traps (1)	20 trap hrs.	no catch
229	September 27-28, 2010	nordic net	20 hrs.	no catch
230	August 27-28, 2011	minnow traps (3)	69 trap hrs.	no catch
231	August 27-28, 2011	broad-scale large mesh (1)	22 hrs.	no catch
232	August 27-28, 2011	broad-scale small mesh (2)	44 hrs.	no catch

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 15\api 15 headwater pond.docx



30 0 30 60

SCALE 1:1,250 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

SV Submerged Vegetation
IV Inundated Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Steep Slope (31 to 70%)

Riparian Vegetation
CF - Coniferous Forest
GF - Grass / Forbe

Substrate Classification
Be -Bedrock
Bo -Boulder
Si -Silt

Bank Features
Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 15
(Headwater Pond)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 15-1	
GIS	DM	12 April 2012		
CHECK	JD	13 April 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_15.mxd

API #15 (OUTFLOW STREAM)

Flow in this stream is intermittent and dependent upon seepage through the beaver dam located at the outflow to the upstream pond. This stream is 415 m in length. When the stream was mapped in July, 2010, approximately 150 m of the stream channel was dry (Figure 15-2). Channel segments consist of a series of high gradient cascades. Channel width varies between 1.5 m and 0.5 m. Maximum depth was 0.12 m. Substrate is mixed. The lower reach of the stream is low gradient. The stream empties into a shallow inlet of Sawbill Bay. Substrate at the mouth of the stream is silt. No aquatic vegetation was observed in the stream channel along its entire length. pH in the stream was 6.6. No fishing effort was expended in the stream. No fish were observed anywhere along the stream.

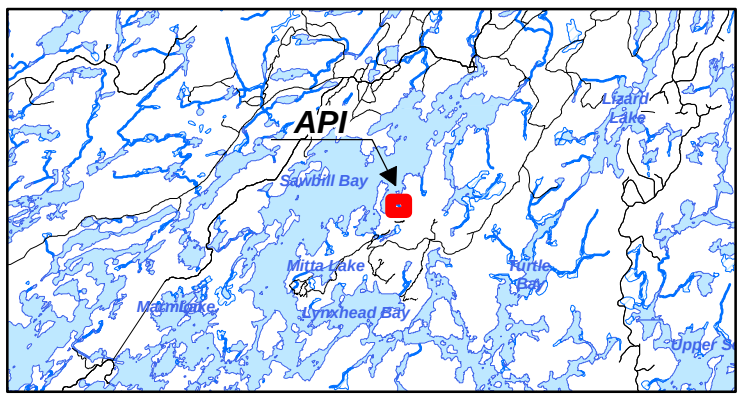
Fishing effort was expended near the mouth of the stream in the inlet of Sawbill Bay (Table 1). The bay is generally less than 2 m in depth. Substrate is predominately sand. Aquatic vegetation was abundant.

Table 1: API #15 (Sawbill Bay near mouth of stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location	Date	Gear	Effort	Catch
233	September 22-23, 2011	broad-scale small mesh	19 hrs.	yellow perch (1 adult, 21 juvenile) walleye (2 adult, 3 juvenile) northern pike (1 juvenile)
234	September 22-23, 2011	broad-scale small mesh	19 hrs.	yellow perch (3 adult, 41 juvenile) walleye (1 juvenile) northern pike (1 adult)
235	September 22-23, 2011	broad-scale large mesh	20 hrs.	northern pike (1 adult) lake whitefish (3 adult)

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 15\api 15 outflow stream.docx

Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	47.80	0.67	0.06	Sa	Si	0
CA(1)	22.26	0.53	0.12	Bo	Co	0
dry	110.97	-	-	-	-	-
CA(2)	22.53	0.81	0.1	Co	Sa	0
dry	38.56	0.56	-	-	-	-
R3/CA(1)	81.77	0.86	0.06	Si	Sa	0
FL(2)	16.68	1.49	-	SI	Sa	0
CA(3)	74.40	0.84	0.04	Si	Sa	0



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
- CA - Cascade
- FL - Flat, Low Gradient, Low Velocity
- R3 - Lowest Quality Run Habitat

Bank Slope
- ← Shallow Slope (0 to 5%)

Substrate Classification
- Bo -Boulder
- Co -Cobble
- Sa -Sand
- Si -Silt

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- MW - Mixed Wood Forest

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT: HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE: AREA OF POTENTIAL IMPACT 15 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	Figure: 15-2	
GIS	DM	09 April 2012		
CHECK	JD	10 April 2012		
REVIEW	--	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_15b.mxd

INTERPRETATION OF CATCHMENT H AQUATICS BASELINE

Neither the headwater pond nor its outflowing stream support fish communities. Flows in the stream are intermittent and dependent upon seepage through the beaver dam controlling the upstream pond. It is unlikely that flows are great enough or sustained over a sufficient period of time to allow fish from Sawbill Bay to enter, spawn and allow for successful incubation of eggs in the lower portion of the stream. No project related impacts to the pond or the stream are anticipated.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment h interpretation.docx

Catchment I

CATCHMENT I

Catchment I has a total area of 85.24 hectares (Figure 3). There is a permanent stream located in this catchment (Figure 2). It flows along the northern edge of the pit, the proposed waste rock stockpile and the proposed location for the office which will include a parking area (Figure 1). Direct alteration to the lower reach of this stream in order to construct these infrastructure components is possible. Flows in the stream may be affected by the removal of portions of the drainage area required to excavate the pit or construct mine infrastructure.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment i overview.docx

API #14 (STREAM)

This stream (API #14) is approximately 846 m in length. There are two tributaries that converge in the upper portion of the stream (Figure 14-1). One of these tributaries flows north, draining a dense forested area. Substrate in this tributary is a mixture of cobble, in high gradient areas, and silt. This tributary is 50 m in length. It is interrupted by an abandoned skidder trail. This trail has impounded drainage creating a shallow pond on its south side. There was no distinguishable channel upstream of the pond. Water flows over the trail into a narrow channel entering a large meadow (Photo 1). The upper portion of API #14 flows through this meadow. The remnants of a man-made dam, that no longer impounds water, exists near the south end of the meadow. A partially breached beaver dam immediately upstream of the old dam, maintains a shallow pond (Photos 2 and 3). A low gradient tributary drains flows into the meadow from the southwest (Figure 14-2; Photo 1). The stream channel downstream of the meadow consists of a series of cascades (Photo 4) in dense forested portions, and lower gradient runs and flats. Substrate is variable and channel width in the lower portion of the stream varies between 1 m and 3 m. The lower reaches of the stream flow near the area currently occupied by the core shack (Photo 5). The stream flows through a culvert, perched approximately 0.3 m above the stream bed (Photo 6). The channel downstream of the culvert is a moderate gradient run consisting of coarse substrate.

The stream empties into a large inlet of Sawbill Bay (Photo 5). The inlet is extremely shallow. Photo 7, taken in June 2010 during low water conditions, illustrates bottom substrate in the bay, near the mouth of API #14. Photo 8, taken in August 2010, illustrates the mouth of API #14 during high water conditions. An extensive weed bed, existed off the mouth of the stream at that time.

Table 1 summarizes field water chemistry parameters measures in the stream. Flows in the stream are likely very flashy. There was no distinguishable surface water flow in the middle portion of the stream in August 2010 (Photo 4). Discharge was calculated to be 0.001 m^3/s and 0.017 m^3/s near the stream mouth in October 2010 and May 2011, respectively.

Table 1: API #14 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2010	20.0	17.4	7.0	180	5.6
May 2011	10.8	8.6	7.4	90	10.0
September 2011	7.0	8.9	7.7	221	9.0

API #14 was electrofished on three occasions (Table 2). Four fish species were captured as far upstream as the large meadow in the upper section of the stream. Juvenile common white suckers were captured in the lower reaches of the stream on two separate occasions, above the culvert but below the first cascade [CA(1)] (Figures 14-1 and 14-2). No adult or young-of-the-year suckers were captured in the stream.

DRAFT

API #14 (STREAM)

Table 2: API #14 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 14-1)	Date	Gear	Effort	Catch
35	August 1, 2010	backpack electrofisher	75 m	finescale dace (7 adult, 5 juvenile) white sucker (4 juvenile) northern redbelly dace (2 adult) fathead minnow (2 adult)
36	August 1, 2010	backpack electrofisher	60 m	finescale dace (72 adult, 16 juvenile, 10 YOY) northern redbelly dace (8 adult) fathead minnow (11 adult, 1 juvenile)
37	May, 2011	backpack electrofisher	450 m	finescale dace (74 adult, 75 juvenile, 82 unk.) brassy minnow (3 adult)
347	September 22, 2011	backpack electrofisher	540 m	finescale dace (19 adult, 26 juvenile, 8 YOY) northern redbelly dace (1 juvenile) white sucker (1 juvenile)
348	September 22, 2011	backpack electrofisher	130 m	no catch

The inlet near the mouth of the API #14 was netted in 2010 and 2011. It appears to be heavily used by juvenile fish, including walleye, smallmouth bass and yellow perch (Table 3).

DRAFT

API #14 (STREAM)

Table 3: API #14 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location	Date	Gear	Effort	Catch
38	August 18-19, 2010	gillnet – experimental mesh	16 hrs.	northern pike (3 adult, 3 juvenile, 1 unk.) walleye (4 adult, 3 juvenile) yellow perch (1 unk.) smallmouth bass (2 adult) white sucker (4 adult) lake whitefish (1 adult)
39	August 20, 2010	gillnet – experimental mesh	7 hrs.	walleye (1 adult, 3 juvenile) smallmouth bass (1 juvenile, 1 unk.) northern pike (1 adult) white sucker (1 adult)
40	August 27-29, 2010	gillnet – experimental mesh	24.5 hrs.	white sucker (4 adult, 1 juvenile) northern pike (5 adult) walleye (6 adult, 8 juvenile, 4 unk.) yellow perch (2 adult, 1 juvenile) smallmouth bass (2 adult) lake whitefish (3 adult)
41	August 28-29, 2010	gillnet – experimental mesh	21 hrs.	walleye (3 adult, 11 juvenile, 8 unk.) northern pike (3 adult, 1 unk.) smallmouth bass (2 unk.) white sucker (3 unk.)
42	August 26, 2010	boat electrofisher	600m	yellow perch (131 juvenile)

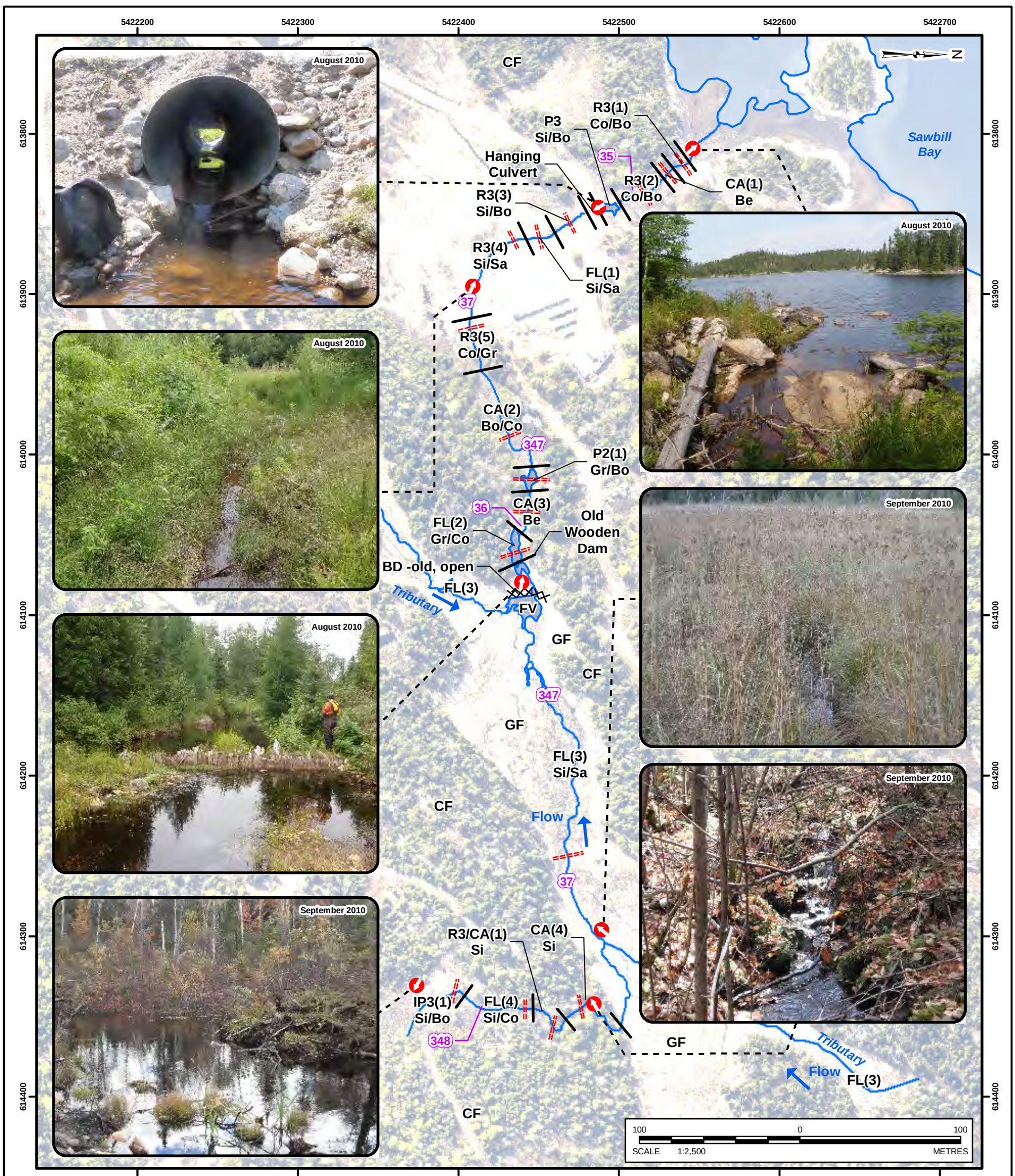
DRAFT

API #14 (STREAM)

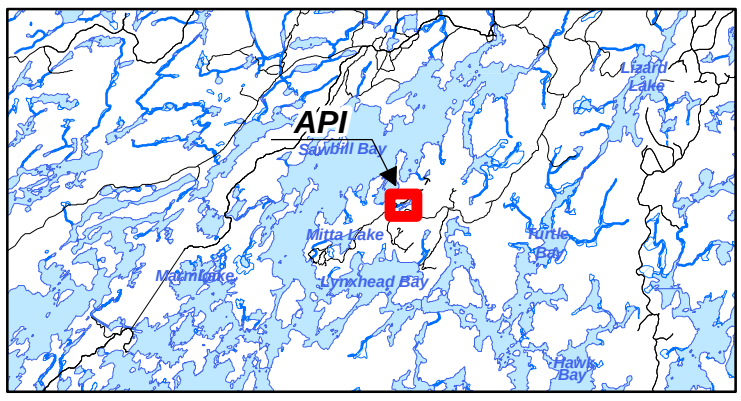
Fish Effort Location	Date	Gear	Effort	Catch
				smallmouth bass (4 juvenile)
43	September 22-23, 2011	broad-scale small mesh gillnet	22.5	yellow perch (45 juvenile) northern pike (1 adult, 1 unk.)
44	September 22-23, 2011	broad-scale small mesh gillnet	22.5	yellow perch (177 juvenile) northern pike (5 unk.) walleye (1 juvenile) spottail shiner (1 adult)
45	September 22-23, 2011	broad-scale large mesh gillnet	23.5	smallmouth bass (1 adult) walleye (3 juvenile) white sucker (1 adult) northern pike (1 unk.) lake whitefish (2 adult)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 14\api 14 stream.docx



Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
R3(1)	11.00	1.18	0.08	Bo	Co	0
CA(1)	8.00	1.04	-	Be	Be	0
R3(2)	32.80	1.34	0.08	Bo	Co	0
P3(1)	14.00	5.4	0.34	Si	Bo	20
CULVERT	6.98	-	-	-	-	-
R3(3)	22.00	1.27	-	Si	Bo	0
FL(1)	18.00	2.58	0.08	Si	Sa	0
R3(4)	67.00	2.56	-	Si	Sa	0
R3(5)	33.00	2.82	0.04	Co	Gr	0
CA(2)	77.12	2.42	-	Bo	Co	0
P2(1)	13.47	5.96	>1.0	Gr	Bo	50
CA(3)	29.40	2.67	-	Be	-	0
FL(2)	20.01	6.87	0.44	Gr	Co	10
FL(3)	666.13	1.82	0.16	Si	Sa	40
CA(4)	53.00	1.3	0.14	Si	-	0
R3/CA(1)	33.00	1.04	0.36	Si	-	0
FL(4)	47.62	3.4	0.18	Si	Co	2
IP3(1)	23.00	25	0.08	Si	Bo	60



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- FV Floating Vegetation

Channel Unit Type

- CA - Cascade
- FL - Flat, Low Gradient, Low Velocity
- IP3 - Impoundment Pool: Class 3
- P2 - Moderate Quality Pool Habitat (low suitability for overwintering)
- P3 - Lowest Quality Pool Habitat (not suitable for overwintering)
- R3 - Lowest Quality Run Habitat

Bank Slope

- ← Shallow Slope (0 to 5%)

Substrate Classification

- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Gr -Gravel
- Sa -Sand
- Si -Silt

Riparian Vegetation

- CF - Coniferous Forest
- GF - Grass and Forbs

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 14 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 14-1	
GIS	DM	09 April 2012		
CHECK	JD	10 April 2012		
REVIEW	JS	16 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_14b.mxd

Beaver Dam

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 14 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 14-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #14 PHOTO LOG

Photo 1: Upper portion of API #14 looking south. Inflowing tributary visible at the southwest end of the meadow.

Photo 2: Ponded area at the downstream end of the meadow.

API #14 PHOTO LOG

Photo 3: Ponded area, ground level, at the western end of the meadow.

Photo 4: Cascade in central portion of API #14 (August 2010).

API #14 PHOTO LOG

Photo 5: Drill core shack and mouth of API #14.

Photo 6: Downstream end of culvert in lower reach of API #14. Receiving bay visible in top left corner of the photograph.

API #14 PHOTO LOG

Photo 7: Bay near the mouth of API #14 during low water conditions June 2010).

Photo 8: Mouth of API #14 (August 2010).

INTERPRETATION OF CATCHMENT I AQUATICS BASELINE

Cyprinids were captured throughout API #14 with the exception of the southwest tributary in the upper portion of the stream. Flow in the stream is seasonal and portions of the stream were dry during field studies. The steep cascades in the central portion of the stream act as a barrier to upstream movement of fish. Juvenile common white suckers were captured in the stream and although, neither adults not young-of-the-year were captured, it seems likely that suckers are able to ascend the lower reaches of the stream, from Sawbill Bay, and may spawn downstream of the cascades in the central portion of the stream. Low water levels on Marmion Reservoir and/or low flows in the stream may periodically inhibit entry to the stream from Sawbill Bay.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment i interpretation.docx

Catchment J

CATCHMENT J

Figures 13-1, 13-2 and 13-3 for this Catchment will be provided at a later date.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment j overview.docx

API #13 (HEADWATER POND)

API #13 is a headwater pond with a total surface area of 19,375 square meters (Figure 13-1). The pond is approximately 160 m in length and 140 m at its widest point. Maximum depth is 5.5 m. Bottom substrate is entirely silt. Vegetation consists of wetland along most its shoreline and dense coniferous forest along the southern and southwestern shorelines (Figure 13-2; Photo 1). There is no inflow to the pond. A single outflow is located at its northern end (Photo 2). Water elevation in the pond is controlled by a beaver dam near its outflow. Table 1 summarizes water chemistry data collected in the pond.

Table 1: API #13 (pond), Basic Water Chemistry Parameter Data

Date/Depth (m)	Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
September 26, 2010				
Surface	12.5	7.0	36	12.4
1	11.4	7.0	36	11.4
2	10.4	6.9	36	10.5
3	10.4	6.9	36	10.4
4	10.0	6.9	36	10.0
5	9.0	-	-	-
May 8, 2011	6.8	7.0	52	9.0
August 27, 2011	22.6	7.3	50	7.0

The pond was fished on three occasions. No fish were captured (Table 2).

Table 2: API #11 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 11-1)	Date	Gear	Effort	Catch
22	September 26–27, 2010	gillnet - experimental mesh	16 hrs	no catch
23	September 26–27, 2010	gillnet - experimental mesh	16 hrs	no catch
24	September 26-27, 2010	minnow traps (2)	34 trap hrs	no catch
25	May 8-9, 2011	gillnet – experimental mesh	17 hrs	no catch
26	May 8-9, 2011	nordic net	16.5 hrs	no catch

DRAFT

API #13 (HEADWATER POND)

Fish Effort Location (see Figure 11-1)	Date	Gear	Effort	Catch
27	May 8-9, 2011	minnow traps (4)	70 trap hrs	no catch
28	August 27-28, 2011	minnow traps (3)	48 trap hrs	no catch
29a	August 27-28, 2011	broad-scale large mesh	16 hrs	no catch
29b	August 27-28, 2011	broad-scale large mesh	16 hrs	no catch
29c	August 27-28, 2011	broad-scale large mesh	16 hrs	no catch
30	August 27-28, 2011	broad-scale small mesh (1)	16 hrs	no catch

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 13\api 13 headwater pond.docx

DRAFT

612500 612600 612700

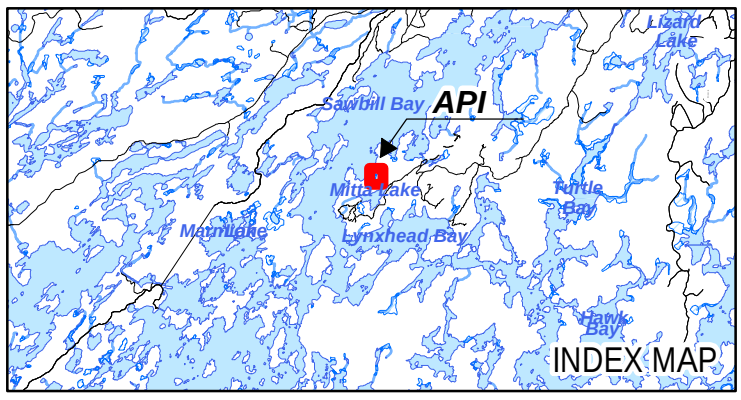
5422200 5422100 5422000 5421900

Outflow

GF
Si
30
27
2.0m
29a
23
Si
GF
CF
28
27
Si
2.0m
FV
2.0m
Be
Si
22
27
28
26
5.5m
Be
GF
24
29b
Beaver Lodge
GF
24
Si
27
29c
25
2.0m
Si
Be
Be
Si
N

612500 612600 612700

40 0 40 80
SCALE 1:1,500 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- FV Floating Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs

Substrate Classification
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

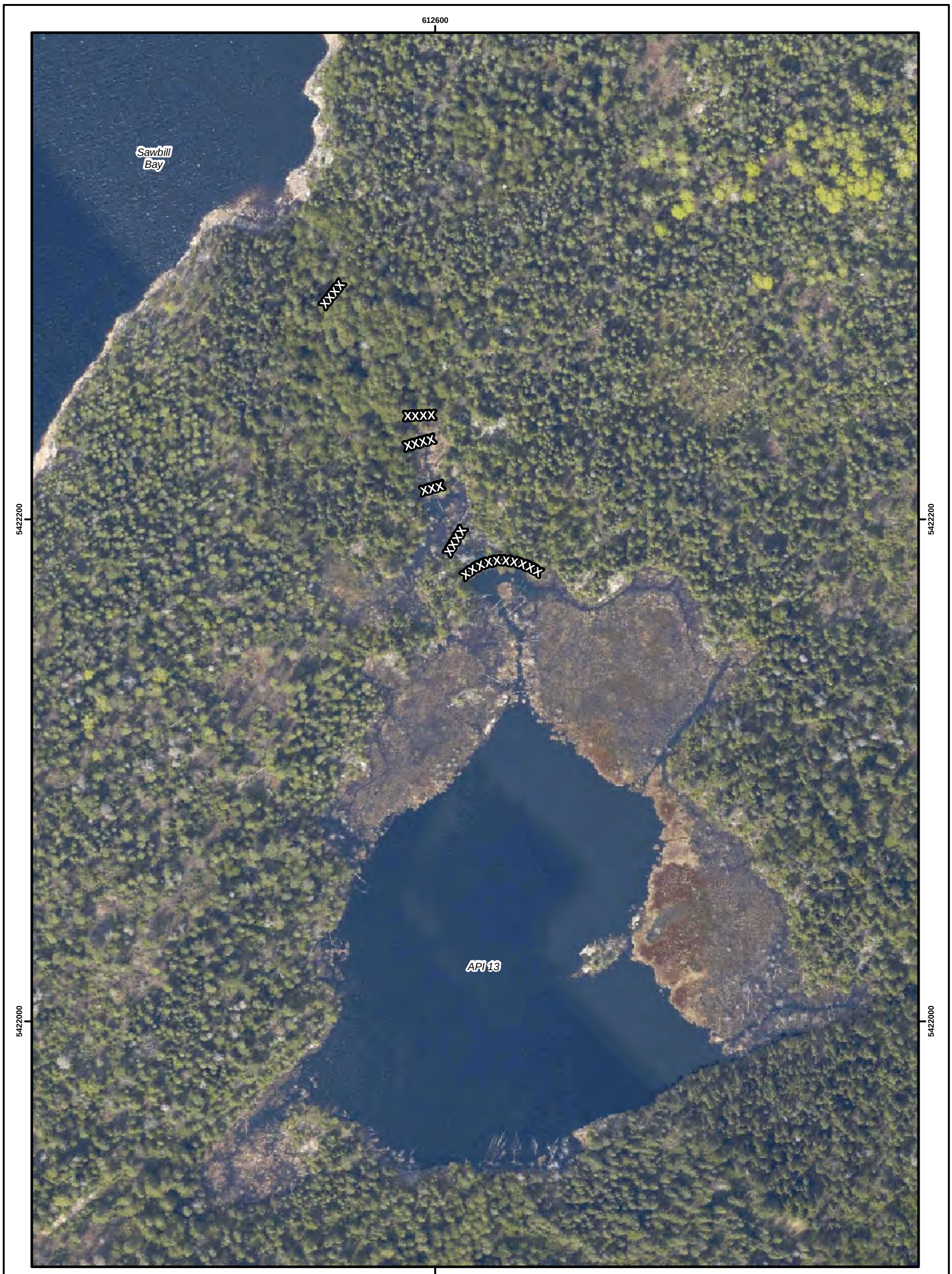
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 13
(HEADWATER POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 13-1	
GIS	DM	12 Apr. 2012		
CHECK	JD	12 Apr. 2012		
REVIEW	JS	12 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_13.mxd



XXXX **Beaver Dam**

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 13 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 13-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #13 (STREAM)

The stream draining API #13 (pond) is approximately 160 m in length (Figure 13-3). The upper portion of the stream is flat, consisting of a series of beaver dams. Substrate is silt and organic material and aquatic vegetation is abundant (Photo 3). Channel width is variable, dependent on areas impounded by dams. The lower portion of the stream consists of a series of steep cascades and small pools. Substrate is predominately bedrock (Photo 4). Channel width is less than 1 m. Flow is permanent in the stream, but very dependent upon seepage through the beaver dams present. Discharge measured near the mouth of the stream was calculated to be 0.001 m^3/s in August 2010, October 2010 and in May 2011. Table 1 summarizes water chemistry parameters recorded in the field in the lower portion of the stream.

Table 1: API #13 (stream), Basic Water Chemistry Parameter Data

Date/Depth (m)	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2010	21.0	17.2	6.3	65	5.9
May 2011	10.8	6.5	7.1	43	7.2
September 2011	11.0	10.2	6.1	52	8.0

The stream was electrofished on three occasions (Table 2). No fish were captured in the stream.

Table 2: API #13 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 11-2)	Date	Gear	Effort	Catch
31	August 2, 2010	backpack electrofisher	100 m	no catch
32	August 2-3, 2010	minnow traps (2)	34 trap hrs	no catch
33	May 8, 2011	backpack electrofisher	150 m	no catch
34	September 23, 2011	backpack electrofisher	175 m	no catch

The mouth of the stream is a steep cascade (Photo 5). The shoreline adjacent to the mouth, along Sawbill Bay, is steep bedrock. There is very little instream cover along the shoreline. The bottom is 3 m deep immediately adjacent to the shore, and consists of silt. Table 3 summarizes fishing effort and catches near the mouth of the stream.

DRAFT

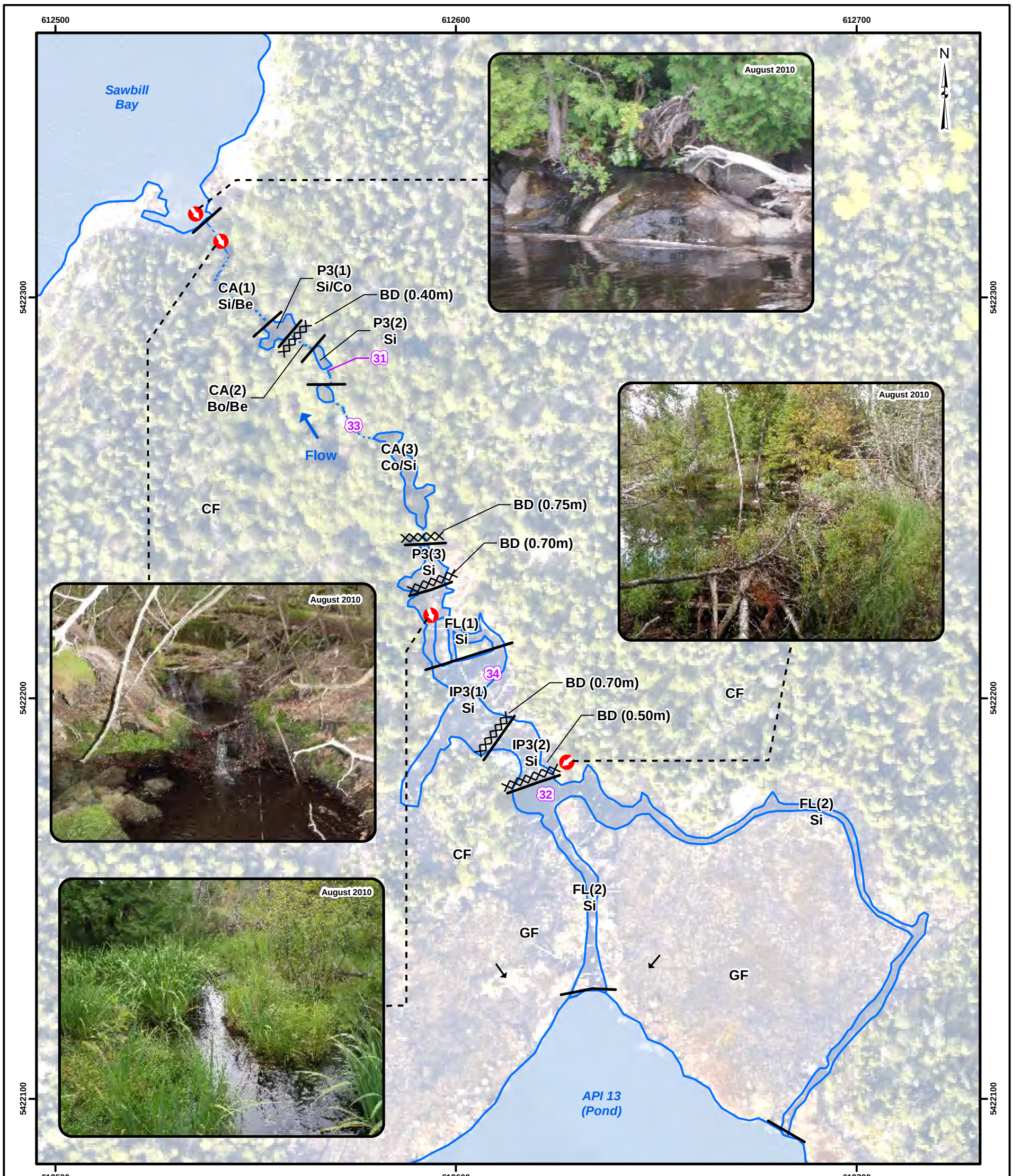
API #13 (STREAM)

Table 3: API #13 (Sawbill Bay), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location	Date	Gear	Effort	Catch
267	August 26, 2010	boat electrofishing	400 m	yellow perch (8 juvenile)
268	August 19-20, 2010	gillnet – experimental mesh	16 hrs	walleye (12)
269	September 23-24, 2011	broad-scale small mesh gillnets	17 hrs	yellow perch (1 juvenile)
270	September 23-24, 2011	broad-scale small mesh gillnets	17.5 hrs	yellow perch (4 juvenile) walleye (2 juvenile)
271	September 23-24, 2011	broad-scale large mesh gillnets	17.25 hrs	lake whitefish (2 adult) northern pike (1 adult, 1 unk.) smallmouth bass (7 adult, 1 juvenile) walleye (1 juvenile)

DRAFT

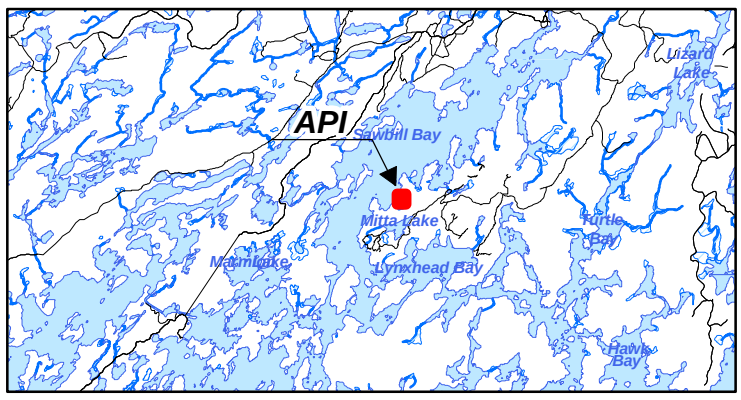
n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 13\api 13 stream.docx



40 0 40

SCALE 1:1,000 METRES

Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
CA(1)	31.60	0.96	0.1	Si	Be	0
P3(1)	5.78	3.4	0.68	Si	Co	0
CA(2)	6.45	0.93	-	Bo	Be	0
P3(2)	10.22	5.82	0.62	Si	-	0
CA(3)	50.98	0.92	0.1	Co	Si	0
P3(3)	11.41	8.23	-	Si	-	0
FL(1)	46.45	1.36	0.56	Si	-	10
IP3(1)	23.38	20	-	Si	-	30
IP3(2)	16.09	18	-	Si	-	10
FL(2)	233.77	4.5	-	Si	-	20



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
- CA - Cascade: Extremely High Gradient and Velocity
- FL - Flat, Low Gradient, Low Velocity
- IP3 - Impoundment Pool: Class 3
- P3 - Lowest Quality Pool Habitat (not suitable for overwintering)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Si -Silt

Bank Slope
- ← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT: HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE: AREA OF POTENTIAL IMPACT 13 (STREAM) (MAP 1 OF 1)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 13-3	
GIS	DM	16 April 2012		
CHECK	JD	16 April 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_13b.mxd

API #13 (HEADWATER POND)

Photo 1: Shoreline of API #13 (headwater pond).

Photo 2: Aerial view of outflow to API #13.

API #13 (HEADWATER POND)

Photo 3: Upper channel of API #13 (stream).

Photo 4: Lower channel of API #13 (stream).

API #13 (HEADWATER POND)

Photo 5: Mouth of API #13 (stream).

Photo 6: Aerial view of API #13 (pond and stream) and Sawbill Bay.

INTERPRETATION OF CATCHMENT J AQUATICS BASELINE

Neither the pond nor the ouflowing stream making up API #13 support fish communities. The stream channel is a function of multiple barriers that exist along its entire length (Photo 6). A series of steep cascades exists in the lower section including at the mouth of the stream. Habitat in the lower portion of the stream consists of bedrock. Flow in the stream is controlled by multiple beaver dams and is likely low year-round. It is unlikely that fish from Sawbill Bay are able to ascend the stream.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment overviews and interpretations\catchment j interpretation.docx

Catchment K

CATCHMENT K

This Catchment has a total surface area of 89.03 hectares (Figure 3). Mitta Lake and its outflowing stream are located in this catchment. Both of these features are located directly over the pit area, and both will be destroyed as the result of pit excavation.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment k overview.docx

API #12 (MITTA LAKE)

Mitta Lake has a total surface area of 171,115 m^2. The shoreline is generally steep and surrounded by exposed bedrock (Figure 12-1). There are no shoals or islands on the lake. Side scan bathymetry mapping indicates that there are two basins in the lake. The deepest of these is located in the southern arm of Mitta Lake. It is 16m deep (Figure 12-2). Table 1 summarizes temperature- dissolved oxygen profile data collected from August 2010 to November 2011. There was a thermocline evident between 4 m and 7 m in August 2010 and between 2 m and 5 m in June 2011. This is consistent with results reported in TBT Engineering (2009). The bottom of Mitta Lake (i.e. >7 m depth) experiences low dissolved oxygen levels during the summer [Table 1, TBT Engineering (2009)]. Late winter dissolved oxygen was greater than 1 ppm throughout most of the water column in March 2011. pH was slightly acidic throughout the water column when measured in June and September 2011 and slightly alkaline in March and November 2011.

The lake bottom in the littoral zone is mix of fine and coarse substrates and bedrock (Figure 12-1). Within the lake basin, substrate consists of fine sediment (Figure 12-3). Aquatic macrophytes are abundant in shallow arms of the lake but not along the steep sloped bedrock portions of the shoreline.

There are several seasonal inflows to the lake, and a single outflow located at the northeast corner. A beaver dam is located at the outflow. Water seeping through the dam maintains a constant supply of water to the upper section of a small stream that connects Mitta Lake to Marmion Reservoir.

The fish community of Mitta Lake was assessed in September 2010 and June 2011 (Table 2). The lake supports populations of common white sucker, brook stickleback, ninespine stickleback, fathead minnow, Iowa darter, mottled sculpin and finescale dace. TBT Engineering identified five fish species in the lake in 2009, including slimy sculpin (TBT Engineering 2009). Because of morphological similarities, slimy sculpin and mottled sculpin can easily be mistaken for one another.

DRAFT

API #12 (MITTA LAKE)

Table 1: API #12 (Mitta Lake), Basic Water Chemistry Parameter Data

Depth (m)	August 2010		March 2011		June 2011		September 2011		November 2011	
	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Water Temperature (°C)	Dissolved Oxygen (mg/L)
Surface	22.67	8.55	-	-	17.19	9.97	15.12	9.09	6.41	10.44
1	21.97	8.75	-0.07	11.33	16.38	9.99	15.14	9.03	6.13	10.5
2	21.10	8.90	1.64	10.08	15.97	10.28	15.06	9.02	6.09	10.2
3	20.30	8.96	2.5	9.37	12.31	-	15.04	9.00	6.05	10.04
4	19.87	8.87	2.8	8.91	7.69	12.1	15.04	8.99	6.04	9.95
5	17.18	10.26	3.12	8.08	5.45	10.9	14.81	8.81	6.02	9.9
6	10.47	5.60	3.26	7.65	4.52	8.59	14.61	8.12	6.01	9.85
7	7.37	0.51	3.35	6.93	4.00	5.91	8.2	1.24	6.00	9.82
8	6.35	0.46	3.42	4.63	3.99	5.00	6.32	0.83	5.99	9.78
9	5.66	0.30	3.47	3.36	3.85	2.2	5.67	0.69	5.98	9.74
10	5.26	0.25	3.53	3.07			5.26	0.61	5.95	9.72
11	4.97	0.21	3.54	2.72			4.94	0.58	5.94	9.69
12	4.77	0.20	3.57	1.56			4.82	0.56	5.9	9.47
13	4.65	0.18	3.58	1.14			4.69	0.55	5.79	7.26

DRAFT

API #12 (MITTA LAKE)

Table 2: API #12 (Mitta Lake), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (See Figure 12-1)	Date	Gear	Effort	Catch
1	September 21-22, 2010	minnow traps (2)	43 trap hrs.	mottled sculpin (1 adult) finescale dace (9 adult, 1 juvenile)
2	September 21-22, 2010	minnow traps (2)	42 trap hrs.	mottled sculpin (1 adult) finescale dace (6 adult, 21 juvenile) brook stickleback (1 adult)
3	September 21-22, 2010	nordic net	20 hrs.	lowa darter (1 adult) white sucker (3 adult, 7 juvenile) mottled sculpin (3 adult, 5 juvenile) fathead minnow (1 adult, 1 juvenile) ninespine stickleback (5 adult) finescale dace (2 adult)
4	September 21-22, 2010	gillnet - experimental mesh	19 hrs.	no catch
5	September 21-22, 2010	gillnet - experimental mesh	15 hrs.	white sucker (2 adult)
6	May 31-June 2, 2011	gillnet - experimental mesh	35 hrs.	no catch
7	May 31-June 2, 2011	gillnet - experimental mesh	37 hrs.	white sucker (2 adult)
8	June 1-2, 2011	gillnet - experimental mesh	19 hrs.	white sucker (1 juvenile)
9	June 1-2, 2011	gillnet - experimental mesh	19 hrs.	white sucker (2 juvenile)
10	May 31-June 1, 2011	nordic net	48 hrs.	white sucker (8 adult, 17 juvenile) brook stickleback (1 adult) ninespine stickleback (48 adult) fathead minnow

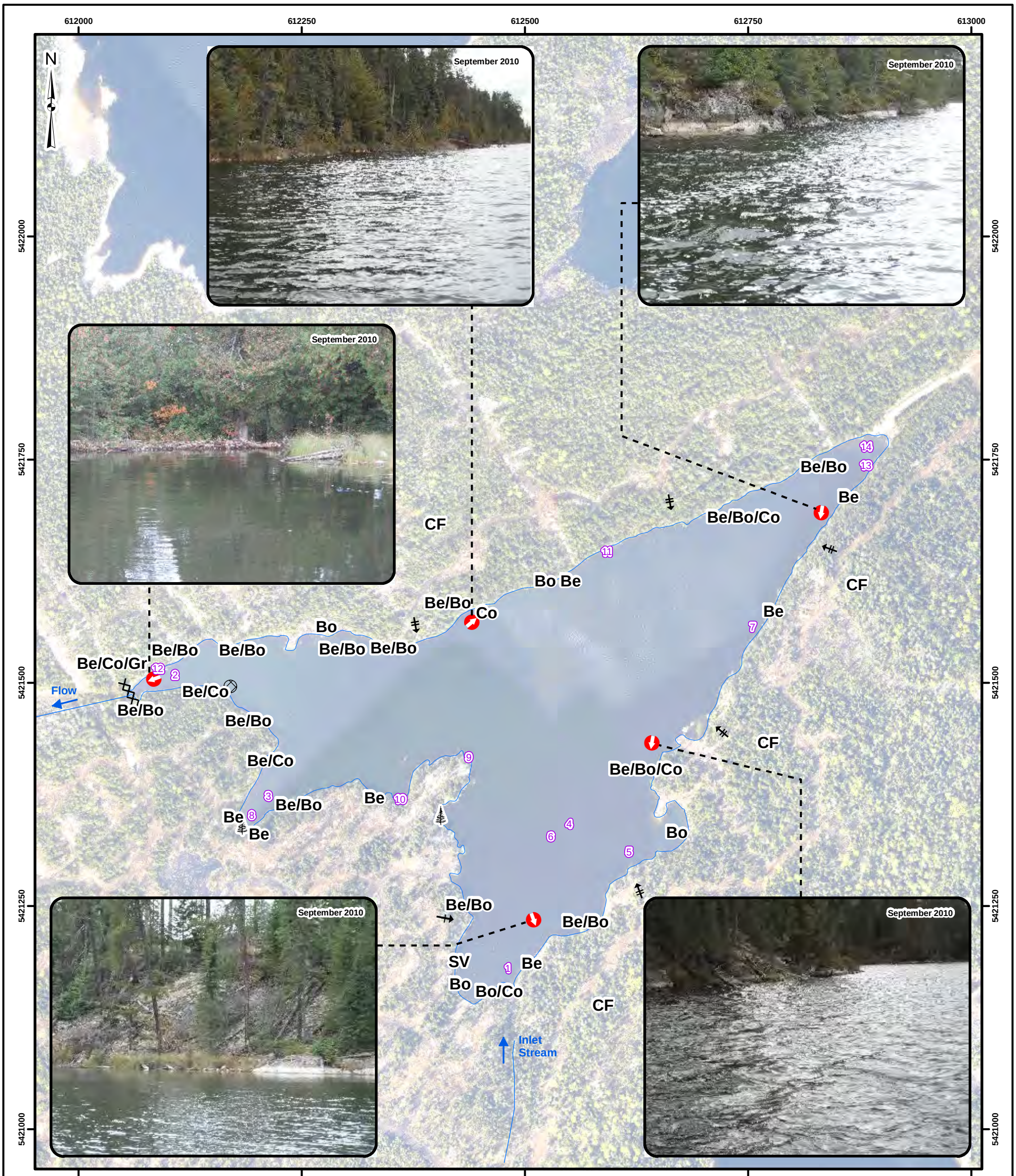
DRAFT

API #12 (MITTA LAKE)

Fish Effort Location (See Figure 12-1)	Date	Gear	Effort	Catch
				(1 adult)
11	May 31-June 2, 2011	nordic net	48.5 hrs.	white sucker (9 juvenile) ninespine stickleback (20 adult)
12	June 1-2, 2011	nordic net	18.25 hrs.	ninespine stickleback (6 adult) sculpin sp. (1 unk.) white sucker (6 adult, 1 juvenile)
13	June 1-2, 2011	nordic net	19 hrs.	ninespine stickleback (73 adult) sculpin sp. (2 adult) fathead minnow (10 adult) brook stickleback (1 adult)
14	June 1-2, 2011	minnow traps (5)	115 trap hrs.	ninespine stickleback (3 adult) brook stickleback (1 adult) finescale dace (10 adult) sculpin sp. (11 adult) fathead minnow (4 adult)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 12\api 12 mitta lake.docx



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- EV Emergent Vegetation
- SV Submergent Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)
- Steep Slope (31 to 70%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- SH - Shrubs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Gr -Gravel
- Sa -Sand
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 12
(MITTA LAKE)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 12-1	
GIS	DM	10 Apr. 2012		
CHECK	JD	10 Apr. 2012		
REVIEW	JS	10 Apr. 2012		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\PondAPI\API_12.mxd

612000 612250 612500 612750 613000

5422000 5421750 5421500 5421250 5421000

N

110 0 110 220

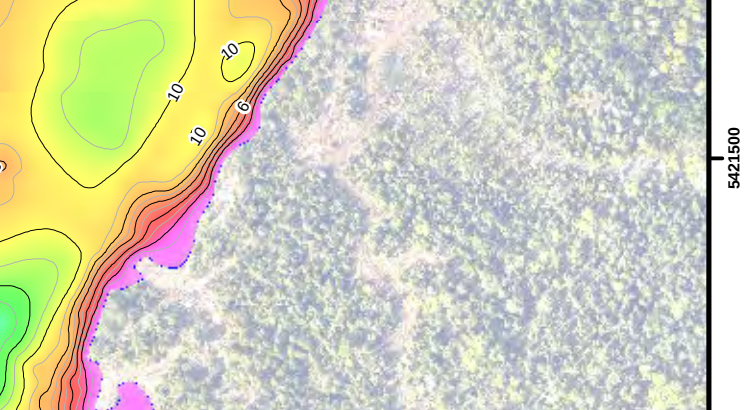
SCALE 1:4,500 METRES

LEGEND:

- Ditch
- River/Stream
- Road
- Lake Bottom Contours - 1 m interval
- Lake Bottom Contours - 2 m interval

Depth of Lake Bottom (metres)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18



REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 12 (MITTA LAKE) BATHYMETRY

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 12-2	
GIS	DM	10 Apr. 2012		
CHECK	JD	10 Apr. 2012		
REVIEW	JS	10 Apr. 2012		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\DraftAquatics\PondAPI\API_12_Bathymetry.mxd

612000 612250 612500 612750 613000

5422000 5421750 5421500 5421250 5421000

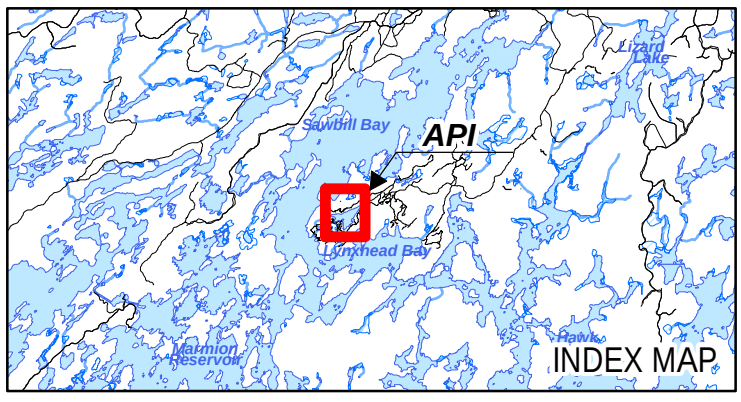
N

110 0 110 220

SCALE 1:4,500 METRES

LEGEND:

- Ditch
- River/Stream
- Road
- Boulders
- Shallow or Exposed Bedrock
- Fine Sediment
- Mixed Coarse and Fine Sediment



REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 12
(MITTA LAKE) INTERPRETED LAKE
BOTTOM SUBSTRATE

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 12-3	
GIS	DM	10 Apr. 2012		
CHECK	JD	10 Apr. 2012		
REVIEW	JS	10 Apr. 2012		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\PondAPI\API_12_LakeBottomSubstrate.mxd

API #12 (STREAM)

The stream channel was altered significantly by drilling activity in the spring of 2011. Although the channel between Mitta Lake and Marmion reservoir has been reconstructed, features within the new channel no longer resemble habitat features mapped in 2010 and described in this report.

The stream connecting Mitta Lake to Marmion Reservoir was approximately 840 m in length. Portions of the upper 300 m of the stream channel were dry, when it was mapped in August 2010. A series of beaver dams existed in the bottom third of the stream (Figure 12-4). These were 1 m to 2 m in depth. Substrate along the entire stream was silt.

The stream empties into a small inlet on Sawbill Bay. The slope of the reservoir bottom, near the mouth of the stream is steep. The shoreline is predominately bedrock (Photo 1). Substrate in the nearshore area consists of boulders. Discharge was calculated to be 0.003 m^3/s and 0.004 m^3/s near the mouth of the stream in October 2010 and May 2011, respectively. The mouth of the stream is steep and the lower reach ends 34 m from the mouth at a beaver dam (Photo 2).

The stream was fished using minnow traps in August 2010 (Table 1). Northern redbelly dace, finescale dace and fathead minnows were captured. Alterations to the stream channel precluded expending additional fishing effort in 2011. Young-of-the-year common white suckers were identified in the lower section of the stream in July 2011 (Brian Jackson 2011, pers. comm.).

Table 1: API #12 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 12-4)	Date	Gear	Effort	Catch
15	August 2-3, 2010	minnow traps (1)	20 trap hrs.	no catch
16	August 2-3, 2010	minnow traps (1)	21 trap hrs.	finescale dace (5 adult)
17	August 2-3, 2010	minnow traps (1)	19 hrs.	northern redbelly dace (133 adult, 8 juvenile) fathead minnow (69 adult, 31 juvenile) finescale dace (74 adult, 5 juvenile)

DRAFT

611800 612000

5421400 5421200 5421000

N

Mitta Lake

Flow

August 2010

August 2010

August 2010

August 2010

August 2010

dry(2)

dry(1)

FL(2)

FL(1) Si

IP3(2) Si

R3(3) Co/Gr

R3(2) Si

IP2(1) Si

17

16

15

R3/CA Si

R3(1) Si

BD

BD

BD

CF

CF

CF

CF

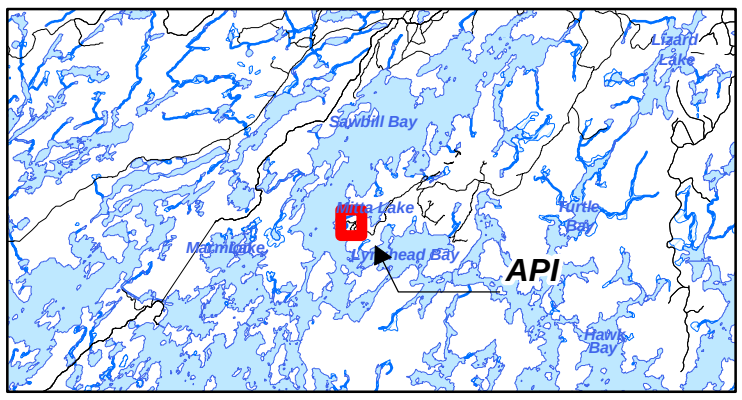
CF

Sawbill Bay

100 0 100

SCALE 1:2,400 METRES

Segment	Length (m)	Channel Width Transect (m)	Max. Depth a transect (m)	Substrate Dominant	Substrate Sub-dominant	In stream Vegetation
R3	34.42	1.04	0.03	Si	Sa	0
R3/CA	31.9	0.74	0.05	Si	-	25
IP2	254.19	65	1.5	Si	-	5
R3	206.23	0.75	-	Si	-	20
dry	30.68	-	-	-	-	-
FL	84.99	-	-	Si	-	-
dry	82.58	-	-	-	-	-
FL	67.95	-	-	-	-	-
IP3(1)	33.48	-	-	Si	-	-
R3	23.97	-	-	Co	Gr	-



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- IV Instream Vegetation

Bank Slope
← Shallow Slope (0 to 5%)

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
CA - Cascade; Extremely high gradient and velocity
R3 - Run Class 2; Moderate quality/Depth (0.75-11.0m)
IP2 - Impoundment Pool: Class 2
IP3 - Impoundment Pool: Class 3

Substrate Classification
Co - Cobble
Gr - Gravel
Sa - Sand
Si - Silt

Riparian Vegetation
CF - Coniferous Forest

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 12 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 12-4	
GIS	DM	26 Mar. 2012		
CHECK	JD	27 Mar. 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_12.mxd

API #12 PHOTO LOG

Photo 1: Mouth of API #12 in Small Bay of Marmion Reservoir.

Photo 2: Mouth of API #12.

INTERPRETATION OF CATCHMENT K AQUATICS BASELINE

Mitta Lake drains a very small catchment area. Inflows to the lake are seasonal and water elevation is controlled by the beaver dam located at its outflow. Mitta Lake supports a fish community comprised of seven fish species. The only large-bodied species inhabiting the lake is common white sucker. Mitta Lake stratifies during the summer and low dissolved oxygen levels exist in the hypolimnion following stratification. Oxygen levels measured in November, after the fall turn-over, and in late winter were high throughout the water column.

Three of the fish species inhabiting the lake, including young-of-the-year common white suckers, have been documented in the stream connecting Mitta Lake with Marmion Reservoir. In addition, northern redbelly dace were captured in the stream. Stream flow is a function of seepage through the beaver dam located at the outflow of the lake and appears to be low during most of the year. Portions of the upper stream channel were dry when assessed in May 2010. Fish from Marmion Reservoir are likely not able to ascend the stream due to the combination of low flows and the steep gradient that exists in the lower section of the stream. The suitability of fish habitat for species documented in the stream has not been assessed since the channel was reconstructed. Habitat conditions described in this report are based upon conditions that existed prior to alteration of the channel.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment k interpretation.docx

Catchment L

CATCHMENT L

Catchment L is overlapped by the proposed waste rock stockpile location (Figure 1). There are two aquatic features within the catchment; a headwater pond (API#11) and its outflowing stream which empties into Lynxhead Bay (Figure 2). The pond and upper reaches of the outflowing stream will be destroyed by creation of the waste rock pile. Stream flow within the lower portions of stream down gradient of the wasterock stockpile may also be altered.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment l overview.docx

API #11 (HEADWATER POND)

API #11 is a headwater pond with a surface area of 26,748 square meters. The pond is approximately 280 m in length and 125 m wide at its widest point. The deepest location in the pond is 5.5 m, occupying a discrete area in the north end of the pond (Figure 11-1). The southern portion of the pond is extremely shallow (photo 2). The pond is surrounded by thick coniferous vegetation (Photo1). Shoreline slope is steep and there is no wetland area surrounding the pond. Aquatic vegetation is abundant throughout the pond. Bottom substrate is predominately silt. There is no inflow to the pond and a single outflow located at its south end. Water from the pond flows into a heavily wooded area at the outflow. There are no beaver dams controlling the water level. Dissolved oxygen is high throughout the water column (Table 1).

Table 1: API #11 (pond), Basic Water Chemistry Parameter Data

Date/Depth (m)	Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
September 28, 2010				
Surface	11.4	7.6	58	10.6
1	11.1	7.6	58	10.5
2	10.9	7.7	58	10.2
3	10.9	7.6	58	9.8
4	9.0	7.6	58	8.0
5	-	-	-	-
August 27, 2011	23.0	8.9	76	9.0

The pond was fished on two occasions. On both occasions, finescale dace, northern redbelly dace and fathead minnow were the only fish species captured (Table 2).

Table 2: API #11 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 11-1)	Date	Gear	Effort	Catch
46	September 28–29, 2010	minnow trap	18 hrs.	finescale dace (27 adult, 2 juvenile) northern redbelly dace (11 adult)
47	September 28–29, 2010	minnow trap	19 hrs.	finescale dace (36 adult) northern redbelly dace (1 adult)

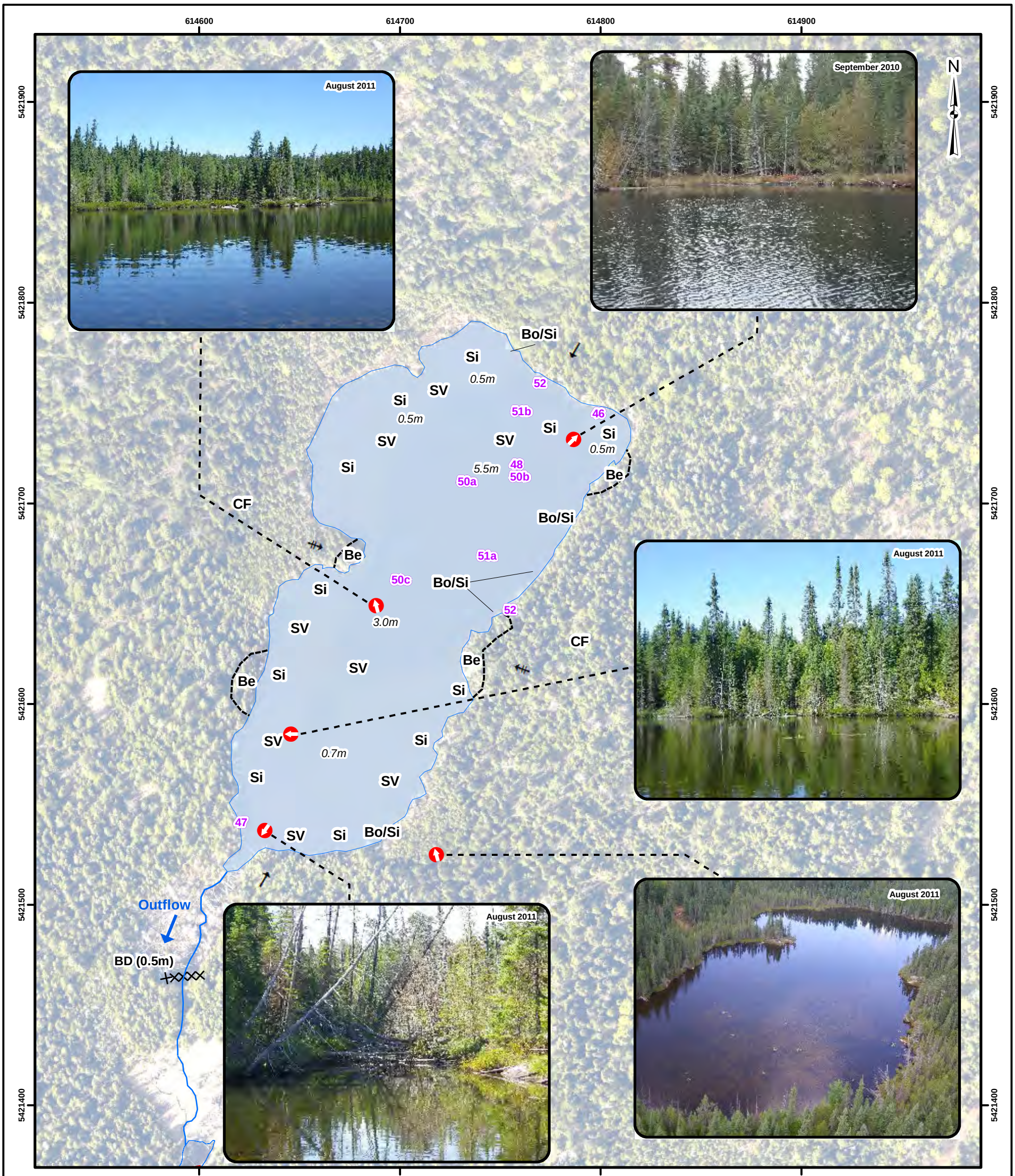
DRAFT

API #11 (HEADWATER POND)

Fish Effort Location (see Figure 11-1)	Date	Gear	Effort	Catch
				fathead minnow (3 adult)
48	September 28–29, 2010	nordic net	18 hrs.	finescale dace (9 adult) fathead minnow (2 adult)
49	September 28–29, 2010	gillnet - single panel (76 mm mesh)	18 hrs.	no catch
50a	August 27-28, 2011	broad –scale large mesh	57 hrs.	no catch
50b	August 27-28, 2011	broad –scale large mesh	57 hrs.	no catch
50c	August 27-28, 2011	broad –scale large mesh	57 hrs.	no catch
51a	August 27-28, 2011	broad –scale small mesh	39 hrs.	finescale dace (7 adult) fathead minnow (1 adult)
51b	August 27-28, 2011	broad –scale small mesh	39 hrs	finescale dace (4 adult) fathead minnow (3 adult)
52	August 27-28, 2011	minnow traps (3)	63 trap hrs.	finescale dace (57 adult) northern redbelly dace (1 adult) fathead minnow (84 adult)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 11\api 11 headwater pond.docx



LEGEND

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- SV Submergent Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Steep Slope (31 to 70%)

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Si -Silt

Riparian Vegetation
- CF - Coniferous Forest

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 11
(HEADWATER POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 11-1	
GIS	DM	11 Apr. 2012		
CHECK	JD	11 Apr. 2012		
REVIEW	JS	11 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_11.mxd

API #11 (STREAM)

The stream channel flowing out of API #11 (pond) consists of a series of flat sections, where beaver dams have created impoundments and a series of steep cascades (Figure 11-2). Total length of the stream from the pond outflow to Lynxhead Bay is 870 m. The upper 100 m of the stream, immediately below the pond outflow, consists of flooded forest. There is an abandoned beaver dam in this section, but it was not functional (i.e. impounding water) at the time of the assessment.

The middle section of the stream consists of a series of grassy meadows. There are four beaver impoundments in this section of the stream. All of the impounded areas are less than 1 m deep. Aquatic vegetation is abundant in the impoundments.

Channel widths in the middle and lower reaches of the stream, excluding impounded areas, varies between 2 m and 7 m. The cascades located throughout the middle and lower reaches are steep flowing over extensive bedrock and boulder outcrops (Figure 11-3; Photo 3).

Table 1 summarizes stream water chemistry parameters recorded in the field.

Table 1: API #11 (stream), Basic Water Chemistry Parameter Data

Date/Depth (m)	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
September 2010	14.0	10.1	6.9	49	8.0
October 2010	8.0	7.3	5.5	68	8.0
September 2011	9.5	10.2	6.8	69	7.0

Channel width at the mouth of the stream is 2 m. The lower channel is lined with boulders (Photo 4). Discharge, measured immediately upstream of the stream mouth in October 2010 was 0.00 m^3/s. The shoreline of Lynxhead Bay adjacent to the mouth of the stream is bedrock (Photo 5). Erosion of the overburden is evident along the shoreline (Figure 11-3; Photo 6). Bottom substrate in the littoral area is entirely sand. Aquatic vegetation and instream cover is sparse.

The lower portion of the stream was electrofished in September 2010. Run and pool channel segments were electroshocked along the entire stream in September 2011. Finescale and northern redbelly dace were the only fish species captured. They were captured throughout the stream (Table 2).

DRAFT

API #11 (STREAM)

Table 2: API #11 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 11-2)	Date	Gear	Effort	Catch
53	September 23, 2010	backpack electrofisher	115 m	finescale dace (27 adult, 27 juvenile, 2 YOY) northern redbelly dace (2 adult)
54	September 24, 2011	backpack electrofisher	641 m	finescale dace (29 adult, 36 juvenile, 1 YOY) northern redbelly dace (5 adult, 5 juvenile) dace sp. (2 YOY unk.)

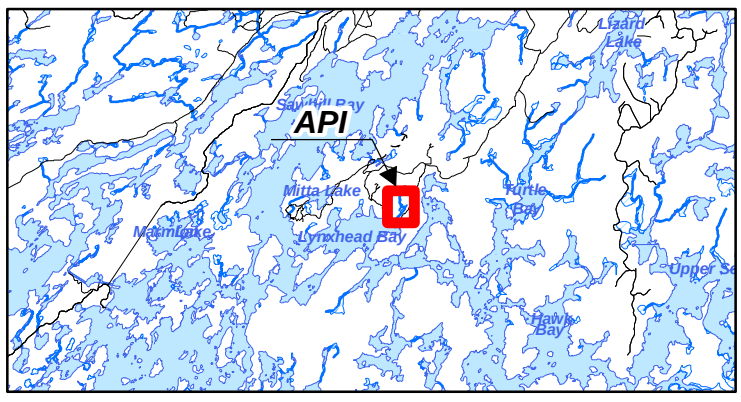
Gillnetting and boat electroshocking was conducted along the shoreline of Lynxhead Bay, adjacent to the mouth of the stream (Table 3).

Table 3: API #11 (Lynxhead Bay), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location	Date	Gear	Effort	Catch
55	August 26, 2010	boat electrofisher	500 m	yellow perch (10 juvenile) northern pike (1 adult)
56	September 24, 2011	broad-scale small mesh gillnets (2)	17.5 hrs	walleye (2 juvenile) yellow perch (15 juvenile)
57	September 24, 2011	broad-scale small mesh gillnets (2)	17.5 hrs	walleye (1 juvenile) northern pike (1 unk.)
58	September 24, 2011	broad-scale large mesh gillnets (2)	17 hrs	lake whitefish (1 adult) white sucker (1 adult) northern pike (1 adult)

DRAFT

Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
CA(1)	4.00	2	0.1	Bo	Bo	0
IP3(1)	20.00	5.1	0.44	Si	Bo	0
CA(2)	13.00	2.65	-	Bo	Co	0
FL(1)	70.82	2.67	0.48	Si	Sa	0
CA(3)	82.77	3.15	0.16	Bo	Co	0
R3(1)	67.47	1.73	0.06	Co	Sa	5
CA(4)	29.87	2.5	-	Be	Sa	0
IP3(2)	52.50	40	-	Si	-	40
FL(2)	224.15	1.66	0.23	Si	-	0
CA(5)	30.30	1.7	-	Be	-	0
FL(3)	30.00	7	-	Si	Bo	5
IP3(3)	52.48	12	-	Si	-	10
IP3(4)	30.56	20	-	Si	-	30
FL(4)	86.73	-	-	Si	-	5
IP3(5)	75.41	-	-	Si	-	2



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type

- CA - Cascade: Extremely High Gradient and Velocity
- FL - Flat, Low Gradient, Low Velocity
- IP3 - Impoundment Pool: Class 3
- R3 - Lowest Quality Run Habitat

Riparian Vegetation

- CF - Coniferous Forest
- GF - Grass and Forbs
- SH - Shrub

Substrate Classification

- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Sa -Sand
- Si -Silt

Bank Slope

- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 11 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 11-2	
GIS	DM	02 April 2012		
CHECK	JD	03 April 2012		
REVIEW	JS	16 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_11b.mxd

Beaver Dam

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 11 (STREAM)
(LOWER REACH)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 11-3	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #11 PHOTO LOG

Photo 1: Aerial view, looking southwards towards outflow.

Photo 2: Southern portion of API #11.

API #11 PHOTO LOG

Photo 3: Cascade located immediately upstream of mouth of API #11 (stream).

Photo 4: Mouth of API #11 (stream), towards Lynxhead Bay.

API #11 PHOTO LOG

Photo 5: Mouth of API #11 (stream) from Lynxhead Bay.

Photo 6: Shoreline immediately east of the mouth of API 11(stream), Lynxhead Bay.

INTERPRETATION OF CATCHMENT L AQUATICS BASELINE

The pond and stream located in Catchment L support cyprinid populations. Flow in the stream appears to be quite variable and may be intermittent. Impounded areas in the stream may provide refugia to cyprinids during periods when there is little or no stream flow. The stream is well shaded which may enhance survival of fish inhabiting the stream. The pond likely acts as a reservoir for fish to repopulate the stream.

It is unlikely that fish from Lynxhead Bay are able to ascend beyond the mouth of the stream due to the steep cascades located in the lower reaches. No fish species, other than those captured in the headwater pond, were captured in the stream. The shoreline of Lynxhead Bay near the mouth of the stream is steep. There has been extensive shoreline erosion. Substrate along the shoreline of Lynxhead Bay adjacent to the mouth of API #11 consists of sand and bedrock. There is very little aquatic vegetation and cover present. The creation of the waste rock stockpile will result in the destruction of the headwater pond and the upper portion of the stream.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment l interpretation.docx

Catchment M

CATCHMENT M

Catchment M has a total area of 111.7 hectares (Figure 3). There is a headwater pond (API #10) and a stream that flows into Turtle Bay within the catchment (Figure 2). It is located east of the proposed waste rock stockpile and the existing site access road (Figure 1). No project-related impacts to the aquatic features in this catchment are anticipated.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment m overview.docx

API #10 (HEADWATER POND)

This pond has a surface area of 13,797 square meters and a maximum depth of 10.0 m (Figure 10-1). At its widest point, the pond is approximately 125 m wide and 200 m in length. The shoreline consists mostly of grasses and shrubs and bedrock outcrops (Photo 1). There is an extensive wetland area surrounding most of the pond. Bottom substrate is primarily silt with some boulders located near the outflow. There is no inflow to the pond although there is a small partially infilled depression located immediately west of API #10 (Photo 2). A large beaver dam is located at the south end of the pond (Photo 3). There is some seepage of water through the dam but water escaping the pond infiltrates the ground immediately downstream of the dam. Water in the pond is slightly acidic (Table 1). Conductivity is low.

Table 1: API #10 (pond), Basic Water Chemistry Parameter Data

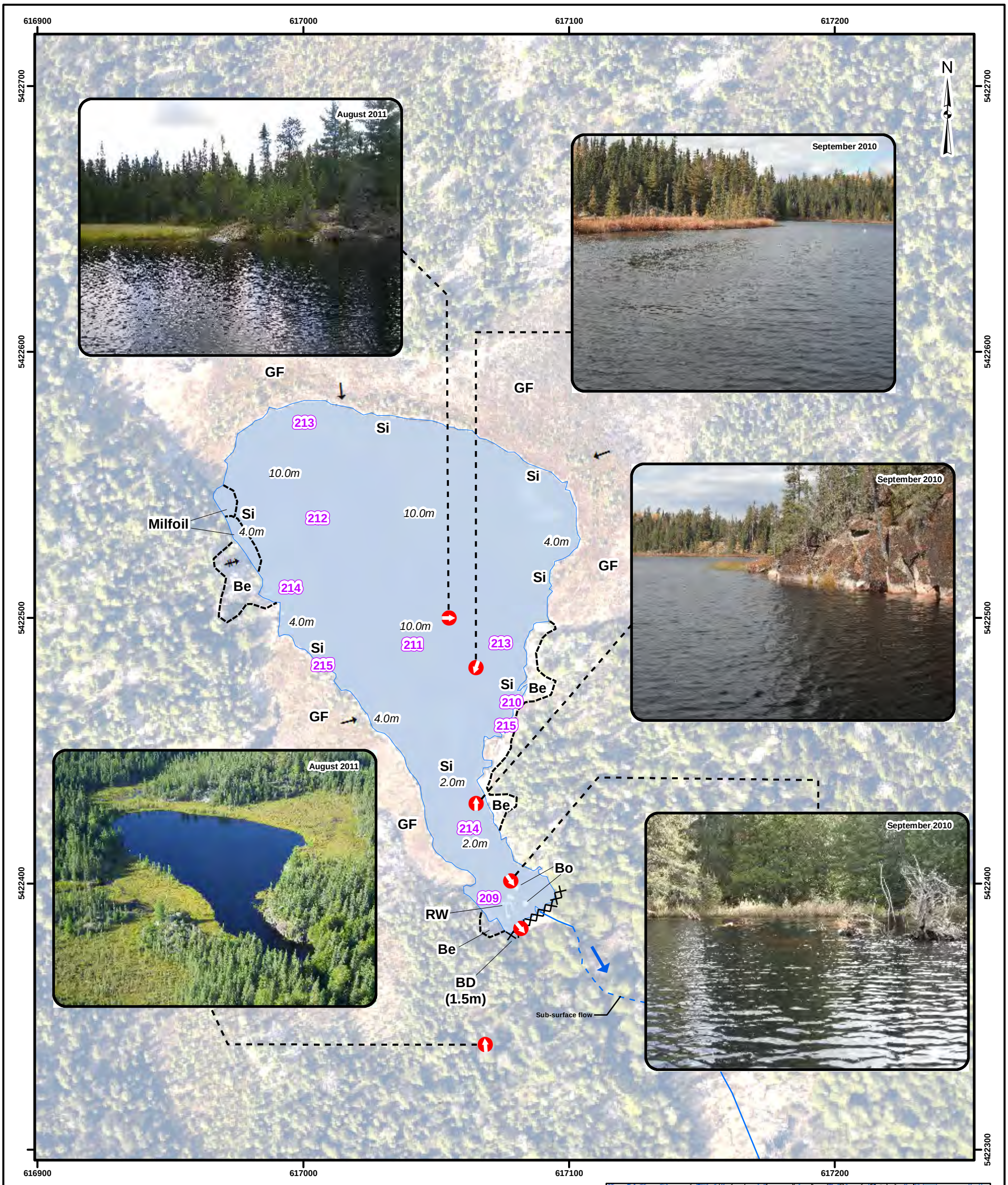
Date	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
Sept. 29,30, 2010	11.0	6.1	12	8.1
Aug. 26, 27, 2011	22.8	6.1	14	7.0

The pond was fished in September 2010 and in August 2011 (Table 2). No fish were captured.

Table 2: API #10 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 10-1)	Date	Gear	Effort	Catch
209	September 29-30, 2010	minnow traps (1)	18 trap hrs.	no catch
210	September 29-30, 2010	minnow traps (1)	18 trap hrs.	no catch
211	September 29-30, 2010	gillnet - experimental mesh	18.5 hrs.	no catch
212	September 29-30, 2010	nordic net	18 hrs.	no catch
213	August 26-27, 2011	broad-scale large mesh (2)	44 hrs.	no catch
214	August 26-27, 2011	broad-scale small mesh (2)	44 hrs.	no catch
215	August 26-27, 2011	minnow traps (3)	60 trap hrs.	no catch

DRAFT



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- RW Root Wad

Bank Slope
- Shallow Slope (0 to 5%)
- Steep Slope (31 to 70%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbes

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 10
(Headwater Pond)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 10-1	
GIS	DM	19 Mar. 2012		
CHECK	JD	20 Mar. 2012		
REVIEW	JS	16 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_MapsvAPI_10.mxd

API #10 (STREAM)

There is no visible surface flow in the upper 50 m of the stream (Figure 10-2). Beyond this, for approximately 200 m, the stream consists of wetted forest and has no identifiable channel. A beaver dam contains water in the upstream section of the stream. Below the dam, a low gradient flat flows through dense forest for approximately 200 m before entering a broad grassy meadow (Figure 10-3).

Stream temperature was low relative to air temperature during assessments of the stream (Table1). This may be due to the cooling effect of subsurface flows and extensive shading in the upper portion of the stream. Water in the stream is acidic. Flow in the lower section of the stream is seasonal. Discharge, measured in October 2010 and May 2011 was calculated to be 0.001 m^3/s and 0.032 m^3/s, respectively. There was water no water in the lower reach of the stream and no measurable discharge, in September 2011.

Table 1: API #10 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
September 2010	12.0	8.5	5.9	21	7.2
May 2011	24.5	8.4	6.0	33	7.1
September 2011	16.0	8.1	6.8	20	4.0

API #10 was electrofished on three occasions. No fish were captured in the stream in May 2011. In September 2010 and 2011, yellow perch, common white sucker and northern pike were captured near the mouth of the stream (Table 2).

Table 2: API #10 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 10-2)	Date	Gear	Effort	Catch
216	September 25, 2010	backpack electrofisher	100 m	yellow perch (1 adult) white sucker (2 YOY)
217	May 11, 2011	backpack electrofisher	125 m	no catch
218	September 25, 2011	backpack electrofisher	68 m	northern pike (1 juvenile)

The mouth of the stream flows through an extensive grassy area before entering Turtle Bay (Photo 4). The channel remains tightly confined in this lower reach. Maximum depth in the lower reach in August 2010 was 1 m. Aquatic vegetation is dense throughout the bay. Shoreline vegetation consists of

DRAFT

API #10 (STREAM)

cattails and sedges. Catch results of fishing effort expended in the vicinity of the mouth of the stream in Turtle Bay (API #36) are summarized in Table 3. Adult and juvenile fish representing a variety of fish species were captured in Turtle Bay near the mouth of API #10.

Table 3: API #36 (Turtle Bay), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location	Date	Gear	Effort	Catch
219	August 24-25, 2010	gillnet – experimental mesh	23 hrs.	yellow perch (3 adult) walleye (3 juvenile) northern pike (1 adult, 2 juvenile) lake whitefish (4 adult) smallmouth bass (2 unk.)
220	August 25-26, 2010	gillnet – experimental mesh	23 hrs.	lake whitefish (2 adult) northern pike (1 juvenile) white sucker (1 adult) walleye (3 juvenile, 3 adult) yellow perch (2 unk.) smallmouth bass (1 adult)
221	August 23-24, 2010	gillnet – experimental mesh	25 hrs.	smallmouth bass (2 adult, 3 unk.) northern pike (6 adult, 6 juvenile) walleye (1 adult, 1 juvenile, 1 unk.) lake whitefish (3 adult) yellow perch (13 unk.)
222	August 23-24, 2010	nordic net	22 hrs.	yellow perch (4 juvenile, 4 adult) northern pike (1 adult, 1 juvenile, 1 unk.)
223	September 24-25, 2010	gillnet – experimental	23 hrs.	yellow perch (10)

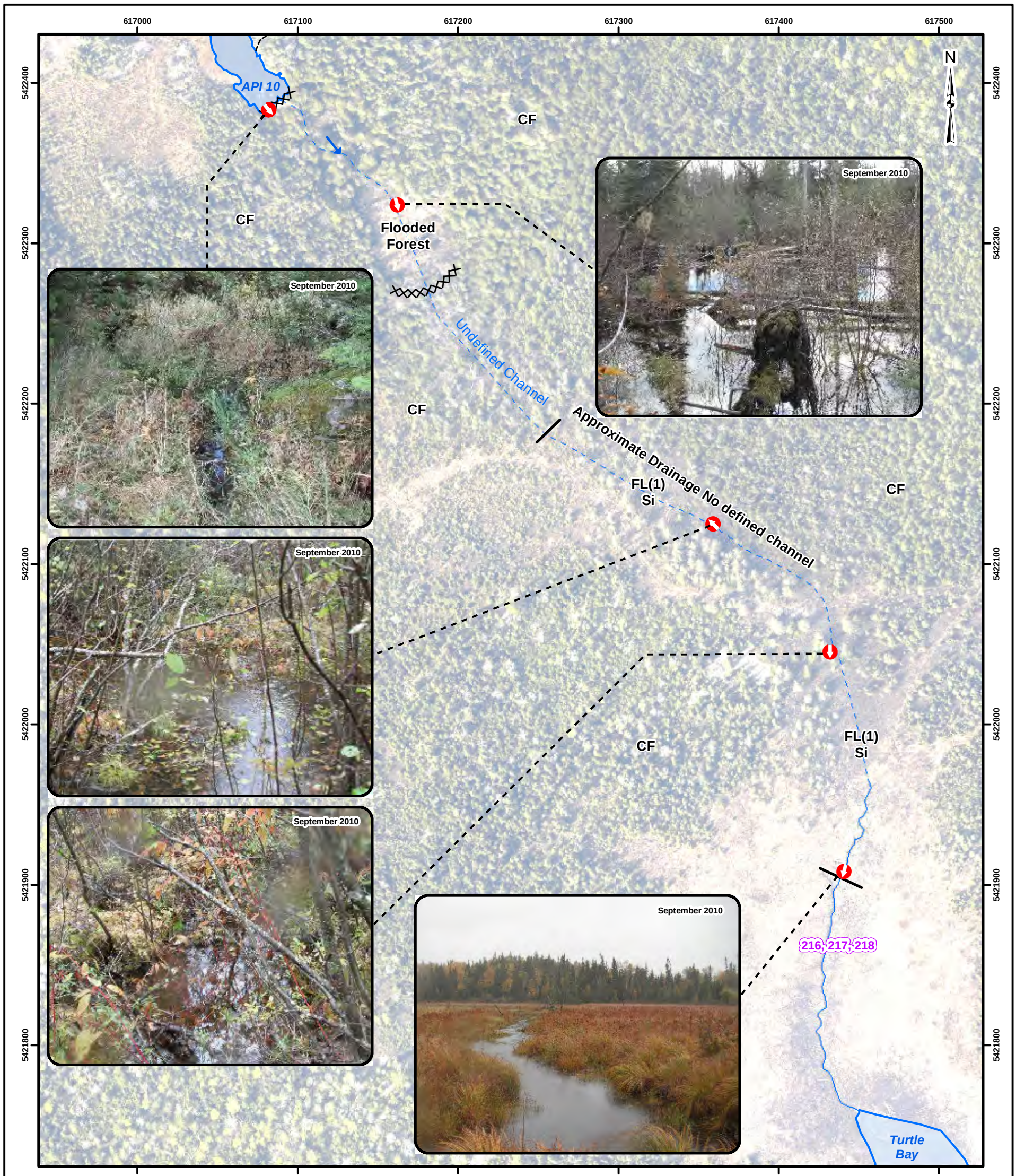
DRAFT

API #10 (STREAM)

Fish Effort Location	Date	Gear	Effort	Catch
		mesh		white sucker (6) cisco (12) walleye (14) northern pike (1) lake whitefish (2)
224	August 25, 2010	boat electrofisher	800 m (721s)	yellow perch (6 juvenile, 6 unk.) blacknose shiner (11 adult, 82 juvenile, 10 YOY) northern pike (2 unk.)
225	August 26, 2010	boat electrofisher	1,000 m (850s)	northern pike (4 unk.) yellow perch (4 juvenile, 10 unk.) blacknose shiner (13 juvenile, 42 adult)

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 10\api 10 stream.docx

DRAFT



Segment	Length (m)	Channel Width a Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	387.49	no defined channel	-	Si	-	10

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity

Bank Slope
Intermediate Slope (6 to 30%)

Substrate Classification
Bo -Boulder
Si -Silt

Riparian Vegetation
CF - Coniferous Forest

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 10 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 10-2	
GIS	DM	28 Mar. 2012		
CHECK	JD	29 Mar. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_10b.mxd

Beaver Dam

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 10 (STREAM)
(LOWER REACH)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 10-3	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #10 PHOTO LOG

Photo 1: Looking southwards towards outflow.

Photo 2: API #10 and shallow pond located west of API.

API #10 PHOTO LOG

Photo 3: Abandoned beaver dam at outflow of API #10.

Photo 4: Mouth of API #10, Turtle Bay.

INTERPRETATION OF CATCHMENT M AQUATICS BASELINE

The headwater pond in this catchment does not support a fish community and is not connected to the stream by surface water flow. Water seeping through the beaver dam at the outflow of the pond, infiltrates the ground immediately below the pond. The upper portion of the stream consists water ponded within dense forest. Drainage from this forested area enters Turtle Bay through a low gradient channel. A stream channel is only distinguishable in the lower 150 m of the stream. Stream flow appears to be seasonal. There was no water in the lower reach of the stream in September 2011 (i.e. above the influence of the reservoir). Fish from Turtle Bay can access the lower reach of the inflowing stream but likely only during periods of high flow (i.e. during freshet) and when the water elevation in the reservoir is high. The mouth of the stream, where the reservoir provides less variable habitat conditions, provides nursery habitat to northern pike and common white sucker. No project related impacts on aquatic features located within Catchment M are anticipated.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment m interpretation.docx

Catchment N

CATCHMENT N

This catchment is located east of the site access road, west of Lizard Lake and TMF#2. The total area of Catchment N is 111.7 hectares (Figure 3). Aquatic features within the catchment include a small lake (API #43), a pond (API #44) and a stream system that conveys flows from them into a single channel, emptying into the upper portion of Turtle Bay (Figure 2). No direct Project impacts are anticipated on the waterbodies. Should TMF Alternative 2 be adopted, a pipeline to conduct tailings from the mine processing facility to the tailings management area will be constructed crossing the stream draining the headwaters (Figure 1). The exact location of the pipeline crossing, has not been identified.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment n overview.docx

API #43 (HEADWATER LAKE)

This lake has a surface area of 28,822 square meters and a maximum depth of 6.0 m (Figure 43-1). The dimensions of the lake are approximately 250 m wide and 200 m in length. The shoreline is tightly contained by a bedrock outcrop on its western shore and thick coniferous forest along its eastern shore. Substrate is predominately silt. There are no inflows to the lake, and one outflow at the south end (Figure 43-2). Water in the pond is slightly acidic and dissolved oxygen low at its deepest point (Table 1). The water was very dark. Secchi depth was less than 1 m.

Table 1: API #43, Basic Water Chemistry Parameter Data (May 2011)

Depth (m)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
Surface	15.1	6.8	16	9.8
1	15.0		16	9.3
2	14.9		16	9.3
3	8.2		17	10.1
4	5.3		18	5.4
5	4.5		18	4.7
6	4.3		18	2.5

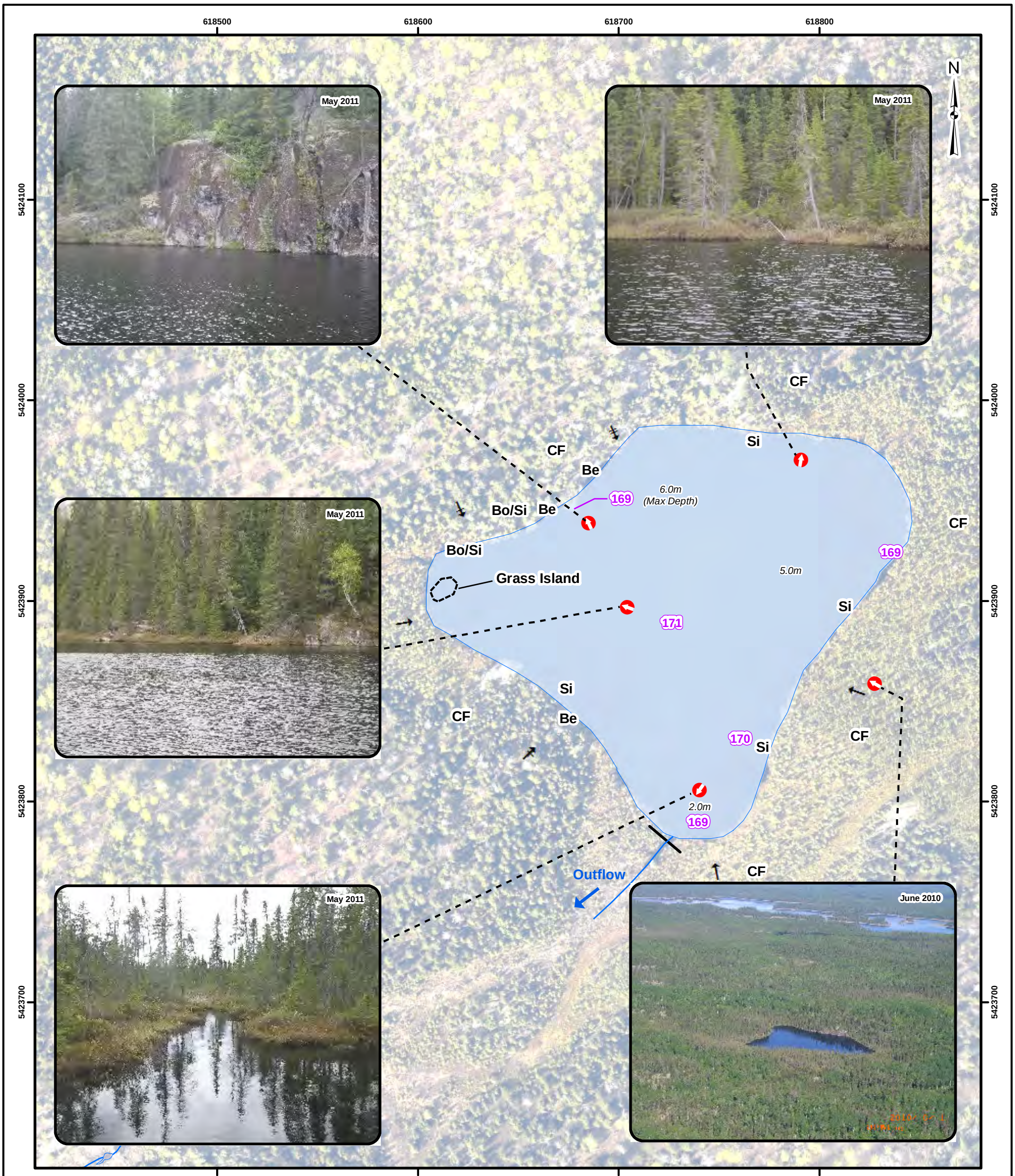
No fish were captured during the May 2011 assessment (Table 2).

Table 2: API #43, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 43-1)	Date	Gear	Effort	Catch
169	May 27-28, 2011	minnow traps (3)	56 trap hrs.	no catch
170	May 27-28, 2011	nordic net	19 hrs.	no catch
171	May 27-28, 2011	gillnet – experimental mesh	19 hrs.	no catch

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 43\api 43 headwater lake.docx



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)
- Steep Slope (31 to 70%)

Riparian Vegetation
CF - Coniferous Forest

Substrate Classification
Bo -Boulder
Si -Silt

Bank Features
Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 43
(Headwater Lake)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 43-1	
GIS	DM	13 Mar. 2012		
CHECK	JD	14 Mar. 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_43.mxd

XXXX **Beaver Dam**

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 43
(HEADWATER LAKE)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 43-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #43 (STREAM)

The stream draining API #43 was assessed in May 2011. Along most of its length, the water flows through a mix of dense forest and a narrow meadow. The upper halve of the stream is intermittent (Figure 43-3). Portions of the upper halve had a low gradient, well defined channel but only the uppermost section appears to be permanently wetted. Flow was only discernable in the upper 100 m of the stream. No fishing effort was expending in the upper section of the stream.

The lower halve of the stream is ephemeral. The channel is undefined, with the exception a short cascade and small pool near its mouth. Most of its lower halve of the stream was dry. A boulder lined cascade was discernable near the lower end of the stream, where it converges with the stream from API #44. Table 1 summarizes water chemistry parameters of the stream, measured in the field.

Table 1: API #43 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2011	18.5	16.4	7.2	19	9.1

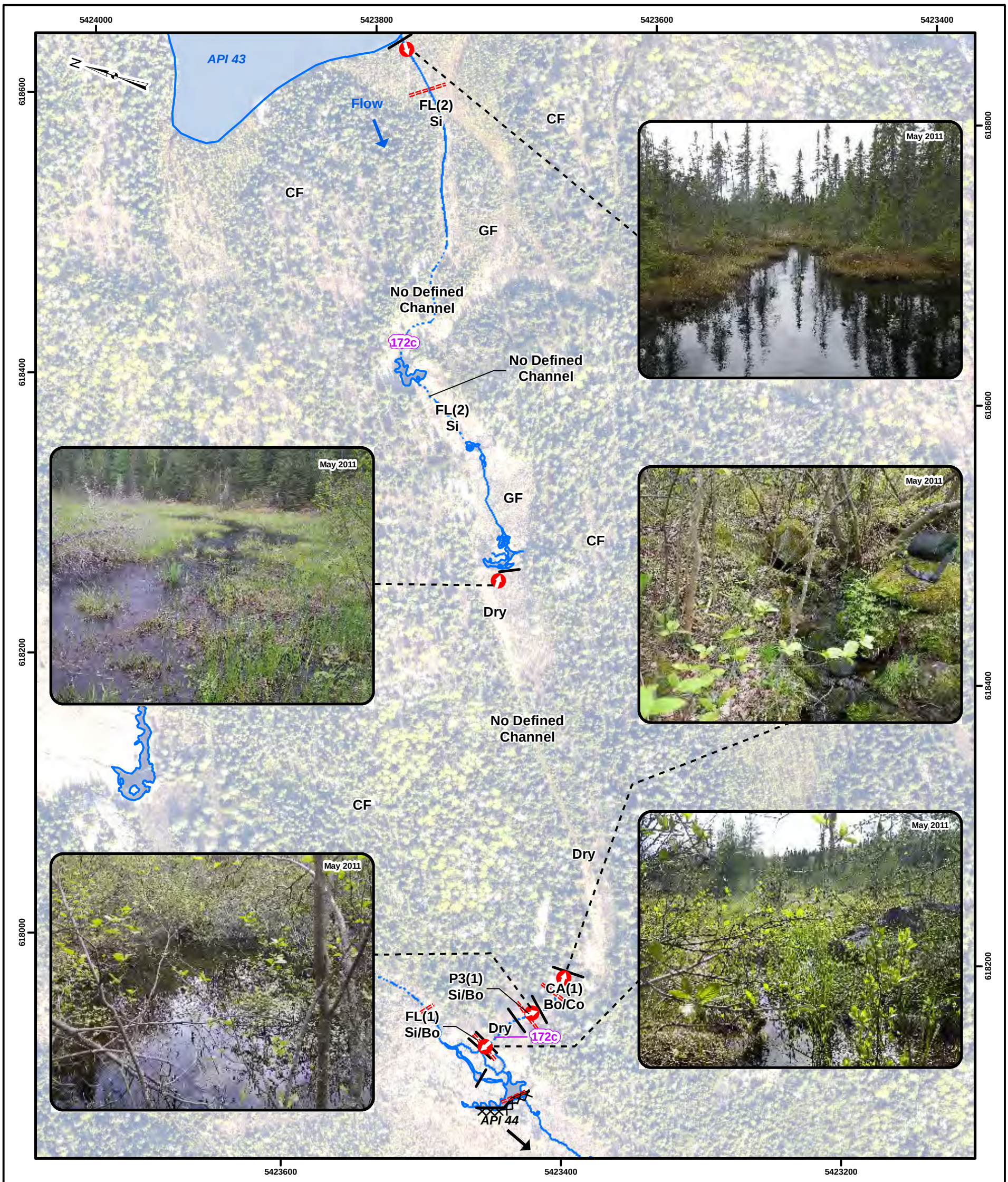
Electrofishing was conducted in the isolated pool located at the base of the dry cascade and finescale dace were captured (Table 2).

Table 2: API #43 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

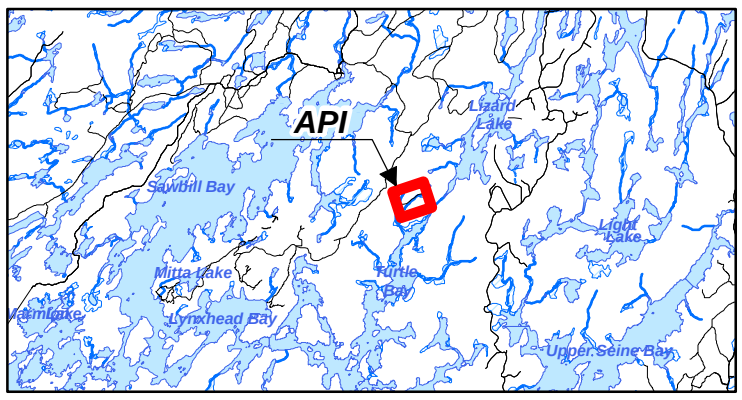
Fish Effort Location (see Figure 43-3)	Date	Gear	Effort	Catch
172c	May 12, 2011	backpack electrofisher	15 m	finescale dace (6 juvenile, 7 adult)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 43\api 43 stream.docx)



Segment	Length (m)	Channel Width a Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	5.20	1.55	0.16	Si	Bo	60
N/A (dry)	27.85	N/A	N/A	N/A	N/A	N/A
P3(1)	19.00	6.65	0.62	Si	Bo	10
CA(1)	35.15	1.1	0.1	Bo	Co	0
N/A (dry)	329.71	N/A	N/A	N/A	N/A	N/A
FL(2)	382.78	6	0.15	Si	-	80



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type

CA - Cascade: Extremely High Gradient and Velocity
FL - Flat, Low Gradient, Low Velocity
P3 - Lowest Quality Pool Habitat (not suitable for overwintering)

Substrate Classification

Bo -Boulder
Co -Cobble
Si -Silt

Riparian Vegetation

CF - Coniferous Forest
GF - Grass and Forbs

Bank Slope

← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 43 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 43-3	
GIS	DM	02 April 2012		
CHECK	JD	03 April 2012		
REVIEW	JS	09 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_43b.mxd

API #44 (HEADWATER POND)

This lake has a surface area of 7,971 square meters and a maximum depth of 8 m (Figure 44-1). The deepest location is a discrete area in the immediate centre of the pond. The dimensions of the pond are approximately 120 m wide and 80 m in length. The shoreline is surrounded by a narrow band of grasses and shrubs. Substrate is predominately silt. There are no discernable inflows or outflows. Water in the pond is slightly acidic and dissolved oxygen was low at its deepest point (Table1). The water was very dark. Secchi depth was less than 1 m.

Table 1: API #44 (pond), Basic Water Chemistry Parameter Data (May 2011)

Depth (m)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
Surface	14.8	6.7	16	8.9
1	14.8		16	8.9
2	10.6		17	9.6
3	5.3		20	4.3
4	4.4		20	2.6
5	4.0		20	2.1
6	4.0		25	1.0
7	4.0		27	0.8
8	4.0		32	0.8

No fish were captured during the May 2011 assessment (Table 2).

Table 2: API #44 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 43-1)	Date	Gear	Effort	Catch
173	May 27-28, 2011	minnow traps (4)	56 trap hrs.	no catch
174	May 27-28, 2011	nordic net	16 hrs.	no catch

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 44\api 44 headwater pond.docx

618750 618800 618850 618900 618950

5424450 5424400 5424350 5424300 5424250 5424200

N

May 2011

May 2011

Outflow (trickle)

CF

CF

173

Si

Si

Si

SH/GF

173

174

4.0m

8.0m

Si

3.0m

173

Si

Si

2.0m

Si

SH/GF

CF

CF

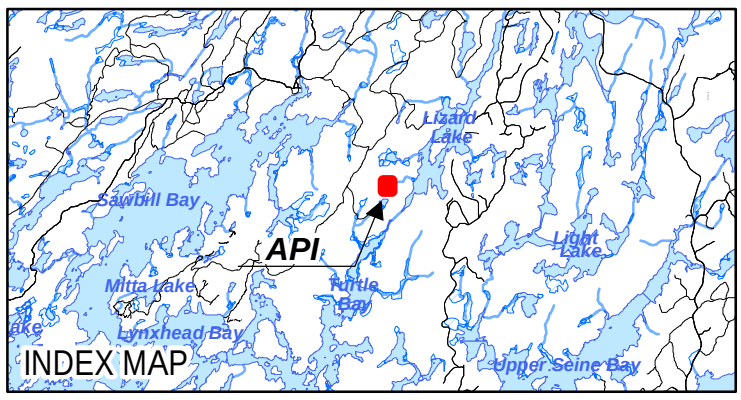
May 2011

May 2011

618750 618800 618850 618900 618950

25 0 25 50

SCALE 1:1,000 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Bank Slope
- ← Shallow Slope (0 to 5%)

Substrate Classification
- Si -Silt

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- SH - Shrubs

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 44 (Headwater Pond)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 44-1	
GIS	DM	15 Mar. 2012		
CHECK	JD	16 Mar. 2012		
REVIEW	JS	18 Mar. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_44.mxd

API #44 (STREAM)

This stream is not connected to the upstream pond (i.e. API #44 (pond). It consists of a defined channel extending almost 1,000 m upstream of its mouth in Turtle Bay. It drains a forested area but also conveys seasonal drainage from API #43 (stream). Channel widths and depths are less than 1 m in the upper 900 m of the stream (Figure 44-2). Substrate consists of silt throughout the stream.

The lower 50 m of the stream (Figures 44-3 and 44-4) consists of a series of shallow (less than 1 m deep) beaver impoundments (Figure 44-3). The mouth of the stream empties into Turtle Bay in a narrow, shallow bay (Photo 1). Aquatic vegetation is abundant at the mouth of the stream. Stream discharge in May 2011 was calculated to be 0.042 m^3/s. Table 1 summarizes basic water chemistry data collected in the lower reach of the stream.

Table 1: API #44 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2011	24.0	11.7	6.6	28	11.6

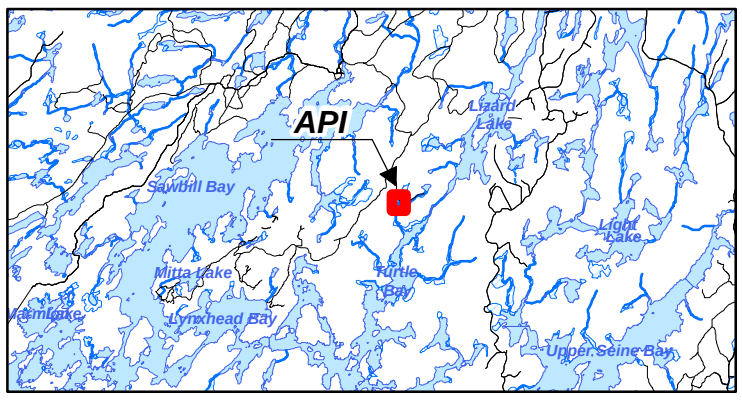
Approximately 400 m of the stream were shocked in May 2011. Table 2 summarizes fish catches. A juvenile common white sucker and finescale dace were captured upstream of the lower beaver dams near the confluence with API #43 (stream). Yellow perch and Iowa darters were captured below the first set of beaver dams near the mouth of the stream. No fishing effort was expended in Turtle Bay outside of the mouth of API #44.

Table 2: API #44, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 44-2, 44-3)	Date	Gear	Effort	Catch
172a	May 11, 2011	backpack electrofisher	200 m	yellow perch (3 juvenile) Iowa darter (2 adult)
172b	May 12, 2011	backpack electrofisher	200 m	white sucker (1 juvenile) finescale dace (2 adult, 3 juvenile)

DRAFT

Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	178.23	0.6	0.52	Si	-	20
IP3(1)	74.65	45	0.56	Si	-	60
FL(2)	184.95	0.66	0.19	Si	-	10



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment Pool: Class 3

Riparian Vegetation
CF - Coniferous Forest
GF - Grass and Forbs
SH - Shrub

Substrate Classification
Si -Silt

Bank Slope
← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

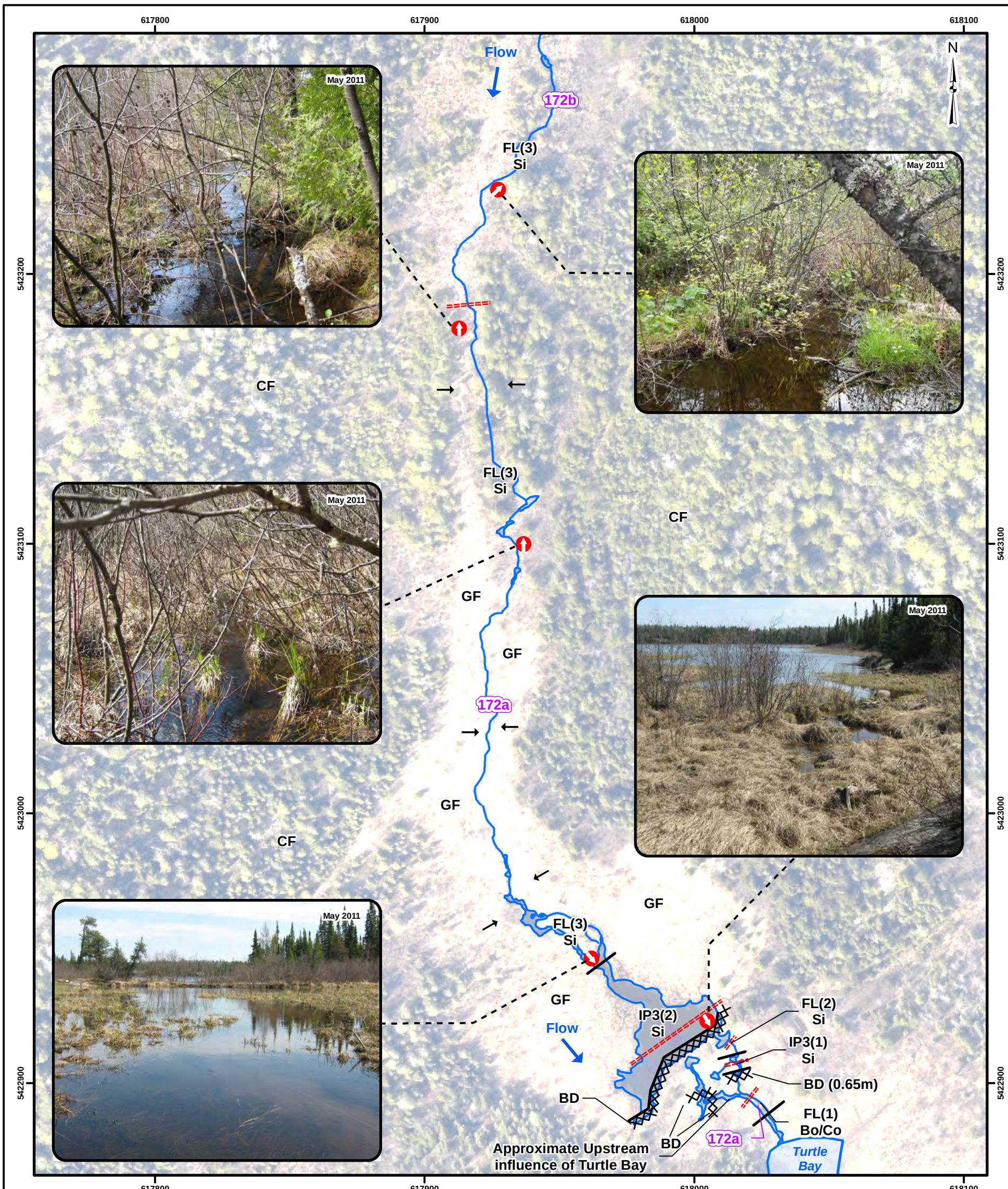
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 44 (STREAM)
(MAP 2 OF 2)

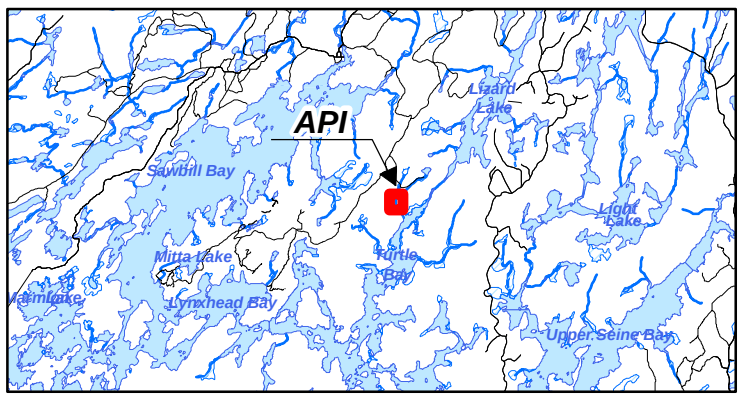
Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 44-2	
GIS	DM	02 April 2012		
CHECK	JD	03 April 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_44c.mxd



Segment	Length (m)	Channel Width a Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetati
				Dominant	Sub-dominant	
FL(1)	54.85	3.2	0.63	Bo/Co	Si	60
IP3(1)	6.80	4.5		Si	-	0
FL(2)	14.04	3		Si	-	60
IP3(2)	45.21	40		Si	-	20
FL(3)	415.45	0.6	0.52	Si	-	20



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment Pool: Class 3

Riparian Vegetation
CF - Coniferous Forest
GF - Grass and Forbs
SH - Shrub

Substrate Classification
Be -Bedrock
Bo -Boulder
Co -Cobble
Si -Silt

Bank Slope
← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 44 (STREAM)
(MAP 1 OF 2)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 44-3	
GIS	DM	02 April 2012		
CHECK	JD	03 April 2012		
REVIEW	JS	15 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_44b.mxd

XXXX **Beaver Dam**

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 44 (STREAM)
(LOWER REACH)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 44-4	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LIDAR_Figures.mxd

API #44 PHOTO LOG

Photo 1: Lower reach and mouth of API #44 (stream) and Turtle Bay.

INTERPRETATION OF CATCHMENT N AQUATICS BASELINE

The ponds originally identified as head waters for this catchment are physically isolated and not connected to the stream system that drains the catchment. These ponds do not support fish communities. The upper portions of both stream tributaries are seasonal. Cyprinids were captured near the mouth of API #43, in a discrete pool and in the upper beaver pond in API #44.

Fish from Turtle Bay appear to be able to ascend the stream beyond the lower set of beaver dams. A juvenile common white sucker was captured as far as 800 m upstream of Turtle Bay below the upper beaver dam. Access to this stream from Turtle Bay is likely restricted to periods of high flow and high water elevation in Marmion Reservoir.

It should be possible to construct the pipeline between the processing facility and TMF Alternative 2 without directly impacting fish or fish habitat in this catchment.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment n interpretation.docx

Catchment Q

CATCHMENT Q

This catchment has a total area of 272.96 hectares (Figure 3). A headwater pond (API #7) flows into a series of beaver impoundments, the largest of which was designated as API #6 (Figure 2, Photo 1). A stream drains API #6, emptying into Lizard Lake (Figure 1). The mouth of the stream was designated as API #38. The southeast corner of the base case TMF overlaps with API #6 and the upper portion of its outflowing stream. These features would be contained within the TMF. API #7 and the series of ponds between the two APIs, would be cut off from the lower section of the catchment. Flows in the lower portion of the stream would potentially be altered by the upstream dam.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment q overview.docx

CATCHMENT Q PHOTO LOG

Photo 1: API #7 and API #6 looking towards Lizard Lake.

API #6 (POND)

The total surface area of API #6 is 5,572 m^2. A significant portion of this area is occupied by mats of grasses and forbs (Photo 1). Its maximum depth is 0.8 m (Figure 6-1). Substrate is entirely silt. Extensive woody debris (i.e. branches, blow down) litters the pond bottom. An occupied beaver lodge is located in the northern end of the pond. The shoreline is ringed by dense coniferous forest. Seepage from upstream beaver ponds provides the only inflow. Water elevation in the pond is controlled by two 2.0 m high beaver dams at the northern edge of the pond. Seepage through the northwest dam was evident (Photo 2). This was the only source of outflowing water.

Water in the pond is neutral and very dark coloured (Table 1).

Table 1: API #6 (pond), Basic Water Chemistry Parameter Data

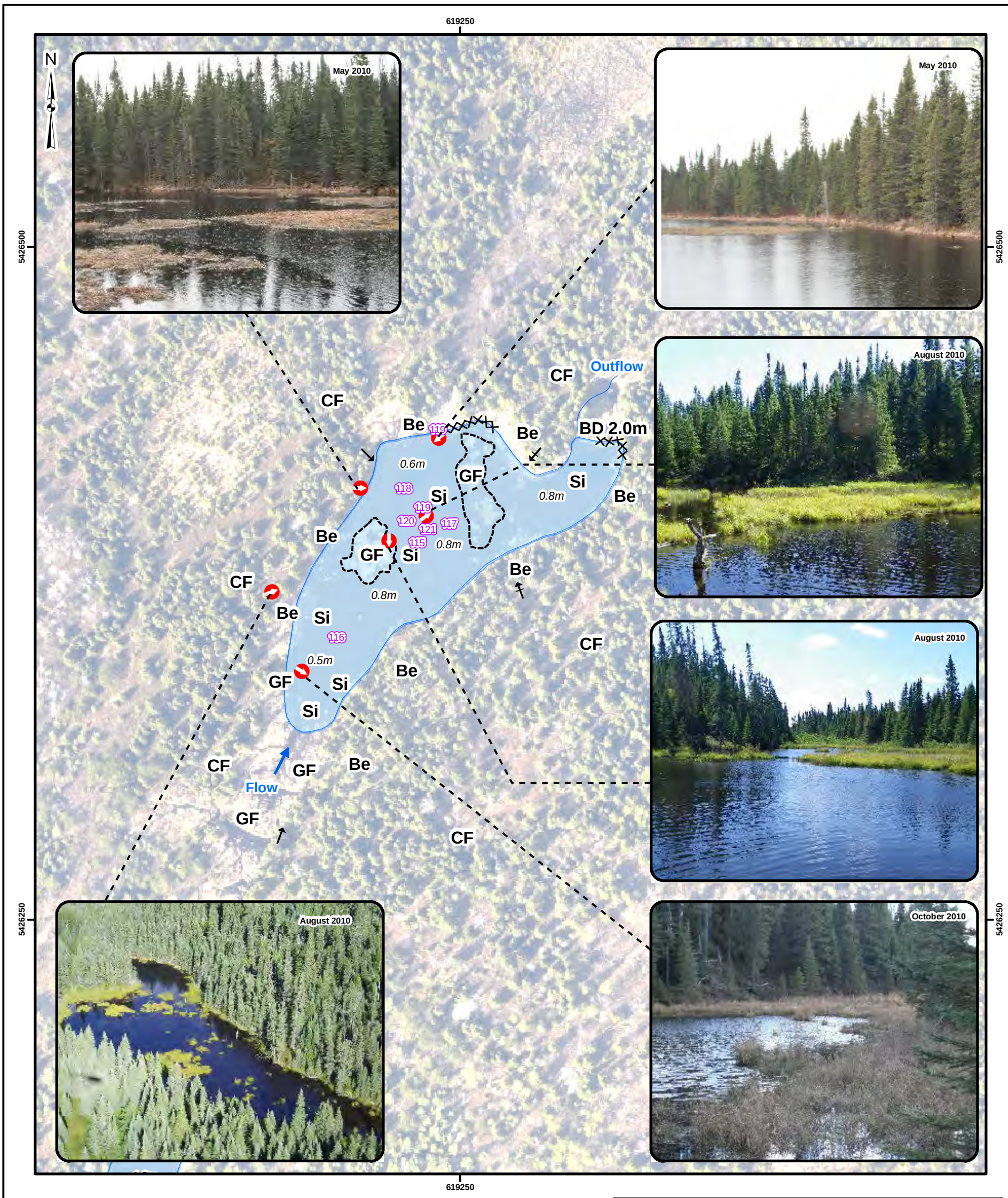
Date	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
October 2010	9.5	7.1	34	8.9
May 2011	12.8	6.8	29	10.1
August 2011	18.6	6.7	30	6.0

API #6 was fished on three occasions. No fish have been captured or observed during the field studies (Table 2).

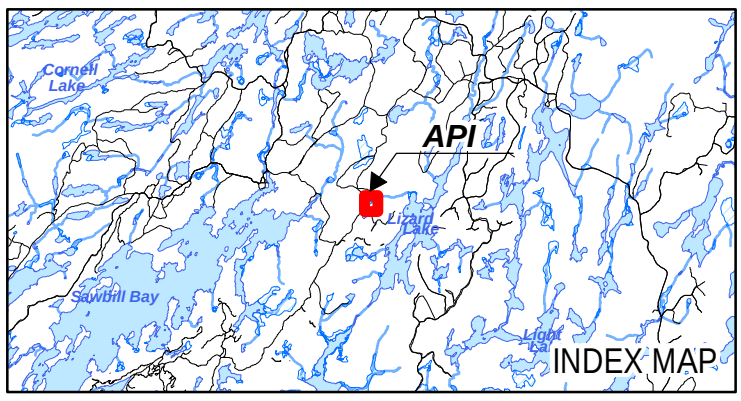
Table 2: API #6 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 6-1)	Date	Gear	Effort	Catch
115	October 16-17, 2010	minnow traps (1)	19.75 trap hrs.	no catch
116	October 16-17, 2010	minnow traps (1)	20 trap hrs.	no catch
117	May 8-9, 2011	nordic net	22.5 hrs.	no catch
118	May 8-9, 2011	minnow traps (4)	92 trap hrs.	no catch
119	August 25-26, 2011	minnow traps (3)	79.5 trap hrs.	no catch
120	August 25-26, 2011	broad-scale large mesh (1)	14.75 hrs.	no catch
121	August 25-26, 2011	broad-scale small mesh (1)	14.75 hrs.	no catch

DRAFT



30 0 30 60
SCALE 1:1,500 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- EV Emergent Vegetation
- SV Submergent Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs

Substrate Classification
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 6 (POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 6-1	
GIS	DM	10 Apr. 2012		
CHECK	JD	10 Apr. 2012		
REVIEW	JS	10 Apr. 2012		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\PondAPI\API_6.mxd

API #6 (STREAM)

The drainage distance between the pond and Lizard Lake is approximately 1,075 m although only the lower 313 m of this drainage has a defined stream channel. The upper portion of the stream consists of wet forest and thick cattail marsh (Figures 6-2 and 6-3). This wet forested area appears to contribute a significant volume of water to the lower stream channel.

The lower reaches of the stream (Figures 6-4 and 6-5) are controlled by beaver dams, and consist of low gradient channel segments. Water was overflowing these dams in May 2011 during high flow conditions and none of them appeared to represent a significant barrier to fish movement. The second and third reaches of the stream consist of a wide flooded meadow. Stream depth was less than 1 m along these segments. Substrate throughout the lower sections of the stream was silt. The discharge in the lower reach of API#6, measured in October 2010 and in May 2011, was calculated to be 0.004 m^3/s and 0.081m^3/s, respectively. Table 1 summarizes water chemistry data collected in the field.

Table 1: API #6 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
October 2010	13.0	3.7	4.2	35	5.7
May 2011	13.6	11.6	6.1	27	4.1

The stream was electroshocked on in October 2010 and in May 2011 (Table 2). In October 2010, a juvenile northern pike was captured in the lower reach of the stream, below the first beaver dam. In May 2011, a single Iowa darter was captured below the first beaver dam and four juvenile common white suckers between the first and second beaver dams. No fish have been captured above the second beaver dam.

Table 2: API #6 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 6-4)	Date	Gear	Effort	Catch
139	October 19, 2010	backpack electrofisher	100 m	northern pike (1 juvenile)
122	May 30, 2011	backpack electrofisher	250 m	Iowa darter (1 adult)
123	May 30, 2011	backpack electrofisher	200 m	white sucker (4 juvenile)
124	May 30-31, 2011	minnow traps (3)	60 trap hrs.	no catch
125	May 30-31, 2011	minnow traps (3)	54 trap hrs.	no catch

DRAFT

API #6 (STREAM)

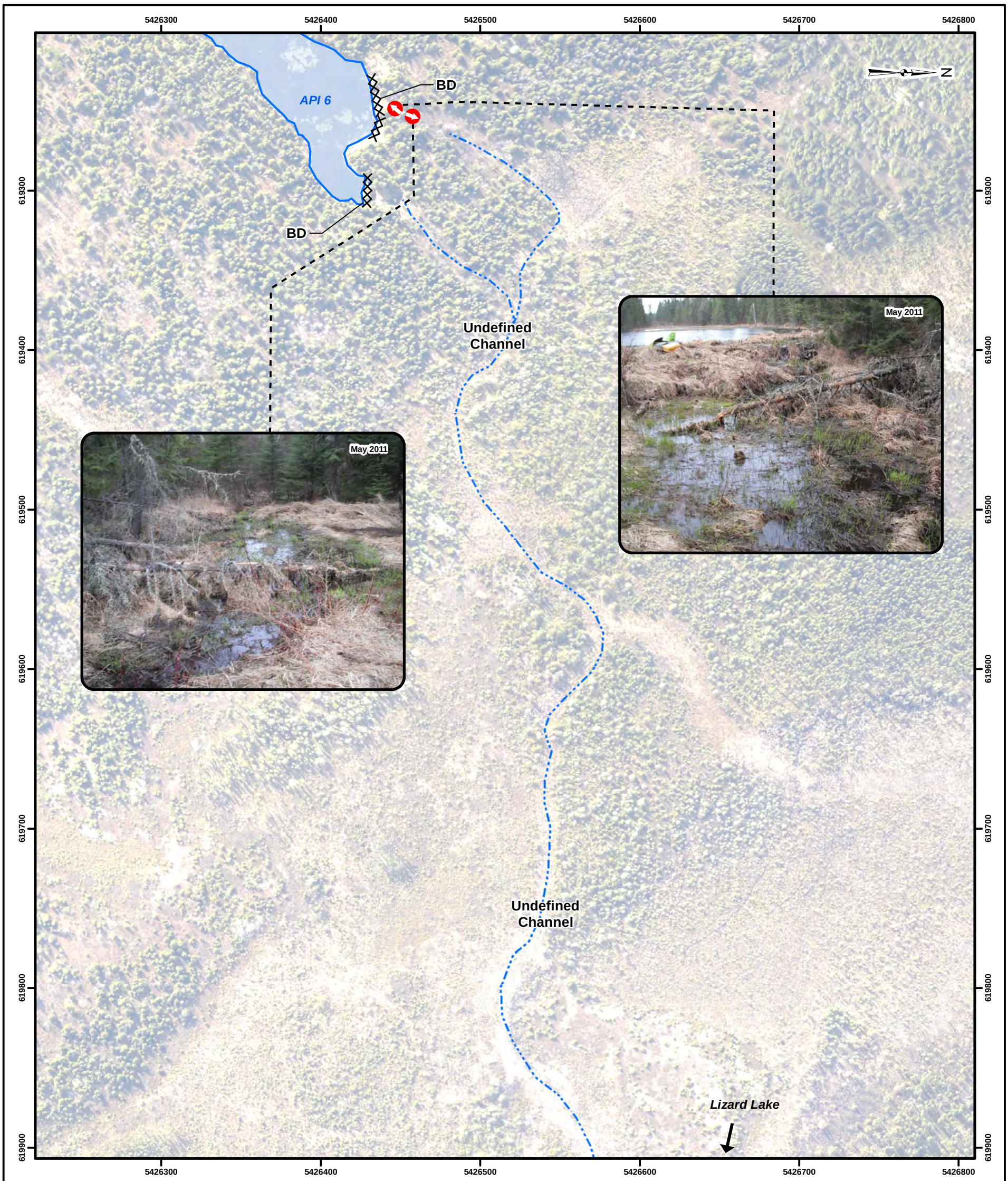
Channel width inside the mouth of the stream varied from 2 m to 5 m. The stream empties into a large, shallow, heavily vegetated bay of Lizard Lake (Photo 3). This bay (API #38) was fished in August 2010 (Photo 4) (Table 3).

Table 3: API #38, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location	Date	Gear	Effort	Catch
138	August 2, 2010	boat electrofisher	1,000 m	northern pike (5 adult) smallmouth bass (2 juvenile, 1 YOY) blacknose shiner (47 juvenile) yellow perch (1 adult, 8 juvenile, 10 YOY) pumpkinseed (1 juvenile, 1 adult)
140	August 21-22, 2010	gillnet – experimental	17 hrs.	walleye (10) white sucker (5) cisco (14) yellow perch (1)
348	August 21-22, 2010	Nordic	19 hrs.	smallmouth bass (1 adult) yellow perch (1 adult, 14 juvenile)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 6\api 6 stream.docx



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity

Riparian Vegetation
CF - Coniferous Forest
GF - Grass and Forbs
SH - Shrub

Substrate Classification
Si -Silt

Bank Slope
← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

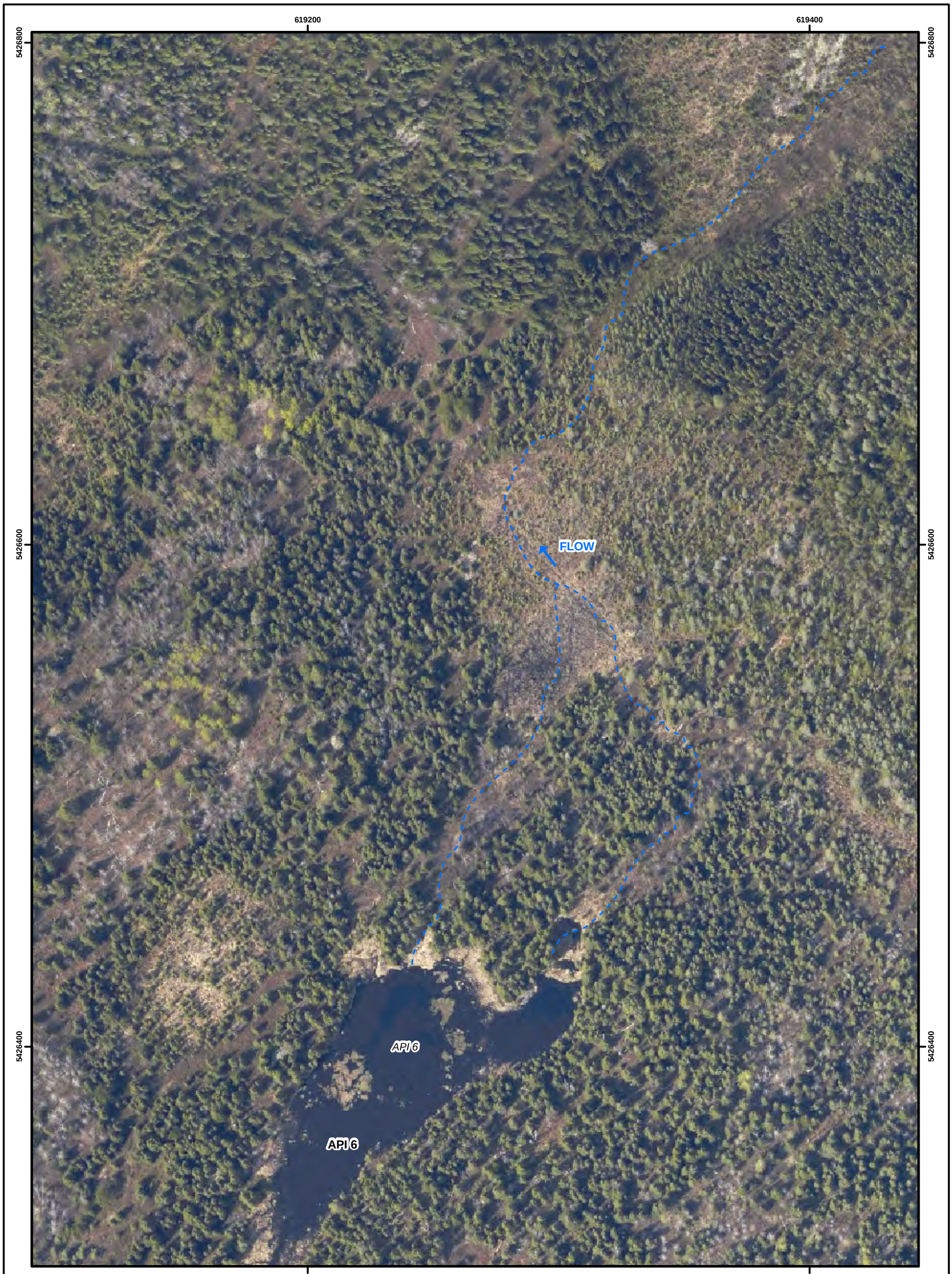
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 6 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 6-2	
GIS	DM	02 April 2012		
CHECK	JD	03 April 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_6c.mxd



Beaver Dam

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

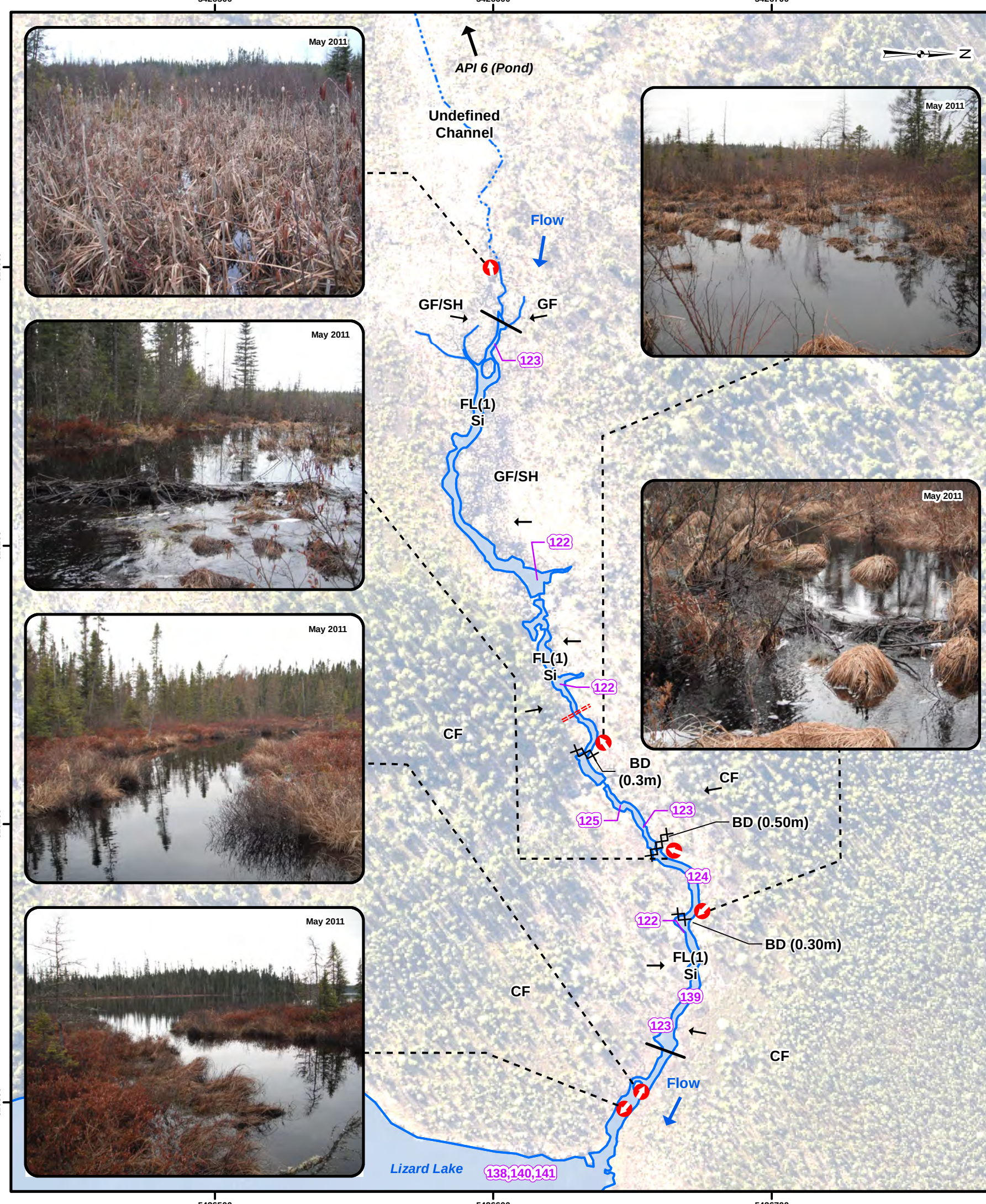
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

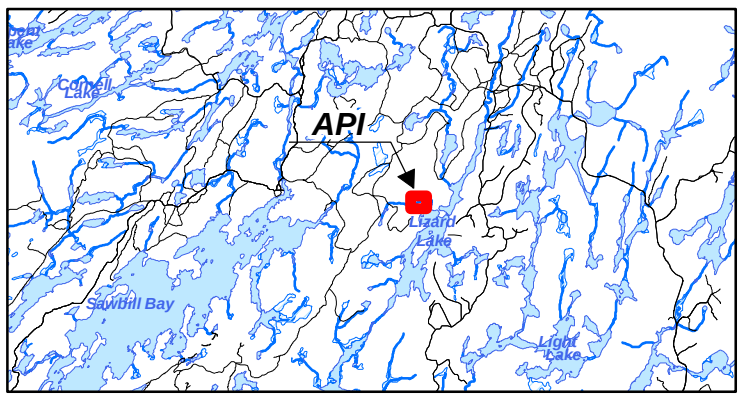
TITLE
AREA OF POTENTIAL IMPACT 6
(POND AND UPPER STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 6-3	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd





Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL	313.19	1.7	0.49	Si	-	10

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity

Riparian Vegetation
CF - Coniferous Forest
GF - Grass and Forbs
SH - Shrub

Substrate Classification
Si -Silt

Bank Slope
← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 6 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 6-4	
GIS	DM	02 April 2012		
CHECK	JD	03 April 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_6b1.mxd

XXXX **Beaver Dam**

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 6 (STREAM)
(LOWER REACH)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 6-5	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #6 PHOTO LOG

Photo 1: API #6 (pond); aerial view.

Photo 2: Beaver dam at north end (outflow) of API #6.

API #6 PHOTO LOG

Photo 3: Aerial view of mouth and lower reaches of API #6 (stream).

Photo 4: Shoreline of Lizard Lake, looking towards the mouth of API #6 (stream).

CATCHMENT Q PHOTO LOG

Photo 1: API #7 and API #6 looking towards Lizard Lake.

API #7 (HEADWATER POND)

The surface area of the pond is 10,319 m^2 although a large portion of the surface area is occupied by thick mats made up of grasses and forbs (Figures 7-1 and 7-2). The pond is approximately 220 m in length and 90 m wide, at its widest point. The maximum depth of the pond is 1.0 m. Substrate is entirely silt although some low lying bedrock was evident along the shoreline. Extensive woody debris (i.e. branches, blow down) litters the pond bottom. An occupied beaver lodge is located in the northern end of the pond. There are no inflows and the outflow is controlled by a 1.2 m high beaver dam. The shoreline is ringed by dense coniferous forest.

Water in the pond is slightly acidic and a very dark colour (Table 1).

Table 1: API #7 (pond), Basic Water Chemistry Parameter Data

Date	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
October 2010	10.4	6.9	38	8.6
May 2011	11.4	6.8	28	9.6
August 2011	16.5	6.6	34	5

API #7 was fished on three occasions. No fish have been captured or observed during the field studies (Table 2).

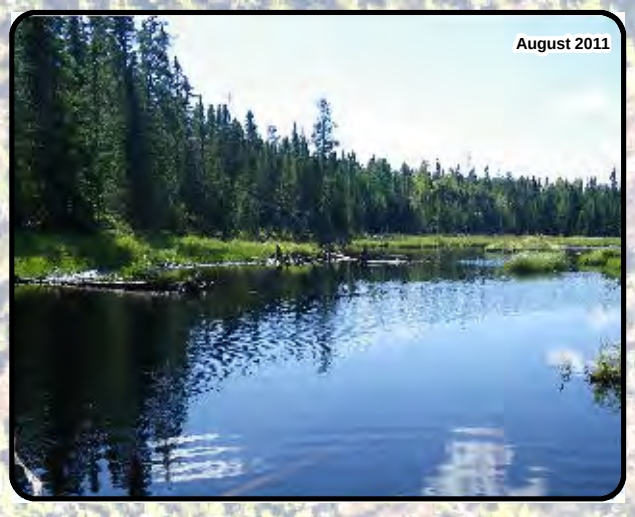
Table 2: API #7 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

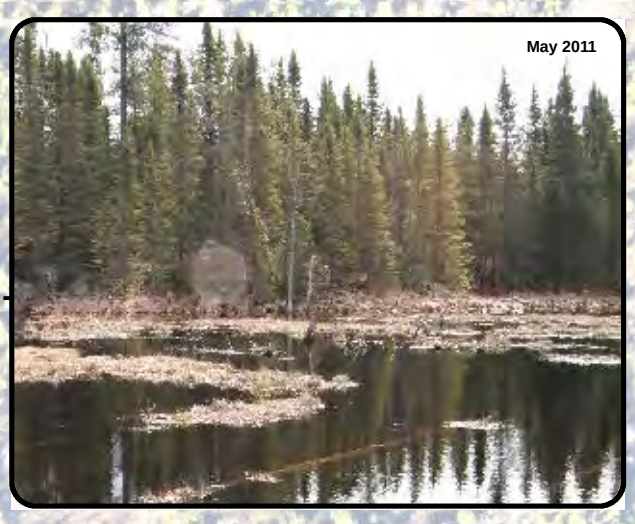
Fish Effort Location (see Figure 7-1)	Date	Gear	Effort	Catch
126	October 16-17, 2010	nordic net	16 hrs.	no catch
127	October 16-17, 2010	minnow traps (1)	16 trap hrs.	no catch
128	October 16-17, 2010	minnow traps (1)	16 trap hrs.	no catch
129	May 8-9, 2011	nordic net	23 hrs.	no catch
130	May 8-9, 2011	nordic net	23 hrs.	no catch
131	August 25-26, 2011	minnow traps (2)	30 trap hrs.	no catch
132	August 25-26, 2011	broad-scale small mesh (2)	30 hrs.	no catch

DRAFT

619000 619250
5426250 5426250

N





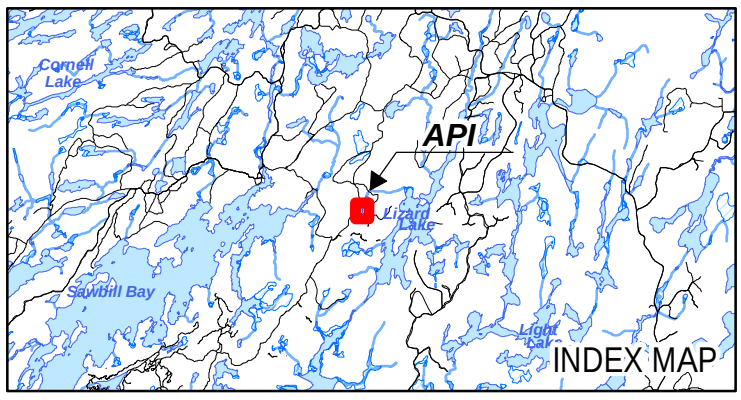
Beaver Dam (1.2m)

CF GF Si Be BD 128 132 126 129 127 130 131 0.5m 1.0m

5426000 5426000

619000 619250

30 0 30 60
SCALE 1:1,500 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- EV Emergent Vegetation
- SV Submergent Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- SH - Shrubs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Gr -Gravel
- Sa -Sand
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 7 (POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 7-1	
GIS	DM	10 Apr. 2012		
CHECK	JD	10 Apr. 2012		
REVIEW	JS	10 Apr. 2012		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\PondAPI\API_7.mxd

XXXX **Beaver Dam**

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 7 (POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 7-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\AquaticsLiDAR_Figures.mxd

API #7 (DOWNSTREAM POND)

The connection between API #7 and API #6 consists of a series of seven beaver ponds (Figure 7-3). There is no discernable flow between the ponds. Maximum depth in all of the ponds is less than 1.0 m. Substrate is predominately silt. The shorelines and edges of the ponds consist of shrubs and grasses. Aquatic vegetation in the ponds is sparse. Basic water chemistry parameters were similar to the upstream pond (Table 1). The ponds were electroshocked in May 2011 (Table 2). No fish were captured or observed.

Table 1: API #7 (downstream ponds), Basic Water Chemistry Parameter Data

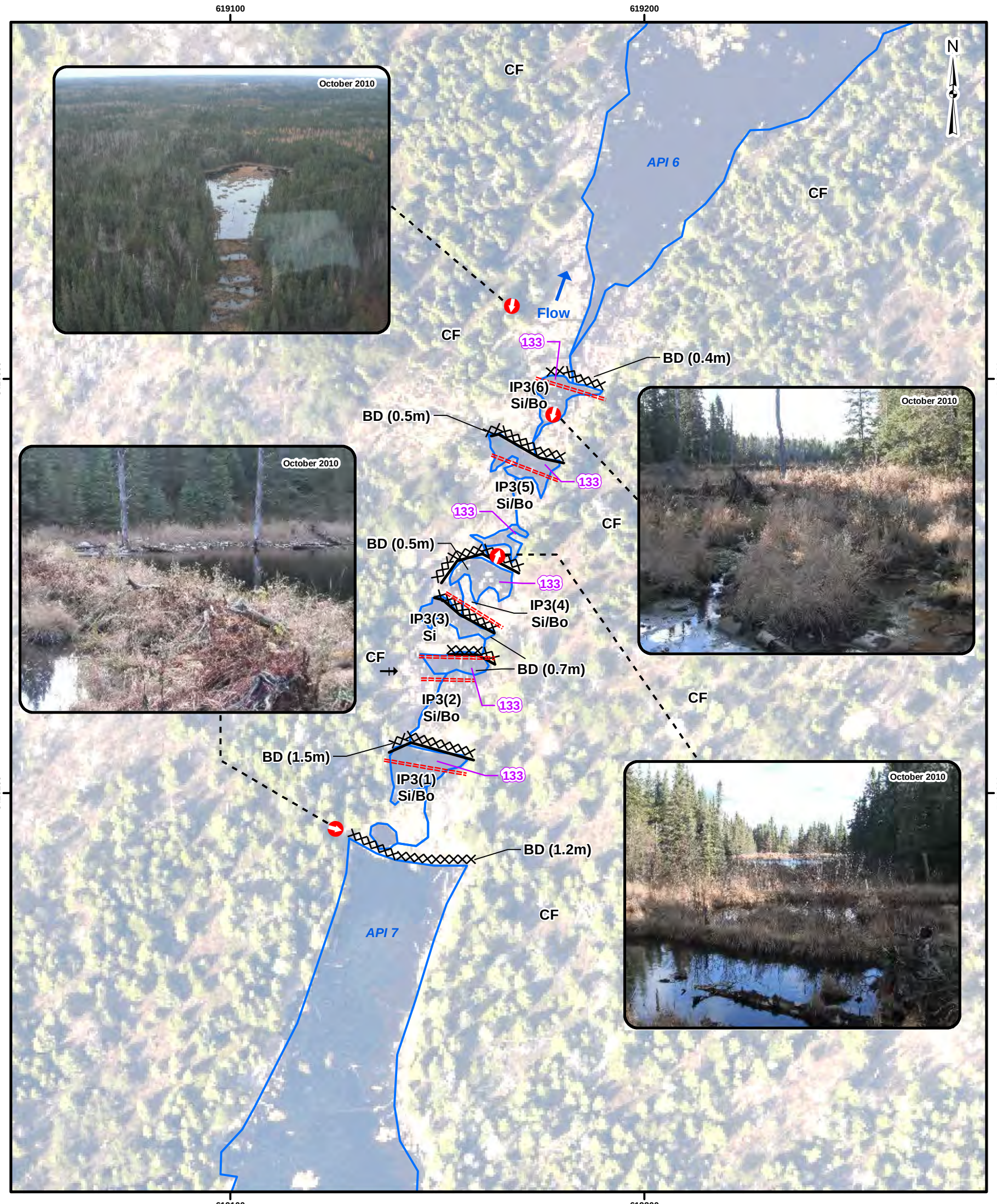
Date	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2010	16.8	6.9	38	6.6

Table 2: API #7 (downstream ponds), Fish Community Assessment (Effort, Gear and Catch Summaries)

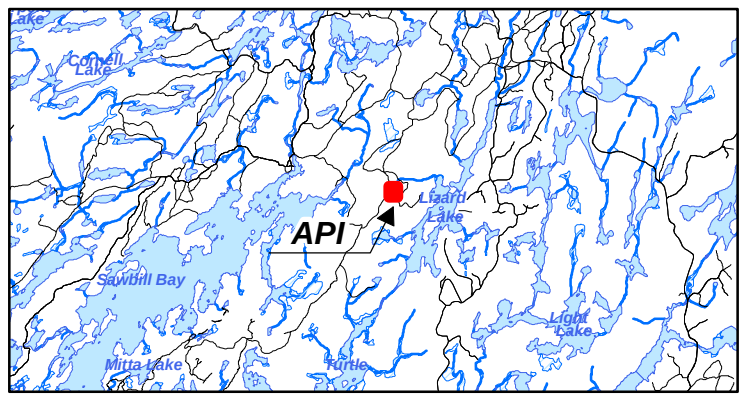
Fish Effort Location (see Figure 7-3)	Date	Gear	Effort	Catch
133	May 31, 2011	backpack electrofishing	200 m	no catch

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 7\api 7 downstream pond.docx



Segment	Length (m)	Channel Width Transect (m)	Max. Depth a transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
IP3(1)	25.35	20	0.45	Si	Bo	0
IP3(2)	17.25	22	-	Si	Bo	0
IP3(3)	9.52	27	-	Si	-	5
IP3(4)	12.00	18	-	Si	Bo	0
IP3(5)	34.28	25	-	Si	Bo	5
IP3(6)	21.57	22	-	Si	Bo	5



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Substrate Classification
Bo -Boulder
Si -Silt

Channel Unit Type
!P3 - Impoundment Pool: Class 3

Bank Slope
Intermediate Slope (6 to 30%)

Riparian Vegetation
CF - Coniferous Forest

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 7
(DOWNSTREAM POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 7-3	
GIS	DM	28 Mar. 2012		
CHECK	JD	29 Mar. 2012		
REVIEW	JS	15 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_7b.mxd

INTERPRETATION OF CATCHMENT Q AQUATICS BASELINE

Juvenile fish captured in the lower reaches of the stream draining Catchment Q provide evidence that the stream is accessible by fish inhabiting Lizard Lake and the flooded areas making up the lower sections of the stream likely serve as spawning and rearing habitat for them. No fish were captured further than the second beaver dam, approximately 150 m upstream of the mouth of API #6. The ponds located in the upper portion of the catchment, all of which were less than 1 m deep, do not support fish communities. There is no defined channel in the upper portion of the stream (i.e. the upper 700 m). A thick cattail marsh and wet coniferous forest exist approximately 300 m from the mouth of the stream. Drainage from the wet upstream portion of the catchment appears to contribute significantly to stream flow.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment q interpretation.docx

Catchment R

CATCHMENT R

The total area of Catchment R is 623.45 hectares (Figure 3). The catchment contains two stream systems which converge and eventually empty into Lizard Lake. The upper portion of the catchment is located within TMF Alternative #1 (Figure 1). Aquatic features within the northeast portion of the catchment include API #46, which is located outside of the proposed TMF and is physically isolated from the rest of the catchment. A series of ponds connected by stream channels, APIs # 3, #4 and #5 exist south of API #46 (Photo 1). If TMF Alternative 1 is adopted, APIs #3, #4 and #5 and their connecting channels will be contained within the TMF.

Aquatic features within the western portion of the proposed TMF include an unnamed lake (API #2) and its outflowing stream. If TMF Alternative #1 is adopted, this lake and a portion of the stream, above API #8, will be infilled and contained within the TMF.

The two systems converge into a single stream that empties into API #8, a small lake. This lake drains into Lizard Lake. If TMF Alternative #1 is adopted, flows into API #8 may be altered, affecting fish access to the lower reaches of its inflow. Flows downstream of API #8 may also be altered, potentially affecting fish from Lizard Lake that may utilize the lower reaches of this stream.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment r overview.docx

CATCHMENT R PHOTO LOG

Photo 1: Aerial image of API #3, API # 4 and API # 5.

API #46 (HEADWATER LAKE)

API #46 is a lake located upstream of TMF Alternative 2, south of the Premier Lake Access Road. It has a surface area of 43,329 m^2 and a maximum depth of 9 m. The shoreline consists mostly of bedrock and boulders (Figure 46-1). The lake bottom adjacent to the shore is very steep. The lake has a single, short inflow that drains a grassy meadow. The outflow is controlled by a 2 m high beaver dam. Water from the lake seeps through a 2.0 m high beaver dam located at the outflow, into the outflowing stream (Figure 46-2). The lake was assessed in May 2011. Table 1 contains basic water chemistry parameters.

Table 1: API #46 (lake), Basic Water Chemistry Parameter Data

Date/Depth (m)	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2011	16.4	8.1	60	10.4

Only finescale dace and fathead minnow were captured in the Lake (Table 2).

Table 2: API #46 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 46-1)	Date	Gear	Effort	Catch
148	May 29-30, 2011	nordic net	20 hrs.	finescale dace (12 adult)
149	May 29-30, 2011	nordic net	21 hrs	finescale dace (25 adult) fathead minnow (6 adult)
150	May 29-30, 2011	gillnet – experimental mesh	20 hrs.	no catch
151	May 29-30, 2011	gillnet – experimental mesh	21 hrs.	no catch
152	May 29-30, 2011	minnow traps (6)	120 trap hrs.	finescale dace (70 adult 7 juvenile) fathead minnow (48 adult, 6 juvenile)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 46\api 46 headwater lake.docx

621500 621750 622000

5431250 5431000 5430750 5430500

N

May 2011

May 2011

May 2011

May 2011

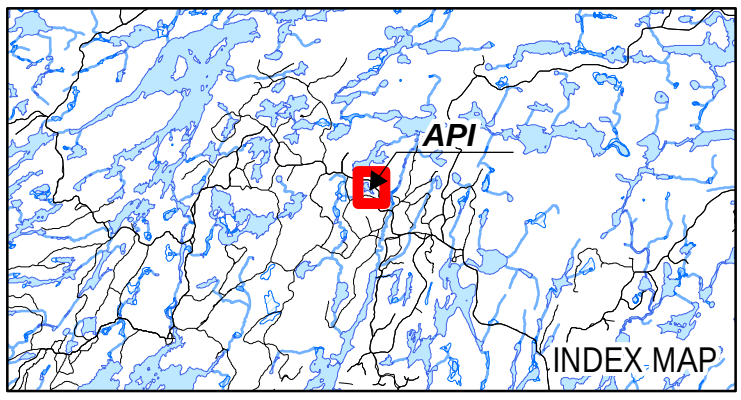
May 2011

May 2011

Premier Road

CF/Be
CF
Be/Co
CF/SH
CF
CF
Be/Bo
Be/Bo
151
CF/GF
Be/Bo
152
Si
Be 152
149
1.5m
9.0m
Be/Bo
CF/Be
Si/Bo
Si
Be
Be
Be
Inflow
CF
Be/Bo
7.5m
Be/Bo
150
152
152
152
CF/Be
Si
8.0m
CF/Be
CF/Be
CF/Be
152
1.2m
Bo
Be
Bo/Co
Be
1.5m
BD
(2.0m)
XXXXX
Outflow
CF/Be
CF/Be
CF/Be
CF/Be
Be
148
Si
CF
0.7m
SH/GF
CF

75 0 75 150
SCALE 1:3,000 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- EV Emergent Vegetation
- SV Submergent Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)
- Steep Slope (31 to 70%)
- Very Steep Slope

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- SH - Shrubs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Gr -Gravel
- Sa -Sand
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 46
(HEADWATER LAKE)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 46-1	
GIS	DM	10 Apr. 2012		
CHECK	JD	10 Apr. 2012		
REVIEW	JS	10 Apr. 2012		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\DraftAquatics\PondAPI\API_46.mxd

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 46 (POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 46-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\AquaticsLiDAR_Figures.mxd

API #46 (STREAM)

Flows are seasonal in this stream, dependent primarily upon seepage through the beaver dam at the outflow of the upstream lake. The stream channel and base flow were distinguishable for approximately 250 m downstream of the lake. The stream becomes a series of isolated puddles within a dense forested area at this point (Figure 46-3). Channel width is approximately 1 m and substrate is a mix of silt, exposed boulders and bedrock.

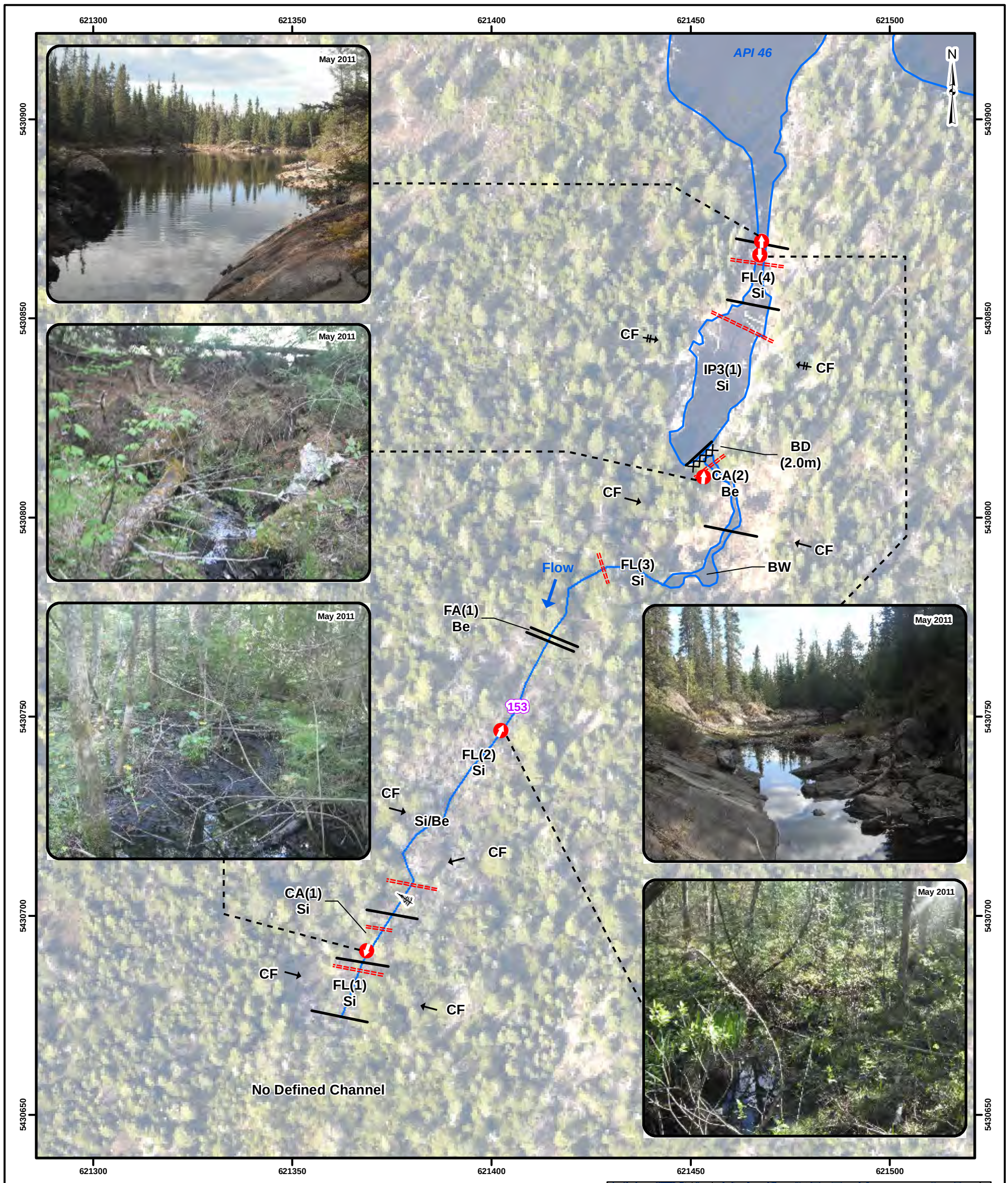
The entire stream channel was electroshocked in May 2011 (Table 1). Finescale dace and pearl dace were captured. Pearl dace had not been captured in the upstream lake.

Table 1: API #46 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries)

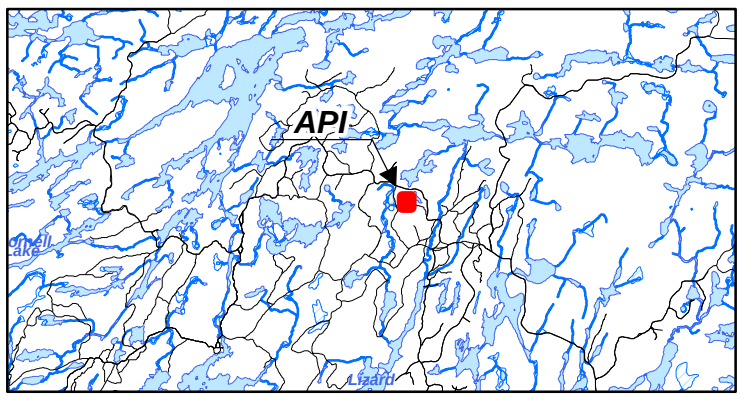
Fish Effort Location (See Figure 46-3)	Date	Gear	Effort	Catch
153	May 30, 2011	backpack electrofisher	250 m	finescale dace (63) pearl dace (1)

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 46\api 46 stream.docx

DRAFT



Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	14.00	0.9	0.38	Si	-	0
CA(1)	14.00	0.6	0.06	Bo	Be	0
FL(2)	83.49	1.05	0.12	Si	Be	0
FA(1)	1.00	1.05	-	Be	-	0
FL(3)	61.29	1.05	0.2	Si	-	0
CA(2)	23.00	1.25	-	Be	-	0
IP3(1)	39.21	11.4	-	Si	-	15
FL(4)	15.41	2.4	-	Si	-	0



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
CA - Cascade
FA - Falls
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment Pool: Class 3

Bank Slope
Shallow Slope (0 to 5%)
Steep Slope (31 to 70%)

Substrate Classification
Be -Bedrock
Bo -Boulder
Si -Silt

Riparian Vegetation
CF - Coniferous Forest

REFERENCE
Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 46 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 46-3	
GIS	DM	11 April 2012		
CHECK	JD	12 April 2012		
REVIEW	JS	16 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_46b.mxd

API #3 (POND)

API #3 has a surface area of 6,059 m^2 (Photo 1). Maximum depth in the pond is 1.2 m (Figure 3-1). The shoreline consists of grasses (Figure 3-2). Substrate throughout the pond is silt. Water elevation in the pond is maintained by a 1.2 m beaver dam located at its south end (Photo 2). Table 1 contains water chemistry data collected during fish community assessment.

Table 1: API #3 (pond), Basic Water Chemistry Parameter Data

Date	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
October 2010	7.7	6.8	65	6.2
August 2011	22.4	7.1	79	6.0

The pond was fished on two occasions. This was the furthest upstream in the catchment that large bodied fish species, northern pike and common white sucker, were captured (Table 2).

Table 2: API #3 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 3-1)	Date	Gear	Effort	Catch
93	October 15-16, 2010	minnow trap	15.5 hrs.	finescale dace (25 adult, 10 juvenile)
94	October 15-16, 2010	minnow trap	15.5 hrs.	finescale dace (42 adult) northern redbelly dace (5 adult)
95	October 15-16, 2010	gillnet - single panel (38 mm mesh)	16 hrs.	no catch
96	August 23-24, 2011	minnow traps (3)	48 trap hrs.	finescale dace (8 adult)
97a	August 23-24, 2011	broad-scale large mesh	32 hrs.	white sucker (2 adult)
97b	August 23-24, 2011	broad-scale large mesh	32 hrs.	no catch
98a	August 23-24, 2011	broad-scale small mesh	32 hrs.	finescale dace (17 adult) northern redbelly dace (14 adult) northern pike (1 unk.)

DRAFT

API #3 (POND)

Fish Effort Location (see Figure 3-1)	Date	Gear	Effort	Catch
98b	August 23-24, 2011	broad-scale small mesh	32 hrs.	finescale dace (45 adult) northern redbelly dace (11 adult)

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 3\api 3 pond.docx

DRAFT

621000

5429750

5429500

N

October 2010

Flow

Outflow

GF

Si

98b

0.7m

97b

GF

Si

CP

Be

Si

EV

0.8m

EV

EV

Si

Si

EV

CF

GF

Be

EV

1.0m

94

CF

CF

Si

96

0.8m

GF

Be

93

GF

Si

BD

(1.5m)

98a

95

Si

1.2m

Si

97a

GF

CF

Be

October 2010

October 2010

October 2010

October 2010

621000

30 0 30 60

SCALE 1:1,500 METRES

API

Lizard Lake

INDEX MAP

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- EV Emergent Vegetation
- SV Submergent Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- SH - Shrubs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Gr -Gravel
- Sa -Sand
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 3 (POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 3-1	
GIS	DM	10 Apr. 2012		
CHECK	JD	10 Apr. 2012		
REVIEW	JS	10 Apr. 2012		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\PondAPIVAPI_3.mxd

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 3 (POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 3-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

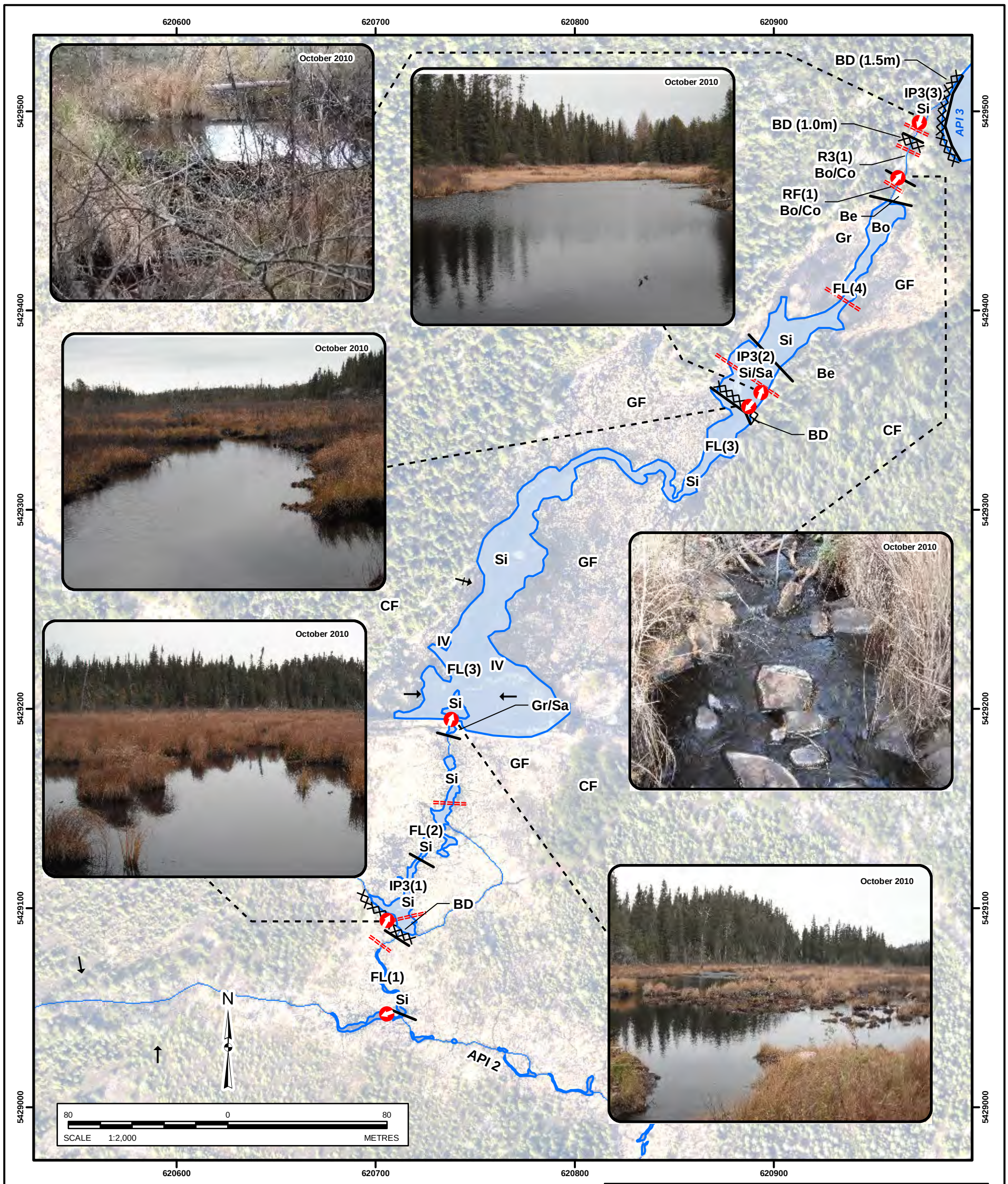
Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LIDAR_Figures.mxd

API #3 (STREAM)

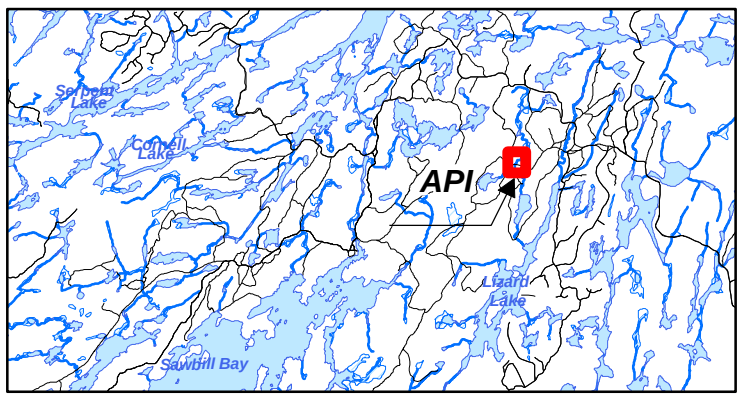
The stream is approximately 725 m in length. It converges with the stream draining API #2 and small lake. This channel eventually empties into API #8, another small lake. The upper portion of API #3 flows through a wide meadow. The channel consists of a series of beaver impoundments/flooded meadow with open water areas. Approximately 150 m above its mouth, the stream is impounded by an abandoned road. There is no culvert. Water flows over the road base (Figure 3-3 and 3-4). Substrate is primarily silt with small sections of boulders. No fishing effort was expended in this section of stream.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 3\api 3 stream.docx

DRAFT



Segment	Length (m)	Channel Width a Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	50.81	2.3	0.4	Si	-	20
IP3(1)	38.30	35	1	Si	-	25
FL(2)	66.55	5.5	-	Si	Gr	20
FL(3)	278.75	7	-	Si	-	10
IP3(2)	29.65	30	-	Si	Sa	5
FL(4)	102.95	10	-	Si	Bo	10
RF(1)	14.48	1.65	0.14	Bo	Co	5
R3(1)	24.27	2.95	0.35	Bo	Co	0
IP3(3)	10.00	7	-	Si	-	5



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- IV Instream Vegetation

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment Pool: Class 3
R3 - Lowest Quality Pool Habitat
RF - Riffle, High Velocity/Gradient Relative to Habitat

Bank Slope
Shallow Slope (0 to 5%)
Intermediate Slope (6 to 30%)

Bank Features
Be - Bedrock

Substrate Classification
Bo -Boulder
Co -Cobble
Gr -Gravel
Sa -Sand
Si -Silt

Riparian Vegetation
CF - Coniferous Forest

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 3 (Stream)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 3-3	
GIS	DM	26 Mar. 2012		
CHECK	JD	27 Mar. 2012		
REVIEW	JS	16 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_3b.mxd

620600
620800
5429400
5429200
5429000

Outflow
XXXX
Abandoned Road
FL(3)
IP3(1)
XXXX
API 2 (Stream)
Flow
API 2 (Stream)

620600
620800

60 0 60
SCALE 1:2,000 METRES

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 3 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 3-4	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #3 PHOTO LOG

Photo 1: Aerial image.

Photo 2: Outflow of API #3 (pond).

API #4 (POND)

This pond has a surface area of 5,102 square meters and a maximum depth of 1.0 m (Photos 1 and 2; Figure 4-1). The pond is surrounded by an extensive area of wetland consisting of grasses and alders (Figure 4-2; Photo 3). Water elevation is partially controlled by an abandoned beaver dam across the outflow, located at the southeast corner of the pond (Photo 4). Bottom substrate consists of silt and organic materials. Emergent and submergent vegetation is abundant. pH in the pond was neutral (Table 1).

Table 1: API #4 (pond), Basic Water Chemistry Parameter Data

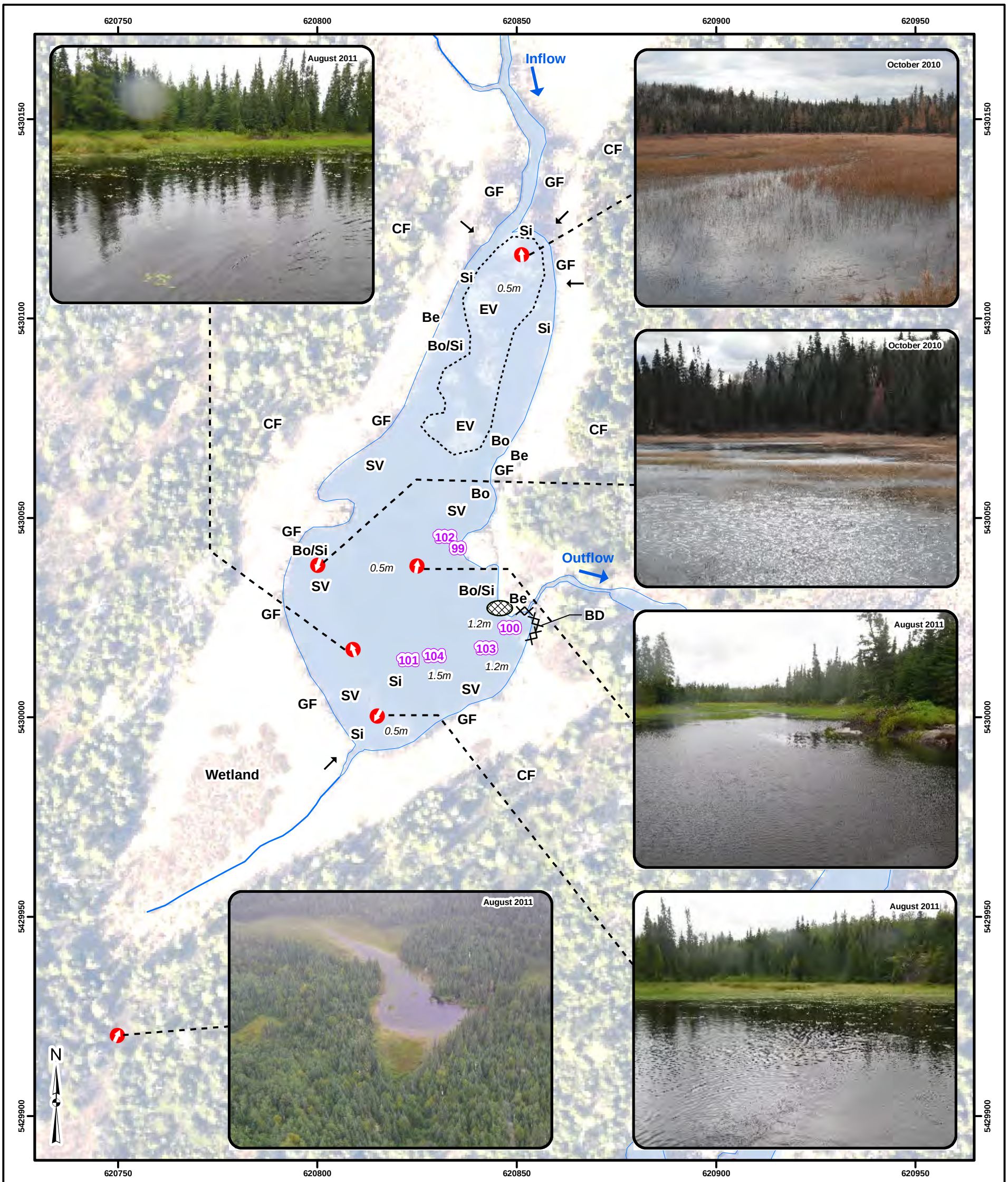
Date	Air Temperature (°C)	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
October 14-15, 2010	10.0	9.6	6.7	72	7.8
August 23-24, 2011	28.0	23.1	7.4	74	7.0

API #4 was fished on two occasions. It is inhabited by finescale and northern redbelly dace. Finescale and northern redbelly dace were the only fish species captured in API#5 and API #3, located up and downstream, respectively (Table 2). The impounded, deepest section of the pond likely represents important low refugia for resident fish during winter and dry periods.

Table 2: API #4 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 4-1)	Date	Gear	Effort	Catch
99	October 14-15, 2010	minnow traps (1)	17 trap hrs.	no catch
100	October 14-15, 2010	minnow traps (1)	17 trap hrs.	finescale dace (1 adult, 1 juvenile)
101	October 14-15, 2010	gillnet - single panel (38 mm mesh)	17 hrs.	no catch
102	August 23-24, 2011	minnow traps (2)	46 trap hrs.	finescale dace (6 adults, 2 juveniles) northern redbelly dace (8 adults)
103	August 23-24, 2011	broad-scale large mesh (1)	24 hrs.	no catch
104	August 23-24, 2011	broad-scale small mesh (1)	23.25 hrs.	finescale dace (20 adults) northern redbelly dace (21 adults)

DRAFT



LEGEND

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- SV Submergent Vegetation
- EV Emergent Vegetation

Bank Slope
- ← Shallow Slope (0 to 5%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Si -Silt

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 4
(POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 4-1	
GIS	DM	12 Apr. 2012		
CHECK	JD	12 Apr. 2012		
REVIEW	JS	12 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_MapsAPI_4.mxd

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 4 (POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 4-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LIDAR_Figures.mxd

API #4 (STREAM)

This stream is approximately 450 m in length. The upper 220 m of the stream consists of shallow beaver impoundments (Figure 4-3). Channel width in impounded areas is variable. The lower 22 m of the stream consists of a low gradient flat segment. Water in the stream was acidic (Table 1). The stream was electrofished in August 2011 (Table 2). Finescale dace was the only fish species captured.

Table 1: API #4 (stream), Basic Water Chemistry Parameter Data

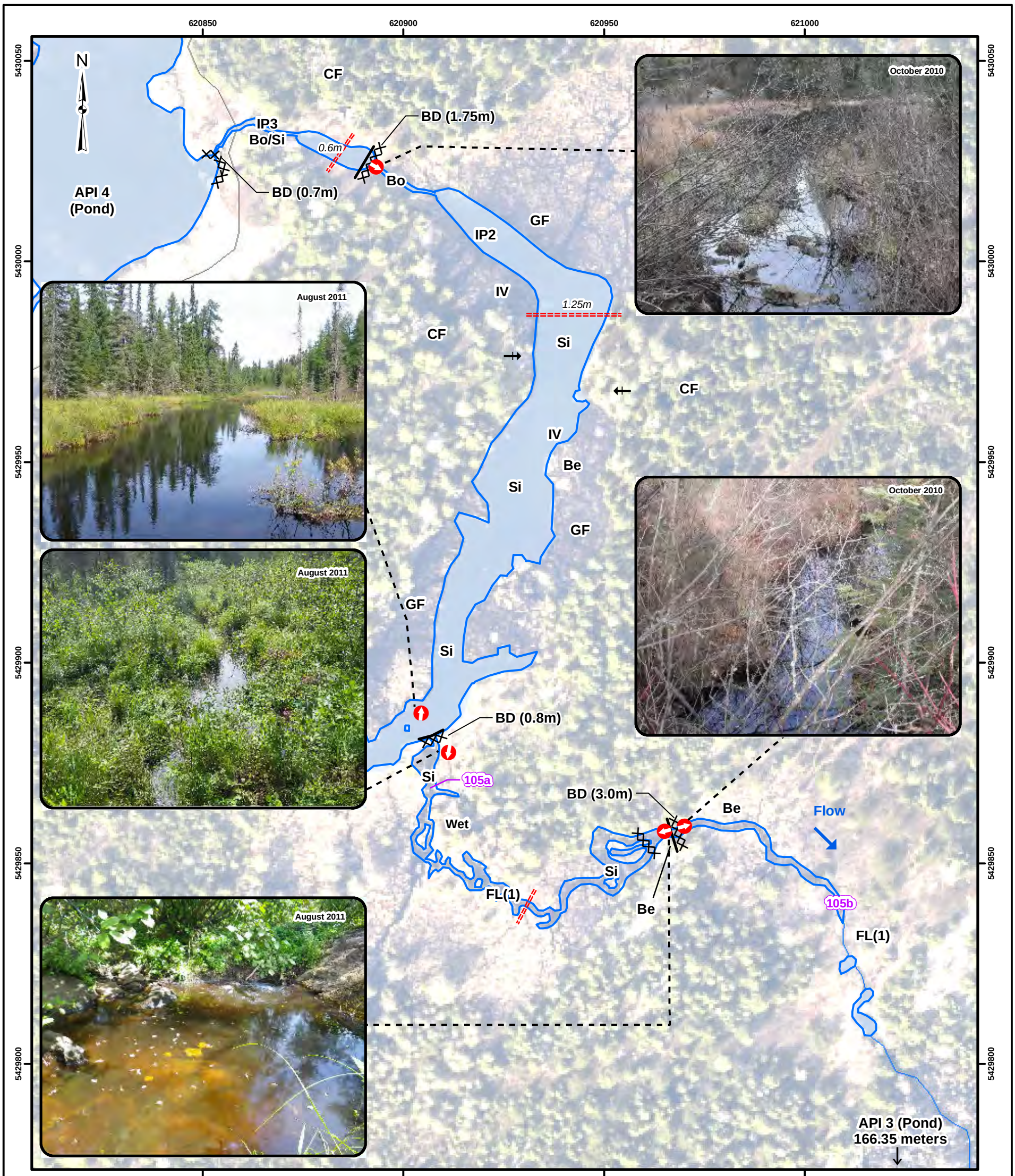
Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2011	28.0	21.0	5.5	70	5.0

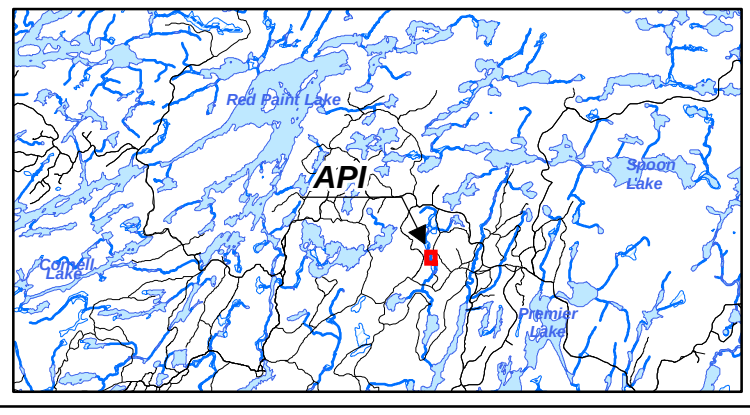
Table 2: API #4 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (See Figure 4-3)	Date	Gear	Effort	Catch
105a	August 30, 2011	Backpack electrofisher	140 m	finescale dace (5 adult, 10 juvenile, 5 YOY)
105b	August 30, 2011	Backpack electrofisher	55 m	finescale dace (10 adult, 8 juvenile)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 4\api 4 stream.docx





Segment	Length (m)	Channel Width a Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
IP-3(1)	42.1	18		Si	Bo	5
IP-3(2)	180.15	29	1.25	Si	-	15
FL(1)	305.04	4.5	0.5	Si	-	20

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

IV Instream Vegetation

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
IP2 - Impoundment Pool: Class 2
IP3 - Impoundment Pool: Class 3

Substrate Classification
Si -Silt
Bo -Boulder

Bank Features
Be - Bedrock

Riparian Vegetation
CF - Coniferous Forest
GF - Grass and Forbs

Bank Slope
Intermediate Slope (6 to 30%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 4 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 4-3	
GIS	DM	22 Mar. 2012		
CHECK	JD	23 Mar. 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_4B_.mxd

API #4 PHOTO LOG

Photo 1: Looking east towards outflow and downstream beaver pond.

Photo 2: Looking west; natural stream channel (inflow) and ponded section.

API #4 PHOTO LOG

Photo 3: Shoreline, wetland.

Photo 4: Outflow, from below beaver dam.

API #5 (POND)

There are is a single inflow and one outflow to API #5. A shallow, low gradient stream enters the pond at its north end. This stream drains a dense forested area approximately 1,265 m upstream of its mouth. The channel becomes undefined at this point (Figure 5-1). The stream consists of a series of small beaver impoundments (8) and flows through a meadow along most of its length. Aquatic vegetation is abundant in the lower segments of the stream. The dominant substrate throughout the stream is silt. Channel width in the upper reaches was generally less than 1 m and maximum depth less than 1 m. This stream was not fished. It is assumed that fish from the downstream pond can access the lower reaches of the stream during most of the year.

The surface area of API #5 is 15,400m^2. The dimensions of the pond, at its widest point are 100 m in width and approximately 125 m in length. Its maximum depth is 4.8 m although much of the pond is comprised of grass islands (Figure 5-2). Bottom substrate is comprised entirely of silt. Water elevation in the pond is maintained by a 2 m high, abandoned beaver dam at its outflow. Surrounding topography is very flat. The pond's northern and eastern shorelines border an extensive area of wetland (Figure 5-3). The western shoreline is heavily forested. The pond was assessed on two occasions. Water is slightly acidic (Table 1).

Table 1: API #5 (pond), Basic Water Chemistry Parameter Data

Date/Depth (m)	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
October 2010				
Surface	10.0	6.9	61	7.8
1	9.9	6.9	61	7.1
2	9.7	6.8	61	6.6
3	9.5	6.9	62	6.4
4	9.4	6.8	63	6.1
5	9.0	6.8	63	6.0
August 2011	22.5	7.0	63	9.0

Northern redbelly dace and finescale dace were the only fish species captured in the pond (Table 2).

DRAFT

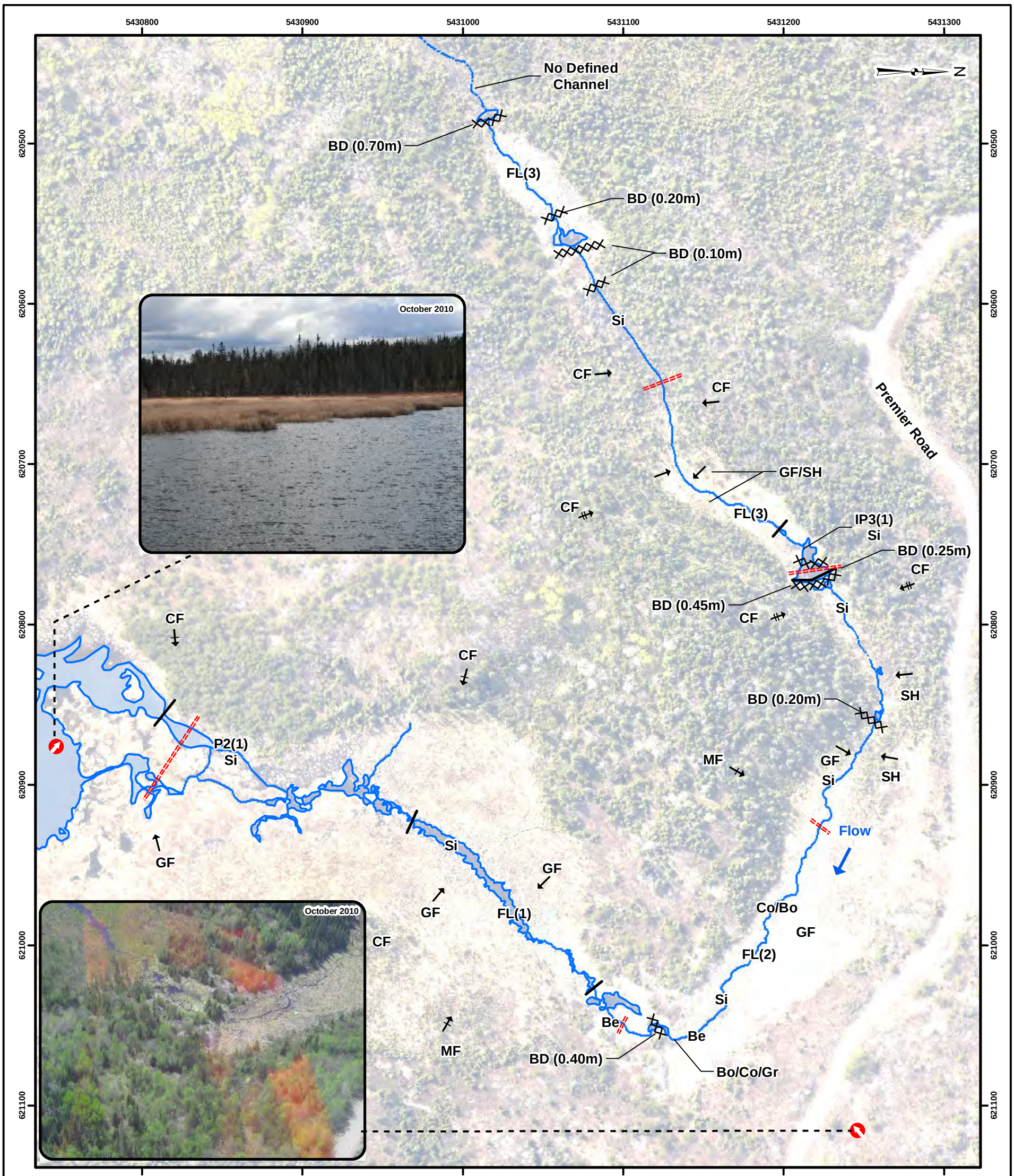
API #5 (POND)

Table 2: API #5 (pond), Fish Community Assessment (Effort, Gear and Catch Summaries)

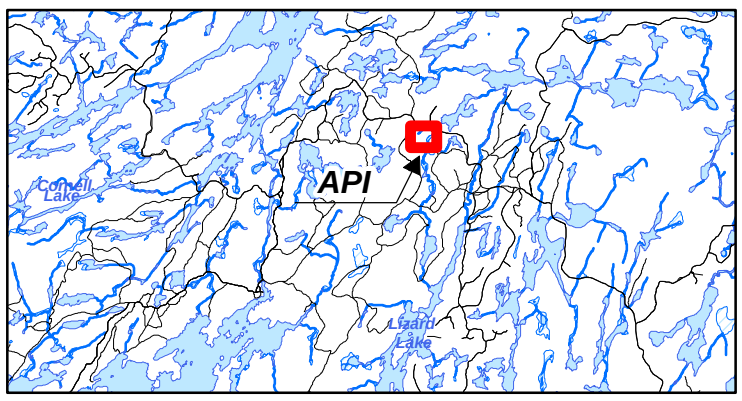
Fish Effort Location (see Figure 5-2)	Date	Gear	Effort	Catch
106	October 14-15, 2010	nordic net	23 hrs.	northern redbelly dace (30 adult) finescale dace (9 adult)
107	October 14-15, 2010	gillnet - single panel (76 mm mesh)	22 hrs.	no catch
108	October 14-15, 2010	minnow traps (1)	22 trap hrs.	finescale dace (1 adult)
109	October 14-15, 2010	minnow traps (1)	22 trap hrs.	northern redbelly dace (16 adult, 1 juvenile) finescale dace (245 adult)
110	August 23-24, 2011	minnow traps (5)	132 trap hrs.	finescale dace (107 adult, 1 juvenile) northern redbelly dace (9 adult)
111a	August 23-24, 2011	broad-scale large mesh	26 hrs.	no catch
111b	August 23-24, 2011	broad-scale large mesh	26 hrs.	no catch
111c	August 23-24, 2011	broad-scale large mesh	26 hrs.	no catch
112a	August 23-24, 2011	broad-scale small mesh	27 hrs.	finescale dace (13 adult) northern redbelly dace (9 adult)
112b	August 23-24, 2011	broad-scale small mesh	27 hrs.	finescale dace (6 adult) northern redbelly dace (3 adult)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 5\api 5 pond.docx



Segment	Length (m)	Channel Width a Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
P2(1)	178.08	100	-	Si	-	80
FL(1)	158.97	6	0.6	Si	Bo	15
FL(2)	435.51	1.04	0.27	Si	-	5
IP3(1)	40.07	20	0.3	Si	-	15
FL(3)	451.70	0.7	-	Si	-	10



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
- FL - Flat, Low Gradient, Low Velocity
- !P3 - Impoundment Pool: Class 3
- P2 - Moderate Quality Pool Habitat (low suitability for overwintering

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Gr -Gravel
- Si -Silt

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- MF -Mixed Forest
- SH - Shrub

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)
- Steep Slope (31 to 70%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

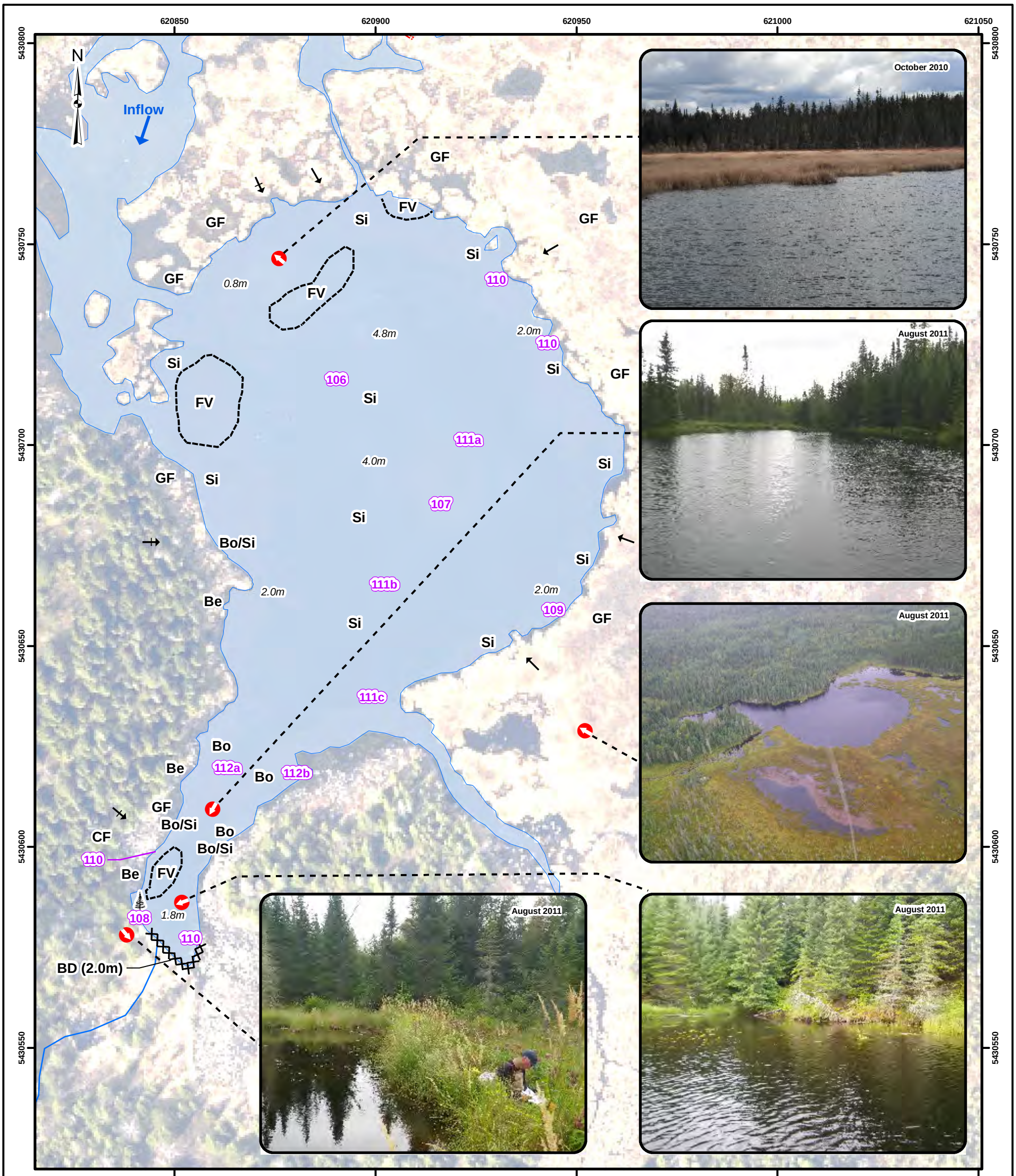
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 5
(Inflow Stream)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 5-1	
GIS	DM	30 Mar. 2012		
CHECK	JD	30 Mar. 2012		
REVIEW	JS	15 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_5c.mxd



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- FV Floating Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Si -Silt

Bank Slope
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 5 (POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 5-2	
GIS	DM	21 Mar. 2012		
CHECK	JD	22 Mar. 2012		
REVIEW	JS	16 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_5.mxd

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 5 (POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 5-3	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\AquaticsLiDAR_Figures.mxd

API #5 (STREAM)

The stream joining the API #5 (pond) with API #4 is 475 m in length. The upper portion of the stream consists of a short cascade and a series of small beaver impoundments, all of which were less than 1 m in depth (Figure 5-4). The lower reaches of the stream flow through an open grassed meadow (Figure 5-5) before entering API 4 (pond). One section of the stream was dry when mapped in October 2010. The flow of water through these dams is likely limited to seepage during dry periods (Photo 1). The lower 262 m of the stream consists of a run segment that flows through a large flooded meadow before flowing into API#4 (Photo #2). This stream was fished in August 2011. Water temperature in the stream was warm. The water was acidic (Table 1).

Table 1: API #5 (stream), Basic Water Chemistry Parameter Data

Date	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2011	23.0	5.5	75	5.0

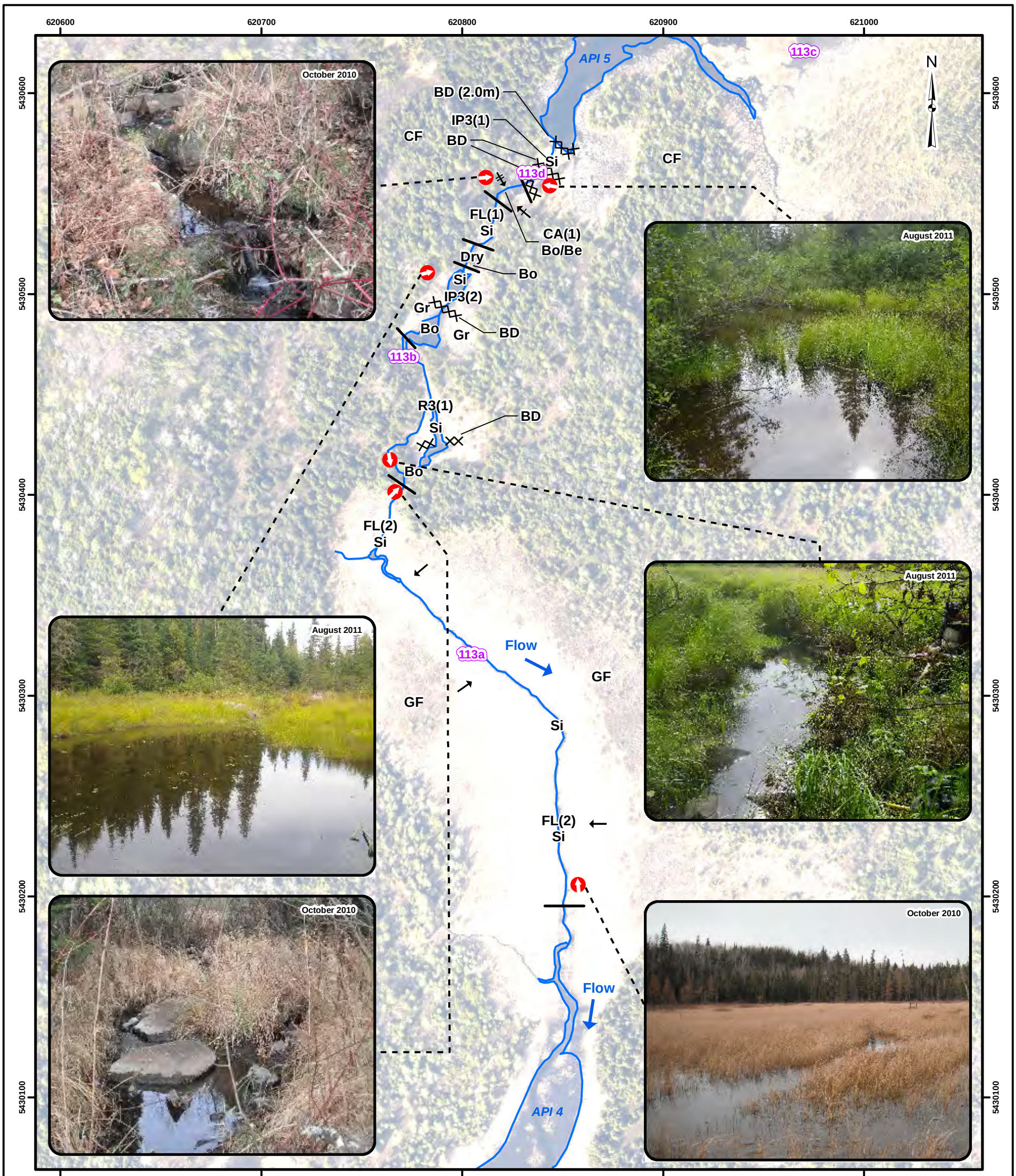
Northern redbelly dace and finescale dace were the only fish species captured in the stream (Table 2).

Table 2: API #5 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

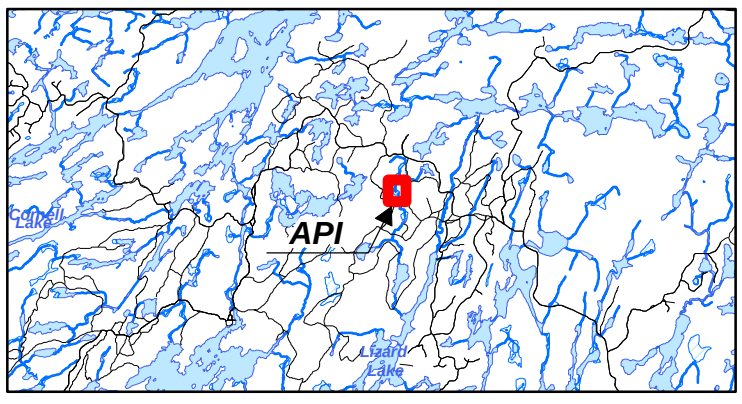
Fish Effort Location (see Figure 5-4)	Date	Gear	Effort	Catch
113a	August 30, 2011	Backpack electrofisher	140 m	finescale dace (52 adult, 169 juvenile, 58 YOY) northern redbelly dace (1 adult)
113b	August 30, 2011	Backpack electrofisher	55 m	finescale dace (5 adult, 60 juvenile, 6 YOY)
113c	August 30, 2011	Backpack electrofisher	150 m	finescale dace (1 adult, 6 juvenile, 3 YOY)
113d	August 30, 2011	Backpack electrofisher	75 m	finescale dace (12 adult, 39 juvenile, 5 YOY)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 5\api 5 stream.docx



Segment	Length (m)	Channel Width a Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
IP3(1)	28.84	14	-	Si	-	20
CA(1)	14.63	1.5	0.14	Bo	Be	0
FL(1)	22.65	4	-	Si	-	0
N/A (dry)	12.23	N/A	N/A	N/A	N/A	N/A
IP3(2)	46.39	20	0.75	Si	Bo	10
R3(1)	86.98	1.5	0.16	Bo	Si	5
FL(2)	262.75	30	-	Si	-	80



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
CA - Cascade: Extremely High Gradient and Velocity
FL - Flat, Low Gradient, Low Velocity
!P3 - Impoundment Pool: Class 3
R3 - Lowest Quality Run Habitat

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)
- Steep Slope (31 to 70%)

Substrate Classification
Be -Bedrock
Bo -Boulder
Si -Silt

Bank Features
Gr -Gravel

Riparian Vegetation
CF - Coniferous Forest
GF - Grass and Forbs

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 5
(OUTFLOW STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 5-4	
GIS	DM	13 Apr. 2012		
CHECK	JD	13 Apr. 2012		
REVIEW	JS	13 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_5b.mxd

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 5 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 5-5	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LIDAR_Figures.mxd

API #2 (HEADWATER LAKE)

API #2 has a total surface area of 122,228 m^2. The shoreline is generally steep and contained by thick coniferous forest and exposed bedrock outcrops (Figure 2-1). A narrow band of alders and grasses and aquatic vegetation rings most of the lake's perimeter. There are no shoals or islands on the lake. Side scan bathymetry mapping indicates that there is a single, 5 m deep basin on the southeast side of the lake, adjacent to a steep bedrock shoreline (Figure 2-2). The lake bottom in the littoral zone is mix of fine and coarse substrates and bedrock. Within the lake basin, substrate consists of fine sediment (Figure 2-3). The lake bottom consists of a mixture of fine and coarse substrate with interspersed boulders.

There is no inflow to the lake, and a single outflow located at the northeast corner. An active beaver lodge was documented on the lake and 0.4m high dam is located at the outflow, at the end of a narrow, weedy bay.

A temperature-dissolved oxygen profile was completed in October 2010 at the deepest location in the lake (Table 1). High dissolved oxygen levels were present throughout the water column. The lake had mixed at the time the profile was completed. It is not known if the lake stratifies fully during the summer months.

Table 1: API #2 (lake), Basic Water Chemistry Parameter Data

Date/Depth (m)	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
October 2010				
Surface	10.7	6.6	43	10.6
1	10.7	6.7	43	10.2
2	10.7	6.6	43	10.2
3	10.7	6.6	43	10.2
4	10.4	6.6	43	10.0
5	10.4	6.3	44	9.6
June 2011	15.2	7.5	54	10.0

The lake was fished in 2010 and 2011 (Table 2). Six fish species were identified in the lake, including pumpkinseed, and northern pike. The forage base consists of yellow perch, Iowa darter and blacknose shiner.

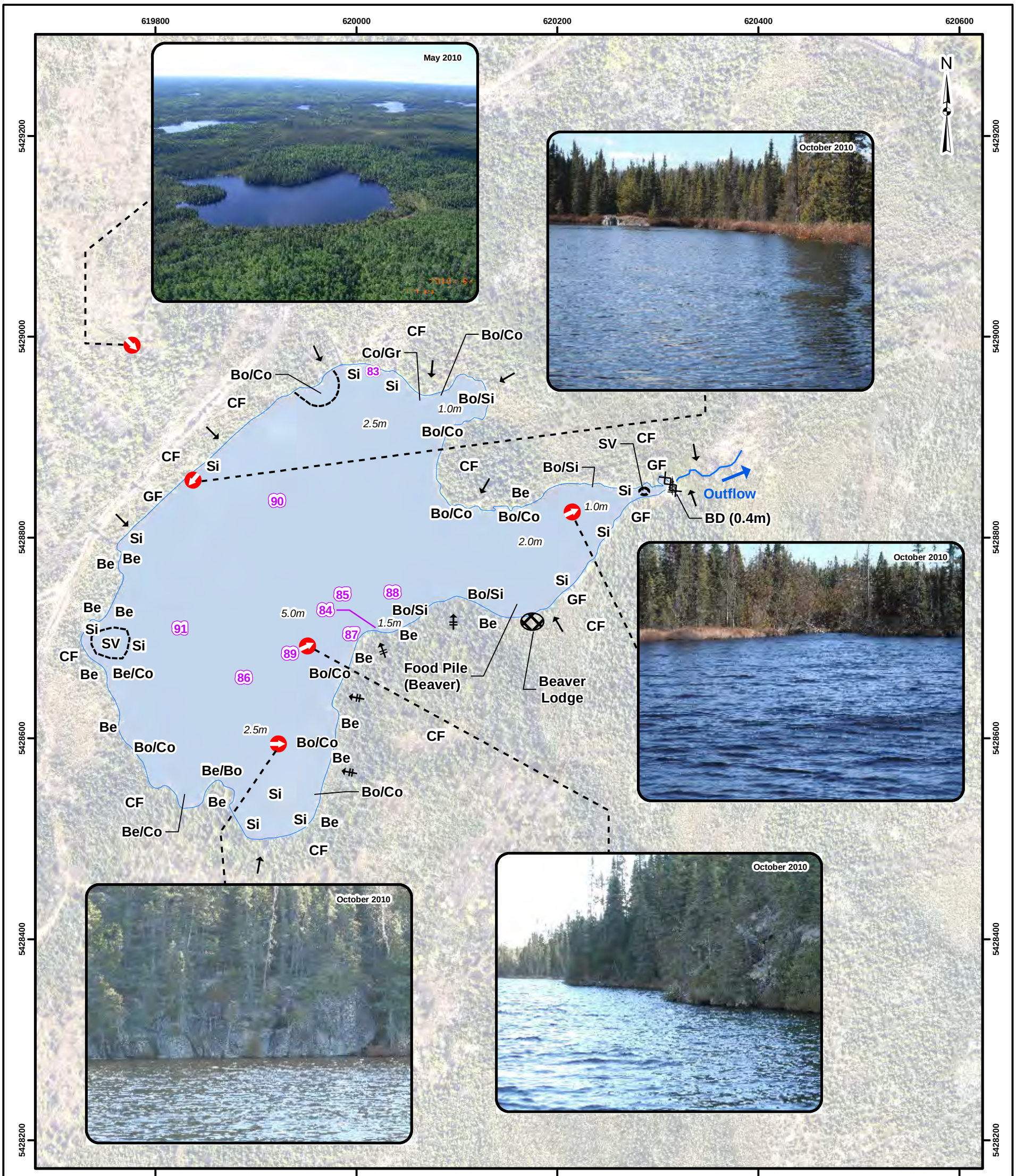
DRAFT

API #2 (HEADWATER LAKE)

Table 2: API #2 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 2-1)	Date	Gear	Effort	Catch
83	October 15-16, 2010	minnow traps (1)	23 trap hrs.	no catch
84	October 15-16, 2010	minnow traps (1)	23 trap hrs.	pumpkinseed (1 juvenile, 3 YOY)
85	October 15-16, 2010	nordic net	22 hrs.	yellow perch (1 adult, 4 juvenile) northern pike (5 adult, 3 juvenile) white sucker (2 adult, 1 juvenile)
85	October 15-16, 2010	gillnet - experimental mesh	20 hrs.	white sucker (6 adult) northern pike (8 adult, 4 juvenile)
87	May 30-31, 2011	minnow traps (5)	90 trap hrs.	no catch
88	May 30-June1, 2011	nordic net	41 hrs.	yellow perch (6 adult, 8 juvenile) northern pike (7 adult) Iowa darter (2 adult) blacknose shiner (2 adult) white sucker (1 adult, 1 juvenile)
89	May 30-June1, 2011	nordic net	40 hrs.	yellow perch (5 adult) northern pike (3 adult) white sucker (1 adult, 1 juvenile)
90	May 30-June1, 2011	gillnet - experimental mesh	41.5 hrs.	northern pike (11 adult, 5 juvenile) white sucker (2 adult, 1 juvenile)
91	May 30-June1, 2011	gillnet - experimental mesh	41.5 hrs.	northern pike (8 adult) white sucker (7 adult, 2 juvenile)

DRAFT



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- SV Submergent Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Steep Slope (31 to 70%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Gr -Gravel
- Sa -Sand
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

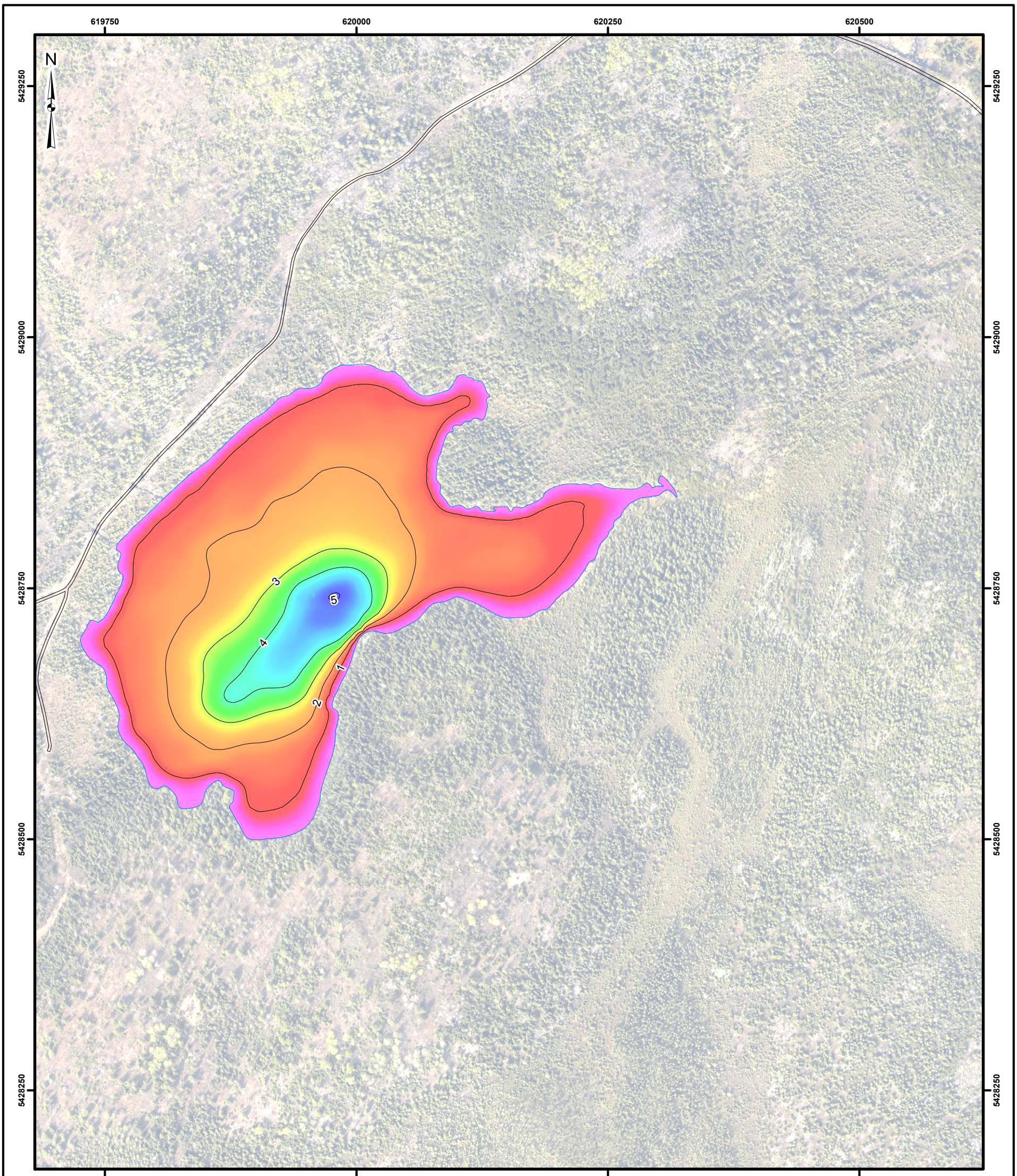
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

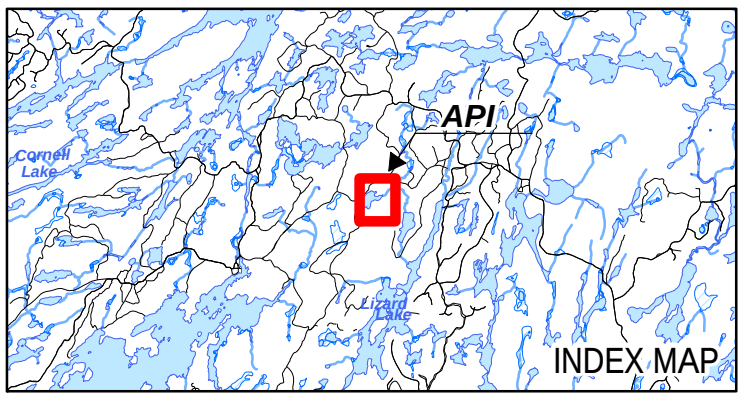
TITLE
AREA OF POTENTIAL IMPACT 2
(Headwater Lake)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 2-1	
GIS	DM	20 Mar. 2012		
CHECK	JD	21 Mar. 2012		
REVIEW	JS	16 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_2.mxd





LEGEND:

- Road
- Lake Bottom Contours - 1 m interval

Depth of Lake Bottom (metres)

1
1.5
2
2.5
3
3.5
4

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

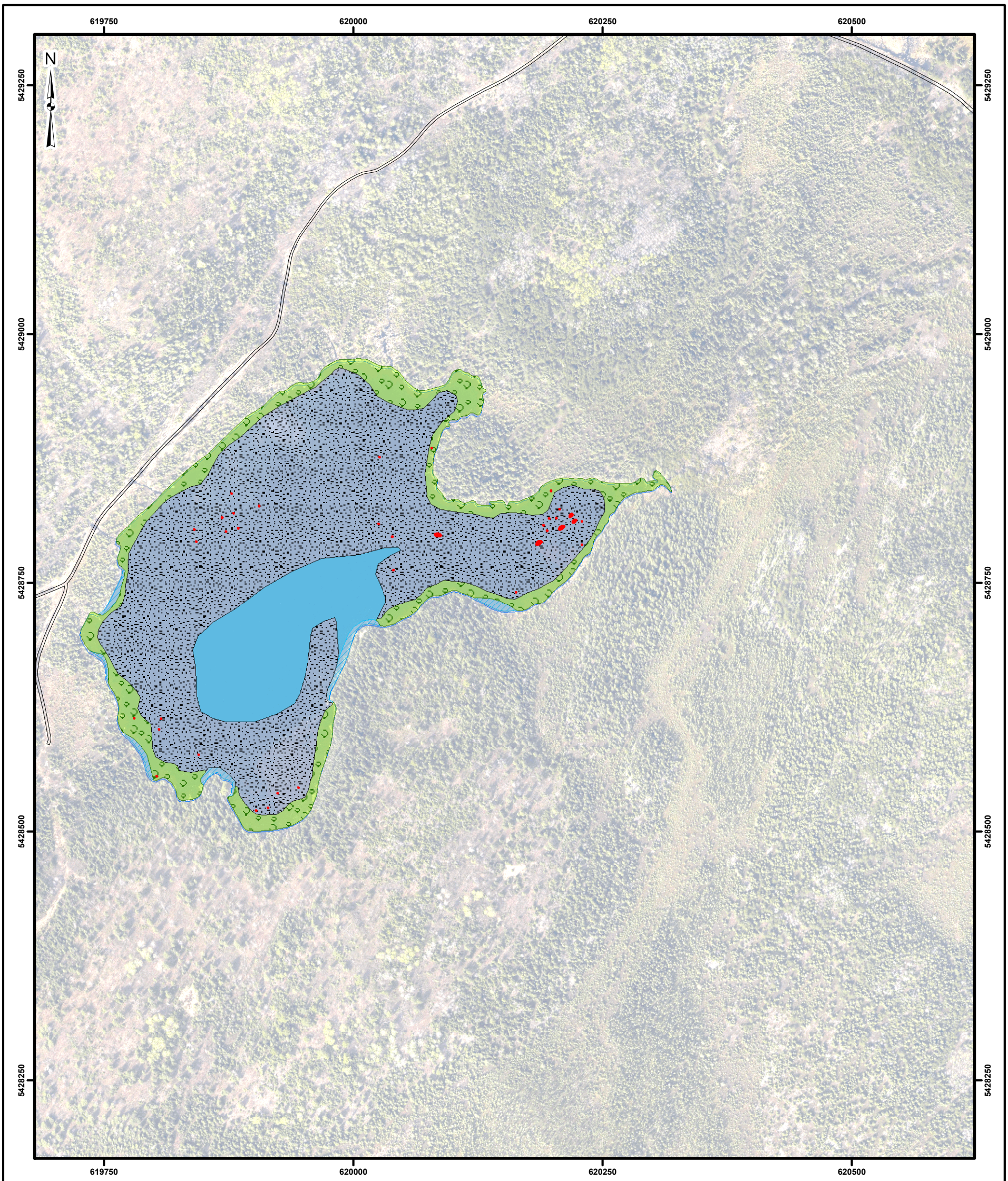
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 2 (HEADWATER LAKE) BATHYMETRY

Golder Associates
Mississauga, Ontario

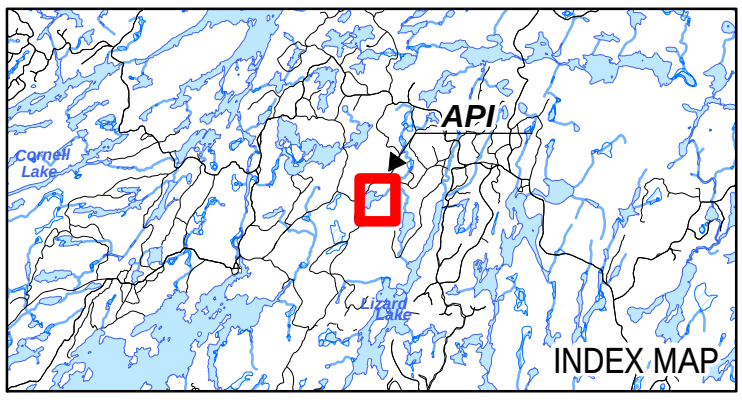
PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 2-2	
GIS	DM	16 Apr. 2012		
CHECK	JD	16 Apr. 2012		
REVIEW	JS	16 Apr. 2012		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\PondAPI\API_2_Bathymetry.mxd



LEGEND:

- Road
- Glacial Erratics
- Boulders
- Shallow or Exposed Bedrock
- Fine Sediment
- Mixed Coarse and Fine Sediment
- Weed



REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 2 (HEADWATER LAKE) INTERPRETED LAKE BOTTOM SUBSTRATE

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 2-3	
GIS	DM	16 Apr. 2012		
CHECK	JD	16 Apr. 2012		
REVIEW	JS	16 Apr. 2012		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Aquatics\PondAPI\API_2_LakeBottomSubstrate.mxd

API #2 (STREAM)

Discharge was calculated to be 0.017 m^3/s at the outflow of the lake in May 2011. Immediately below the outflow, this stream becomes a flooded cedar swamp. Flowing water was only evident in the upper 50 m of the channel (Figure 2-4). The stream channel is indistinguishable throughout much of the upper 425 m of the stream. Downstream of the inflow of API #3, the stream channel meanders through an extensive wide, grassy meadow (Figures 2-5 and 2-6). The channel is punctuated by beaver dams and channel width varies between two and eight metres. Channel width increases as the stream approaches API #8 due to the backwater effect of caused by the water elevation in the lake. Substrate is silt throughout the lower portions of the stream. Table 1 contains water chemistry parameters measured in the stream during assessment.

Table 1: API #2 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
August 2011	25.0	18.5	6.5	53	4.0

Electrofishing was conducted in the lower reaches of the stream in August, 2011 (Table 2). A single central mudminnow was captured in the lower reach of the stream, immediately upstream of API #8.

Table 2: API #2 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 2-5, 2-6)	Date	Gear	Effort	Catch
92a	August, 25, 2011	Backpack electrofisher	95 m	central mud minnow (1 adult)
92b	August, 25, 2011	Backpack electrofisher	200 m	no catch
92c	August, 25, 2011	Backpack electrofisher	100 m	no catch
92d	August, 25, 2011	Backpack electrofisher	20 m	no catch
92e	August, 25, 2011	Backpack electrofisher	125 m	no catch

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 2\api 2 stream.docx

5428800 5428900 5429000 5429100

620300 620400 620500 620600

N

API 2

BD (0.4m)

FL(1)

CF

Cedar Swamp

Si

Flow

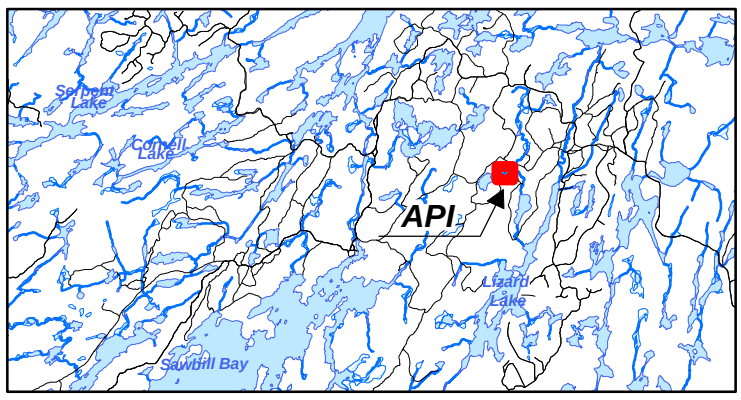
Gr

5428800 5428900 5429000 5429100

50 0 50

SCALE 1:1,500 METRES

Segment	Length (m)	Channel Width a Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	425.73	1.2	0.19	Si	-	0



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity

Substrate Classification
Si -Silt

Bank Features
Gr - Gravel

Riparian Vegetation
CF - Coniferous Forest

Bank Slope
← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 2 (STREAM)
(MAP 1 OF 3)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 2-4	
GIS	DM	26 Mar. 2012		
CHECK	JD	27 Mar. 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_2d.mxd

620700 620800 620900

5429200 5429100 5429000 5428900 5428800

N

API 3

Flow

Gr

API-3

API 2 (stream)

Gr

FL(1)

Gr

CF

Si

Gr

92e

CF

BD (0.4m)

CF

FL(1)

92b

Si

Gr

CF

API 2 (stream)

92d

Gr

CF

Flow

92c

FL(1)

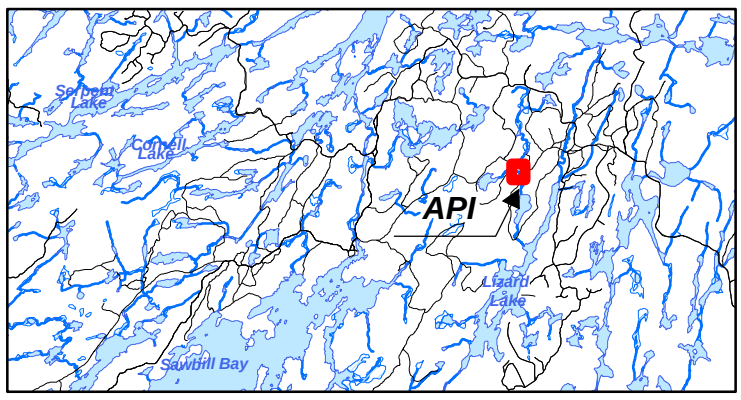
Gr

Si

620700 620800 620900

50 0 50

SCALE 1:1,500 METRES



Segment	Length (m)	Channel Width Transect (m)	Max. Depth a transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	528.73	1.2	0.19	Si	-	0

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity

Substrate Classification
Si -Silt

Bank Features
Gr - Gravel

Riparian Vegetation
CF - Coniferous Forest

Bank Slope
Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 2 (STREAM) (MAP 2 OF 3)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 2-5	
GIS	DM	26 Mar. 2012		
CHECK	JD	27 Mar. 2012		
REVIEW	JS	16 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_2c.mxd

Segment	Length (m)	Channel Width Transect (m)	Max. Depth a transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	32.71	6	-	Si	-	15
IP3(1)	263.00	8	1.25	Si	-	15
FL(2)	205.29	2.6	0.48	Si	-	20

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- IV Instream Vegetation

Substrate Classification
Si -Silt

Bank Features
Gr - Gravel

Riparian Vegetation
CF - Coniferous Forest

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment Pool: Class 3

Bank Slope
← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 2 (STREAM) (MAP 3 OF 3)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 2-6	
GIS	DM	26 Mar. 2012		
CHECK	JD	27 Mar. 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_2b.mxd

API #8 (LAKE)

This lake has a surface area of 180,619 square meters and a maximum depth of 7.0 m (Figure 8-1). Shoreline substrate is predominately boulder and cobble except for an extensive sandy section along the northeast shore. The inflow, API#2, is flat and wide where it empties into the lake (Figure 8-2, Photo 1). The outflow is much narrower and is impounded downstream by beaver dams in several locations downstream although the backwater effect does not extend to the mouth of the lake's outflow. The pond is surrounded by a broad band of wetland habitat consisting of grasses and alders. Emergent vegetation is abundant at both the inflow and the outflow and along much of the shoreline. pH in the lake was slightly acidic. Dissolved oxygen was high throughout the water column (Table 1).

Table 1: API #8 (lake), Basic Water Chemistry Parameter Data (October 2010)

Depth (m)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
Surface	10.0	6.7	53	9.1
1	9.9	-	53	8.9
2	9.9	-	53	8.8
3	9.8	-	53	8.7
4	9.8	-	53	8.7
5	9.7	-	53	8.7
6	9.5	-	53	8.6
7	-	-	-	-

The lake supports populations of northern pike, pumpkinseed, common white suckers and burbot (Table 2). Although no small bodied fish were captured, finescale dace and northern redbelly dace were captured in APIs located upstream of the lake.

Table 2: API #8 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 8-1)	Date	Gear	Effort	Catch
134	October 17-18, 2010	minnow traps (2)	44 trap hrs.	pumpkinseed (3 YOY)
135	October 17-18, 2010	minnow traps (1)	22 trap hrs.	no catch
136	October 17-18, 2010	gillnet - experimental mesh	22 hrs	white sucker (2 adults) northern pike (1 adult, 1 juvenile)
137	October 17-18, 2010	gillnet - experimental mesh	21 hrs.	white sucker (4 adults) northern pike (1 adult, 3 juvenile)

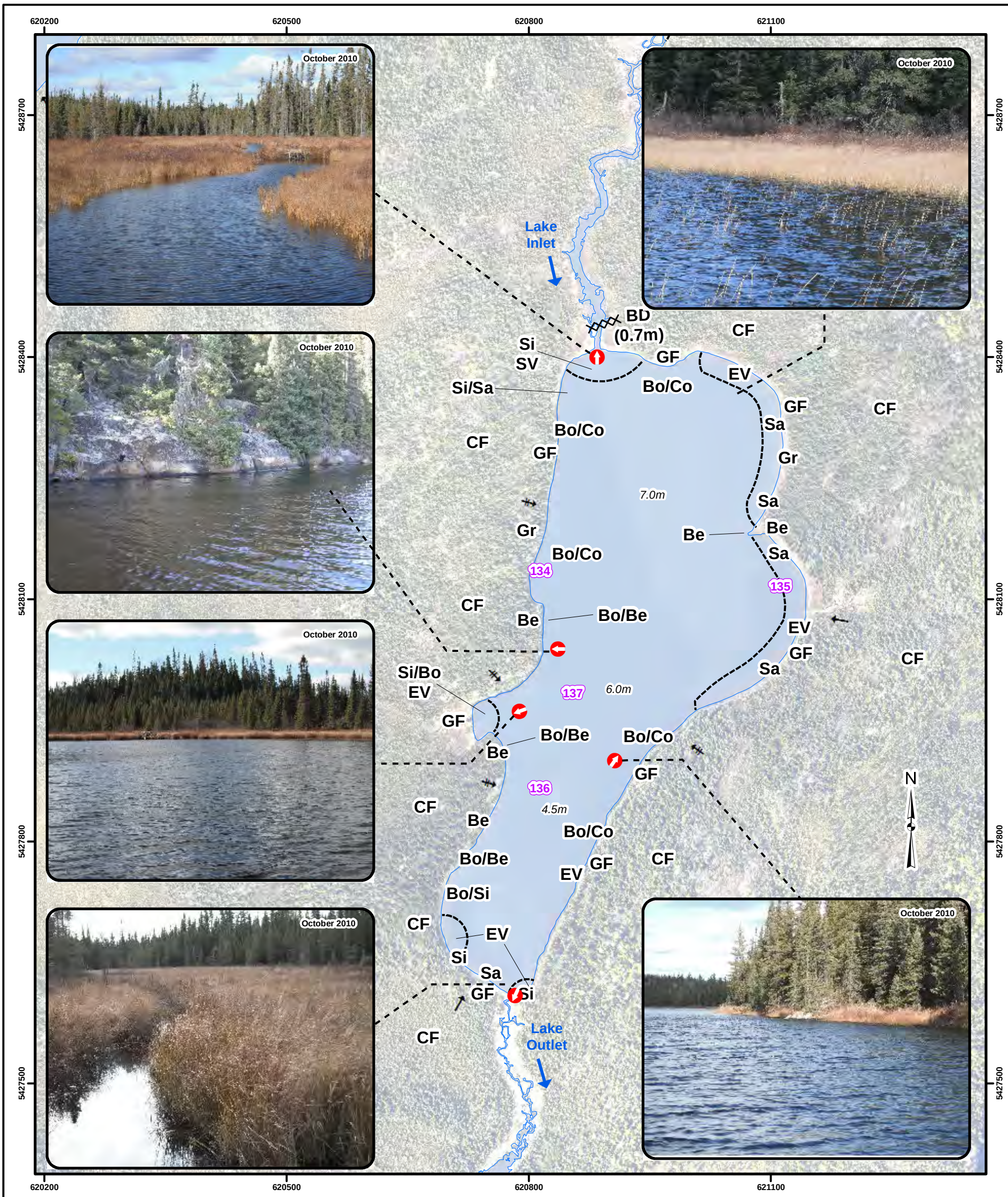
DRAFT

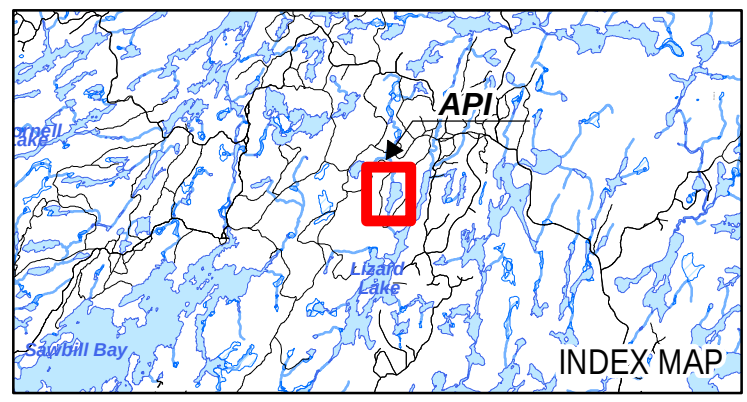
API #8 (LAKE)

Fish Effort Location (see Figure 8-1)	Date	Gear	Effort	Catch
				burbot (1 juvenile)

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 8\api 8 lake.docx

DRAFT





LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- EV Emergent Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Steep Slope (31 to 70%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Gr -Gravel
- Sa -Sand
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 8
(HEADWATER POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 8-1	
GIS	DM	12 Apr. 2012		
CHECK	JD	12 Apr. 2012		
REVIEW	JS	12 Apr. 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_8.mxd

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 8 (LAKE)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 8-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #8 (STREAM)

The stream connecting API #8 to Lizard Lake is approximately 700 m long. Channel segments consist of flats and beaver impoundments (Figures 8-3, 8-4 and 8-5). It is low gradient along its entire length (Photos 2 and 3). A total of seven beaver dams and impoundments exist along the stream. All of the impounded areas are less than 1 m deep. The lower reaches of the stream are tightly contained by coniferous forest and dense, overhanging shrubs and discharge into Lizard Lake on a small point (API #39) (Photo 4). Aquatic vegetation is abundant throughout the stream. Substrate is primarily sand and silt. The lower reach of the stream was electroshocked in the fall of 2010. The lower 400 m of stream was electrofished in October 2010. No fish were captured (Table 1).

Table 1: API #8 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 8-4)	Date	Gear	Effort	Catch
147	October 19, 2010	backpack electrofisher	400 m	no catch

The shoreline adjacent to the mouth of API #8 is shallow and heavily vegetated (Figure 8-5). The shoreline is very flat. Shoreline vegetation is comprised of a mix of black spruce and cedars. The area around the mouth of the stream, in Lizard Lake was sampled in August 2010 (Table 2).

Table 2: API #39 (Lizard Lake), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location	Date	Gear	Effort	Catch
141	August 21-22, 2010	gillnet – experimental mesh	17 hrs.	walleye (2 juvenile, 8 adult) white sucker (5 adult) cisco (5 juvenile, 5 adult, 4 unk.) yellow perch (1 unk.)
142	August 22, 2010	gillnet – experimental mesh	3 hrs.	cisco (1 unk.)
143	August 21, 2010	nordic net	2 hrs.	smallmouth bass (1 juvenile) yellow perch (1 juvenile)
144	August 22, 2010	minnow traps (3)	15 trap hrs.	no catch
145	August 21, 2010	gillnet – experimental mesh	8 hrs.	northern pike (1 adult) white sucker (1 adult)

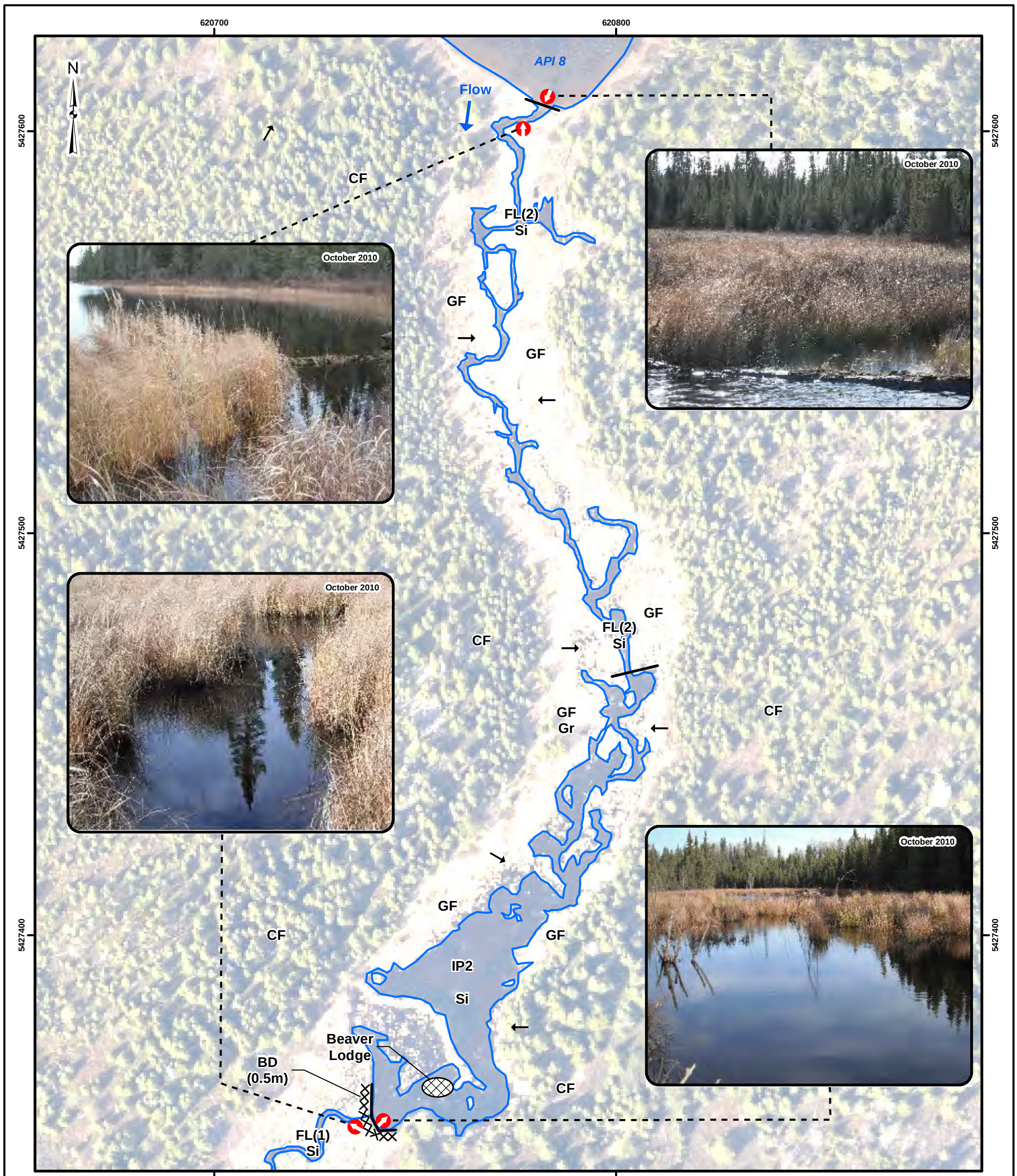
DRAFT

API #8 (STREAM)

Fish Effort Location	Date	Gear	Effort	Catch
				cisco (1 adult)
146	August 21, 2010	boat electrofisher	1,000 m	yellow perch (8 YOY, 238 juvenile) northern pike (4 adult) smallmouth bass (1 juvenile) Iowa darter (1 unk.) pumpkinseed (1 juvenile) spottail shiner (3 YOY, 1 juvenile)

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 8\api 8 stream.docx

DRAFT



Segment	Length (m)	Channel Width / Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	40.05	20	-	Si	-	15
IP2	161.41	55	>1.0	Si	-	30
FL(2)	190.15	5	-	Si	-	-

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment Pool: Class 3

Substrate Classification
Si -Silt

Riparian Vegetation
GF - Grass and Forbs
CF - Coniferous Forest

Bank Slope
← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 8 (STREAM)
(MAP 2 OF 2)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 8-3	
GIS	DM	28 Mar. 2012		
CHECK	JD	29 Mar. 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_8c.mxd

Segment	Length (m)	Channel Width Transect (m)	Max. Depth a transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	421.74	2.9	0.22	SA	Si	5
IP2	64.24	60	>1.0	Si	-	30
FL(2)	76.51	1	-	Si	-	0

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

OHV Overhanging Vegetation

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
IP2 - Impoundment Pool: Class 2

Substrate Classification
Sa -Sand
Si -Silt

Riparian Vegetation
GF - Grass and Forbs
CF - Coniferous Forest
SH - Shrub

Bank Slope
← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 8 (STREAM)
(MAP 1 OF 2)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 8-4	
GIS	DM	26 Mar. 2012		
CHECK	JD	27 Mar. 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_8b.mxd

XXXX Beaver Dam

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 8 (STREAM)
(LOWER REACH)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 8-5	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #8 PHOTO LOG

Photo 1: Aerial view showing inflowing stream. Lizard Lake (outflow) is in the distance.

Photo 2: Outflowing stream and first beaver impoundment.

API #8 PHOTO LOG

Photo 3: Beaver dam, approximately 300 m downstream of lake outflow.

Photo 4: Mouth of API #8 stream (Lizard Lake).

API #8 PHOTO LOG

Photo 5: First beaver dam located approximately 75 m upstream of stream mouth.

Photo 6: Second beaver dam located approximately 180 m upstream of stream mouth.

INTERPRETATION OF CATCHMENT R AQUATICS BASELINE

API #46 and its ouflowing stream, outside of the northeast boundary of TMF Alternative 1 are physically isolated from the rest of the catchment. There is no stream channel connecting API #46 to API #5. Fish are unable to move between these features and the API's within the TMF area.

API's #3, #4 and #5 are part of a series of shallow beaver impoundments. Northern redbelly dace and finescale dace were captured throughout this area. Flows and wetted area are dependent upon beaver activity. One section of stream near API #5 was dry at the time it was assessed. A northern pike and several adult common white suckers were captured in API #3, a shallow beaver pond. These were the only large bodied fish species captured upstream of API #8, a natural lake located downstream of the TMF Alternative 1 footprint. Despite having to traverse several barriers, these fish likely originated from API #8. Habitat conditions upstream of the lake are likely highly variable and not conducive to supporting sustainable populations of either species, yet these individuals were able to survive in at least one of the beaver impoundments. No juvenile fish of either species were captured in the ponds.

The fish community in API #2 is also isolated from the lower portion of the catchment. A stream channel was only evident immediately below the lake, after which water seeps through a flooded forest area. Several fish species (i.e. yellow perch, Iowa darter, blacknose shiner, central mudminnow) captured in API #2, were not found aquatic features located lower in the catchment.

It is highly unlikely that fish from Lizard Lake can traverse the series of beaver dams to access the uptstream lake (API#8). There are seven barriers between Lizard Lake and API #8 (Figure 8-5; Photos 5, 6). The lower stream reaches of the stream and the heavily vegetated mouth of the stream likely represent important spawning and nursery habitats for many of the fish species inhabiting Lizard Lake including northern pike and cyprinid species. Fast flowing water, over the lower dams in the spring may also provide good spawning conditions for sucker species. The silt substrate within the lower reaches of the stream is not optimal for species such as walleye.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment r interpretation.docx

Catchment S

CATCHMENT S

Catchment S has a total drainage area of 230.85 hectares (Figure 3). There are two lakes and a connecting stream in the catchment, which drains into Lizard Lake. API #45 is small lake that is located adjacent to, but outside of, the northern edge of TMF Alternative 2 (Figures 1 and 2). This lake was assessed primarily to determine if there were inflows located along its southern shore, which might be directly impacted by construction of a dam to contain tailings in the TMF.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment s overview.docx

API #45 (LAKE)

API #45 has a surface area 143,751 m^2 and a maximum depth of 7.5 m (Figure 45-1). The shoreline is dominated by bedrock for the most part and the lake bottom slopes sharply from shore. The exception is the south end of the lake, also the shallowest area, which is flat and contained by dense coniferous forest. Substrate on the lake is predominantly bedrock and silt. There is a narrow inlet choked with aquatic vegetation at the southernmost end of the Lake. It extends towards the proposed TMF (Photo 1 and 2). There is a seasonal inflow at the end of this bay. A second, ephemeral inflow exists at the northwest end of the lake (Figure 45-2). The outflow of the lake is controlled by a 2 m high beaver dam. Very little water escapes the lake through this dam. The stream channel immediately below the lake outflow was almost dry when the lake assessed in May 2011. There are two active beaver lodges on the lake. Table 1 summarizes surface water chemistry parameters measured in the field.

Table 1: API #45 (lake), Basic Water Chemistry Parameter Data

Date	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
May 2011	14.8	6.9	39	10.0
August 2011	21.8	6.8	15	7.0

Table 2 summaries fishing effort and catches in API #45. The lake supports northern pike, common white sucker, yellow perch and pumpkinseed. Although no cyprinids were captured during netting, unidentifiable shiner sp(p). were found in several northern pike stomachs.

Table 2: API #2 (lake), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 45-1)	Date	Gear	Effort	Catch
175	May 28-29, 2011	nordic net	19 hrs.	northern pike (1 adult) white sucker (1 adult)
176	May 28-29, 2011	nordic net	18 hrs.	northern pike (1 adult) yellow perch (4 juvenile)
177	May 28-29, 2011	nordic net	19 hrs.	white sucker (1 unk.) northern pike (1 adult, 5 juvenile, 1 unk.)
178	May 28-29, 2011	gillnet – experimental	19 hrs.	no catch

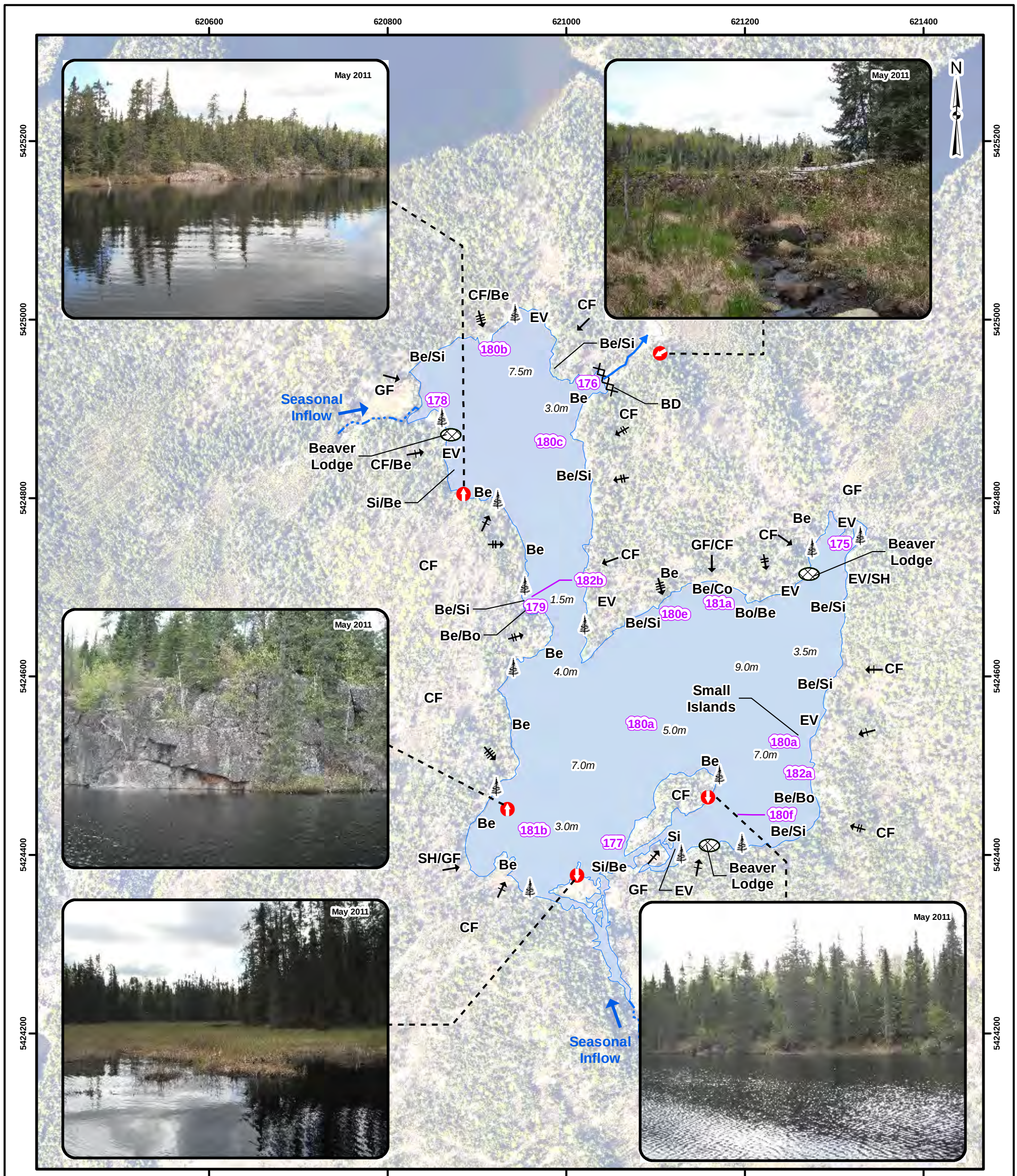
DRAFT

API #45 (LAKE)

Fish Effort Location (see Figure 45-1)	Date	Gear	Effort	Catch
		mesh		
179	May 28-29, 2011	minnow traps (6)	108 trap hrs.	no catch
180a	August 25-26, 2011	broad-scale large mesh	21 hrs.	northern pike (1 adult, 3 juvenile)
180b	August 25-26, 2011	broad-scale large mesh	21 hrs.	northern pike (1 adult)
180c	August 25-26, 2011	broad-scale large mesh	21 hrs.	no catch
180d	August 25-26, 2011	broad-scale large mesh	21 hrs.	northern pike (2 adult)
180e	August 25-26, 2011	broad-scale large mesh	21 hrs.	northern pike (3 adult, 1 juvenile) common white sucker (1 adult)
180f	August 25-26, 2011	broad-scale large mesh	21 hrs.	northern pike (1 adult)
181a	August 25-26, 2011	broad-scale small mesh	20 hrs.	yellow perch (1 adult, 7 juvenile) northern pike (1 juvenile)
181b	August 25-26, 2011	broad-scale small mesh	20 hrs.	yellow perch (5 adult, 8 juvenile)
182a	August 25-26, 2011	minnow traps (2)	40 trap hrs.	pumpkinseed (6 juvenile) yellow perch (1 juvenile)
182b	August 25-26, 2011	minnow traps (2)	60 trap hrs.	no catch

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 45\api 45 lake.docx



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- SV Submergent Vegetation

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- SH - Shrub

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)
- Steep Slope (31 to 70%)
- VerySteep Slope (> 70%)

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 45
(LAKE)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 45-1	
GIS	DM	12 April 2012		
CHECK	JD	13 April 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\API_45.mxd

Beaver Dam

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 45 (LAKE)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 45-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #45 PHOTO LOG

Photo 1: Aerial view looking south towards TMF Alternative 2.

Photo 2: Shallow bay, south end of API #45.

INTERPRETATION OF CATCHMENT S AQUATICS BASELINE

API #45 is a warm water lake. The footprint of TMF Alternative 2 could potentially impact the seasonal drainage at the south end of API #45. The shallow, weedy bay that this inflow empties into is likely spawning habitat for the resident northern pike population and nursery habitat for other fish species inhabiting the lake. Water elevation in this bay and on the lake is controlled by a 2 m beaver dam at the lake outflow. The exact siting of the TMF boundaries will determine how much of the lake's drainage area may be impacted by the TMF.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment s interpretation.docx

Catchment T

CATCHMENT T

This catchment occupies the western portion of TMF Alternative 2, east of Lizard Lake and Turtle Bay (Figure 1). There is a single aquatic feature within this catchment, a permanent stream (API #40) that empties into the east side of Turtle Bay (Figure 3). If this TMF option is adopted, the upper section of the stream will be infilled. The small inlet at its mouth, part of Turtle Bay, and the stream's lower reaches would cease to receive water from the upper portion of the catchment.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment t overview.docx

API #40 (STREAM)

This stream was mapped in August 2011. The stream is approximately 1,200 m in length and flows through a flat meadow. Channel gradient is low along its entire length. Channel width in the lower reach of the stream is 13 m to 18 m (Figures 40-1 and 40-2; Photo 1). The reservoir backwater effect was evident approximately 500 m upstream of its mouth when the stream was mapped. The mouth of the stream and its lower reach are heavily vegetated (Photos 2 and 3). Bottom substrate is predominately silt along the entire length of the stream. Stream discharge measured in October 2010, in the lower reach, was calculated to be 0.002 m^3/s.

A series of low beaver dams exist beginning approximately 450 m upstream of the mouth of the stream. Upstream of the dams, channel width narrows to 1 m to 2 m. Maximum channel depths occur in impounded areas but are less than 1.5 m. The mid-reaches of the stream meander through a wide grassy meadow (Photo 4). Channel width is generally less than 1 m. Several low head beaver dams also exist in the middle reaches (Figure 40-3).

The upper portion of API #40, upstream of the final beaver impoundment, receives water from two tributaries originating from a heavily forested area (Photos 5 and 6). Flow in these tributaries is likely seasonal. Table 1 summarizes basic water chemistry data collected in the middle reaches of API #40 during field assessments. The water is slightly acidic and conductivity is low.

Table 1: API #40 (stream), Basic Water Chemistry Parameter Data

Date	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
October 2010	5.1	4.6	25	10.4
May 2011	10.8	6.0	31	10.2
September 2011	16.7	-	35	4.0

API #40 was backpack electroshocked on three occasions (Table 2). Juvenile northern pike, common white sucker and burbot were the only fish species captured. Juvenile northern pike and common white suckers were captured as far as the second last beaver dam, approximately 1,100 m upstream of the mouth of the stream (Fishing location # 159; Figure 40-3).

DRAFT

API #40 (STREAM)

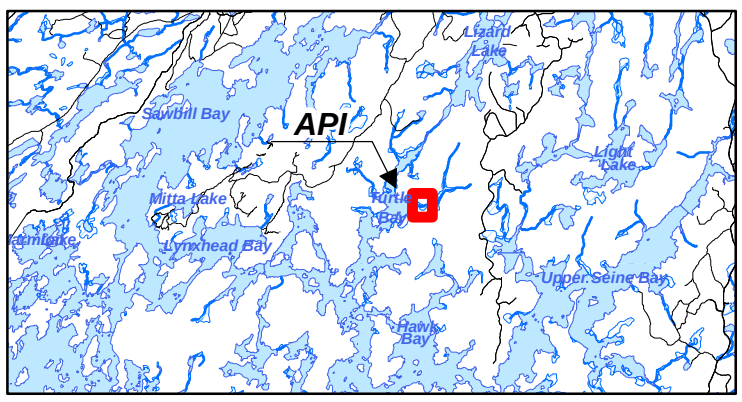
Table 2: API #40 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 40-1, 40-3)	Date	Gear	Effort	Catch
157	October 20, 2010	backpack electrofisher	250 m	white sucker (1 juvenile) northern pike (1 juvenile)
158	May 10, 2011	backpack electrofisher	850 m	northern pike (1 juvenile)
159	September 01, 2011	backpack electrofisher	240 m	northern pike (2 juvenile)
160 (mouth)	August 25, 2010	boat electrofisher	600 m	yellow perch (72 juvenile) blacknose shiner (54 adult)
345	September 01, 2011	backpack electrofisher	200 m	white sucker (1 juvenile) burbot (1 juvenile)
346	September 01, 2011	backpack electrofisher	60 m	no catch
347	September 01, 2011	backpack electrofisher	300 m	no catch

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 40\api 40 stream.docx

Segment	Length (m)	Channel Width Transect (m	Max. Depth transect (m	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
IP3	16	70	<1.5	Si	-	60
FL	600	1.8	0.62	Si	-	30



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment pool formed behind a dam

Bank Slope
← Shallow Slope (0 to 5%)

Riparian Vegetation
CF - Coniferous Forest
GF - Grass / Forbes

Substrate Classification
Si -Silt

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 40 (STREAM)
(MAP 1 OF 2)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 40-1	
GIS	DM	09 April 2012		
CHECK	JD	10 April 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_40a.mxd

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

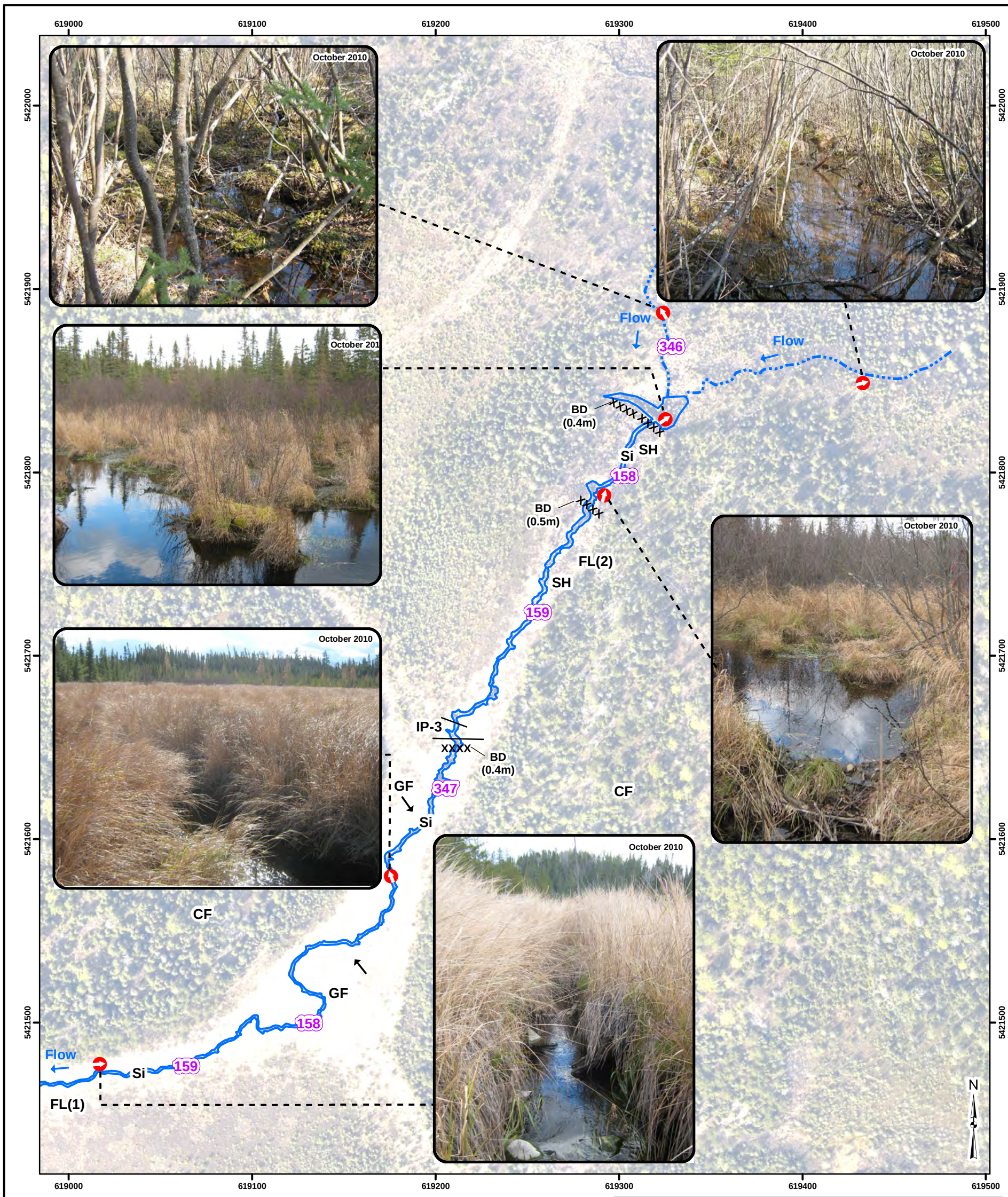
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 40 (STREAM) (LOWER REACH)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 40-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

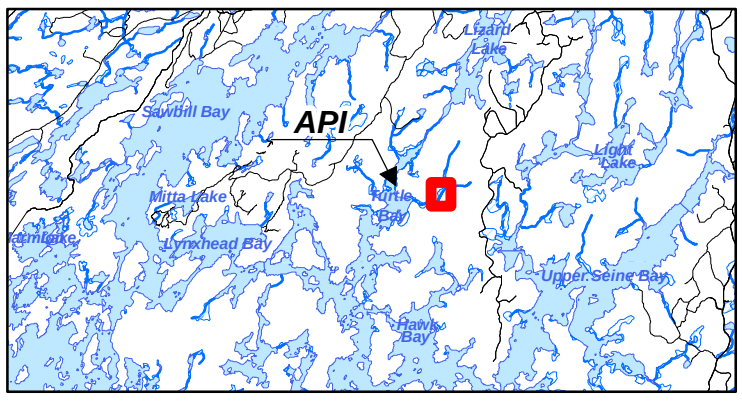
Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd



75 0 75

SCALE 1:2,200 METRES

Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	372	-	-	Si	-	60
IP3	8	-	-	Si	-	-
FL(2)	215	-	-	Si	-	-



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment pool formed behind a dam

Riparian Vegetation
CF - Coniferous Forest
GF - Grass / Forbes
SH - Shrub

Substrate Classification
Si -Silt

Bank Slope
← Shallow Slope (0 to 5%)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 40 (STREAM)
(MAP 2 OF 2)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 40-3	
GIS	DM	09 April 2012		
CHECK	JD	10 April 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_40b.mxd

API #40 PHOTO LOG

Photo 1: Mouth and lower reach of API #40 (August 2011).

Photo 2: Mouth of API #40 (October 2010).

API #40 PHOTO LOG

Photo 3: Mouth of API #40 (September 2010).

Photo 4: Convergence of upper tributaries of API #40 (August 2011).

API #40 PHOTO LOG

Photo 5: Mid-reach of API #40 (August 2011).

Photo 6: Upper tributary of API #40 (August 2011).

INTERPRETATION OF CATCHMENT T AQUATICS BASELINE

The capture of juvenile northern pike and common white suckers in the upper reaches of API #40 indicates that the stream is used as nursery habitat for these species. The stream, particularly the lower reaches, is also suitable for these species as spawning habitat. Although water elevation in Marmion Reservoir influences habitat conditions in the lower portion of the stream, creation of the TMF would result in the alteration of habitat in the upper and middle reaches of the stream and could also affect habitat suitability in the lower reaches.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment t interpretation.docx

Catchment U

CATCHMENT U

This catchment occupies the eastern portion of TMF Alternative 2, east of Lizard Lake and Turtle Bay (Figure 1). It has a total area of 200.68 hectares (Figure 3). There is a single aquatic feature within this catchment, a permanent stream (API #9) that empties into Light Bay/Upper Seine Bay (Figure 2). If this TMF option is adopted, the upper portion of the stream, upstream of the cascade located approximately 1,070 m upstream of its mouth, will be destroyed. Flows in the lower portion of the stream will be potentially altered due to the creation of a tailings dam.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment u overview.docx

API #9 (STREAM)

The stream was mapped in the May 2011. The stream is approximately 1,800 m in length. There is no pond or lake associated with the stream. The upper reaches are located in and drain a low lying meadow (Figures 9-1 and 9-2; Photo 1). There are eight beaver dams on the stream, most of which are inactive, that have a moderating effect on flows. Impounded areas behind the dams likely provide important refugia for stream dwelling fish (Photo 2). During high water conditions, the waters of Light Bay/Upper Seine Bay approach the mouth of API #9, to the base of the first beaver dam (Figures 9-3 and 9-4). There was no observable flow through this dam at high water and only a trickle of water escaping from it at low water connecting the beaver impoundment to Upper seine Bay (Photos 3 and 4). Discharge, measured in the lower reach in October 2010 and May 2011, was 0.001 m^3/s and 0.019 m^3/s, respectively.

The first beaver dam which rises 0.8 m above the surface of the Upper Seine River during high water conditions, is a barrier to fish movement. This is supported by fish community sampling results.

Other than within beaver impoundments, stream segments are tightly contained, and have narrow channels. Channel widths of the runs and flats in the lower reaches vary between 0.65 m and 1.8 m. Maximum channel depth never exceeded 0.6 m. The most significant physical feature of API #9 is a steep rocky cascade, approximately 1,070 m upstream of it mouth. Photos 5 and 6 illustrate extremes in flow conditions at this location. Water in the stream is very dark coloured and slightly acidic (Table 1).

Table 1: API #9 (stream), Basic Water Chemistry Parameter Data

Date	Surface Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
October 2010	3.7	5.9	26	4.7
May 2011	12.0	5.9	29	7.0
August 2011	17.0	6.5	26	4.0

The lower reaches of stream were backpack electroshocked in October 2010 and in May and August 2011. The upper reaches were shocked in August 2011 (Table 2). Central mudminnow and fathead minnows were the only fish species captured. No fish were captured or observed upstream of the cascade. Channel width in the upper most reach is less than 0.5 m and was too to electrofish in many sections. The mouth of API #9 (i.e. Light Bay/Upper Seine Bay) has not been fished.

DRAFT

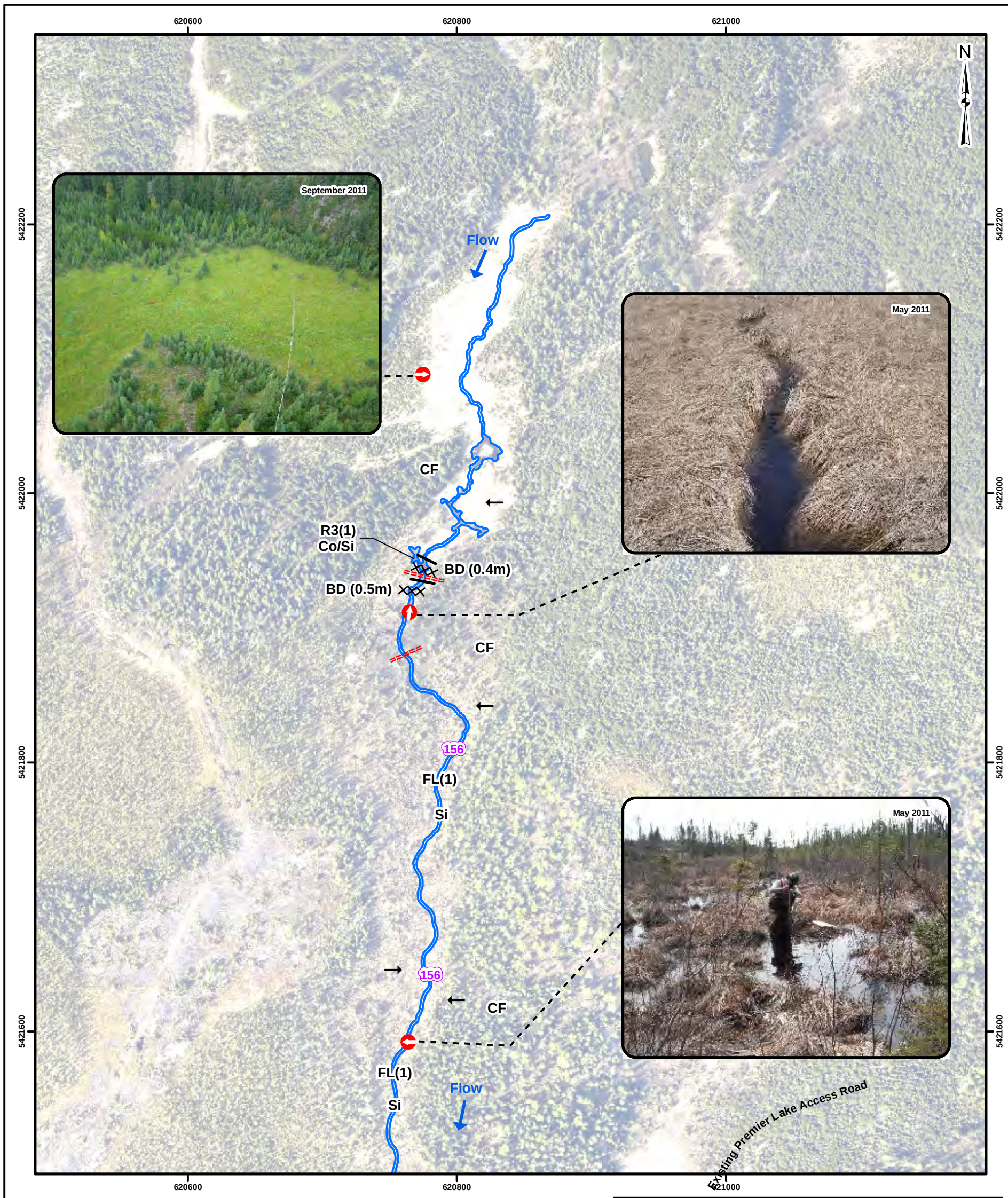
API #9 (STREAM)

Table 2: API #9 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figures 9-1, 9-3)	Date	Gear	Effort	Catch
154	October 18, 2010	backpack electrofisher	440 m	fathead minnow (1 adult)
155	May 11, 2011	backpack electrofisher	800 m	central mudminnow (21 adults)
156	August 31, 2011	backpack electrofisher	1,385 m	central mudminnow (9 adult, 10 juvenile)

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 9\api 9 stream.docx

DRAFT



Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	489.89	6	-	Si	-	30
R3(1)	16.23	1.35	0.6	Co	Si	30

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
FL - Flat, Low Gradient, Low Velocity
R3 - Lowest Quality Run Habitat

Bank Slope
← Shallow Slope (0 to 5%)

Substrate Classification
Co -Cobble
Si -Silt

Riparian Vegetation
CF - Coniferous Forest

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 9 (STREAM)
(MAP 1 OF 2)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 9-1	
GIS	DM	22 Mar. 2012		
CHECK	JD	23 Mar. 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_9B.mxd

40 0 40
SCALE 1:1,200 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 9 (STREAM)
(UPPER REACH)

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 9-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LIDAR_Figures.mxd

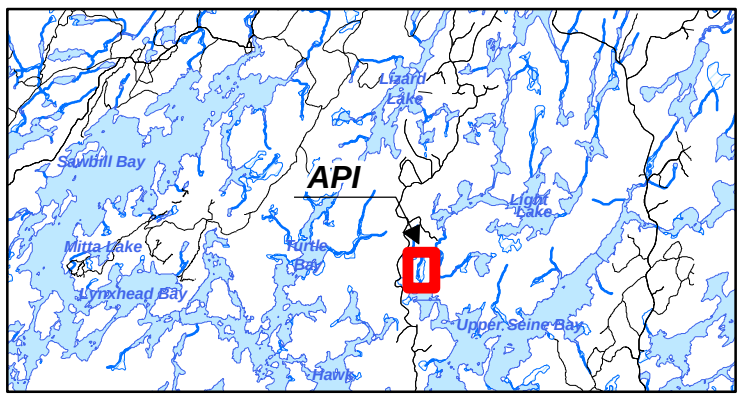
620600 620800 621000 621200

5421400 5421200 5421000 5420800

Flow
FL(5)
Si/Bo
MW
R3(1)
Be/Si
MW
CA(1)
Be/Si
IP3(6)
Si/Bo
IP3(5)
Si
BD (0.5m)
FL(4)
Si
IP3(4)
BD (0.4m)
Si
155-156
FL(3)
Si
Si
IP3(3)
BD (0.4m)
FL(2)
Si
SH/GF
Si
IP3(2)
BD (0.4m)
FL(1)
Si
SH/GF
154
Si/Bo
IP3(1)
BD (0.8m)
Flow
Light Bay /
Upper Seine Bay
N

100 0 100
SCALE 1:3,000 METRES

Segment	Length (m)	Channel Width Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
IP3(1)	63.60	10	-	Si	Bo	0
FL(1)	131.60	1.8	0.24	Si	-	0
IP3(2)	83.49	8	-	Si	-	0
FL(2)	134.69	1.1	0.4	Si	-	10
IP3(3)	66.29	15	-	Si	-	5
FL(3)	277.43	1.15	0.24	Si	-	15
IP3(4)	27.45	5	-	Si	-	5
FL(4)	139.32	2.5	0.26	Si	-	40
IP3(5)	44.85	10	-	Si	-	10
R3(1)	101.69	0.65	0.36	Be	Si	5
CA(1)	70.02	1.35	0.26	Be	Si	0
IP3(6)	36.76	10	-	Si	Bo	15
FL(5)	153.05	1.2	0.58	Si	Bo	60



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
CA - Cascade: Extremely High Gradient and Velocity
FL - Flat, Low Gradient, Low Velocity
IP3 - Impoundment Pool: Class 3
R3 - Lowest Quality Run Habitat

Bank Slope
Shallow Slope (0 to 5%)
Steep Slope (31 to 70%)

Substrate Classification
Be -Bedrock
Bo -Boulder
Si -Silt

Riparian Vegetation
CF - Coniferous Forest
GF - Grass and Forbs
MW - Mixed Wood
SH - Shrubs

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

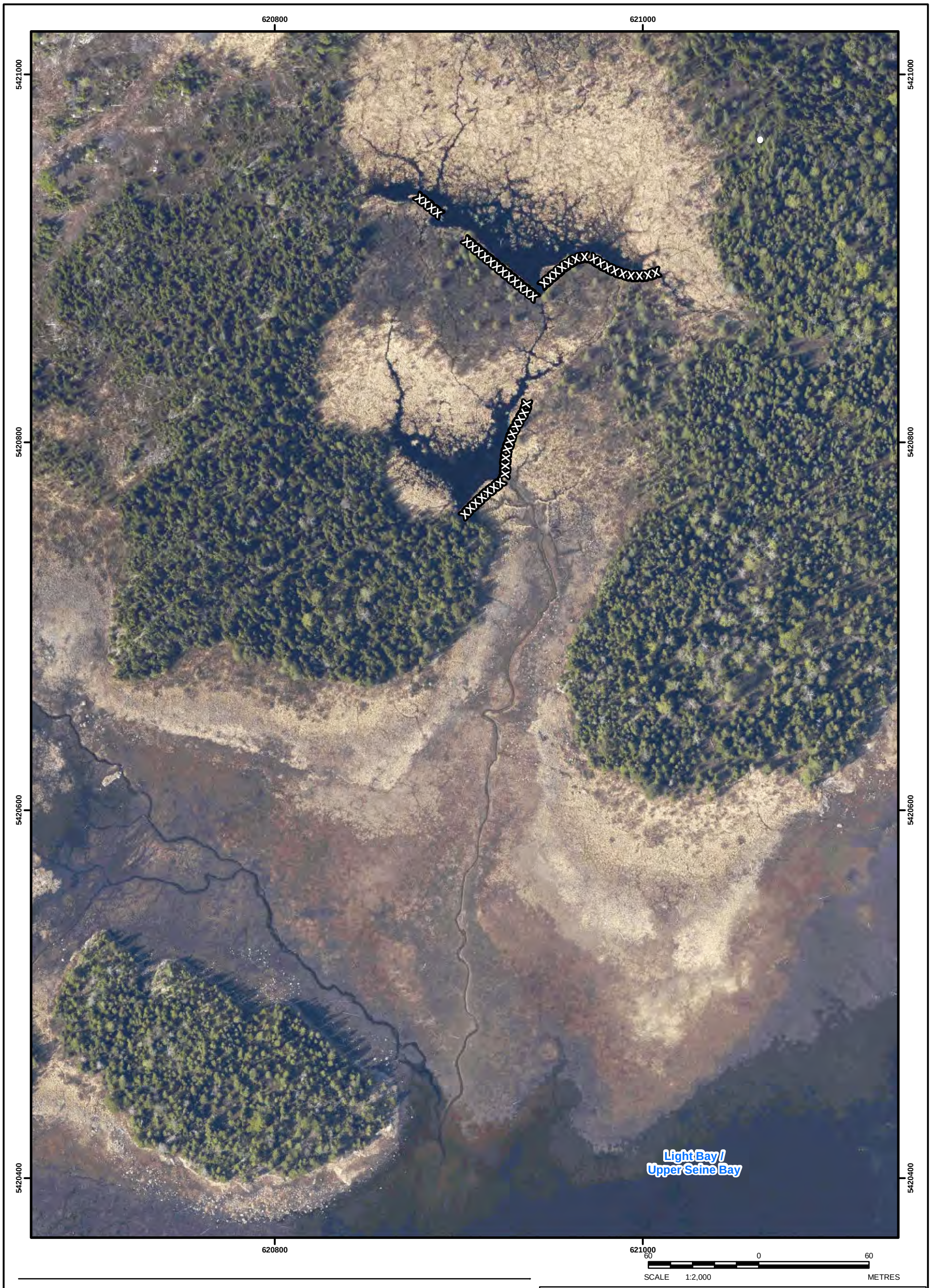
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 9 (STREAM)
(MAP 2 OF 2)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 9-3	
GIS	DM	21 Mar. 2012		
CHECK	JD	22 Mar. 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\LimitedSpace_API_9A.mxd



PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 9 (STREAM)
LOWER REACH

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 9-4	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #9 PHOTO LOG

Photo 1: Headwater reach of API #9 (August 2011).

Photo 2: Beaver pond immediately downstream of cascade.

API #9 PHOTO LOG

Photo 3: Upper Seine bay and mouth of API #9 (first three beaver impoundment areas).

Photo 4: Stream channel near mouth of API #9, Upper Seine Bay (August 2011).

API #9 PHOTO LOG

Photo 5: Cascade (May 2011).

Photo 6: Cascade (August 2011).

INTERPRETATION OF CATCHMENT U AQUATICS BASELINE

Two fish species, fathead minnow and central mudminnow, were captured in API #9, in the lower reaches of the stream. The stream channel below the first beaver dam, is barely connected to Upper Seine Bay when the water elevation in Marmion Reservoir is low. There was no observable flow between the impoundment and the bay other than seepage through the dam. This dam is a barrier to fish movement. During high water conditions the base of the first beaver dam is unundated by water from the bay but the top of the dam remains 0.8 m higher than the water's surface. The mouth of API #9, below the first beaver dam, is heavily vegetated and likely represents important spawning and nursery habitats for many of the fish species inhabiting Upper Seine Bay, during periods of high water elevation. The upper section of API #9, above the cascade, does not support a fish community. The cascade prevents cyprinids occupying the lower sections of the stream, from moving upstream. Flows in the stream are very flashy (Photos 4 and 5). Impounded areas are the only available refugia for cyprinids occupying the lower reaches of the stream, during periods of low flow.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment u interpretation.docx

Catchment Z

CATCHMENT Z

Catchment Z consists of a stream (API 41) which drains the western edge of TMF Alternative 2 (Figure 1). The drainage area of the catchment is 74.8 hectares. Flows within the upper section of API #41, could be altered by construction of a dam to contain tailings in the TMF.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment z overview.docx

API #41 (STREAM)

The stream is approximately 330 m in length (Figure 41-1). The stream channel consists of two segments of low gradient flats and a large beaver impoundment, located approximately 156 m from its mouth (Photo 1). Stream substrate consists of silt. The stream flows through a grassy meadow along its entire length and its origin is in this meadow (Figure 41-2; Photo 2). Channel depth is less than 1 m and channel width varies from less than 1 m in the upper reach to 1.65 m near its mouth (Photo 3). Aquatic vegetation is abundant in the lower reach.

The lower stream segment empties into Turtle Bay in a shallow, weedy bay (Photo 4). Shoreline vegetation consists mainly of cattails and sedges. Due to the shallowness of the bay, habitat conditions are very dependent upon the water elevation in Marmion Reservoir (Figure 41-2).

Table 1 summarizes basic water chemistry parameters recorded during field studies. Water is slightly acidic. Discharge recorded in the lower reach in October 2010 and in May 2011 was 0.001m^3/s and 0.003 m^3/s, respectively.

Table 1: API #41 (stream), Basic Water Chemistry Parameter Data

Date	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µmhos)	Dissolved Oxygen (mg/L)
October 2010	12.0	7.6	5.9	36	8.0
May 2011	18.2	10.0	6.3	43	7.4
August 2011	18.0	18.3	6.9	32	5.0

The stream was electroshocked on three occasions. A single northern pike was captured near the mouth of the stream. No fish were captured upstream of the first beaver dam (habitat map).

Table 2: API #41 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 41-1)	Date	Gear	Effort	Catch
165	October 20, 2010	backpack electrofishing	120 m	northern pike (1 adult)
166	May 11, 2011	backpack electrofisher	180 m	no catch
167	August 31, 2011	backpack electrofisher	150 m	no catch

The inlet near the mouth of API #41 was fishing in August and September, 2010 (Table 3). Juvenile fish representing a number of different species were captured in the bay.

DRAFT

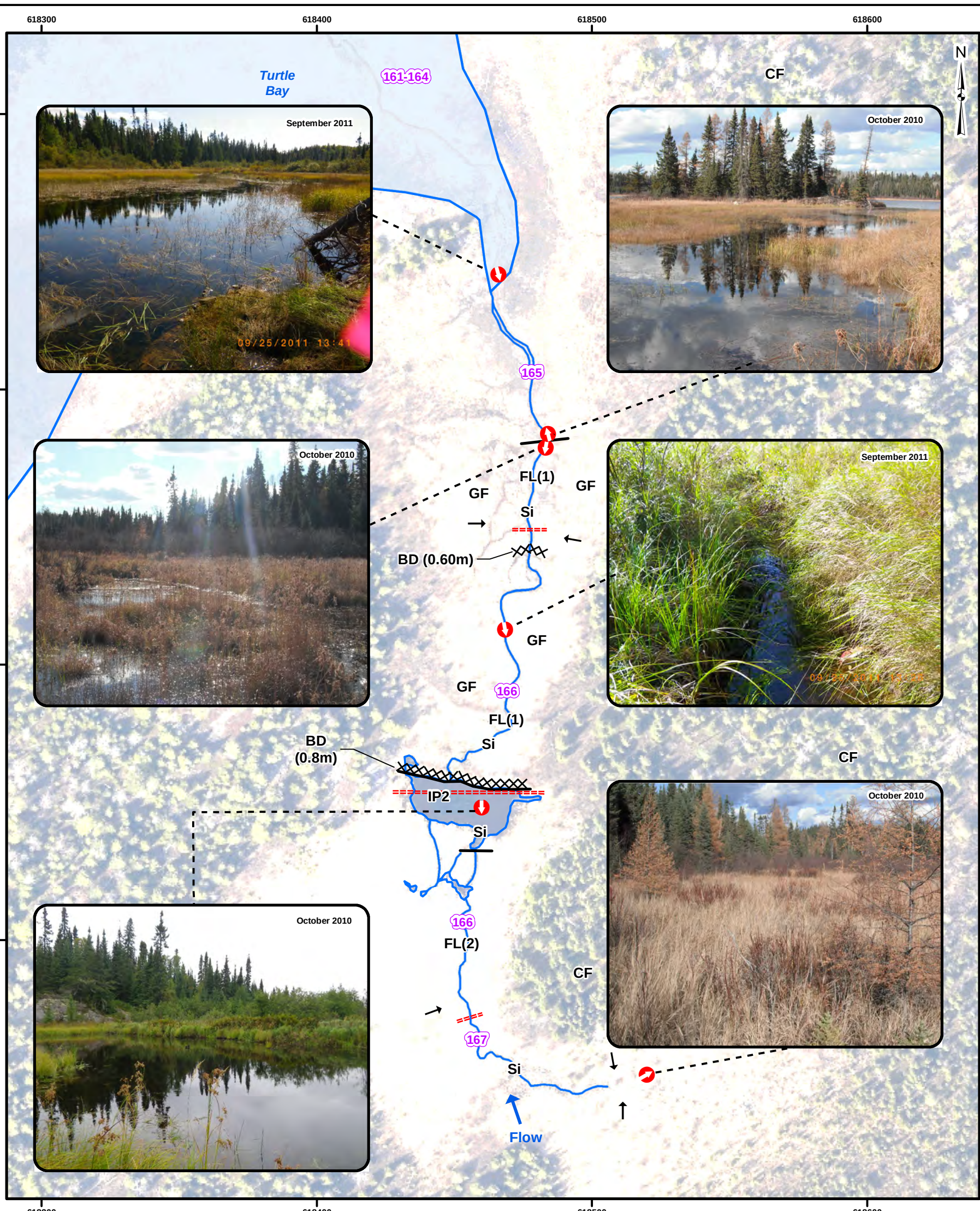
API #41 (STREAM)

Table 3: API #41 (stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

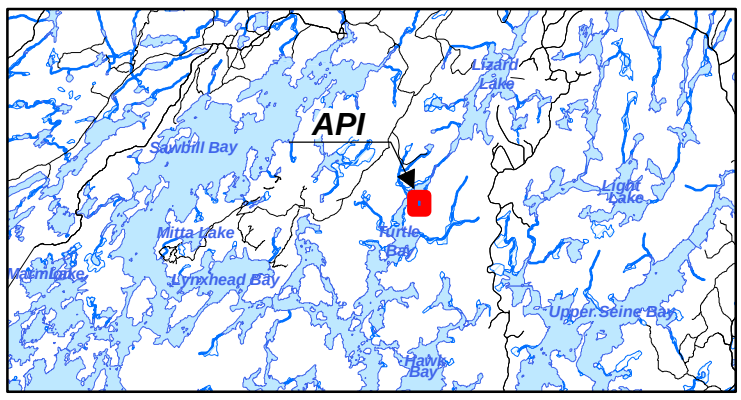
Fish Effort Location	Date	Gear	Effort	Catch
161	August 25, 2010	boat electrofisher	600 m	yellow perch (8 juvenile, 19 unk.)
162	August 24, 2010	nordic net	25 hrs.	smallmouth bass (1 unk.) northern pike (3 adult, 2 juvenile) yellow perch (5 adult, 3 juvenile)
163	August 23, 2010	nordic net	29 hrs.	yellow perch (14 juvenile)
164	September 24, 2010	gillnet – experimental mesh	23 hrs.	yellow perch (5 adult, 5 unknown) white sucker (4 adult, 2 juvenile) lake herring (3 adult, 9 unk.) walleye (7 adult, 7 juvenile) northern pike (1 adult) lake whitefish (2 adult)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 41\api 41 stream.docx



Segment	Length (m)	Channel Width Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetation
				Dominant	Sub-dominant	
FL(1)	156.51	1.65	0.45	Si	-	30
IP2	28.44	60	1.25	Si	-	15
FL(2)	147.52	0.71	0.17	Si	-	30



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- BW Backwater
- SV Submergent Vegetation
- OHV Overhanging Vegetation

Channel Unit Type
- FL - Flat, Low Gradient, Low Velocity
- IP2 - Impoundment Pool: Class 2

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- SH - Shrub

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 41 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 41-1	
GIS	DM	02 April 2012		
CHECK	JD	03 April 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_41b.mxd

XXXX **Beaver Dam**

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 41 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 41-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #41 (TURTLE BAY)

The shallow bay near the mouth of API was fished in August and September 2010 (Table 1). The bay appears to be nursery habitat for a variety of species and likely an attraction for predator species.

Table 1: API #41 (Turtle Bay), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 41-1)	Date	Gear	Effort	Catch
161	August 25, 2010	boat electrofisher	600 m	yellow perch (19 adult, 8 juvenile)
162	August 24, 2010	nordic net	25 hrs.	smallmouth bass (1 unk.) northern pike (3 adult, 2 juvenile) yellow perch (5 adult, 3 juvenile)
163	August 23, 2010	nordic net	29 hr.	yellow perch (14 juvenile)
164	September 24, 2010	gillnet – experimental mesh	23 hr.	yellow perch (5 adult, 5 unk.) white sucker (2 juvenile, 4 adult) cisco (3 adult, 9 unk.) walleye (7 adult, 7 juvenile) northern pike (1 adult) lake whitefish (2 adult)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 41\api 41 turtle bay.docx

API #41 PHOTO LOG

Photo 1: Aerial view looking from mouth of API #41, upstream to beaver impoundment.

Photo 2: Beaver impoundment and upstream reach of API #41.

API #41 PHOTO LOG

Photo 3: Mouth of API #41.

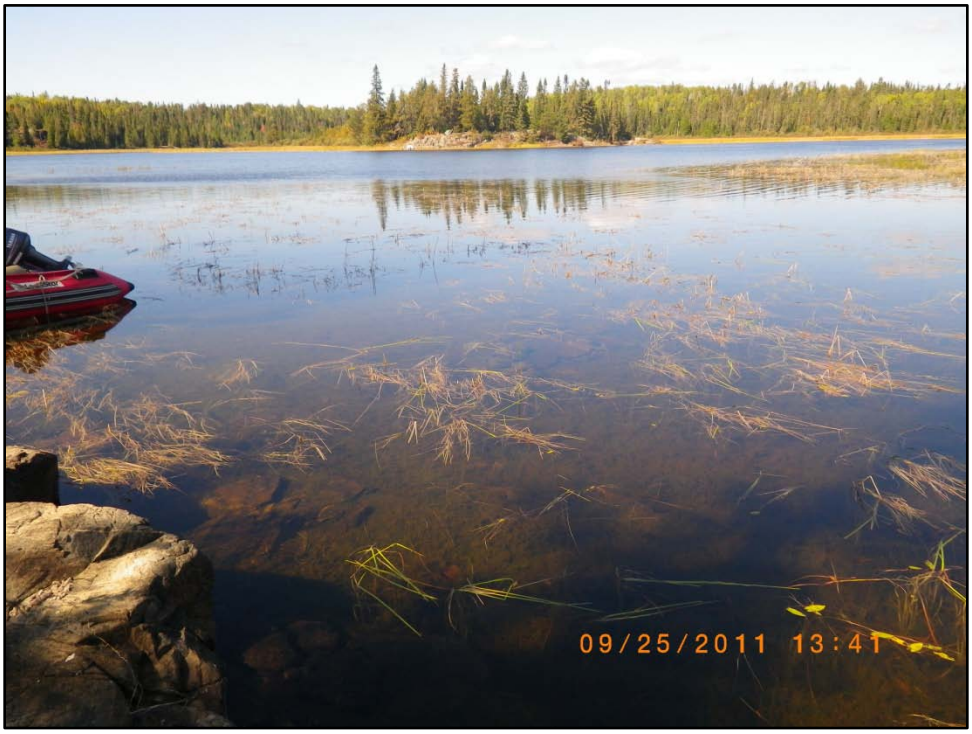


Photo 4: Looking into Turtle bay from the mouth of API #41.

INTERPRETATION OF CATCHMENT Z AQUATICS BASELINE

The shallow bay that API #41 flows into is utilized by a variety of fish species. The lower reach of the stream is accessible to fish from the bay during high water. The upper sections of the stream (i.e. above the first beaver dam) does not support a fish community. No catches of fish were made upstream of the first beaver dam. Due to the relatively small drainage area, 74.8 hectares, and the total length of the stream, 330 m, flow volumes in the stream are likely low year-round. Habitat suitability in the lower reach is primarily a function of reservoir water elevation.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment z interpretation.docx

Catchment A1

CATCHMENT A1

Catchment A1 has a total surface area of 10.17 hectares (Figure 3). The aquatic features in the catchment are a headwater pond (API #69) and an outflowing stream that connects the pond to Lynxhead Bay (Figure 2). The pond is located at the south east tip of the pit (Figure 1). The pond may be destroyed during excavation of the pit. Flows in the stream will be altered if the pond is destroyed and/or if a portion of the catchment is disturbed.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment a1 overview.docx

API # 69 (HEADWATER POND)

API #69 is a partially infilled beaver pond. It has a total surface area of 9,871 m^2, although much of this consists of thick mats of sedges (Figures 69-1 and 69-2). A large open water portion of the pond exists in the southwest end. A seasonal inflow also exists at the south end of pond. Pond elevation is controlled by a 1 m high beaver dam (Photo 1). Maximum water depth in the pond is 2 m, in a discrete section near the dam. Submerged terrestrial vegetation (i.e. mature black spruce) lies along the bottom throughout the pond (Photo 2).

The pond was backpack electroshocked and seine netted in 2011 (Table 1). Finescale dace and northern redbelly dace were captured.

Table 2: API #69, Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location (see Figure 69-1)	Date	Gear	Effort	Catch
345	September 29, 2011	seine net	100 m^2	finescale dace (15 adult)
346	September 29, 2011	backpack electrofisher	80 m	finescale dace (5 adult, 1 juvenile, 3 YOY) northern redbelly dace (6 adult)

DRAFT

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\api 69\api 69 headwater pond.docx

612200 612300 612400

5420800 5420700

N

CF

CF

Sedge/Deadfall

Be

Sedge

CF

Be

Si

Be

Inflow

Be

SV

345

2.0m

346

Be

SV

Be

BD
(1.0m)

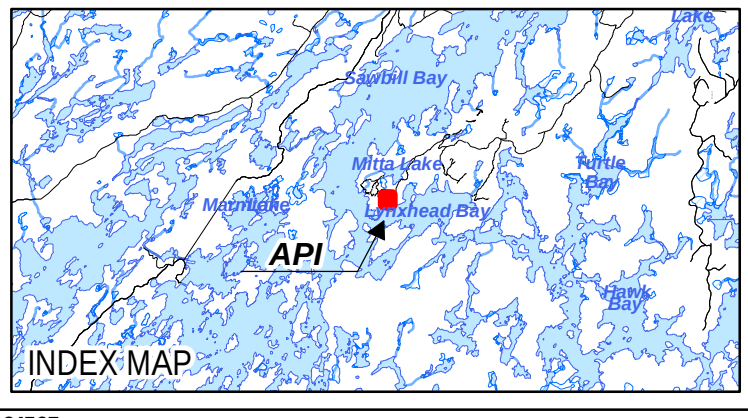
CF

Outflow

612200 612300 612400

25 0 25 50

SCALE 1:1,000 METRES



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Bank Slope
- Steep Slope (31 to 70%)

Riparian Vegetation
CF - Coniferous Forest

Inundated Vegetation
SV - Submergent Vegetation

Substrate Classification
Si -Silt

Bank Features
Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 69
(Headwater Lake)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 69-1	
GIS	DM	12 April 2012		
CHECK	JD	13 April 2012		
REVIEW	JS	--/--/--		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_MapsvAPI_69.mxd

XXXX **Beaver Dam**

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREA OF POTENTIAL IMPACT 69 (POND)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	Apr. 2012	FIGURE: 69-2	
GIS	RRD	Apr. 2012		
CHECK	JD	Apr. 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\Aquatics\LiDAR_Figures.mxd

API #69 (OUTFLOWING STREAM)

This stream channel was altered by drilling activity in the spring of 2011. Although the channel between the headwater pond and Marmion reservoir has been reconstructed, features within the new channel no longer resemble habitat features mapped in 2010 and described in this report.

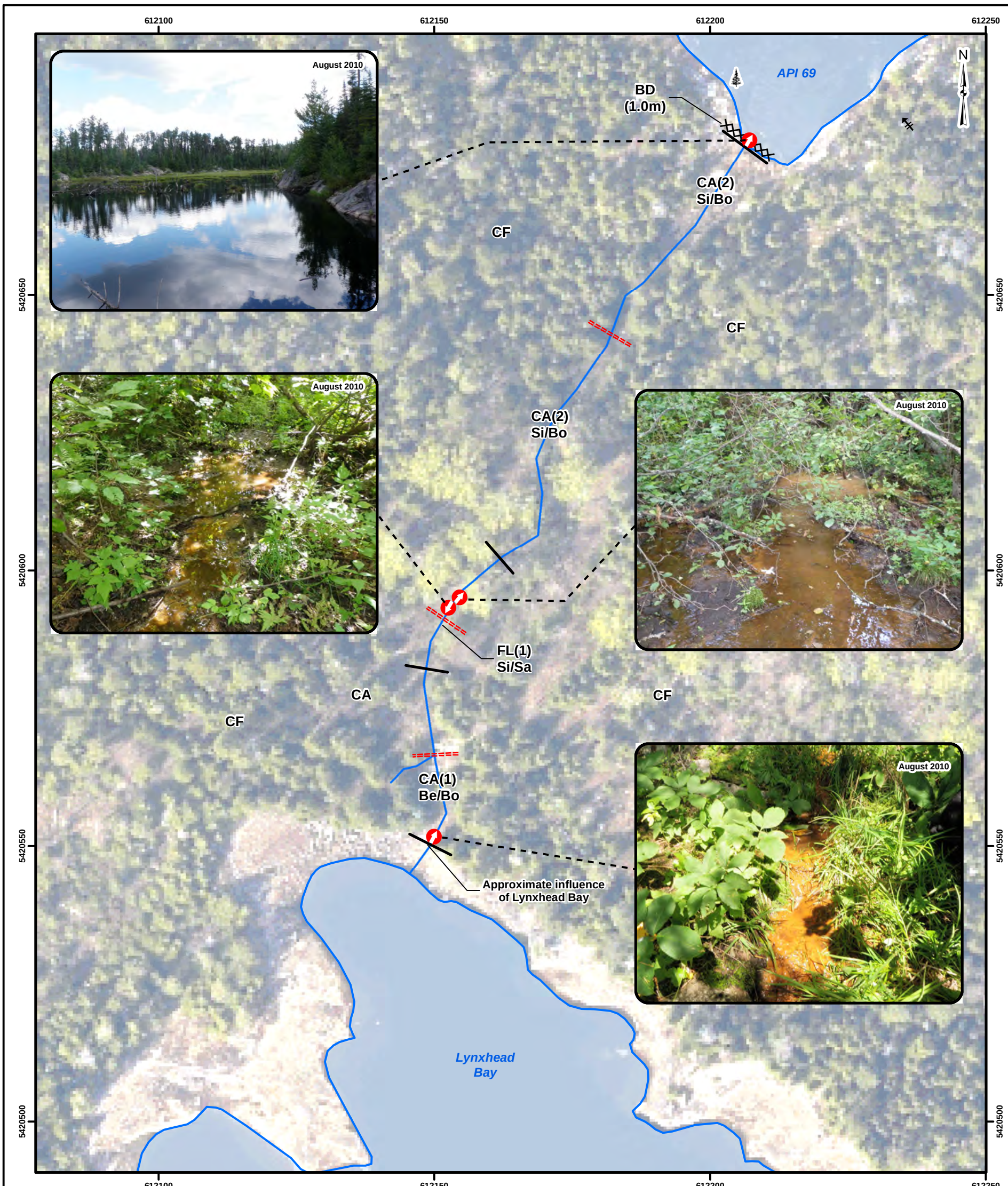
This stream was 157 m in length. Flow in the stream is dependent upon seepage through the beaver dam located at its upstream end. The channel is comprised of two high gradient cascades on either end of flat channel segment (Figure 69-3). The stream flows through dense forest. Channel width is less than 1 m in the cascade segments. Substrate is predominately bedrock near the mouth of the stream and silt in the upper segments. Channel gradient near the mouth is very steep. Water in the channel was a dark brown color, often associated with high concentrations of iron. pH in the stream was 5.73. The stream was not fished. However, no fish were observed in the stream channel in 2010, when the stream was mapped, or in 2011, when the upstream pond was fished.

The mouth of the stream empties into Marmion Reservoir, in a shallow inlet, along the southern portion of the Hammond Penninsula (API #31). The shoreline near the mouth is steep and predominately bedrock (Photos 3 and 4). Aquatic vegetation is sparse in the small inlet. Substrate is predominately silt. The inlet was fished in 2010 (Table 1).

Table 1: API #31 (mouth of stream), Fish Community Assessment (Effort, Gear and Catch Summaries)

Fish Effort Location	Date	Gear	Effort	Catch
248	August 26, 2010	boat electrofisher	400 m	yellow perch (117 juvenile, 171 unk.) northern pike (1 unk.) blacknose shiner (3 adult)
249	August 20, 2010	minnow traps (4)	96 trap hrs.	no catch
250	August 26-27, 2010	gillnet – experimental mesh	14 hrs.	smallmouth bass (2 adult) yellow perch (2 unk.) northern pike (1 adult) walleye (1 adult, 4 juvenile, 5 unk.) white sucker (1 adult)

DRAFT



Segment	Length (m)	Channel Width at Transect (m)	Max. Depth at transect (m)	Substrate		In stream Vegetatio
				Dominant	Sub-dominant	
CA	29.00	0.69	-	Be	Bo	0
FL	32.00	1.57	0.12	Si	Sa	0
CA	96.00	0.64	-	Si	Bo	5

LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Woody Debris
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- Beaver Lodge

Channel Unit Type
CA - Cascade
FL - Flat, Low Gradient, Low Velocity

Bank Slope
← Shallow Slope (0 to 5%)

Substrate Classification
Be -Bedrock
Bo -Boulder
Sa -Sand
Si -Silt

Riparian Vegetation
CF - Coniferous Forest

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 69 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 69-3	
GIS	DM	12 April 2012		
CHECK	JD	13 April 2012		
REVIEW	JS	15 April 2012		

Path: Z:\Projects\2010\10-1118-0020\GIS\MXDs\March_2012\API_Maps\Rivers\API_69b.mxd

API #69 PHOTO LOG

Photo 1: Beaver dam at API #69 outflow and open water portion of the pond.

Photo 2: Northern portion of API #69.

API #69 PHOTO LOG

Photo 3: Small inlet, near mouth of API #69, Marmion Reservior.

Photo 4: Mouth of API #69.

INTERPRETATION OF CATCHMENT A1 AQUATICS BASELINE

API #69 consists of a shallow, partially infilled beaver pond inhabited by finescale and northern redbelly dace. The pond was likely created as a result of beaver activity. This dam still controls the outflow of the pond. Flow in the stream that connects the pond to Marmion Reservoir are dependent upon seepage through this dam. Gradient throughout much of the stream and at its mouth is very steep and it is unlikely fish from the reservoir are able to access the stream. Water in the stream was very acidic, and reddish-brown in color. The stream is not inhabited by fish. The stream channel was mapped prior to the channel being reconstructed in 2011. Habitat conditions described in this report are based upon conditions that existed prior to alteration of the channel.

Despite a lack of instream cover, the area surrounding the mouth of the stream is a shallow inlet used as nursery habitat by a variety of fish species. The shoreline is primarily bedrock and the substrate is silt.

n:\active\2010\other offices\1118 mississauga waste\10-1118-0020 osisko hammond reef\baseline report\catchment a1 interpretation.docx

APPENDIX B

Habitat Preference Tables

DRAFT

FISH HABITAT PREFERENCE TABLES

INTRODUCTION

The draft guidelines for the preparation of the Hammond Reef Mine Project (the Project) Environmental Impact Statement (EIS) requires that habitats for each potentially affected species identified be characterized as spawning, rearing/nursery, feeding, migratory corridor and overwintering/summer refuge habitats (Canadian Environmental Assessment Agency 2011). These habitat classes are proposed for No Net Loss (NNL) Planning and are defined as follows:

- spawning habitat is used by fish for the specific act of reproduction;
- nursery/rearing habitat is used by developing embryos and young-of-the-year (YOY) and sub-adult fish for foraging and refuge from predators;
- feeding habitat is used by adult fish for feeding or periods between feeding events;
- overwintering/summer refugia are used by YOY, sub-adult and adult fish to survive periods of hostile conditions (e.g. flows and water temperature extremes; and
- migratory corridors are used by fish to access important habitats described above.

Fish species considered in this report were identified during baseline studies completed in 2010 and 2011 (Table 1). Habitat suitability relationships describing spawning, rearing/nursery, feeding, migratory corridor and overwintering/summer refuge habitats for each of the species listed in Table 1 were derived using information obtained from published HSI models, technical papers and published literature.

Within each habitat class, information pertaining to habitat characteristics was divided between general information related to the type of habitat and specific information related to both lentic and lotic environments.

For many of the characteristics, strength of association (low, medium, high) between habitat and life stage was assessed in the literature. Definitions between sources were consistent and so where applicable, these strength associations and have been included as part of this review. The following provides a definition for each of the ratings used:

- High – Indicates that a fish species is always or nearly always associated with habitats possessing this character;
- Medium – indicates that a species is frequently or often associated with habitats possessing this character; and
- Low – Indicates a species is sometimes or infrequently associated with habitats possessing this character.

FISH HABITAT PREFERENCE TABLES

Table 1: Fish Species Captured During Baseline Studies

Family/Subfamily	Species Common Name	Species Scientific Name
Coregoninae	Lake Whitefish[1.] Cisco[1.]	*Coregonus clupeaformis* *Coregonus artedi*
Umbridae	Central Mudminnow	*Umbra limi*
Esocidae	Northern Pike	*Esox lucius*
Cyprinidae	Longnose Dace Blacknose Dace Northern Redbelly Dace Finescale Dace Pearl Dace Fathead Minnow Spottail Shiner[1.] Blacknose Shiner Brassy Minnow	*Rhinichthys cataractae* *Rhinichthys atratulus* *Chrosomus eos* *Chrosomus neogaeus* *Semotilus margarita* *Pimephales promelas* *Notropis hudsonius* *Notropis heterolepis* *Hybognathus hankinsoni*
Catostomidae	Common White Sucker	*Catostomus commersoni*
Gadidae	Burbot	*Lota lota*
Gasterosteidae	Ninespine Stickleback Brook Stickleback	*Pungitius pungitius* *Culaea inconstans*
Centrarchidae	Smallmouth Bass Pumpkinseed	*Micropterus dolomieu* *Lepomis gibbosus*
Percidae	Walleye Yellow Perch Iowa Darter	*Sander vitreus* *Perca flavescens* *Etheostoma exile*
Cottidae	Mottled Sculpin	*Cottus bairdi*

FISH HABITAT PREFERENCE TABLES

Table 2: Habitat Preferences, Lake Whitefish (*Coregonus clupeaformis*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Fall broadcast spawner with ideal water temperature range of 0.5 to 7.8 °C; flowing water not required for spawning (7) (11) **Lentic -** Spawning in shallow water over gravel, cobble, boulder and sometimes sand; infrequently over silt and clay substrate with emergent vegetation if slight current present (7) (8) (11) **Lotic -** Spawning from 0-5+m to 30 m over coarse substrates of boulder, cobble, rubble, gravel, sand (4) (7) (8) (11) (13)	**Lotic -** YOY with depth preference of 0-2 m in spring , no seasonal preference from 2-5 m, low association with emergent or submergent vegetation or over in-situ cover (5) (7) Juveniles associated with depths to 10 m with boulder, cobble, rubble and gravel substrate in association with vegetation and woody debris or in pelagic areas (7) (12)	**General -** YOY are initially limnetic feeders, switching to benthic feeding as fish learn local food availability (8) Adults benthic feeders on snails, clams, chironomid larvae and small fish (12)	**Lotic -** In summer, YOY in lotic environments leave shallow inshore waters as water temperature warms and move to deeper pelagic waters at depths of 5-10 m with substrate preference for boulder, cobble, gravel and sand (7) (12) Adults move into shallow waters in the fall to spawn on shoals or rocky ledges and return to deepwater habitat to overwinter (7) (12) Marked onshore movements into shallow water habitats at night, possibly to feed (12)	**General -** Late winter dissolved oxygen levels from 4 to >7 mg/L preferred (13) **Lentic -** associated with low velocity/pool habitat (10) **Lotic -** Typically associated throughout the year with depths of 5+m, below thermocline (6)

FISH HABITAT PREFERENCE TABLES

Table 3: Habitat Preferences, Cisco (*Coregonus artedi*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Fall broadcast spawners at water temperatures of 2 to 5°C with hatch occurring after ice break up (7) **Lentic -** Spawning over a range of depths from1 to 5+ m deep with primary preference for cobble, rubble, gravel or sand; secondary substrate of boulder, silt/clay or hard-pan clay (4) (7) (8) **Lotic -** Lacustrine areas of large rivers with spawning in pools at depths from 1 to 2+ m over boulder, cobble, rubble or gravel substrate (10)	**Lentic -** YOY in 0-2 m of water, in fall from 2 to 5+ m deep over boulder, boulder-cobble, rubble or gravel substrate (5) In spring, juveniles located in habitats of sparse vegetation over rock substrate, in fall in non-vegetated areas over rock (7) **Lotic -** Juveniles associated with pool or run habitats (10)	**General -** Adults feed in the water column on a wide variety of small prey including zooplankton, crustaceans, larval insects, algae and occasionally, small fish (9) Juveniles feed at or near bottom of nearshore areas, at night (8)	**Lentic -** YOY, juveniles and adults move below thermocline (from shallow to deep water) in spring and summer with movement in reverse direction when temperatures cool again (8)	**Lentic -** Adult habitat primarily the pelagic zone of lakes from 5 to 10+ m with late summer movement to just below thermocline and as upper waters cool, into shallower waters (6) (7) **Lotic -** Adults associated with pool or run habitats (10)

FISH HABITAT PREFERENCE TABLES

Table 4: Habitat Preferences, Central Mudminnow (*Umbra limi*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring spawners from mid to late April at water temperature of 13 °C along flooded stream and pond banks where eggs adhere to flooded vegetation (3) (7) **Lentic -** Spawning in 0-1 m in submergent/emergent vegetation (4) (7) **Lotic -** Spawning associated with pool habitat; strong association with flooded terrestrial vegetation (10)	**Lentic -** YOY with depth preference from 0-2 m; substrate preference of silt/clay or muck (organic detritus) and cover preference of submergent/emergent vegetation (7) **Lotic -** Depth preference from 0-0.2m, substrate preference for silt/clay and cover preference for vegetation; turbidity intolerant (10)	**General -** Nocturnal feeder on small crustaceans, insect larvae and molluscs near bottom in vegetation cover (3) (9) **Lentic -** YOY with depth preference from 0-2 m; substrate preference of silt/clay or muck (organic detritus) and cover preference of submergent/emergent vegetation (7) **Lotic -** Depth preference from 0-0.2m, substrate preference for silt/clay and cover preference for vegetation (10)	**General -** YOY move from flooded stream and pond banks back to main water body when approximately 30 mm in length (3)	**General -** Heavily vegetated ponds and pools of small creeks, including those with floating mat shores. Summer habitat of vegetated ponds or pools of small creeks where the bottom has a thick layer of organic material (3) (7) Tolerate of hypoxia and known to take atmospheric oxygen when dissolved oxygen levels are low allowing for survival in isolated pools which may become stagnant and warm (3) (7) Preferred substrate a thick layer of organic material and detritus to escape predation and survive drought **Lotic -** Adults in 0-2 m year round; high association with submergent and emergent vegetation (6)

FISH HABITAT PREFERENCE TABLES

Table 5: Habitat Preferences, Northern Pike (*Esox lucius*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring spawners, in colder areas, after ice break up at water temperatures between 4.4 to 12°C (8) Over flooded terrestrial vegetation in areas of calm, shallow water or weedy bays or backwaters (1) Optimum spawning habitat is a dense mat of flooded emergent vegetation such as sedges, cattails or grasses with a large basal coverage for egg adhesion (2) (3) Substrate preference for silt and sand although spawning-site preference is more related to adequate submergent vegetation (4) (7)	**General -** Shallow, vegetated areas such as flooded marshes, flooded terrestrial vegetation, or weedy bays (1) **Lentic -** Depth preference from 0-2 m in spring, 2-5 m in fall; over substrates of silt, clay or hardpan clay near submergent/emergent vegetation cover; specific preference by YOY for submerged vegetation versus other aquatic vegetation types (2) (5) (7) (8) Juveniles typically found along shorelines with adequate food and cover at depths of <2 m; same substrate preference as YOY, always in association with submergent vegetation (7)	**General -** Day active feeders with preference for ambush cover in the form of aquatic plants, tree stumps, fallen logs (1) YOY initial food preference for invertebrates such as Ephemeroptera, Isopoda, Cladocera with switch to vertebrate prey in fish ≥130 mm; habitat preference for submerged vegetation with rooted aquatic plants to offer cover and increased plankton and therefore the best food supply (2) (3)	**General -** From lakes and rivers up tributaries to flooded marshes, wetlands or shallow pools during spawning (1) **Lentic -** Adults usually found within shallow, vegetated regions of lakes in spring and fall, moving to deeper water as water temperature increases in summer and ice-cover forms in winter (7) (8) Movement by juveniles to areas of emergent vegetation in late summer where dissolved oxygen concentrations higher (3) **Lotic -** Avoidance for strong currents (>1.5 m/s) that can block spawning migrations (1)	**General -** Dissolved oxygen concentration important habitat variable affecting overwinter survival although NRPK more tolerant of low D.O. during winter than other temperate species; optimal temperature preference for adults between 19 and 21°C (1) (7) **Lotic -** Occur more frequently in lakes than rivers; summer habitat limited in some lakes by combination of high surface temperatures and low oxygen concentration in cooler, deeper strata (1) Adults at depths from 0-10 m throughout the year; along margins of vegetated areas or areas with in-situ materials (fallen logs, tree stumps, shoals, boulders) and substrates of mud, silt, or hardpan clay (6) (7)

FISH HABITAT PREFERENCE TABLES

Table 6: Habitat Preferences, Longnose Dace (*Rhinichthys cataractae*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring spawners, eggs settle in and adhere to substrate (4) (9) **Lentic -** Low association in lakes but where found spawning from 0 to 2 m over wave swept inshore areas with gravel, cobble, rubble and/or boulder substrates (4) (7) **Lotic –** Depth from 0-0.2 m over gravel in riffle habitat (10)	**Lentic -** Low association in lakes but where found nursery habitat in inshore shallow areas where YOY utilize overhanging vegetation for cover; juveniles in 0-2 m of water, low association with submergent/emergent vegetation (5) (7) **Lotic -** Juveniles in 0-0.6 m of water with high preference for boulder, cobble, rubble, gravel; low preference for bedrock, sand, silt/clay, detritus; not associated with emergent/submergent vegetation, algae, woody debris; in riffle or rapid habitat(10)	**General -** Night feeder on aquatic insects, worms, crustaceans and molluscs (9)	**Lentic -** Low association in lakes but where found movement off-shore to deeper areas of lakes after ~4 months (7)	**General -** Late winter dissolved oxygen levels of 2 mg/L considered ideal with pH range of 6 to 9 (13) **Lentic -** Low association in lentic environments, where found, adults in 0-2 m of water with preference for rubble, gravel, sand substrate (6) **Lotic -** Adults in 0-0.6 m of water with high preference for boulder, cobble, rubble, gravel; low preference for bedrock, sand, silt/clay, detritus; not associated with emergent/submergent vegetation, algae or woody debris; in riffle or rapid habitat(10)

FISH HABITAT PREFERENCE TABLES

Table 7: Habitat Preferences, Blacknose Dace (*Rhinichthys atratulus*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring spawner in water temperatures between 12 and 27°C; eggs pushed into substrate in shallow riffles, fertilized and guarded by male (9) **Lentic –** Low association with lake spawning but when present in 0-1 m of water with high association for rubble and gravel, medium association for sand (4) **Lotic –** High association for gravel substrate in the fast water of shallow riffles (1) (14)	**Lentic –** Low association with lake habitat for YOY, where present in 0-2 m water with no seasonal preference; high association with silt (5) **Lotic –** Juveniles with depth preference for 0-0.6 m; high substrate association for rubble, gravel, sand, silt/clay substrate, medium for boulder, cobble; low for bedrock; high association for wood, substrate and overhead cover; high association for pool, riffle and run habitat, low turbidity tolerance (10)	**General -** Benthic feeder, primarily aquatic insect larvae and to a lesser extent worms and algae; adults will prey on their own eggs during spawning (9)		**Lentic –** In water from 0-2 m deep with no seasonal preference (6) **Lotic –** Depth preference from 0-0.6 m, with high association for rubble, gravel, sand, silt/clay substrate, medium for boulder, cobble; low for bedrock; cover preference with high association for wood, substrate and overhead cover; velocity preference with high association for pool, riffle and run, low turbidity tolerance (10)

FISH HABITAT PREFERENCE TABLES

Table 8: Habitat Preferences, Northern Redbelly Dace (*Chrosomus eos*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring/summer broadcast spawner on masses of filamentous algae at water temperatures of 21-27°C (3) (4) **Lentic –** High association with lake habitats; high association for water depth of 0-2 m; medium association with gravel substrate, high association with sand and silt substrate; high association with submergent vegetative cover (4.) (7.) Lotic – High association for spawning locations with pool habitat and algae cover (10.)	**Lentic –** YOYs with high association for water depth from 0-2 m; high association for silt/clay and detritus substrate (5) (7) **Lotic –** Juveniles with high association for depth from 0-0.6 m; medium from 0.61 to 1 m; high association for silt and detritus substrates (10)	**Lentic -** Young feed on diatoms, algae, zooplankton and aquatic insects; in wetlands associated with open water marsh/marsh wetland with mixed organic substrates and floating leaved plants (3)	**General –** Adults inhabit depths of <2 m but move into deeper water following a diel migration pattern (6) (7)	**General -** Preference for boggy lakes, creeks, ponds and quiet pool-like expansions of streams over detritus and silt substrates (?) **Lentic –** Adults with high association for water depth of 0-2 m and medium association for 2-5 m; high association with substrates ranging from gravel, sand, silt-clay and detritus; high association with submergent/emergent vegetation (6) (7) **Lotic –** Adults with high association for depth of 0-0.6 m; medium association for 0.61 to 1 m; high association for silt and detritus substrates (10)

FISH HABITAT PREFERENCE TABLES

Table 9: Habitat Preferences, Finescale Dace (*Chrosomus neogaeus*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Late spring at water temperature between 13 and 18 °C, broadcast spawners, often within masses of filamentous algae(4) (7) (9) **Lentic –** High association in lakes at depths from 0-2 m; high association for sand and silt substrate, medium for gravel; cover preference for logs and brush (4) (7) **Lotic –** high association 0.21 to 1 m; high silt/clay and detritus substrate; high wood cover; high pool velocity class (10)	**Lentic –** Medium association in lakes, where present found year round to depths of 2 m; high association with silt substrate; in wetlands associated with open water marsh/marsh wetland with mixed organic substrates and floating leaved plants (3) (5) **Lotic –** High association with depth from 0.6 m; high association with silt/clay and detritus substrate; high association with pool habitat;(10)	**General -** Small molluscs, aquatic and terrestrial insects and algae; in wetlands associated with open water marsh/marsh wetland with mixed organic substrates and floating leaved plants (3) (9)		**General –** Cool heavily vegetated slow moving shallow waters of lakes and streams with bottoms of silt and detritus, often associated with “tea” stained waters (9) **Lentic -** Year round association from 0-5 m; high association with gravel, sand silt substrate; high association with submergent/emergent vegetation cover and logs; (6) **Lotic –** high association with depth from 0.6 m; high association with silt/clay and detritus substrate; high association with pool habitat (10)

FISH HABITAT PREFERENCE TABLES

Table 10: Habitat Preferences, Pearl Dace (*Semotilus margarita*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawner at water temperature between 13 and 18 °C; in northern lakes, spawn in tributary streams or in vegetation on the periphery of lakes in early spring, about the time of spring melt and ice-off occurs (3) (11) **Lentic –** Low lake affinity but where found in 0-1 m water, high association with gravel and sand substrate; in beaver ponds and small lakes typically over soft organic substrates; low association with submergent/emergent vegetation (4) (11) **Lotic –** High association with depth from 0.6-1.0 m; high association with gravel, sand substrate; high association with riffle habitat (10)	**Lentic –** YOY from 0-2 m deep year round; low association with emergent/submergent vegetation (5) **Lotic –** High association with gravel, sand, silt/clay substrate; medium boulder, cobble, rubble and detritus, low bedrock; high association with vegetative cover; high association with pool habitat, medium with run habitat, low with riffle habiatat; turbidity intolerant (10)	**General –** filamentous algae, small crustaceans, larval aquatic insects, molluscs and terrestrial insects that fall in the water; in wetlands in open water marshes with mixed organic substrate and floating leaved plants (3) (9)		**Lentic –** Low lake association but where found in 0-2 m water year round, high association with gravel, sand, silt substrate, medium with rubble low association with emergent/submergent vegetation; (6) **Lotic –** High association with gravel, sand, silt/clay substrate; medium with boulder, cobble, rubble, detritus, low with bedrock; high association with vegetative cover; high association with pool habitat, medium with run, low with riffle; turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 11: Habitat Preferences, Fathead Minnow (*Pimephales promelas*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawner in water temperatures of 16 to 29 C, nest builders under rock or wood (4) (9) **Lentic –** Medium association with lakes; high association for depth from 0-2 m; medium association for gravel, high rubble, sand and silt substrate; medium association for submergent/emergent vegetation; high association for overhead and in-situ cover (4) (7) (12) **Lotic –** High association for depth from 0.61-1.0 m; high association for wood, substrate and overhead cover; high association for pool habitat, turbidity tolerant, substrate irrelevant, except when it includes stones under which eggs may be laid (10)	**Lentic –** YOY medium association with lakes; high association with depths from 0-2 m; medium to high association with sand, silt/clay substrate; medium association with submergent/emergent vegetation; Juveniles, high association with depth from 0-2 m, low from 2-5 m; medium association with cobble, rubble, sand, silt/clay substrates, low with gravel; medium association with emergent vegetation and in-situ cover, high with no cover (5) (7) (12) **Lotic –** High association with depth from 0-0.6 m; high association for cobble, rubble, gravel, sand, silt/clay substrates; medium for boulder, detritus; low for bedrock; high association with pool and run habitat, turbidity tolerant (10)	**General –** feed on algae, organic detritus, aquatic insect larvae and zooplankton; in wetlands associated with open water marsh and marsh of mineral, organic or mixed substrate and submergent vegetation (3)		**Lentic –** Medium to high association with lakes; high association for depth from 0-2 m, low from 2-5 m; medium association with cobble rubble substrate, high for gravel, sand, silt/clay; high association for submergent/emergent vegetation, no cover and in-situ cover (6) (7) **Lotic –** High association with depth from 0-0.6 m; high association for cobble, rubble, gravel, sand, silt/clay substrate; medium for boulder, detritus; low for bedrock; high association for pool and run habitat,, turbidity tolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 12: Habitat Preferences, Spottail Shiner (*Notropis hudsonius*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spawning over open sand or gravel shoals in clear, cold or cool lakes and likely occurs in similar fashion in rivers (3) (4) (9) **Lentic –** Medium to high association with lakes; high association for depth from 0-2 m, medium from 2-5+ m; high association for gravel, sand substrate, medium to high for cobble, rubble substrate; medium to high association for submergent/emergent vegetation cover (4) (7) (8) (12) **Lotic –** High association for rubble, sand substrate; high association for pool, riffle, run habitats (10)	**Lentic –** YOY and juvenile with medium to high association for lake environment. YOY at depths from 0-10+ m with high association for rubble, cobble, gravel, sand substrate, medium for silt/clay; high association for submergent/emergent vegetation. Juveniles at depth to 2 m; with medium association for cobble and gravel substrates, high for sand, silt/clay; medium association for pelagic areas; medium association for submergent vegetation or no cover, high for emergent vegetation (5) (7) (12) **Lotic –** High association for depths from 0-1 m; high association for gravel, sand substrates; high association for vegetative cover; high association for pool and riffle habitat, turbidity intolerant (10)	**General –** Plankton, aquatic insect larvae(especially Chironomidae and Emphemeroptera), algae, crustaceans, eggs, young fish within open water marsh or marsh with mineral substrate and emergent vegetation (3)	**General –** Known observations of spottail shiner migrating short distances up tributary streams to spawn in riffle areas (10)	**Lentic –** Medium to high lake association; year round at depths of 0 to 10+ m; medium association for cobble, rubble, silt/clay substrate, high for gravel, sand, medium association with pelagic areas; medium association for in-situ cover and medium to high association for submergent/emergent vegetation(6) (7) (8) (12) **Lotic –** High association for depth from 0-1 m; high association with gravel, sand substrates; high association with vegetation cover; high association for pool and riffle habitat, turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 13: Habitat Preferences, Blacknose Shiner (*Notropis heterolepis*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
Lentic – High association with lake environs at depths from 0-1 m; medium association for gravel substrate, high for sand; high association with submergent/emergent vegetation (4) (7) **Lotic –**high association with sand substrate (10)	**Lentic –** High association with lakes; YOY and juveniles at depth from 0-2 m; medium association with silt substrate, high for gravel sand; high association for submergent /emergent vegetation (5) (7) **Lotic –** High association for depths from 0-0.6 m; high association with gravel, sand substrates; high association with vegetation cover; high association with pool habitat, turbidity intolerant (10)	**General –**Cladocera, insects and green algae off of aquatic plants in open water marsh/marsh with mixed mineral and organic substrate (3)		**Lentic –** High association with lakes; year round at depths from 0-2 m; high association with gravel, sand substrate; high association with submergent and emergent veg. cover (6) (7) **Lotic –** High association with depths from 0-0.6 m; high association with gravel, sand substrate; high association with vegetation cover; high association with pool habitat, turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 14: Habitat Preferences, Brassy Minnow (*Hybognathus hankinsoni*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring broadcast spawner in shallow areas depositing eggs near or on vegetation at water temperature of 10 to 13 °C (3) (8) **Lentic –** At depths from 0-1 m; medium association with gravel substrate, high with sand, silt/clay; medium to high association for submergent /emergent vegetation cover, high for in-situ cover (4) (7) **Lotic –** High association for silt/clay substrate; high association for pool habitat, turbidity intolerant (10)	**Lentic –** Low lake association.; YOY and juvenile with medium association at depths from 0-2 m; low association for rubble substrate, medium to high for gravel, sand, silt/clay; medium association with submergent/emergent vegetation cover for juveniles (5) (7) **Lotic –**High association for depths from 0-2 m; high association for gravel, sand, silt/clay substrates; medium for cobble, rubble; low for bedrock, boulder, detritus; high association for pool habitat (10)	**General –** In schools feeds on aquatic insect larvae, tiny crustaceans and algae from the bottom; associated with open water marsh, marsh and meadow marsh with mixed mineral or organic substrates and submergent/emergent vegetation (3) (9)	**General –** Schools often use shallow, flooded ground where water temperature is warmer than in deeper pools or channels, especially in late summer; return to main water body when temperature relationship is reversed (3)	**General –** Inhabit small, slow flowing weedy creeks, cool, acidic, boggy streams and shallow lakes (8) **Lentic –** Low lake association but where found at depths from at 0-2 m year round; medium to high association for gravel, sand, silt/clay substrate; medium association for submergent and emergent vegetation cover (6) (7) **Lotic –**At depths from 0-2 m; high association with gravel, sand, silt/clay substrates; medium with cobble, rubble; low with bedrock, boulder, detritus; high association with pool habitat (10)

FISH HABITAT PREFERENCE TABLES

Table 15: Habitat Preferences, Common White Sucker (*Catostomus commersoni*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spawning occurs in spring at water temperatures from 6 to 23 °C, broadcast spawning over sand or gravel in streams or along lake margins and shoals, with eggs adhering to the substrate (3) (4) Spawning habitat in inlets, outlets, small creeks and rivers with relatively swift shallow waters running over a gravel bottom. Stream populations reach maximum abundance in low to moderate gradient streams (15) **Lentic –** Low to medium association for lakes at depths from 0-2 m; medium association with rubble, and sand substrate, high for gravel; low association with submergent/emergent vegetation (4) (7) (12) **Lotic –** High substrate association with rubble and gravel, turbidity tolerant (10) (15)	**General –** Larvae 10-12 mm remain among sand and gravel in shallow water; 12-17 mm larvae feed at surface in moderate current, often in association with water weed (3) **Lentic** – YOY and juveniles with year round association at depths from 0-5 m; low association with boulder/cobble substrate, medium with silt, high with sand; high association with submergent vegetation (5) (7) (12) **Lotic –** Juveniles with high depth association from 0 - 0.6 m; low substrate association for boulder and rubble, medium for cobble, gravel, sand and detritus, high for bedrock and silt/clay; low cover association with substrate, medium for vegetation and high for wood and overhead cover; high association for riffle and run habitat (10)	**General –** Sac-fry feed on surface associated zooplankton, after yolk absorption to benthic organisms such as chironomids and fingernail clams, juveniles feed primarily on benthic organisms, adults on amphipods, gastropods and large immature aquatic insects (15). In wetlands consists of open water marsh with mixed mineral and organic substrates(3) (9)	**General –** Upstream spawning migration in spring to early summer, from lentic systems or stream pools to spawning riffles when daily maximum water temperature reaches 10°C (15)	**General –** Broad temperature tolerance with optimal summer temperature of 24°C (15) **Lentic –** Adults with medium lake presence and year round association for depths from 0-10+ m; low association for bedrock, boulder, cobble and silt; medium for rubble, high for gravel and sand; medium association with emergent vegetation, high for in-situ cover (6) (7) (12) **Lotic** – Adults with high depth association from 0-1.0 m; low substrate association for bedrock, boulder, cobble and silt/clay, medium for rubble and high for gravel, sand; high cover association with wood; high velocity association for pool and run, turbidity tolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 16: Habitat Preferences, Burbot (*Lota lota*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Winter broadcast spawners at water temperatures from 1-10 °C (4) **Lentic –** High association for lakes at depths from at least 0-5 m; medium association for sand and silt substrate, high for boulder, cobble, rubble and gravel; (4) (7) **Lotic –** High association for depth from 1 to >2 m; high substrate association with gravel and sand (10)	**Lentic –** YOY with high lake presence, in spring from 0-5 m, 5+ m in fall; YOY and juveniles with medium to high association for boulder, cobble, rubble, gravel and sand; medium association with submergent/emergent vegetation and overhead cover, high for in-situ cover (5) (7) **Lotic –** Juveniles with medium substrate association for boulder, cobble, gravel, silt/clay, high association for rubble and sand substrate; medium cover association for vegetation, high for wood; high association with pool and run	**General –** Forages at night on bottom for crustaceans and a wide variety of fishes (9)	**General** – Increased flow of water and oxygenation of eggs in riverine enviro. May influence tributary spawning migrations in lacustrine populations (12)	**Lentic –** Adults with high lake presence at depths from 5 to 10+ m year round; medium association with rubble and gravel, high with bedrock, boulder, cobble, sand, silt /clay and muck; medium association with submergent/emergent vegetation, overhead or no cover; high association with in situ cover(6) (7)

FISH HABITAT PREFERENCE TABLES

Table 17: Habitat Preferences, Ninespine Stickleback (*Pungitius pungitius*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawners at water temperatures from 9-17 °C, nest builders (4) **Lentic –** High association in lakes at depths from 0-5+m;medium association with cobble, sand and silt substrate, high for rubble and gravel; high association with submergent/emergent vegetation cover, and between rocks; (4) (7) **Lotic –** High substrate association for rubble; high cover association (10)	**Lentic** – YOY and juveniles with high lake presence; in spring from 0-2 m, in fall from 2 to 5+ m; low association with gravel substrate, high with cobble, rubble, sand and silt/clay; medium association with submergent /emergent vegetation and in-situ cover (5) (7) **Lotic** – High cover association for submerged vegetation and algae; high association for pool and run habitat	**General –** Feed on aquatic insects, crustaceans, fish eggs and fry in wetlands of open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3)		**Lentic –** Adults with high lake presence in summer at depths from 0-2 m, 2-10+ m year round; low association with gravel substrate, medium with pelagic zone, high with cobble, rubble, sand, silt/clay, hard-pan clay; medium association with submergent /emergent vegetation and in-situ cover medium association with gravel substrate, high with sand and silt; high association for submergent vegetation; (6) (7)

FISH HABITAT PREFERENCE TABLES

Table 18: Habitat Preferences, Brook Stickleback(*Culaea inconstans*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General –Spring spawners at water temperature of 8-19 °C in shallow water where they construct a nest of grass, green algae or reeds (3) (4) **Lentic –** High association with lakes at depths from 0-1 m; medium association with gravel substrate, high for sand and silt; high association with submergent/emergent cover and sticks (4) (7) (12)	**Lentic -** YOY and juveniles with medium to high presence in lakes; in spring from 0-2 m, in fall from 2 to 5+ m; high association with gravel substrate, medium with sand and silt/clay; medium to high association with submergent/emergent vegetation; (5) (7) (12) **Lotic –** Juveniles with medium association for depth from 1.0 to 2.0 m, high from 0 to 1.0 m; low substrate association for bedrock and detritus, medium for boulder, cobble, rubble, high for gravel, sand and silt/clay; high cover association for vegetation; high association for pool and run habitat, turbidity intolerant	**General –** Feed on aquatic insects, larvae and small crustaceans, fish eggs and fry, snails, worms and algae in wetlands of open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3)		**Lentic –** Adults with high lake presence in summer at depths from 0-2 m, 2-10+ m year round; Low association for muck and clay, medium for rubble substrate, high for gravel, sand and silt; medium association for in-situ cover, high for submergent /emergent vegetation; (6) (7) (12) **Lotic -** ; Medium association for depth from 1.0 to 2.0 m, high from 0 to 1.0 m Low substrate association for bedrock and detritus, medium for boulder, cobble, rubble, high for gravel, sand and silt/clay high association for pool and run habitat, turbidity intolerant, turbidity

FISH HABITAT PREFERENCE TABLES

Table 19: Habitat Preferences, Smallmouth Bass (*Micropterus dolomieu*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawners at water temperature from 13-24 °C, nest builders (4) **Lentic –** high association for lakes at depths from 0-2 m; medium association for bedrock, and sand substrate, high for rubble, and gravel; low association with submergent/emergent vegetation; with boulders, docks and logs; (4) (7) **Lotic –** High association for depth from 0.21 to >2 m; high association for rubble, gravel and sand	**Lentic –** YOY and juveniles with high presence in lakes at depths from 0-2 m in spring and 2-5+ m in fall; low association with silt substrates, medium with bedrock, gravel, sand, high with boulder and boulder/cobble;low association with submergent/emergent vegetation, medium with in-situ cover (5) (7) **Lotic –** Juveniles with low depth association from 0 to 0.2 m, medium from 0.21 to 0.6 m, high from 0.61 to >2.0 m; medium substrate association for gravel, high for boulder and cobble; high association for wood, substrate and overhead cover; high association for pool habitat, turbidity intolerant (10)	General – Feed on crayfish, aquatic insects, fish, tadpoles, frogs and plant material in wetlands of open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3) (9)		**Lentic –** Adults with high lake presence at depths from 0-2 m in summer, 2-10 m year round; low association with sand substrate, medium with hard-pan clay, high with boulder, cobble, rubble and gravel; low association with submergent/emergent vegetation, medium with in-situ cover (6) (7) **Lotic -** Adults with low depth association from 0.2 to 0.6 m, medium from 0.61 to 1.0 m, high from 1.0 to >2.0 m; low substrate association with sand, silt/clay and detritus, medium for bedrock and high for boulder, cobble, rubble and gravel; high association for wood, substrate and overhead cover; high association for pool and riffle habitat, turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 20: Habitat Preferences, Pumpkinseed (*Lepomis gibbosus*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spawning in late spring/early summer at water temperatures of 13-24°C in shallow inshore waters of ponds, lakes or slow moving rivers at depths from 0.15-0.30 m, nest builders using rocky, sandy or clay substrates, near or in submergent vegetation (3) (4) **Lentic –** High association with lakes at depths from 0-2 m; medium association with clay substrate, high for gravel and sand; high association with submergent/emergent vegetation cover; (4) (7) **Lotic –** Medium association with depth from 0-0.21 m, high for 0-0.2 m; high substrate association for gravel, sand, silt/clay and detritus	**General** – Often show distinct habitat segregation according to age class with younger fish amongst denser vegetation (3) **Lentic –** YOY and juveniles with high lake presence; year round at depths from 0-2 m; high association with sand and silt substrate; high association with submergent/emergent vegetation and overhead cover (5) (7) **Lotic –** Juveniles with high depth association from 0 to 1.0 m; low substrate association for bedrock, hard-pan, detritus, medium association for cobble, rubble and high association for gravel, sand, silt/clay; high cover association for vegetation and wood; high association for pool habitat, turbidity intolerant	**General** – Feed primarily on invertebrates living on aquatic plants although molluscs, small fish and aquatic vegetation also eaten; in wetlands in open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3) (9)		**Lentic –** Adults with high lake presence at depth of 0-2 m year round; low association with rubble substrate, medium for gravel, high for sand and silt; high association with submergent/emergent vegetation; (6) (7) **Lotic –** Adults with high depth association from 0 to 1.0 m; low substrate association for bedrock, hard-pan, detritus, medium association for cobble, rubble and high association for gravel, sand, silt/clay; high cover association for vegetation and wood; high association for pool habitat, turbidity intolerant

FISH HABITAT PREFERENCE TABLES

Table 21: Habitat Preferences, Walleye (*Sander vitreus*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General –Spring broadcast spawner at water temperatures from 4-12 °C, at night, on windswept, coarse gravelly to boulder shoals of lakes after ice-out, or in rocky riffles and rapids of rivers. Homing behaviour for repeat spawning locations has been reported in the literature (3) (16) (18) Submergent vegetation is rarely used for spawning but may be used, along with other types of substrate if gravel-rubble is not present (17) (18) **Lentic –** Medium association for lakes at depths from 0-5+ m; low to high association with bedrock, boulder, cobble, rubble, gravel, sand and hard-pan clay substrates; low to medium association with submergent/emergent vegetation; spawning locations have sufficient exchanges or movements of water to permit adequate oxygen supply to developing embryo (4) (7) (12) (18) **Lotic –** Medium association for depth from 0.2 to 0.6 m, high from 0.61 to 1.0 m; high substrate association for cobble and rubble ; many spawning sites are below barriers of some sort (either natural or man-made) spawning locations have sufficient exchanges or movements of water to permit adequate oxygen supply to developing embryo (10) (17) (18)	**General –** Inshore areas important as nursery habitat for YOY; strong schooling tendencies and often associated with Yellow Perch; (12) (17) (18) **Lentic –** YOY and juveniles with high lake presence; in spring at depths from 0-5 m, in fall from 5+ m; medium association with boulder, cobble substrate, high with gravel, sand, YOY also with muck, hard-pan clay and pelagic zone; medium association with submergent/emergent vegetation (5) (7) (12) (17) **Lotic –** Juveniles with low depth association from 0 to 0.6 m, medium 0.61 to 1.0 m, high from 1.0 to >2.0 m; low substrate association for boulder and detritus, medium association for cobble and rubble, high for gravel and sand; high cover association for vegetation, wood and substrate; medium association with run habitat, high with pool, turbidity intolerant (10) (17)	**General –** Fry eat zooplankton and aquatic insects before switching to fish at 1.5 to 2.5 cm in length; diet of juveniles and adults consists primarily of fish and to lesser extent on aquatic invertebrates such as mayfly larvae and crayfish(3) (9) (16) (18) Feeding occurs near or at the bottom In wetlands in open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation although not preferred habitat (3)	**Lentic –** YOY with movement pattern towards the bottom at depths of 3-9 m in late summer; larval movement and dispersion influenced by lake currents, prevailing winds and wave action (3) (17) Adults in lakes often migrate up rivers to spawn (16) **Lotic –** The drift of larvae fish has been documented in several river systems (17)	**General -** d **Lentic –** Adults with high lake presence at depths from 0-5 m year round, 5-10 m in summer; low association for hard-pan clay, medium for boulder, cobble and silt, high for rubble, gravel, sand, silt/clay and muck; low association with submergent/emergent vegetation, high overhead and in-situ cover (6) (7) (12) **Lotic –** Adults with low depth association from 0 to 0.6 m, medium 0.61 to 1.0 m, high from 1.0 to >2.0 m; low substrate association for boulder and detritus, medium association for cobble and rubble, high for gravel and sand; high cover association for vegetation, wood and substrate; medium association with run habitat, high with pool, turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 22: Habitat Preferences, Yellow Perch (*Perca flavescens)*

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring broadcast spawner at water temperatures from 7-22 °C (4) **Lentic –** High association with lakes at depths from 0-5+ m; medium association for rubble, silt/clay substrate, high for gravel and sand; medium association with submergent/emergent vegetation; (4) (7) **Lotic –** High association for depth from 0.21 to >2 m; high substrate association for gravel and sand (10)	**Lentic –** YOY and juveniles with high lake presence; in spring at depths from 0-5 m, 5+ m in fall; medium to high association with cobble rubble, gravel, sand and silt substrate; medium to high association with submergent/emergent vegetation, high with pelagic zone, YOY with medium association to overhead and in-situ cover (5) (7) **Lotic –** Juveniles with high depth association from 0 to 1.0 m;	**General –** Yellow Perch will occupy holes in dense vegetation and ambush prey; in wetlands feed in open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3)		**Lentic –** Adults with high lake presence at depths from 0-10+ m year round; low association with bedrock, boulder, cobble, rubble and clay, medium with gravel, high with sand, silt and muck; high association with submergent/emergent vegetation; (6) (7) **Lotic –** Adults with high depth association from 0 to >2.0 m; low substrate association with detritus, medium association with boulder, cobble, rubble and silt/clay, high association for gravel, sand; medium cover association for wood, high for vegetation; high association with pool habitat, turbidity intolerant

FISH HABITAT PREFERENCE TABLES

Table 23: Habitat Preferences, Iowa Darter (*Etheostoma exile)*

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring broadcast spawner at 12-15 °C in shallow waters near shore of lakes and streams on bottom organic debris, aquatic vegetation or fibrous root material; on sand or on organic material on sand when no undercut bank available (3) (4) (9) (14) **Lentic –** Medium association for lake environments in depths of 0-1 m; high association for rubble, gravel, sand and silt substrates (4) **Lotic –** High association for depth of 0.2-0.6 m; high association for gravel, sand substrate; high association for vegetation and overhead cover; high association for pool habitat (10)	**General -** Larval fish use pools 0.9-1.2 m deep (3) **Lentic –** YOY with medium association for lakes at depths from 0-5 m year round; high association for gravel, sand, silt substrate; medium association with submergent vegetation (5) **Lotic –** High association for depth of 0-0.61 m; high association for gravel and sand substrates, medium association for silt/clay and detritus, low for bedrock and boulder; High cover association for vegetation and algae; high association for pool habitat; low turbidity tolerance (10)	**General –** Bottom feeder on insect larvae of midge and mayfly, small crustaceans including amphipods, copepods and cladocerans; molluscs (3) (9) (14) **Lentic –** Wetland habitats of open water marsh and marsh with mixed mineral or organic substrates and submergent, floating, emergent vegetation (3)		**General –** Clear standing or slow moving waters of ponds, lakes or rivers at depths of<1.5 m (3) **Lentic –** Low association for lake environs, where found year round association at depths from 0-5 m; high association for gravel, sand, silt substrate; medium cover association for submergent vegetation; (6) **Lotic –** High association for depth from 0-0.6 m; high association for gravel, sand, medium silt/clay, detritus substrates; low for bedrock and boulder; high cover association for vegetation and algae; high association for pool habitat, low turbidity tolerance (10)

FISH HABITAT PREFERENCE TABLES

Table 24: Habitat Preferences, Mottled Sculpin (*Cottus bairdi*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring spawners at temperatures from 6-16 °C; nest builders (4) **Lentic –** Medium association with lake environments, where present in 0-1 m of water under rocks and logs; high association with boulder, cobble, rubble, gravel, sand, silt/clay substrates (4) (7) (11) **Lotic –** High association with depths from 0-0.2 m; high association with rubble or gravel substrates, medium with sand and silt/clay; high association for substrate and overhead cover (10)	**Lentic –** YOY typically inhabit 0-2 m, up to 5+ m in some cases with high association for boulder, cobble, rubble substrate, medium for gravel and sand; juveniles associated with substrates of boulder, rubble and sand and use in-situ cover under rocks and logs in littoral zone from summer through fall (5) (7) **Lotic –** Juveniles with high association for depth from 0-0.6 m; high association for gravel, sand, silt/clay substrates; medium for boulder, cobble, rubble, low for bedrock and detritus; high association with instream vegetation, substrate and overhead cover; high association for pool and riffle habitat (10)	**General -** Bottom substrates, feeds on aquatic insect larvae and occasionally worms and small crustaceans of streams and lakes (9) **Lentic –** at night in open sandy areas (11)		**General -** Intolerant of high water temperatures, occupy an average temperature of approx 17 °C **Lentic –** High association for depth from 0-2 m; high association for boulder, gravel, sand substrate; high association with use of substrate for cover (6) (7) **Lotic –** Adults with high association for depths from 0-0.6 m; high association for gravel, sand, silt/clay substrate; medium for boulder, cobble, rubble, low for bedrock and detritus; high association with instream vegetation, substrate and overhead cover; high association for pool and riffle habitat (10)

REFERENCES CITED

1 Inskip, P.D. 1982. Habitat suitability index models: Northern Pike. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.17. 40 p.

2 Holland, L.E. and M.L. Huston. 1984. Relationship of young-of-the-year Northern Pike to aquatic vegetation types in backwaters of the upper Mississippi River. North American Journal of Fisheries Management 4:514-522.

3 Hall-Armstrong, J, A.G. Harris and R.F. Foster. 1996. Fish use of wetlands in Northwestern Ontario: a literature review and bibliography. Northwest Sci. & Technol., Ont. Min. Natur. Resour., Thunder Bay, Ont. TR-90. 54 pp+.

4 Lane, J.A., C.B. Portt and C.K. Minns. 1996. Spawning habitat characteristics of Great Lakes fishes. Can. MS Rep. Fish. Aquat. Sci. 2368: v+48p.

5 Lane, J.A., C.B. Portt and C.K. Minns. 1996. Nursery habitat characteristics of Great Lakes fishes. Can. MS Rep. Fis. Aquat. Sci. 2338: v+42p.

6 Lane, J.A., C.B. Portt and C.K. Minns. 1996. Adult habitat characteristics of Great Lakes fishes. Can. MS Rep. Fis. Aquat. Sci. 2358: v+43p.

7 Langhorne, A.L., M. Neufeld, G. Hoar, V. Bourhis, D.A. Fernet, and C.K. Minns. 2001. Life history characteristics of freshwater fishes occuring in Manitoba, Saskatchewan, and Alberta, with major emphasis on lake habitat requirements. Can. MS Rpt. Fish. Aquat. Sci. 2579:xii+170p.

8 Roberge, M., T. Slaney and C.K. Minns. 2001. Life history characteristics of freshwater fishes occurring in British Columbia with major emphasis on lake habitat requirements. Can. MS Rpt. Fish. Aquat. Sci. 2574: i + 41 p.

9 Holm, E., N.E. Mandrak and M.E. Burridge. 2009. The ROM field guide to freshwater fishes of Ontario. Royal Ontario Museum, Friesens Printers , Altona, MB. 462p.

10 Portt, C.B., G. Coker and C.K. Minns. 1999. Riverine habitat characteristics of fishes of the Great Lakes watershed. Can. MS Rpt. Fish. Aquat. Sci. 2481:vi+62p.

11 Bradbury, C. M., M. Roberge and C.K. Minns. 1999. Life history characteristics of freshwater fishes occurring in Newfoundland and Labrador, with major emphasis on lake habitat characteristics. Can. MS Rep. Fish. Aquat. Sci. 2485:vii+150p.

12 Richardson, E.S., J.D. Resit and C.K. Minns. 2001. Life history characteristics of freshwater fishes occurring in the Northwest Territories and Nunavut, with major emphasis on lake habitat characteristics. Can. MS Rep. Fish. Aquat. Sci. 2569:vii+146p.

13 Fish Species Habitat Suitability Index Models for the Alberta Oil Sands Region (Golder 2008).

14 Scott, W.B. and E. J. Crossman, 1973. Freshwater fishes of Canada. Bulletin 184, Fisheries Research Board of Canada, Ottawa, ON. xviii + 966p.

15 Twomey, K.A., K.L. Williamson and P.C. Nelson. 1984. Habitat suitability index models and instream flow suitability curves: White Sucker. U.S. Fish Wildl. Serv. FWS/OBS-82/10.64. 56 pp.

16 McMahon, T.E., J.W. Terrell, and P.C. Nelson. 1984. Habitat suitability information: Walleye. U.S. Fish Wildl. Serv. FWS/OBS-82/10.56. 43 pp.

17 Kerr, S.J., B.W. Corbett, N.J. Hutchinson, D. Kinsman, J.H. Leach, D. Puddister, L. Stanfield and N. Ward. 1997. Walleye habitat: A synthesis of current knowledge with guidelines for conservation. Pecid Community Synthesis, Walleye Habitat Working Group, Ontario Ministry of Natural Resources, Peterborough, Ontario. 82 p.

18 Colby, P.J., R.E. McNicol and R.A. Ryder. 1979. FAO Fish. Synop. Synopsis of biological data on the walleye, *Stizostedion v. vitreum* (119): 139 p.

APPENDIX C

Definitions for Fish Habitat Mapping Variables

DRAFT

Lake Habitat Mapping

Limnetic Zone: The open-water region of a lake that is too deep to support rooted aquatic vegetation.

Littoral Zone: The shallow area of a lake that extends from the waterline to the lakeward limit of rooted aquatic vegetation.

Macrophytes: Macrophytes are aquatic plants which are large enough to be seen with the unaided eye, as opposed to phytoplanktonic organisms. Macrophytes are specifically adapted to aquatic habitats, growing either in the water or along the margins of waterbodies. Flooded terrestrial vegetation does not qualify. There are two basic types of macrophytes which are distinguished when habitat mapping lakes; emergent and submergent macrophytes.

> ***Emergent Macrophytes:*** Macrophytes which grow in wet or boggy areas or which are rooted in water but extend above the water surface. Typical examples include Cattails, Bulrushes and Sedges.
>
> ***Submergent Macrophytes:*** Macrophytes which are rooted and which grow under the water. This includes floating-leaved aquatic plants and plants which may have flower stalks that extend above the surface. Typical examples include pondweeds, Coontail and water lily.

Pinnacle: A small, isolated point of lake bottom which is exposed above the water line and surrounded by a shoal. Can be thought of as a very small island or a shoal which has a small portion above water.

Shelf: Frequently observed in deep lakes; it is the area of the bottom located near shore, between the waterline and the drop-off. The distance between these points can be highly variable. In areas of shallow bottom slope, the shelf may be extensive, whereas, in areas of steep bottom slope the shelf may not exist. In deep, clear lakes, the shelf is typically the primary area that is habitat mapped since the bottom is visible and characteristics of substrate, cover and vegetation can be recorded.

Shoal: A shallow but submerged area isolated from the shorelines of a lake. Can be composed of a variety of materials depending upon regional geology. May be “clean” (free of fines) if shallow enough to be affected by wave action and may have a significant potential to provide spawning habitat. Therefore, shoal areas in large, deep lakes receive particular attention during habitat mapping.

Slope: The change in vertical height relative to the change in horizontal distance. For lakes, this measurement describes the steepness of the shoreline above and below the water surface.

> ***Bottom Slope:*** The slope of the lakebed on a line perpendicular to shore, from the waterline to the lakeward side.
>
> ***Shore Slope:*** The slope of the lake shore immediately above the waterline.

Substrate: The material which comprises the bottom of a water body. Can be highly variable depending on regional geology, weathering, location within the lake, etc. Described by substrate particle size. Particle sizes include fines (clay, silt and sand), gravel, cobble, boulder and bedrock. Golder employs specific criteria for particle size classes which are defined in this document.

DRAFT

Substrate particle size classes used for both lake and watercourse mapping include:

- Organic material;
- Si - silt/clay (<0.06 mm in diameter);
- Sa - sand (0.06-2.0 mm);
- Gr - gravel (2-64 mm);
- Co - cobble (64-256 mm);
- Bo - boulder (>256 mm); and
- Bd – bedrock.

Watercourse Habitat Mapping

Stream Pattern: Stream pattern describes the sinuosity of the channel or the degree to which the channel deviates from straightness. Sinuosity is the channels meander pattern which can range from straight to tortuously meandering. Sinuosity is expressed as the ratio of the length of channel between two points on the stream to the straight line distance between the same two points.

Substrate: Stream substrate is the material found on the bottom of the channel portion of the watercourse. It refers to the surficial deposits that can be seen when viewing the streambed. As part of the habitat evaluation process, the substrate is evaluated with respect to particle size composition. Particle size composition refers to the proportions of the substrate particles within each category from a series of size categories (Table 1). These range from fine sediments (fines are particles <2 mm in size and include clay, silt and sand) through gravels, cobbles, boulders and bedrock. A substrate evaluation is conducted by visual observation. The observer estimates the percentage of the substrate particles, by surface area, in each of the size categories. Note: the term rubble is sometimes used for cobble sized particles – within this size class, cobble refers to rounded rock while rubble refers to angular rock.

Undercut Bank: An undercut bank is a bank that has been eroded at the base by flowing water, allowing water to be present underneath a portion of the bank. Although undercutting usually adds to bank instability, it may also provide cover for fish. If the overhanging portion of the bank provides and effective with >9 cm over water with a depth of >0.15 m, it provides a cover feature and the location and extent should be recorded on the habitat map.

Unstable Bank: A portion of the stream bank that is unstable in that it has, or has potential to, shed material into the stream. Instability may be due to various factors such as slumping, gullying, erosion or undercutting. Record the location and extent of unstable banks on the habitat map.

Wetted Width: The width of the water surface measured at right angles to the direction of flow. If an island(s) is present creating more than one channel, the total wetted width is the sum of the individual wetted widths. Wetted width is dependent on stream discharge and varies as water level varies.

DRAFT

Channel Unit (sometimes referred to as habitat type): Channel units are the hydraulic and morphological features of a stream channel. A channel unit is a section of channel which is homogeneous with respect to water depth, velocity and cover and is separated from other channel units by gradients in these parameters. Channel units are sometimes referred to as habitat types. The most common channel units are **pool**, **riffle** and **run**, although a total of 12 channel units have been defined (Table A-1).

Table A-1: List of Channel Units

Channel Unit	Description
Falls	Highest water velocity; involves water falling over a vertical drop; impassable to fish
Cascade	Extremely high gradient and velocity; extremely turbulent with entire water surface broken; may have short vertical sections but overall is passable to fish; armoured substrate; may be associated with chute
Chute	Area of channel constriction, usually due to bedrock intrusions; associated with channel deepening and increased velocity
Rapids	Extremely high velocity; deeper than riffle; substrate extremely coarse (large cobble/boulder); instream cover in pocket eddies and associated with substrate
Riffle	High velocity/gradient relative to run habitat; surface broken due to submerged or exposed bed material; shallow relative to other channel units; coarse substrate; usually limited instream or overhead cover for juvenile or adult fish (generally ≤0.5 m deep)
Run	Moderate to high velocity; surface largely unbroken; usually deeper than a riffle; substrate size dependent on specific hydraulics
Flat	Low gradient area characterized by low velocity and near-laminar flow; differentiated from pool habitat by high channel uniformity; more depositional than run habitat
Pool (Scour)	Discrete portion of channel featuring increased depth and reduced velocity relative to riffle/run habitats; formed by channel scour
Impoundment Pool	Includes pools which are formed behind dams; tend to accumulate sediment/organic debris more than scour pools; may have cover associated with damming structure; identify as Class 1, 2 or 3 as for scour pools; record dam type (e.g. debris, beaver, landslide)
Backwater	Discrete, localized area of variable size exhibiting reverse flow direction; generally produced by bank irregularities; velocities variable but lower than main flow; substrate similar to adjacent channel with higher percentage of fines – record large/significant backwater areas
Snye	Discrete section of non-flowing water connected to a flowing channel only at its downstream end; generally formed in a side-channel or behind a peninsula
Boulder Garden	Significant occurrence of large boulders providing significant instream cover; always in association with an overall channel unit such as a riffle or run

DRAFT

APPENDIX D

Fish Tissue and Benthic Community Results

DRAFT

July 3, 2012
Report No. 10-1118-0020 **(5200)**

Golder Associates

Appendix D: Benthic Invertebrate Community Indices Summary Statistics

	R1	R2	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
Simpson's Diversity Index														
Average	0.68	0.43	0.59	0.44	0.51	0.52	0.59	0.35	0.52	0.71	0.42	0.63	0.58	0.66
Median	0.66	0.38	0.60	0.45	0.63	0.51	0.57	0.28	0.51	0.71	0.43	0.63	0.58	0.69
Min	0.63	0.18	0.38	0.31	0.00	0.41	0.43	0.16	0.35	0.68	0.00	0.49	0.38	0.45
Max	0.75	0.73	0.71	0.58	0.69	0.63	0.73	0.74	0.65	0.72	0.67	0.74	0.75	0.76
SD	0.06	0.22	0.13	0.10	0.29	0.09	0.13	0.23	0.12	0.01	0.27	0.09	0.14	0.13
SE	0.02	0.10	0.06	0.05	0.13	0.04	0.06	0.10	0.06	0.01	0.12	0.04	0.06	0.06
Simpson's Evenness Index														
Average	0.52	0.52	0.42	0.30	0.62	0.40	0.55	0.31	0.41	0.40	0.60	0.32	0.47	0.36
Median	0.58	0.54	0.41	0.26	0.55	0.45	0.58	0.34	0.41	0.39	0.58	0.28	0.42	0.26
Min	0.40	0.28	0.23	0.16	0.35	0.28	0.35	0.11	0.22	0.26	0.39	0.23	0.20	0.23
Max	0.61	0.75	0.75	0.48	1.00	0.51	0.70	0.46	0.57	0.59	1.00	0.48	0.80	0.73
SD	0.09	0.18	0.20	0.13	0.28	0.11	0.13	0.14	0.13	0.13	0.25	0.10	0.26	0.21
SE	0.04	0.08	0.09	0.06	0.12	0.05	0.06	0.06	0.06	0.06	0.11	0.04	0.12	0.09
Taxa Richness														
Average	6	4	7	7	5	6	5	7	6	9	4	9	7	11
Median	6	5	6	7	5	6	5	5	5	9	4	9	7	12
Min	5	2	4	5	1	4	3	3	5	6	1	7	2	4
Max	7	6	11	9	9	7	7	11	7	12	7	11	11	18
SD	0.84	1.64	2.59	1.67	2.92	1.14	1.58	3.90	0.89	2.39	2.24	1.58	3.39	5.45
SE	0.37	0.73	1.16	0.75	1.30	0.51	0.71	1.74	0.40	1.07	1.00	0.71	1.52	2.44
Density														
Average	9698	13870	4577	23748	13068	8120	37549	11878	66495	52996	7146	16783	20171	6465
Median	8318	11723	2931	18792	14137	7241	28963	12068	17240	43445	2802	18619	19352	8663
Max	18274	29308	14999	36333	21378	15214	65512	25170	188994	76115	15861	25558	41419	9051
Min	2112	2414	388	16895	3793	4138	12499	3189	15861	38618	1896	7241	2758	2758
SD	6545.17	10597.36	5934.46	8448.59	6565.25	4328.99	24100.92	8379.69	76045.58	16747.82	6775.64	7193.03	13924.80	3328.06
SE	2927.09	4739.28	2653.97	3778.32	2936.07	1935.98	10778.26	3747.51	34008.62	7489.85	3030.16	3216.82	6227.36	1488.35
%EPT														
Average	0.48%	0.60%	1.05%	0.32%	0.87%	14.82%	0.00%	1.10%	0.00%	9.64%	3.64%	8.83%	0.00%	5.33%
Median	0.00%	0.00%	0.00%	0.00%	0.00%	16.67%	0.00%	1.37%	0.00%	6.80%	0.00%	9.44%	0.00%	5.71%
Max	2.42%	1.81%	2.94%	1.02%	4.35%	28.57%	0.00%	2.70%	0.00%	22.13%	18.18%	17.14%	0.00%	12.50%
Min	0.00%	0.00%	0.00%	0.00%	0.00%	3.98%	0.00%	0.00%	0.00%	4.76%	0.00%	1.69%	0.00%	0.00%
SD	1.08%	0.85%	1.45%	0.47%	1.94%	9.91%	0.00%	1.14%	0.00%	7.19%	8.13%	5.96%	0.00%	4.70%
SE	0.48%	0.38%	0.65%	0.21%	0.87%	4.43%	0.00%	0.51%	0.00%	3.21%	3.64%	2.67%	0.00%	2.10%

DRAFT

Table 1: Mercury Levels in Fish Tissue Samples from Lizard Lake

Date Sampled	Sample No.	Species	Fork Length (mm)	Mercury (µg/g)	Detection Limit (µg/g)
21-AUG-10	BHRI0URICISC031	Cisco	273	0.178	0.050
22-AUG-10	BHRI0URICISC035	Cisco	269	0.166	0.050
22-AUG-10	BHRI0URICISC036	Cisco	253	0.142	0.050
22-AUG-10	BHRI0URICISC037	Cisco	245	0.155	0.050
22-AUG-10	BHRI0URICISC038	Cisco	243	0.146	0.050
22-AUG-10	BHRI0URICISC048	Cisco	245	0.166	0.050
22-AUG-10	BHRI0URICISC049	Cisco	255	0.149	0.050
22-AUG-10	BHRI0URICISC050	Cisco	257	0.140	0.050
21-AUG-10	BHRI0UR1WHSC032	White Sucker	482	0.190	0.050
22-AUG-10	BHRI0UR1WHSC034	White Sucker	440	0.408	0.050
22-AUG-10	BHRI0UR1WHSC043	White Sucker	414	0.187	0.050
22-AUG-10	BHRI0UR1WHSC044	White Sucker	462	0.140	0.050
22-AUG-10	BHRI0UR1WHSC045	White Sucker	463	0.234	0.050
22-AUG-10	BHRI0UR1WHSC051	White Sucker	505	0.277	0.050
22-AUG-10	BHRI0UR1WALL033	Walleye	539	1.30	0.050
22-AUG-10	BHRI0UR1WALL041	Walleye	653	1.73	0.050
22-AUG-10	BHRI0UR1WALL042	Walleye	515	1.20	0.050
22-AUG-10	BHRI0UR1WALL046	Walleye	530	1.51	0.050
22-AUG-10	BHRI0UR1WALL047	Walleye	334	0.921	0.050
22-AUG-10	BHRI0UR1WALL055	Walleye	456	0.796	0.050
22-AUG-10	BHRI0UR1WALL056	Walleye	542	1.01	0.050

DRAFT

Table 2: Mercury Levels in Fish Tissue Samples from Turtle Bay

Date Sampled	Sample Number	Species	Fork Length (mm)	Mercury (µg/g)	Detection Limit (µg/g)
25-AUG-10	BHRIOUR5BNSH118, R6BNSH183,BNSH	Blacknose Shiner	composite sample	0.083	0.050
24-AUG-10	BHRI0UR6LKWH051	Lake Whitefish	520	0.214	0.050
24-AUG-10	BHRI0UR6LKWH022	Lake Whitefish	545	0.292	0.050
24-AUG-10	BHRI0UR6LKWH052	Lake Whitefish	493	0.250	0.050
25-AUG-10	BHRI0UTBLKWH062	Lake Whitefish	547	0.237	0.050
25-AUG-10	BHRI0UTBLKWH063	Lake Whitefish	545	0.214	0.050
25-AUG-10	BHRI0UTBLKWH066	Lake Whitefish	515	0.135	0.050
25-AUG-10	BHRI0UR6LKWH166	Lake Whitefish	N/A	0.260	0.050
26-AUG-10	BHRI0UTBLKWH167	Lake Whitefish	500	0.329	0.050
26-AUG-10	BHRI0UTBWHSC169	White Sucker	493	0.193	0.050
25-SEP-10	BHRIOUTBWHSC 001	White Sucker	483	0.301	0.050
25-SEP-10	BHRIOUTBWHSC 006	White Sucker	474	0.162	0.050
25-SEP-10	BHRIOUTBWHSC 007	White Sucker	464	0.198	0.050
25-SEP-10	BHRIOUTBWHSC 009	White Sucker	365	0.072	0.050
26-AUG-10	BHRI0UR6WALL021	Walleye	328	0.292	0.050
24-AUG-10	BHRI0UR6WALL023	Walleye	470	0.935	0.050
24-AUG-10	BHRI0UR6WALL035	Walleye	258	0.366	0.050
25-AUG-10	BHRU0UR6WALL054	Walleye	318	0.267	0.050
25-AUG-10	BHRI0UTBWALL059	Walleye	332	0.289	0.050
26-AUG-10	BHRI0UTBWALL079	Walleye	286	0.290	0.050
26-AUG-10	BHRI0UTBWALL170	Walleye	434	0.542	0.050
26-AUG-10	BHRI0UTBWALL171	Walleye	371	0.432	0.050
22-AUG-10	BHRI0UTBWALL054	Walleye	476	0.736	0.050

DRAFT

Table 3: Mercury Levels in Fish Tissue Samples from Sawbill Bay

Date Sampled	Sample No.	Species	Fork Length (mm)	Mercury (µg/g)	Detection Limit (µg/g)
18-AUG-10	BHR10U15BNSH005	Blacknose Shiner	composite sample	0.066	0.050
19-AUG-10	BHR10U13LKWH019	Lake Whitefish	496	0.335	0.050
28-AUG-10	BHR10U13LKWH041	Lake Whitefish	N/A	0.257	0.050
28-AUG-10	BHR10U13LKWH042	Lake Whitefish	N/A	0.185	0.050
28-AUG-10	BHR10U13LKWH043	Lake Whitefish	N/A	0.312	0.050
21-SEP-11	OHR11FSBLKWH001	Lake Whitefish	496	0.197	0.050
21-SEP-11	OHR11FSBLKWH002	Lake Whitefish	540	0.235	0.050
21-SEP-11	OHR11FSBLKWH004	Lake Whitefish	491	0.113	0.050
21-SEP-11	OHR11FSBLKWH007	Lake Whitefish	508	0.229	0.050
21-SEP-11	OHR11FSBLKWH008	Lake Whitefish	478	0.147	0.050
21-SEP-11	OHR11FSBLKWH012	Lake Whitefish	432	0.102	0.050
23-SEP-11	OHR11FSBLKWH016	Lake Whitefish	470	0.119	0.050
23-SEP-11	OHR11FSBLKWH017	Lake Whitefish	465	0.176	0.050
24-SEP-11	OHR11FSBLKWH019	Lake Whitefish	N/A	0.324	0.050
24-SEP-11	OHR11FSBLKWH020	Lake Whitefish	466	0.264	0.050
19-AUG-10	BHR10U13WHSC016	White Sucker	519	0.208	0.050
19-AUG-10	BHR10U13WHSC017	White Sucker	440	0.124	0.050
19-AUG-10	BHR10U13WHSC020	White Sucker	462	0.231	0.050
19-AUG-10	BHR10U13WHSC021	White Sucker	505	0.217	0.050
20-AUG-10	BHR10U13WHSC030	White Sucker	495	0.286	0.050
27-AUG-10	BHR10U13WHSC038	White Sucker	N/A	0.161	0.050
28-AUG-10	BHR10U13WHSC039	White Sucker	N/A	0.255	0.050
28-AUG-10	BHR10U13WHSC040	White Sucker	N/A	0.156	0.050
21-SEP-11	OHR11FSBWHSC011	White Sucker	505	0.356	0.050
23-SEP-11	OHR11FSBWHSC015	White Sucker	490	0.374	0.050
24-SEP-11	OHR11FSBWHSC022	White Sucker	464	0.320	0.050
21-SEP-11	OHR11FSBWALL003	Walleye	387	0.402	0.050
19-AUG-10	BHR10U13WALL009	Walleye	389	0.588	0.050
19-AUG-10	BHR10U13WALL010	Walleye	330	0.310	0.050
19-AUG-10	BHR10U13WALL012	Walleye	306	0.232	0.050
19-AUG-10	BHR10U13WALL013	Walleye	380	0.383	0.050
19-AUG-10	BHR10U13WALL014	Walleye	343	0.385	0.050
19-AUG-10	BHR10U13WALL018	Walleye	515	1.35	0.050
20-AUG-10	BHR10U12WALL005	Walleye	489	0.354	0.050
20-AUG-10	BHR10U12WALL006	Walleye	430	0.810	0.050
21-SEP-11	OHR11FSBWALL005	Walleye	405	0.317	0.050
21-SEP-11	OHR11FSBWALL006	Walleye	346	0.393	0.050
21-SEP-11	OHR11FSBWALL009	Walleye	346	0.362	0.050
21-SEP-11	OHR11FSBWALL010	Walleye	389	0.469	0.050
21-SEP-11	OHR11FSBWALL013	Walleye	450	0.446	0.050
23-SEP-11	OHR11FSBWALL014	Walleye	270	0.273	0.050
23-SEP-11	OHR11FSBWALL018	Walleye	350	0.342	0.050
24-SEP-11	OHR11FSBWALL021	Walleye	561	1.66	0.050
24-SEP-11	OHR11FSBWALL023	Walleye	330	0.339	0.050

DRAFT

Table 4: Fish Contaminant Data

Parameter	Units	BHRI0UR6LKWH051		BHRI0UR6LKWH022	BHRI0UR6LKWH052	BHRI0UTBLKWH062	BHRI0UTBLKWH063	BHRI0UTBLKWH066	BHRI0UR6LKWH166
Date Sampled		24-AUG-10		24-AUG-10	24-AUG-10	25-AUG-10	25-AUG-10	25-AUG-10	25-AUG-10
		MDL	Results	Results	Results	Results	Results	Results	Results
Total Aluminum	mg/kg wwt	5.0	12.5	10.2	8.4	7.7	7.6	25.3	20.7
Total Antimony	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Arsenic	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Barium	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Berylium	mg/kg wwt	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Total Bismuth	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Boron	mg/kg wwt	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Cadmium	mg/kg wwt	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Total Calcium	mg/kg wwt	20	148	2910	135	79	132	113	131
Total Chromium	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Cobalt	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Copper	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Iron	mg/kg wwt	10	<10	12	12	14	<10	<10	14
Total Lead	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Magnesium	mg/kg wwt	20	254	274	237	222	261	232	243
Total Manganese	mg/kg wwt	20	<20	<20	<20	<20	<20	<20	<20
Total Mercury	mg/kg wwt	0.050	0.214	0.292	0.250	0.237	0.214	0.135	0.260
Total Molybdenum	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Nickel	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Phosphorus	mg/kg wwt	20	2190	3350	2190	2230	2200	2010	2020
Total Potassium	mg/kg wwt	20	3280	3260	3120	3420	3410	2860	3230
Total Selenium	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

DRAFT

Parameter	Units	BHRI0UR6LKWH051		BHRI0UR6LKWH022	BHRI0UR6LKWH052	BHRI0UTBLKWH062	BHRI0UTBLKWH063	BHRI0UTBLKWH066	BHRI0UR6LKWH166
Date Sampled		24-AUG-10		24-AUG-10	24-AUG-10	25-AUG-10	25-AUG-10	25-AUG-10	25-AUG-10
		MDL	Results	Results	Results	Results	Results	Results	Results
Total Silver	mg/kg wwt	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Total Sodium	mg/kg wwt	20	475	613	627	413	405	305	384
Total Strontium	mg/kg wwt	20	<20	<20	<20	<20	<20	<20	<20
Total Thallium	mg/kg wwt	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Tin	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Titanium	mg/kg wwt	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Uranium	mg/kg wwt	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Vanadium	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Zinc	mg/kg wwt	10	<10	<10	<10	<10	<10	<10	<10
Total Zirconium	mg/kg wwt	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

DRAFT

AQUATIC ENVIRONMENT TSD
VERSION 1

APPENDIX 2.III

Draft Habitat Accounting Procedure and Conceptual No Net Loss Plan

February 2013
Project No. 10-1118-0020
Hammond Reef Gold Project

October 16, 2012

OSISKO HAMMOND REEF GOLD LTD.

Fish Habitat Accounting Procedure: Hammond Reef Gold Project Conceptual No Net Loss Plan

Version 5.0

Submitted to:
Alexandra Draypack
Osisko Hammond Reef Gold Ltd.
155 University Avenue
Suite 1440
Toronto, ON M5H 3B7

DRAFT

REPORT

Report Number: 10-1118-0020V4
Distribution:

1 e-copy - Osisko Hammond Reef Gold Ltd.
1 copy - Golder Associates Ltd.

Golder Associates

Table of Contents

1.0 INTRODUCTION **3**

2.0 OBJECTIVE **3**

3.0 OVERVIEW OF APPROACH TO NO NET LOSS PLANNING **3**

4.0 THE PROJECT AND POTENTIAL IMPACTS ON AQUATIC FEATURES **5**

5.0 THE AQUATIC ENVIRONMENT AND BASELINE DATA COLLECTION **10**

5.1 Habitat Mapping and Determination of Habitat Areas 10

5.2 Fish Species Presence and Species Weighting 17

5.3 Species Guilds and Weighting 18

5.4 Ecotypes and Fish Community Composition 21

5.5 Species Associations by Ecotype 22

5.6 Habitat Classes and Habitat Sensitivity Weighting 27

5.7 Calculation of Weighted Useable Area Scores 27

6.0 SUMMARY OF HABITAT LOSSES **33**

7.0 COMPENSATION APPROACHES **38**

7.1 Compensation Calculations 41

7.2 Additional Mitigation and Compensation Measures 44

7.2.1 Summary of Offsetting Compensation Measures 45

7.3 Steep Rock Mine Habitat Compensation 46

9.0 REFERENCES **52**

10.0 CLOSURE **54**

TABLES

Table 1: Aquatic APIs Potentially Directly Affected, by the Osisko Hammond Reef Gold Project (Preferred Option) 7

Table 2: Habitat Features and Variables Measured During Baseline Studies[1] 11

Table 3: Fish Species Captured During Baseline Studies 18

Table 4: Fish Habitat Groupings 19

Table 5: Species Habitat Weights (SHW) by Habitat Group 20

Table 6: Fish Community Composition by Ecotype 23

Table 7: Example of HSI scores for two fish species 29

DRAFT

Table 8: Example of WUA Calculation of Two APIs Showing Estimates of Habitat Losses 32
Table 9: Aquatic APIs affected by Project Footprint 34
Table 10: Example of Preliminary WUA Calculation of Two APIs Showing Estimates of Habitat Gains 41

FIGURES

Figure 1: Site Layout (Preferred Alternative) 6
Figure 2: Project Footprint and Aquatic APIs 9
Figure 3: Area of Potential Impact (API #9) LiDAR Image 13
Figure 4: Area of Potential Impact (API #9) Habitat Data Overlay 14
Figure 5: API #9 Bathymetry 15
Figure 6: API #9 Lake Bottom Substrate 16
Figure 7: Potential Fish Habitat Compensation Works 40
Figure 8: Potential Fish Habitat Compensation Works 43
Figure 9: APIs Requiring MMER in TMA 49
Figure 10: APIs Requiring MMER in WRS 50

APPENDICES

APPENDIX A
Definitions for Habitat Variables

APPENDIX B
Fish Habitat Preference Tables

APPENDIX C
Habitat Accounting Model

DRAFT

1.0 INTRODUCTION

In Canada, the fish resources and the habitats that support them are protected by the *Fisheries Act* (the Act), federal legislation that is administered by Fisheries and Oceans Canada (DFO) and Environment Canada. The harmful alteration or disruption, or destruction (HADD) of fish habitat is prohibited by Subsection 35(1) of the Act unless it is authorized pursuant to Subsection 35(2). In keeping with the guiding principal of No Net Loss outlined in DFO's Policy for the Management of Fish Habitat (DFO 1986), authorizations are issued on condition that the proponent implements measures to compensate or offset the HADD arising from their project. The measures that a proponent intends to implement to compensate for the HADD of fish habitat arising from their project are described in compensation plans, also referred to as a No Net Loss Plans (NNLPs). In addition to describing the compensation measures, NNLPs also provide a quantification of fish habitat harmfully altered or disrupted, or destroyed, by the project as well as the habitat gained through the compensation.

2.0 OBJECTIVE

The following provides a description of how fish habitat losses and gains were calculated in the NNLP developed to offset habitat altered by the Hammond Reef Gold Project (the Project). The methodology outlined in this report forms the basis of NNL planning for the project. The methodology is consistent with NNLPs developed and approved for other mining projects by Golder Associates Ltd. (Golder), notably the De Beers Snap Lake Diamond Project (Golder 2004), the Imperial Oil Kearl Oil Sands Project (Golder 2007) and the Agnico-Eagle Mines Meliadine Gold Project Conceptual Fish Habitat Compensation Plan (Golder 2011). Key guidance documents used to formulate the habitat accounting approach include the *Practitioners Guide to Compensation for DFO Habitat Staff* (DFO 2006), *Review of Approaches for Estimating Changes in Productive Capacity from Whole Lake/Stream Destruction and Related Compensation Projects* (Packman et. al. 2006) and *An Introductory Guide to Preparing and Assessing No Net Loss Plans* (Minns 2010).

Bill C-38, passed in June, 2012, and implemented into policy in January 2013, amends the Act to focus on the protection of fish that support commercial, recreational or Aboriginal fisheries and to more effectively manage activities that pose the greatest threat to these fisheries. Habitat policy, including 'no net loss' is currently under review to ensure consistency with the Act's focus on managing threats to recreational, commercial and Aboriginal fisheries. As the new direction on the formulation for NNL planning becomes available; it will be applied to the habitat accounting procedure as appropriate.

3.0 OVERVIEW OF APPROACH TO NO NET LOSS PLANNING

A number of steps were required to document how habitat losses and gains were calculated. These are as follows:

- Evaluate baseline habitat characteristics in the areas where habitat alteration will occur.
- Determine which fish species and life history stages will be affected by habitat alteration (species present).
- Determine the quantity and quality of habitat affected by the Project.
- Determine the quantity and quality of habitat gained/created by compensation measures.

DRAFT

- Estimate the net change in habitat quality and quantity.

The Habitat Evaluation Procedure (HEP) approach developed by the U.S. Fish and Wildlife Service (USFW 1980) was adopted to determine the quantity and quality of fish habitat affected by mine construction, operation and closure including the pit, the preferred tailings management and waste rock storage facilities and all other infrastructure (e.g., roads, transmission corridors, process facilities). While more recent methodologies have been developed, in particular Minns et al (2001) and Minns (2010), the HEP approach was preferred for the following reasons:

- DFO has agreed with the application of this method, also used in the Meliadine Gold Project (Golder 2011).
- Golder has successfully demonstrated the use of HEP in a number of approved NNLPs and was familiar with the Meliadine project.
- The HEP approach, though more subjective, offered greater flexibility in terms of the range of habitat variables that could be used.
- The HEP approach can be applied using baseline data collected by Golder for this project.

HEP uses Habitat Units (HUs), a single dimensionless value that integrates habitat quantity and quality, where the HU is the product of habitat quantity measured as a unit area (typically square metres) (HA) and habitat quality expressed as a Habitat Suitability Index (i.e., HU = HSI x HA). Minns et al (2001) use the term Weighted Useable Area (WUA) in place of HU as it more accurately reflects the fact that although the value is dimensionless, it is weighted based on the habitat preferences of the fish species present in each habitat unit and inherently linked to HA. The number of WUAs harmfully altered, disrupted or destroyed through the construction, operations and post-closure phases of the Project were compared to the WUAs gained from habitat created or enhanced. For No Net Loss to be achieved:

$$WUA_{lost} - WUA_{compensation} = 0$$

Not all habitat loss will be immediate. It is expected that some HADDs will take place over time through the construction and operational phases of the Project. Once detailed engineering is available, it will be possible to predict the timing of losses (i.e., scheduling for tailings dam construction and filling of the tailings management area). Similarly, not all compensation works will be completed immediately, and it is anticipated that it will take time to create functioning habitats and to detect the results of habitat enhancement. Where there is a lag between loss of habitat and creation of functioning compensation habitat, WUA_{lost} may need to be compensated using a replacement ratio of $WUA_{compensation}$: WUA_{lost} greater than 1.

HSI models are derived using a comparison of a set of habitat variables (e.g., depth, substrate). Suitability value is rated on a 5-point scale, from 0.0 to 1.0 with a rating of 1.0 representing optimal habitat, for each life stage of each species. The HSI relationships used to determine habitat suitability were based on published HSI models and life history studies, existing data collected as part of the project, and upon professional judgement (e.g., expert opinion provided by northern Ontario fisheries managers and researchers).

DRAFT

4.0 THE PROJECT AND POTENTIAL IMPACTS ON AQUATIC FEATURES

The project is situated on the Hammond Peninsula, which extends out into the Upper Flood Waters (Upper Marmion Reservoir). The eastern edge of the peninsula is bordered by Lizard Lake, which is physically connected to the Upper Flood Waters. The Project will consist of an open pit, ore processing facility, a waste rock storage area(s) and tailings management facility (TMF) as well as a road network and transmission line to support operation of the Mine (Figure 1). Ancillary structures, such as a permanent accommodation camp, will also be part of the project footprint. A number of sub-catchments drain the Project footprint.

Aquatic features may be potentially impacted by the following:

- Construction and permanent camp operation;
- Pit excavation including blasting;
- Construction of process facilities, including buildings, explosives plant, parking lots and a mine spill emergency pond;
- Storage of tailings, waste rock, overburden and low grade ore;
- Construction of tailings dams, and diversion of natural watercourses around tailings and wasterock storage areas;
- Surface water management and discharge;
- Construction and maintenance of access roads (including aggregate extraction), electrical transmission and tailings pipeline corridors;
- Quality and quantity of mine effluent and sewage treatment effluent; and
- Construction and operation of effluent discharge and water intakes.

Detailed construction, engineering and surface water management plans have not been completed so potential Project-related impacts cannot be fully described or quantified in this report. A full assessment of impacts and quantification of residual direct and indirect impacts (i.e., after mitigation has been taken into account) was carried out and is described in the Environmental Impact Study (EIS) and Aquatic Technical Support Document (TSD).

DRAFT

610000 615000 620000

5425000 5420000

Cornell Lake

PERMANENT ACCOMMODATION CAMP

EXPLORATION CAMP

TAILINGS MANAGEMENT FACILITY

Lizard Lake

SUBSTATION

SECONDARY AND TERTIARY CRUSHERS

EXPLOSIVES STORAGE

Sawbill Bay

PROPANE FARM

STOCKPILE

SECURITY STATION

PARKING

Snail Bay

PARKING

TRUCK SHOP

PROCESSING PLANT

CRUSHED ORE STOCKPILE

FUEL STORAGE

FRESHWATER AND FIRE EMERGENCY PUMP STATION

MINE WATER PUMP STATION

WASTE ROCK STOCKPILE

MINE WATER EMERGENCY SPILL POND

EAST PIT

GYRATORY CRUSHER PAD

Mining Area

ORE STOCKPILE

WEST PIT

OVERBURDEN STOCKPILE

OVERBURDEN STOCKPILE

Lynxhead Bay

610000 615000 620000

5420000

N

LEGEND

- Weather Station
- Index Contour (5m interval)
- Ditch
- Marsh/Swamp
- River/Stream
- Road
- Trail
- Tailings Management Facility
- Pump Station
- Mine Water Spill Emergency Pond
- Office and Truck Shop, Explosives Storage and Processing Plant
- Exploration Camp
- Open Pits
- Waste RockStockpile
- Overburden Stockpiles
- Ore Stockpile

DRAFT

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000
SCALE 1:20,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
SITE LAYOUT
(PREFERRED ALTERNATIVE)

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	CGE	30 May. 2012		
GIS	RRD	26 Jul. 2012		
CHECK	JS	26 Jul. 2012		
REVIEW	--	--/--/--		

FIGURE: 1

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\SiteLayouts\SiteLayout_June26Layout.mxd

During the aquatic baseline program, aquatic features were assessed within and adjacent to the Project footprint, including water crossings located along the corridors. These features have been termed areas of potential impact (APIs). APIs include a number of permanent streams and associated beaver (*Castor canadensis*) impoundments as well as several small lakes, the largest of which is Mitta Lake (Figure 2). Table 1 summarizes the aquatic features (APIs) impacted or altered by various project components based upon the most recent site plan. Detailed fish community composition and habitat mapping information for most of the APIs listed in Table 1 can be found in Fish and Fish Habitat Baseline Studies Interim Report (Golder 2012).

Table 1: Aquatic APIs Potentially Directly Affected, by the Osisko Hammond Reef Gold Project (Preferred Option)

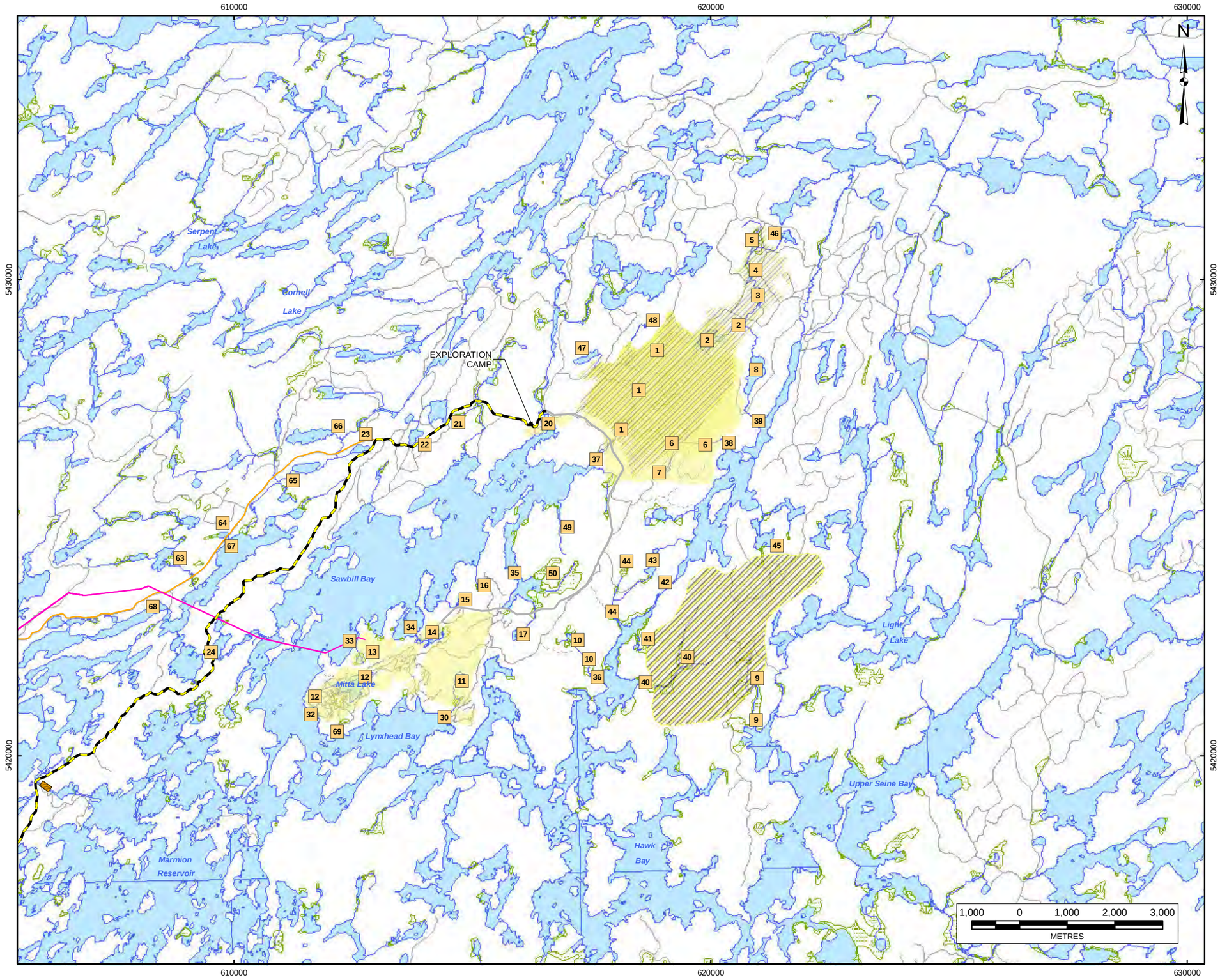
Infrastructure Feature	Aquatic API	Description
Open Pit	Mitta Lake (API #12) and its outlet stream	17.2737 ha Headwater lake; approximately 0.0449 ha of Lower Reach - stream; empties into Sawbill Bay; supports white sucker (*Catostomus commersoni*), ninespine stickleback (*Pungitius pungitius*), brook stickleback (*Culaea inconstans*), fathead minnow (*Pimephales promelas*), Iowa darter (*Etheostoma exile*), mottled sculpin (*Cottus bairdii*) and finescale dace (*Phoxinus neogaeus*).
	■ API #14	■ Upper portions of approximately 0.1169 ha Lower Reach stream; empties into Sawbill Bay; supports brassy minnow (*Hybognathus hankinsoni*), finescale dace, northern redbelly dace (*Phoxinus eos*), fathead minnow; juvenile white sucker captured in lower reach.
	■ API #69	■ 0.9871 ha Headwater pond and 0.0165 ha of Headwater stream; pond supports white sucker, pearl dace, Iowa darter, brassy minnow, central mudminnow (*Umbra limi*), blacknose shiner (*Notropis heterolepis*), finescale dace and northern redbelly dace. No fish were found to exist within the outlet stream.
Other Mine Facilities	Sawbill Bay	Localized filling within the drawdown zone along Hammond Reef peninsula to provide adequate space for mine buildings, parking, etc.; approximately 0.8 ha of seasonal habitat within the drawdown zone will be destroyed. Area provides seasonal nursery/foraging habitat for baitfish species, northern pike (*Esox Lucius*), smallmouth bass (*Micropterus dolomieu*)
Mine Water Spill Emergency Pond	API #13	1.9375 ha Headwater pond; approximately 0.0396 ha of Headwater stream and 0.0476 ha of Headwater beaver impoundments; both pond and stream are fishless. Empties into Lynxhead Bay.
Waste rock Stockpile	API #11	2.7777 ha Headwater pond; approximately 0.0787 ha of Headwater stream including (several) 0.1030 ha of beaver impoundments; empties into Lynxhead Bay; supports finescale dace, northern redbelly dace, fathead minnow.
Tailings Management Facility	API #47	

DRAFT

Table 1: Aquatic APIs Potentially Directly Affected, by the Osisko Hammond Reef Gold Project (Preferred Option) (Continued)

Infrastructure Feature	Aquatic API	Description
Corridors	API #48	Approximately 0.0123 ha of Headwater - ephemeral/ seasonal stream, 0.0430 ha of Headwater - permanent stream and several Headwater beaver ponds (1.0198 ha total); approximately 0.2051 ha Headwater pond; no hydraulic connection to downstream aquatic features. Finescale dace captured in one of the beaver ponds.
	■ API #1	■ Approximately 0.0894 ha of Lower Reaches – inlet stream, including 0.5836 ha of beaver impoundments; empties into Sawbill Bay; upper sections support pearl dace, finescale dace and fathead minnows; juvenile and young-of-the-year (YOY) white sucker captured in lower sections.
	■ API #7	■ 1.0962 ha Headwater pond; partially in-filled; fishless; connected to API #6 by a series of small, Headwater beaver ponds (approximately 0.0721 ha).
	■ API #6	■ 0.5385 ha pond, 0.0437 ha of Lower Reaches – inlet stream, and 0.1004 ha of Lower Reaches - ephemeral stream; empties into Lizard Lake; pond and ephemeral stream are fishless; white sucker and lowa dater captured in lower segment of stream.
	■ API #2	■ 12.4351 ha Headwater lake and 0.2217 ha of Headwater stream and 0.3808 ha of Headwater beaver impoundments; supports pumpkinseed (*Lepomis gibbosus*), northern pike, yellow perch (*Perca flavescens*), lowa darter, white sucker, blacknose shiner.
	■ Water crossing locations along the Hardtack, Sawbill access roads, and site access road (API 20-23 and 63 68)	■ 14 Culvert locations; movement of fish between waterbodies located up/downstream of water crossings.
Open Pit	Mitta Lake (API #12) and its outlet stream	17.2737 ha Headwater lake; approximately 0.0449 ha of Lower Reach - stream; empties into Sawbill Bay; supports white sucker, ninespine stickleback, brook stickleback, fathead minnow, lowa darter, mottled sculpin and finescale dace.

DRAFT



LEGEND

- Raft Lake Cut Location
- Trail
- Road
- On-Site Road
- Raft Lake Access Road Alternative 2
- Project Access Road
- Project Transmission Line
- River/Stream
- Lake
- Wetland
- Project Footprint
- TMF Alternatives

DRAFT

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

SCALE 1:80,000

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
PROJECT FOOTPRINT AND AQUATIC APIS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 2.0
DESIGN	CGE	14 Nov. 2008	FIGURE: 2	
GIS	CGE	13 Apr. 2012		
CHECK	SP	13 Apr. 2012		
REVIEW	RJ	13 Apr. 2012		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXD\Draft\Aquatics\Figure2_footprint_API.mxd

A detailed analysis of all project-related effects was carried out as part of the Environmental Assessment (EA) and Aquatic TSD, and a comprehensive accounting of lost or altered habitats was based upon the results of this impact assessment. Potential indirect effects may take place in the lower reaches of watercourses that drain the Project footprint due to alterations of natural hydrographs. Fish from downstream water bodies (including the Upper Marmion Reservoir) use the lower sections of some water courses to reproduce, and as nursery habitats. The alteration of headwater ponds and streams may also impair downstream flow or movement of fish, other aquatic organisms (i.e., benthic invertebrates) and nutrients into receiving waters. Water quality and hydrologic modelling was used to determine the geographic extent and magnitude of downstream effects.

5.0 THE AQUATIC ENVIRONMENT AND BASELINE DATA COLLECTION

Baseline data collection for the Project involved two primary tasks:

- Habitat mapping, evaluating baseline habitat conditions.
- Fish species presence/absence sampling; determining which fish species will be affected by alterations to fish habitat, and their distributions.

5.1 Habitat Mapping and Determination of Habitat Areas

Golder has developed technical procedures for measuring and characterizing fish habitat in watercourses and waterbodies, provided and presented previously to DFO and Ontario Ministry of Natural Resources (MNR). Habitat is mapped to provide an inventory of the available habitats and to identify the locations of habitats that are of importance to fish, such as migration routes, spawning habitats and rearing habitats. During the 2010, 2011 and 2012 field seasons, these mapping protocols were applied to aquatic features potentially impacted by the project. Table 2 contains a summary of data/variables measured during habitat mapping. These variables are defined in Appendix A. Some variables are further broken down to classes (e.g., size ranges of gravel or cobble substrate) within the technical procedures. Physical features, their locations and/or distribution were measured and recorded on data sheets and field maps by field crews. GPS referenced digital photos illustrating channel/shoreline characteristics also have been collected for each aquatic feature. This information was used to create maps of each API. Interpretation of completed maps, field data sheets, photos, aerial photography and fish capture data (e.g., where capture data can be associated with a specific habitat type) was used to characterize and quantify habitat features in relation to the requirements of fish species present and their life history stages.

DRAFT

Table 2: Habitat Features and Variables Measured During Baseline Studies[1]

Habitat Features (waterbodies)	Channel Units (watercourses)	Habitat Features (watercourses)	Substrate Types
Littoral/limnetic zones	Falls	Shoal	organic material
Shelf	Cascade	Slough	clay/silt
Shoals	Chute	Log jam	Sand
Bottom slope	Rapids	Undercut banks	Gravel
Submerged vegetation	Riffle	Unstable banks	cobble
Emergent vegetation	Run	Inundated vegetation	boulder
Depth	Flat	Beaver dam	bedrock
Water Quality Parameters	Pool	Exposed bar	**Channel Unit Measures**
	Impoundment pool	Islands	Wetted width
Dissolved oxygen	Backwater	Bank/riparian vegetation	Channel width
Water temperature	Snye	Bank slope	Channel unit length
pH	Boulder garden	Gradient	Channel profile (depth)
		Overhead cover	Velocity
		Instream cover	

Notes:
1. Definitions for habitat variables can be found in Appendix A.

Habitat maps for the project have been created by overlaying Light Detection and Ranging (LiDAR) images of aquatic features with field data (Figure 3).

Stream segment lengths and widths measured for all watercourse segments in the field were used to determine stream area. Two types of stream width data were collected during the baseline study: wetted width and channel width. Wetted width or the width of the water present in the channel at the time of the survey varied with stream discharge, and measures were dependent upon when mapping took place (e.g., freshet vs. late summer, following rainfall events). Habitat areas within channel segments were calculated based upon segment length and measures of channel width, which is defined as the portion of the channel that contains stream bed substrate, whether wet or dry, and is bordered by rooted terrestrial vegetation (e.g., the width representative of the normal high water mark). Channel width is not dependent on stream discharge and does not vary as water level varies.

Littoral zone habitat was mapped on all lakes and ponds potentially impacted by the project (Figure 4). Digital elevation (e.g., bathymetry) and substrate maps were produced for natural lakes potentially impacted by the Project using single beam, sidescan sonar (Figure 5 and 6). For small ponds, spot depths and bottom grabs were collected during habitat mapping to determine general bathymetric and substrate characteristics.

The resulting datasets are extensive, covering a broad range of habitat variables and allow for a detailed description of fish habitats in both stream and lake settings. For the purpose of calculating habitat losses/gains, two approaches may be used:

- The approach used by Minns (2010) and Minns et al. (2001), which is to reduce the number of habitat variables, based on literature relating use to a simple set of variables – depth, substrate, cover, discharge.

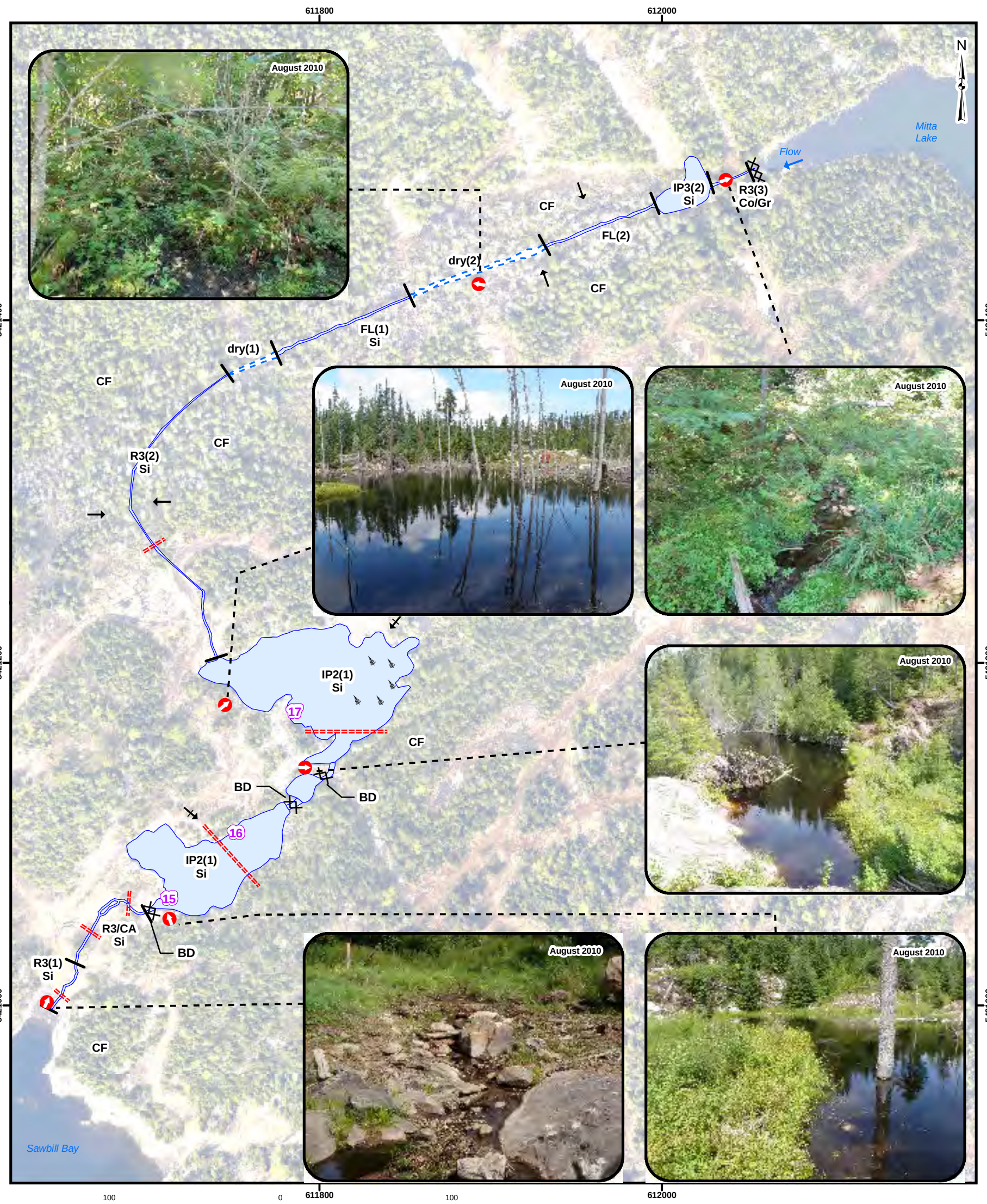
DRAFT

- The approach used in the HEP analysis, which is to utilize more of the collected habitat data but in a less objective, more descriptive manner.

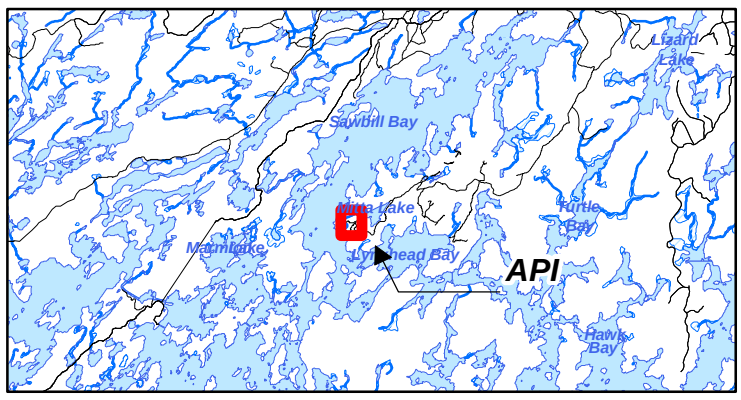
Golder is using the latter method, but with more attention given to using more standardized descriptions of habitat preferences for individual species (or species guilds), life cycle stages and ecotypes as developed in the Minns' lake and stream models.

The two papers by Minns et al. (2001) and Minns (2010) also completed an analyses of key habitat preferences that looked at grouping species according to trophic status, reproductive guild and thermal preference data, which was subsequently used in these documents as a means of grouping species into "habitat guilds" and assigning weights to the species habitat calculations. Golder has modified the selected approach by adopting these groupings (with a minor modification) to improve on the approach chosen for evaluation the project habitat losses and gains as outlined in the following sections.

DRAFT



Segment	Length (m)	Channel Width Transect (m)	Max. Depth a transect (m)	Substrate Dominant	Substrate Sub-dominant	In stream Vegetation
R3	34.42	1.04	0.03	Si	Sa	0
R3/CA	31.9	0.74	0.05	Si	-	25
IP2	254.19	65	1.5	Si	-	5
R3	206.23	0.75	-	Si	-	20
dry	30.68	-	-	-	-	-
FL	84.99	-	-	Si	-	-
dry	82.58	-	-	-	-	-
FL	67.95	-	-	-	-	-
IP3(1)	33.48	-	-	Si	-	-
R3	23.97	-	-	Co	Gr	-



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- Fish Effort Location
- Channel Unit Boundary
- Transects
- XXXX BD Beaver Dam (height m)
- IV Instream Vegetation

Bank Slope
← Shallow Slope (0 to 5%)

Channel Unit Type
- FL - Flat, Low Gradient, Low Velocity
- CA - Cascade; Extremely high gradient and velocity
- R3 - Run Class 2; Moderate quality/Depth (0.75-11.0m)
- IP2 - Impoundment Pool: Class 2
- IP3 - Impoundment Pool: Class 3

Substrate Classification
- Co - Cobble
- Gr - Gravel
- Sa - Sand
- Si - Silt

Riparian Vegetation
- CF - Coniferous Forest

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

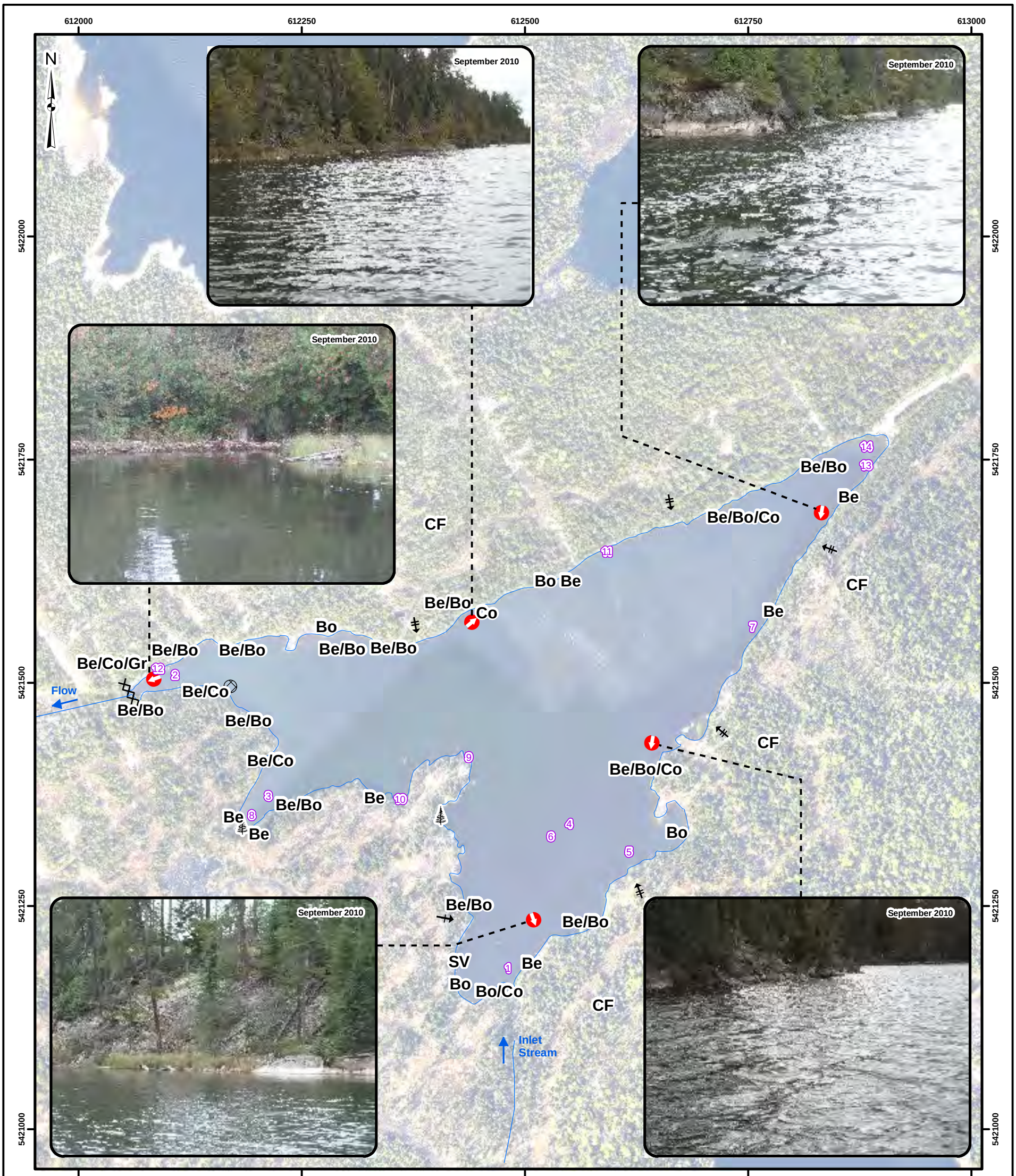
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 12 (STREAM)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	DM	21 Mar. 2012	FIGURE: 3	
GIS	DM	26 Mar. 2012		
CHECK	JD	August. 2012		
REVIEW	JS	August. 2012		

Path: C:\workspaceJohn_Seyler\API_12.mxd



LEGEND: Legend features may not occur on every map

- Photo Location & Direction
- # Fish Effort Location
- Woody Debris
- XXXX BD Beaver Dam (height m)
- Beaver Lodge
- EV Emergent Vegetation
- SV Submergent Vegetation

Bank Slope
- Shallow Slope (0 to 5%)
- Intermediate Slope (6 to 30%)
- Steep Slope (31 to 70%)

Riparian Vegetation
- CF - Coniferous Forest
- GF - Grass and Forbs
- SH - Shrubs

Substrate Classification
- Be -Bedrock
- Bo -Boulder
- Co -Cobble
- Gr -Gravel
- Sa -Sand
- Si -Silt

Bank Features
- Be -Bedrock

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 12
(MITTA LAKE)

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 4	
GIS	DM	10 Apr. 2012		
CHECK	JD	August. 2012		
REVIEW	JS	August. 2012		

Path: C:\workspaceJohn_Seyler\API_12_pond.mxd

612000 612250 612500 612750 613000

5422000 5421750 5421500 5421250 5421000

N

SCALE 1:4,500

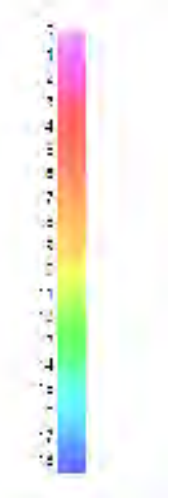
110 0 110 220

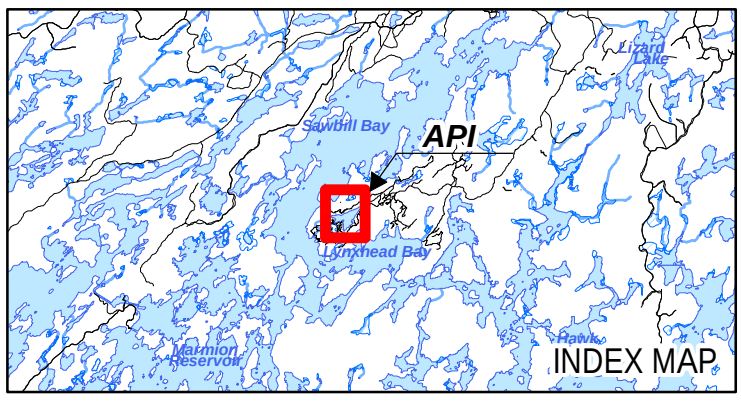
METRES

LEGEND:

- Ditch
- River/Stream
- Road
- Lake Bottom Contours - 1 m interval
- Lake Bottom Contours - 2 m interval

Depth of Lake Bottom (metres)





REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

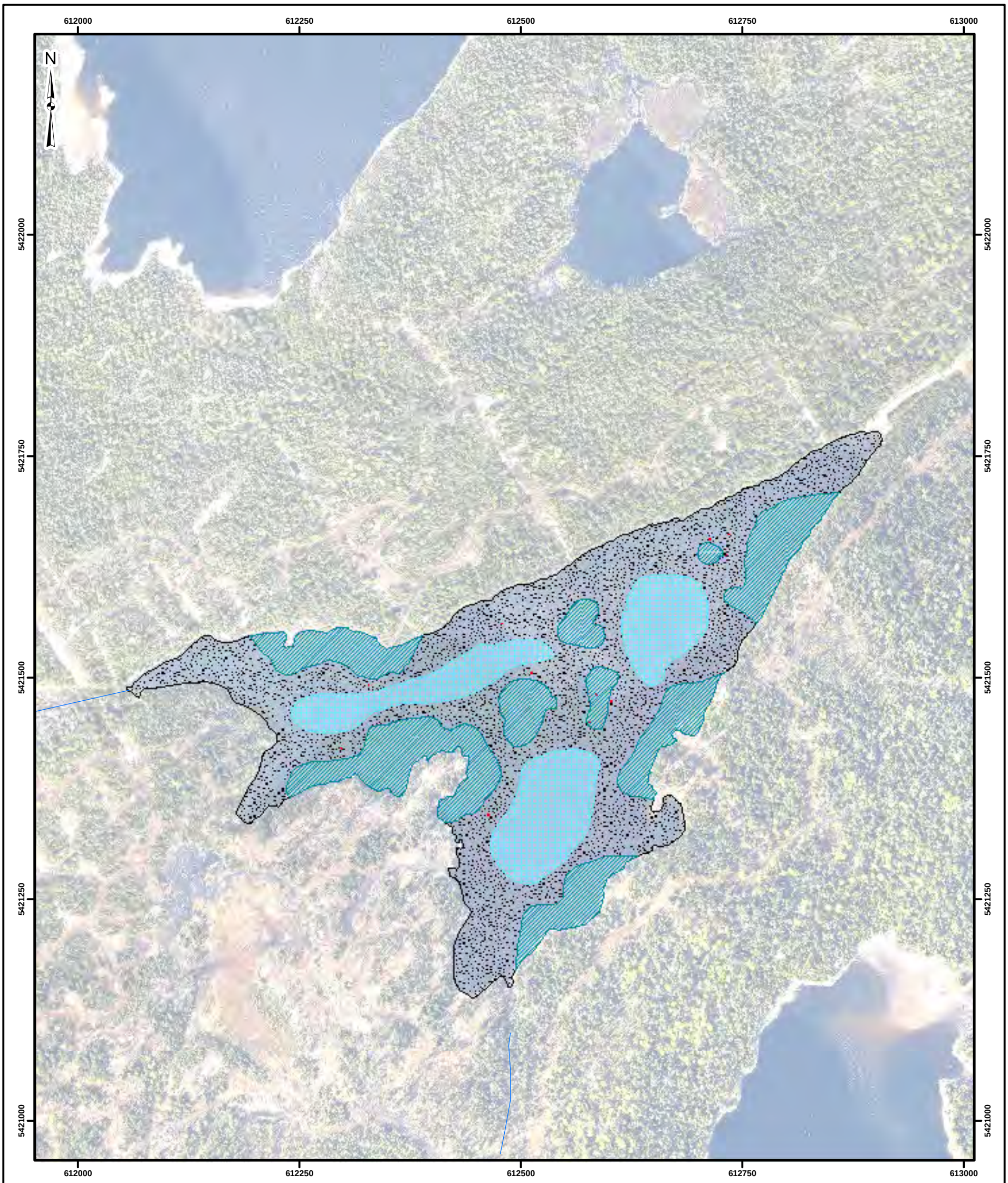
TITLE

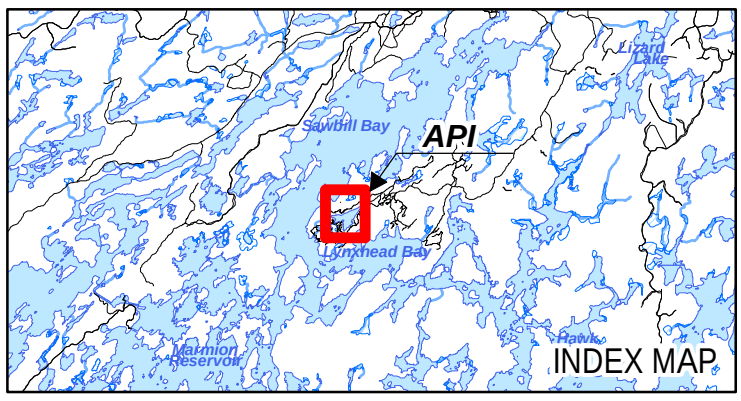
AREA OF POTENTIAL IMPACT 12 (MITTA LAKE) BATHYMETRY

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 5	
GIS	DM	10 Apr. 2012		
CHECK	JD	August. 2012		
REVIEW	JS	August. 2012		

Path: C:\workspace\John_Seyler\API_12_Bathymetry.mxd





LEGEND:

- Ditch
- River/Stream
- Road
- Boulders
- Shallow or Exposed Bedrock
- Fine Sediment
- Mixed Coarse and Fine Sediment

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

DRAFT

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREA OF POTENTIAL IMPACT 12
(MITTA LAKE) INTERPRETED LAKE
BOTTOM SUBSTRATE

Golder Associates
Mississauga, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	REV. 0
DESIGN	RRD	06 Jan. 2012	FIGURE: 6	
GIS	DM	10 Apr. 2012		
CHECK	JD	August. 2012		
REVIEW	JS	August. 2012		

Path: C:\workspace\John_Seyler\API_12_LakeBottomSubstrate.mxd

5.2 Fish Species Presence and Species Weighting

The objectives of the baseline fish sampling program were as follows:

- To establish what fish species and life history stages were present in each aquatic feature and catchment; and
- Identify fish frequented waters and non-fish bearing waters relative to project footprint.

Each aquatic feature was visited by field crews on multiple occasions during several open water seasons. No fish sampling was undertaken during the winter. Where habitat mapping has identified features (e.g., pools) that provide conditions consistent with overwinter requirements of fish species present, those features will be characterized as overwinter habitat.

A variety of gears were used to confirm fish presence and fish community composition. Passive gears were set for 18 to 24 hour periods and at a variety of depths in ponds and small lakes. Fishing gears included the following:

- Nordic nets;
- Standard experimental gill net gangs;
- Large and small mesh broadscale monitoring nets;
- Minnow traps;
- Backpack electrofishing;
- Boat electrofishing; and
- Observations in channels too narrow/shallow to effectively electrofish or set passive fishing gear.

Data recorded on catch records included location (GPS coordinates), time, date, gear type, depth, effort (metres shocked or hours fished), and the numbers and life history stage (fry, juvenile and adults) by species of all fish captured.

The 24 fish species listed in Table 3 were captured during aquatic baseline studies. This list reflects sampling results from watercourses and waterbodies that may be altered by the Project during construction, operation or closure of the pit, waste rock storage and tailings management areas. Species listed in Table 3 include seven species captured only in the Upper Marmion Reservoir and Lizard Lake. Fish inhabiting these features use habitat within the Project footprint seasonally (e.g., lower reaches of watercourses to reproduce). Fish community composition varies between catchments potentially affected by the project, and each catchment will be considered separately for the purposes of habitat accounting.

DRAFT

Table 3: Fish Species Captured During Baseline Studies

Family/Subfamily	Species Common Name	Species Scientific Name
Coregoninae	lake whitefish[1] cisco[1]	*Coregonus clupeaformis* *Coregonus artedi*
Umbridae	central mudminnow	*Umbra limi*
Esocidae	northern pike	*Esox lucius*
Cyprinidae	longnose dace[1] northern redbelly dace finescale dace pearl dace fathead minnow spottail shiner[1] blacknose shiner golden shiner[1.] brassy minnow golden shiner	*Rhinichthys cataractae* *Phoxinus eos* *Phoxinus neogaeus* *Margariscus margarita* *Pimephales promelas* *Notropis hudsonius* *Notropis heterolepis* *Notemigonis crysoleucas* *Hybognathus hankinsoni* *Notemigonus crysoleucas*
Catostomidae	common white sucker	*Catostomus commersoni*
Gadidae	burbot	*Lota lota*
Gasterosteidae	ninespine stickleback brook stickleback	*Pungitius pungitius* *Culaea inconstans*
Centrarchidae	smallmouth bass[1] pumpkinseed	*Micropterus dolomieu* *Lepomis gibbosus*
Percidae	walleye[1] yellow perch Iowa darter	*Sander vitreus* *Perca flavescens* *Etheostoma exile*
Cottidae	mottled sculpin	*Cottus bairdii*

Note:
[1] Captured only in Upper Marmion Reservoir and/or Lizard Lake

5.3 Species Guilds and Weighting

The assumption in designating guilds for the purpose of habitat accounting is that all member species share the same habitat requirements, vulnerabilities to habitat alteration and will benefit equally from proposed compensation measures.

To develop Species Habitat Weights (SHW), Minns et al. (2001) grouped fish into “habitat groups” using thermal preference and feeding ecology (i.e., piscivorous and non-piscivorous species). Using a more rigorous statistical approach, Minns (2010) undertook a similar analyses and grouped fish into habitat groups using thermal preference and spawning habitat preference. A key rule of this weighting procedure is that the sum of the individual weights for all species recorded for the area must sum to 1.0. For the purpose of weighting/grouping fish, Golder has adapted the latter approach and grouped the species present into a number of these guilds (Table 4)

DRAFT

Table 4: Fish Habitat Groupings

Habitat Group	Description	Piscivore	Non-Piscivore
Cold + A1 (lake)[1]	lake stenotherms		**Group 1**: lake whitefish, cisco
Cold + A1 (stream)[1]	stream stenotherms	**Group 3**: burbot	**Group 2**: pearl dace
Cold +A2	stream salmon, lamprey	N/a	N/a
Cold + B	sculpins, sticklebacks		**Group 4**: brook stickleback, ninespine stickleback
Cool + A1	percids, redhorses, darters, dace	**Group 6**: northern pike, walleye	**Group 5**: longnose dace, brassy minnow, finescale dace, northern redbelly dace, golden shiner, Iowa darter, yellow perch, white sucker
Cool + A2	nonguarding darters, chubs, lamprey	N/a	N/a
Cool + B	guarding darters, pomoxids	N/a	N/a
Warm + A	shiners,moronids, gars, suckers		**Group 7**: blacknose shiner, central mudminnow, emerald shiner, spottail shiner
Warm + B	centrarchids, minnows, bullhead	**Group 9**: smallmouth bass	**Group 8**: fathead minnow, pumpkinseed

Note:

[1] this was one category in Minns (2010), however, has been split into a lake versus stream grouping here.

This classification or grouping of fish resulted in nine categories, which were assigned weights as follows:

- Piscivores (3 categories): 0.5 (combined score); and
- Non-piscivores (6 categories): 0.5 (combined score).

In this way, piscivores are given the same proportional weight as non-piscivores. In addition, this approach also gives some consideration to relative abundance and biomass by assigning more weight to generally larger, though less abundant piscivores and less to non-piscivores. Minns (2010) also considered giving more weight to species considered to have "fishery potential" and well as "species richness". The former included species that were considered important as sportfish or commercial fish, which is also consistent with DFO's habitat priorities. Some adjustment in the weights for individual fish also was made to recognize their values to recreational and commercial fisheries. Final SHW's for each species are shown in Table 5.

DRAFT

Table 5: Species Habitat Weights (SHW) by Habitat Group

Group	Species	Weight
Group 1: Cold+A1-Lake: Non-Piscivore	lake whitefish	0.04
	cisco	0.04
Group 2: Cold+A1-Stream: Non-Piscivore	pearl dace	0.03
Group 3: Cold+A1-Stream: Piscivore	burbot	0.03
Group 4: Cold+B: Non-Piscivore	ninespine stickleback	0.013
	brook stickleback	0.013
	mottled sculpin	0.013
	brassy minnow	0.013
	finescale dace	0.03
	redbelly dace	0.03
	golden shiner	0.03
	longnose dace	0.013
	white sucker	0.03
	Iowa darter	0.013
	yellow perch	0.03
Group 6: Cool+A1: Piscivore	walleye	0.17
	northern pike	0.17
Group 7: Warm+B: Non-Piscivore	blacknose shiner	0.013
	emerald shiner	0.03
	spottail shiner	0.03
	central mudminnow	0.013
Group 8: Warm+B: Non-Piscivore	fathead minnow	0.03
	pumpkinseed	0.013
Group 9: Warm+B: Piscivore	smallmouth bass	0.17
Total		**1.00**

DRAFT

These SHWs were used as multipliers to adjust the final calculation of WUA totals for each API in each ecotype. Within each ecotype, streams and lakes were tallied separately. The overall habitat value of each ecotype is dependent on the same list of fish species and will be inherently sensitive to the hierarchy of fisheries identified in the *Fisheries Act*, i.e., sports and commercial species, First Nations species, baitfish, etc. With this weighting, ecotypes supporting piscivores generally will receive a higher ranking. For example, the habitat scores for Receivers would receive a higher HU score because of the presence of walleye and smallmouth bass, compared to Lakes and Warmwater Streams. Only fish that were captured within each ecoptype were ranked in terms of the existing habitat; as such, fish that were not present did not contribute to the total weighted useable area.

5.4 Ecotypes and Fish Community Composition

Aquatic APIs in the study area can be classified into distinct ecological types (eco-types). These are as follows:

- Lake Ecotype (e.g., Mitta Lake and API #2): surrounded by natural shoreline features, diverse substrates and habitats (i.e., deeper than 5 m and may include several basins); generally support diverse fish communities relative to other eco-types;
- Headwater Ponds Ecotype: including their inflows and outflows (e.g., API #6, #7, #11, #13 #69); generally shallow (i.e., <2 m deep) with outflows/water elevation controlled by beaver dams, substrate consists of silt, organic material, may be partially infilled and/or contain flooded terrestrial vegetation. Many of the headwater ponds assessed during baseline studies were found to be fishless;
- Warm Water Stream Ecotype: shallow to steep gradient channels with interspersed beaver impoundments (e.g., API #1, #14, #47, #48), excluding lower reaches;
- Seasonal or Intermittent Stream Ecotype: portions of some streams have no defined channels. In these locations flows are conveyed periodically through flooded forest areas in response to precipitation events. Some streams have been characterized as seasonal (i.e., have defined channels but are dry for extended periods), because stream flow is largely dependent on precipitation generated runoff;
- Inflows to Receiving Waters Ecotype: the lower reaches of warm water streams, some of which are used by fish in the receiving waterbodies as spawning and/or nursery habitat. Juvenile white suckers, northern pike and yellow perch were captured in the lower segments of some streams flowing into the Upper Floodwaters and Lizard Lake. The lower reaches of the streams in which these species were documented tend to be flat and are likely accessible to fish from receiving waters during periods of high flow/water elevation. Some of these inflows are not accessible to fish from downstream receivers due to steep cascades located at their mouths; and
- Receiving Waters Ecotype: Upper Flood Waters (including Sawbill Bay, Lynxhead Bay and Turtle Bay), Lizard Lake and API #8.

Table 6 summarizes fish species assemblages, by ecotype, in all APIs assessed during baseline studies.

The potentially impacted portion of each API will be partitioned into homogenous habitat patches. For lakes, headwater ponds and receiving waters, these will be defined as littoral area (extending from the high water mark to 3 m depth), and the open water/metalimnion (the area inside the 3 m contour). For permanent, seasonal and intermittent streams, habitat patches will be defined as ponds (permanently impounded areas), shallow gradient, pool/riffle channel and high gradient (i.e., cascade) channel segments.

A productive capacity index (PCI) (Minns 2010) was applied to each habitat patch within each ecotype to factor in differences in productivity of each, and their contributions to downstream aquatic features. PCI designations are 1.0 for lakes, headwater ponds and receiving waters, 2.5 for warm water streams and inflows to receiving waters and 0.75 to seasonal and intermittent streams. The value 0.75 was chosen for intermittent features to recognise, not so much that their productive capacity is lower than permanent streams, but rather to recognize that they only provide direct habitat for fish during a portion of the year (roughly one third of the year).

Once the WUA for each Ecotype is determined for each API, it is multiplied by the PCI to give an Ecotype Weighted Useable Area (EWUA). This value provides a means of more directly comparing Ecotypes,

DRAFT

recognizing the differences in productive capacity and can be used to assist in determining compensation where "like for like" compensation cannot be achieved.

5.5 Species Associations by Ecotype

A summary table was prepared (Table 6) that lists all of the species found within each ecotype. In general, this shows that species such as walleye, smallmouth bass, lake whitefish and cisco are restricted to receivers, and that there are a number of fishless waterbodies, both streams and lakes.

DRAFT

Table 6: Fish Community Composition by Ecotype

API Number	Fish Species Present																					
	lake whitefish	cisco	central mudminnow	northern pike	longnose dace	northern redbelly dace	finescale dace	pearl dace	fathead minnow	spottail shiner	blacknose shiner	golden shiner	brassy minnow	white sucker	burbot	ninespine stickleback	brook stickleback	smallmouth bass	pumpkinseed	walleye	yellow perch	Iowa darter	mottled sculpin
Ecotype: Lakes																							
Mitta L.						X	X		X					X		X	X					X	X
#2				X										X		X			X		X		
#46[1]							X		X														
#45[1]				X										X					X		X		
#47[1]							X	X															
Ecotype: Headwater Ponds																							
#6	Fishless																						
#7	Fishless																						
#4[1]						X	X																
#5[1]						X	X																
#11						X	X		X														
#13	Fishless																						
#10[1]	Fishless																						
#15[1]	Fishless																						
#16[1]	Fishless																						
#17						X	X		X														
#43[1]	Fishless																						
#44[1]	Fishless																						

DRAFT

Table 6: Fish Community Composition by Ecotype (Continued)

API Number	Fish Species Present																						
	lake whitefish	cisco	central mudminnow	northern pike	longnose dace	northern redbelly dace	finescale dace	pearl dace	fathead minnow	spottail shiner	blacknose shiner	golden shiner	brassy minnow	white sucker	burbot	ninespine stickleback	brook stickleback	smallmouth bass	pumpkinseed	walleye	yellow perch	Iowa darter	mottled sculpin
#48	Fishless																						
#69						X	X																
Ecotype: Warm Water Streams																							
#1							X		X														
#2			X																				
#3[1]				X		X	X																
#4[1]						X	X																
#5[1]						X	X																
#9[1]			X						X														
#6	Fishless																						
#7	Fishless																						
#10	Fishless																						
#11						X	X																
#14						X	X		X														
#15[1]	Fishless																						
#16[1]	Fishless																						
#40[1]				X										X									
#47							X	X															
#44[1]							X							X									

DRAFT

Table 6: Fish Community Composition by Ecotype (Continued)

API Number	Fish Species Present																					
	lake whitefish	cisco	central mudminnow	northern pike	longnose dace	northern redbelly dace	finescale dace	pearl dace	fathead minnow	spottail shiner	blacknose shiner	golden shiner	brassy minnow	white sucker	burbot	ninespine stickleback	brook stickleback	smallmouth bass	pumpkinseed	walleye	yellow perch	Iowa darter	mottled sculpin
#46[1]							X	X															
#43[1]	Fishless																						
#69	Fishless																						
Ecotype: Seasonal and Intermittent Streams																							
API #48							X																
Ecotype: Inflows to Receiving Waters																							
#1							X		X					X	X								
#6				X										X								X	
#8				X										X									
#10				X										X							X		
#11						X	X																
#12						X	X		X					X									
#13	Fishless																						
#14						X	X		X				X	X									
#40[1]				X										X									
#41[1]				X																			
#44																					X	X	
#49[1]				X							X			X							X	X	
#50[1]				X										X									

DRAFT

Table 6: Fish Community Composition by Ecotype (Continued)

API Number	Fish Species Present																					
	lake whitefish	cisco	central mudminnow	northern pike	longnose dace	northern redbelly dace	finescale dace	pearl dace	fathead minnow	spottail shiner	blacknose shiner	golden shiner	brassy minnow	white sucker	burbot	ninespine stickleback	brook stickleback	smallmouth bass	pumpkinseed	walleye	yellow perch	Iowa darter	mottled sculpin
#69	Fishless																						
Ecotype: Receiving Waters																							
Upper Reservoir	X	X		X						X	X	X		X	X			X		X	X	X	
Lizard Lake		X		X	X					X	X			X	X			X	X	X	X	X	X
#8				X										X	X			X					

Note:
[1] Assessed, will not be affected by the Project

DRAFT

5.6 Habitat Classes and Habitat Sensitivity Weighting

The draft guidelines for the preparation of the Project EA requires that habitats for each potentially affected species be characterized as spawning, rearing/nursery, feeding, migratory corridor and overwintering/summer refuge habitats (Canadian Environmental Assessment Agency 2011). These habitat classes have been adopted for NNL Planning and are defined as follows:

- Spawning habitat is used by fish for the specific act of reproduction;
- Nursery/rearing habitat is used by developing embryos and YOY and sub-adult fish for foraging and refuge from predators;
- Feeding habitat is used by adult fish for feeding or periods between feeding events;
- Overwintering/summer refugia are used by YOY, sub-adult and adult fish to survive periods of hostile conditions (e.g., flows and water temperature extremes); and
- Migratory corridors are used by fish to access important habitats described above.

A conservative approach to classifying specific habitats was used. No specific studies to document spawning activity or overwintering locations were undertaken during baseline studies. For the purpose of habitat classification, it was assumed that stream or lake habitat segments possessing characteristics consistent with habitat requirements of fish species or guilds of fish are spawning or overwintering habitats. Habitats identified as one of the five types listed above were rated equally (i.e., no type(s) of habitat were valued higher than others). The Habitat Unit Score (HU score) is the unweighted average of the life stage specific HSI scores.

Appendix B provides descriptive summaries of life stage habitat requirements for all species. In addition to assigning an HSI score for each life stage for each species, the weightings based on the fish grouping adapted from Minns et al. (1991) and Minns (2010), because they are linked to some common habitat features in common, i.e., thermal preference, feeding strategy, reproductive strategy, will also serve to strengthen the habitat linkages.

5.7 Calculation of Weighted Useable Area Scores

Habitat loss and gain was calculated based on a HEP type of approach (U.S. FWS 1980; 1981). The premise of the HEP approach is that an area of aquatic habitat can be composed of a variety of habitat types (e.g., deep pools, shallow riffles) and that these habitat types will have differing levels of suitability for species that may occur in that habitat area. Recommended steps to perform a HEP analysis include identification of impacted areas, delineation of cover types, selection of evaluation species, calculation of total area of available habitat, and the calculation of a habitat suitability index for available habitat.

Habitat suitability relationships describing spawning, rearing/nursery, feeding, migratory corridor and overwintering/summer refuge habitats for each of the species listed in Table 2 have been derived using

DRAFT

published HSI models, technical papers and other environmental impact assessments completed by Golder (Appendix B). References consulted for the development of habitat suitability relationships include the following:

- Life History Characteristics of Freshwater Fishes Occurring in Newfoundland and Labrador, with Major Emphasis on Lake Habitat Requirements (Bradbury et al. 1999).
- Synopsis of biological data on the walleye (Colby et al. 1979).
- Habitat suitability information: Smallmouth bass (Edwards et al. 1983).
- Fish Species Habitat Suitability Index Models for the Alberta Oil Sands Region (Golder 2008).
- Fish use of wetlands in northwestern Ontario: A literature review and bibliography (Hall-Armstrong et al. 1996).
- Habitat suitability index models: Northern pike (Inskip 1982).
- Literature review on fishes interactions with aquatic macrophytes with special reference to the Upper Mississippi River system (Janacek 1988).
- Walleye Habitat: A Synthesis of Current Knowledge with Guidelines for Conservation Ontario. Ministry of Natural Resources (Kerr et. al. 1997).
- Life History Characteristics of freshwater Fishes Occurring in Manitoba, Saskatchewan and Alberta, with Major Emphasis on Lake Habitat Requirements (Langhorne et al. 2001).
- Ecological significance of vegetation to northern pike, *Esox lucius*, spawning (McCarragher et al. 1972).
- Habitat suitability information: walleye (McMahon et al. 1984).
- Riverine Habitat Characteristics of Fishes of the Great Lakes Watershed (Portt et al. 1999).

For the purpose of habitat accounting, an ordinal ranking system was used to rank the quality of spawning, rearing/nursery, feeding, migratory corridor and overwintering/summer refuge habitats based on field data, as “optimal” (2 categories), “sub-optimal” (1 category) or “unsuitable” (2 categories). These rank categories correspond with SI values of 1.0, 0.75, 0.5, 0.25 and 0.0, for each habitat type, respectively.

The assignment of HSI scores for each species and for each life stage is based on an assessment of the habitat in each feature based on the species habitat preference table and the descriptive summary (including maps and descriptive information) provided in the factsheets for each API in the Interim Baseline Report (Golder 2012). Scoring of the HSI for each life stage takes into consideration the following:

- Within the habitat type, for example littoral zone and open water zone for lake ecotypes, the approximate area of suitable habitat. For example, in the case of spawning habitat for white sucker, the amount of suitable spawning habitat may only be a portion of the total littoral zone;

DRAFT

- For the suitable habitat present, the quality of this habitat for the specie's life stage, for example, there may be suitable nursery habitat present for white sucker, but it may be rated as poor because of the lack of cover in the form of macrophyte growth or coarse substrates that provide refuge. Other factors affecting the quality of the habitat could include inadequate depth, cover, flow or substrate conditions;
- For the suitable habitat present, there may be a number of other constraints that would lower the suitability/availability of the habitat, for example:
  - The presence of predator species or competition may be considered as a factor that reduces the suitability or availability of the habitat
  - The potential for mid-summer or winter anoxia to exist, which would limit access to the habitat or result in mortality to fish using the habitat
  - Seasonality of the habitat: access to the habitat may be limited by the seasonality/permanence of stream flows or by seasonal water level fluctuations in ponds or lakes (for example the fluctuations on Upper Marmion Reservoir imposed by the operating regime of the Raft Lake dam)
  - Barriers to fish movement or isolation of habitat: In some cases, this aspect of habitat may be addressed under the Migration SI component of a species' HSI score, which refers to species that undertake long, specific, directed migrations, for example, walleye. However, a number of species do not undertake such migrations and all species undertake smaller migrations during their life for feeding, overwintering, seeking refuge from predators, etc. For example, a stream may be partitioned into a number of segments by complete or partial fish barriers (beaver dams, falls, rapids, cascades, debris jams). which at least partially isolate fish populations. The suitability of a stream with barriers would score lower than one without, even if the fish species was not a typical "migrating species", for example, fathead minnow, finescale dace, or Iowa darter.
  - Other thermal or chemical limitations: the presence of a thermocline or portions of habitat that are in waters with a thermal regime outside of that of the species may reduce habitat suitability, for example, smallmouth bass may be limited to shallow waters if deep, offshore waters are too cold. There may also be conditions were contaminants in water/sediment render them unsuitable for fish.

Table 7 provides an example of the rationale and HSI scoring for two fish species in Mitta Lake and API#2. In both cases, the resultant combined scoring for white sucker and northern pike is greater than the scoring for individual scores for either spawning or nursery habitat.

Table 7: Example of HSI scores for two fish species

API/Species	Life Stage	HSI Score	Rationale
Mitta Lake – White Sucker	Spawning	0.25	Habitat exists in both littoral and open water habitat units. There is limited suitable habitat area for the life stage in the habitat unit. Habitat quality is poor

DRAFT

Table 7: Example of HSI scores for two fish species (Continued)

API/Species	Life Stage	HSI Score	Rationale
	Nursery	0.25	Habitat exists in both littoral and open water habitat units. There is limited suitable habitat area for the life stage in the habitat unit. Habitat quality is poor due to lack of cover and sparce macrophytes. Habitat productivity is generally low
	Feeding	0.5	Habitat exists in both littoral and open water habitat units. There is fairly abundant suitable habitat area for the life stage in the habitat unit. Habitat quality is moderate due to limited littoral areas, thermocline effects and sparce macrophytes. Habitat productivity is generally low
	Over-wintering	0.5	Habitat exists in both littoral and open water habitat units. There is fairly abundant suitable habitat area for the life stage in the habitat unit. Habitat quality is moderate due to limited littoral areas, probable winter oxygen limitations and sparce macrophytes. Habitat productivity is generally low
	Migration	na	
Total HSI score		0.35	
API#2 – northern pike	Spawning	0.5	Habitat exists in both littoral and open water habitat units. There is moderate amount of suitable habitat area for the life stage in the habitat unit. Habitat quality is good, but macrophytes are sparce
	Nursery	0.5	Habitat exists in both littoral and open water habitat units. There is moderate amount of suitable habitat area for the life stage in the habitat unit. Habitat quality is poor to moderate due to lack of cover and sparce macrophytes. Habitat productivity is generally low
	Feeding	0.75	Habitat exists in both littoral and open water habitat units. There is fairly abundant suitable habitat area for the life stage in the habitat unit. Habitat quality is good due to abundance of prey, but some limitations in terms of possible thermocline effects and sparce macrophytes. Habitat productivity is generally low
	Over-wintering	0.5	Habitat exists in both littoral and open water habitat units. There is fairly abundant suitable habitat area for the life stage in the habitat unit. Habitat quality is good due to abundance of prey, but some limitations; probable winter oxygen limitations and sparce macrophytes. Habitat productivity is generally low
	Migration	na	
Total HSI score		0.60	

For each of the watercourse segments and waterbodies that will be affected by the Project, habitat suitability was assigned using species-specific habitat suitability relationships for fish species present. In addition to the

DRAFT

descriptive information for each species and life stage described in Appendix B, consideration was be given to the key habitat criteria described in the lake model described by Minns et al. (2001) and the stream model described by Minns (2010). These methodologies emphasis substrate, depth, cover and discharge (stream model only). The quantification of WUAs takes into account the following:

- Fish habitat mapping data;
- A general description of habitat conditions, the qualitative assessment of habitat use potential and the documented fish use;
- Fish species presence and distribution data; and
- Species guild associations.

The following is the general formula for calculating WUA and EWUA:

$$WUA = (HA * (SUM_{1-24} (SHW_1 * HU_1) + (SHW_2 * HU_2) + ... + (SHW_{24} * HU_{24}))$$

$$EWUA = WUA * EPCI$$

Where:
WUA = Weighted Useable Area
HA= Available Habitat Area
SHW= Species Habitat Weight
HU = Average Habitat Suitability score
EWUA = Ecotype Weighted Useable Area
EPCI = Ecotype Productive Capacity Index

The calculation of WUAs for each aquatic feature affected by the Project follows these steps:

- The quantification of habitat areas (m^2) for each aquatic feature (API) in each Ecotype affected by the Project;
- Characterization of affected habitat within each ecotype into homogenous habitat patches;
- The application of species valuation (HSI and species weightings) to each habitat patch and calculation of total Useable Weighted Area for each API and each ecotype;
- The determination of each habitat class in each aquatic feature, based on species guilds and life cycle stages;
- The assignment of HSI values for each of the species or guilds present;
- The calculation of the Weighted Useable Area for each Ecotype Habitat unit;
- The application of productive capacity index (CPI) to each API within each Ecotype; and
- Sum all WUA values of aquatic features affected by the Project by Ecotype and sum these to determine total habitat losses (HADD) due to the Project.

DRAFT

For each affected watercourse segment and waterbody, multiplication of the habitat area (surface area in m^2) by the habitat quality (as represented by the HSI assignments) results in the derivation of WUAs. Based on the applied methods, the derived WUAs represent the overall value of the habitat for fish species that are present or could reasonably be expected to be present.

Fish habitats within the Upper Marmion Reservoir and along corridors were included in habitat loss accounting. The normal, summer water elevation of 415.2 m above sea level[1] was used to establish the location of the boundary between the Upper Reservoir and inflowing streams.

Habitat areas, HSI values and calculated HUs for each of the relevant fish species within the affected watercourse segments and waterbodies was presented in habitat accounting spreadsheets. Table 7 summarizes the preliminary results of an example of a WUA spreadsheet used to calculate habitat loss for two APIs in one Ecotype, and Appendix C contains the full spreadsheet. Appendix B summarizes the habitat preferences for all species found in the study area according to life stage that was used to rank the habitat for each species. An identical procedure was used to calculate habitat gains associated with habitat compensation works.

It is important to note that the resultant WUA's and EWUA's, while linked to the total areas of the habitat units within each ecotype, represent a species weighted score that will always be less than the absolute area of the habitat unit being evaluated. However, since the same approach is applied to both the habitat losses and the habitat gains, the model provides an effective method of applying DFO habitat principles. This is also consistent with Minns (2010) and Minns et al. (2001).

Table 8: Example of WUA Calculation of Two APIs Showing Estimates of Habitat Losses

Total Area	Available Habitat Area (HA)	Number of Species Present	Total Weighted Useable Area (WUA)	Ecotype Weighted Useable Area (EWUA)
API # 12 172,737 m^2				
Littoral	8,891 m^2	8	397 HU	397 HU
Open Water	163,846 m^2	8	7,311 HU	7,311 HU
API # 2 124,351 m^2				
Littoral	5990 m^2	5	632 HU	632 HU
Open Water	118,361 m^2	5	9,476 HU	9,476 HU
Total			17,816 HU	

[1] Normal high water elevation provided by MNR (Jackson 2012, pers. comm.)

DRAFT

The key differences between API #12 and API #2 that contribute to the habitat scores are as follows:

- API #12 has a similar Littoral Habitat Unit as API #2 and a much smaller Open Water Habitat Unit.
- API #2 has fewer species, but has more predators and sportfish present than API #12.
- The productive capacity index for lake ecotypes is 1; therefore, there is no difference between the WUA and the EWUA.
- The destruction of Mitta Lake results in the loss of 397 HU of littoral habitat and 7,311 HU of open water habitat, compared to the loss of 632 HU of littoral habitat and 9,476 HU of open water habitat for API #2.

6.0 SUMMARY OF HABITAT LOSSES

Using this model, and reviewing the APIs affected by the mine footprint, Table 9 shows the area of each API affected and the corresponding HU (WUA) values.

DRAFT

Table 9: Aquatic APIs affected by Project Footprint

Infrastructure Feature	Aquatic API	Description	Description of Potential Impact
Open Pit	■ Mitta Lake (API #12) and its outlet stream	■ 17.2737 ha Headwater lake; approximately 0.0449 ha of Lower Reach - stream; empties into Sawbill Bay; supports white sucker (*Catostomus commersoni)*, ninespine stickleback (*Pungitius pungitius)*, brook stickleback (*Culaea inconstans*), fathead minnow (*Pimephales promelas)*, Iowa darter (*Etheostoma exile)*, mottled sculpin (*Cottus bairdii*) and finescale dace (*Phoxinus neogaeus)*.	■ Mitta Lake forms the active pit. The destruction of Mitta Lake results in the loss of 396 HU of useable littoral habitat and 7,311 HU of useable open water habitat.
	■ API #14	■ Upper portions of approximately 0.1169 ha Lower Reach stream; empties into Sawbill Bay; supports brassy minnow (*Hybognathus hankinsoni),* finescale dace, northern redbelly dace (*Phoxinus eos)*, fathead minnow; juvenile common white sucker captured in lower reach.	■ API #14 will be removed for the construction of the Support and Ancillary Structures near the open pit. Destruction of API #14 results in a loss of 45 HU of useable low gradient stream habitat and 119 HU of useable high gradient stream habitat.
	■ API #69	■ 0.9871 ha Headwater pond and 0.0165 ha of Headwater stream; pond supports white sucker, pearl dace, Iowa darter, brassy minnow, central mudminnow (*Umbra limi*), blacknose shiner, finescale dace and northern redbelly dace. No fish were found to exist within the outlet stream.	■ Headwater pond and upper reaches of API #69 will be destroyed through the construction of the open pit. Destruction of API #69 results in a loss of 224 HU of useable littoral habitat, 1080 HU of useable open water habitat.

DRAFT

Table 9: Aquatic APIs affected by Project Footprint (Continued)

Infrastructure Feature	Aquatic API	Description	Description of Potential Impact
Other Mine Facilities	■ Sawbill Bay	■ Localized filling within the drawdown zone along Hammond Reef peninsula to provide adequate space for mine buildings, parking, etc. approximately 0.8 ha of seasonal habitat within the drawdown zone will be destroyed. Area provides seasonal nursery/foraging habitat for baitfish species, northern pike, smallmouth bass	■ About 0.8 ha of the drawdown zone along the Hammond Reef peninsula Shoreline will be destroyed. Resulting loss of about 1200 HU of useable habitat destroyed
Mine Water Spill Emergency Pond	■ API #13	■ 1.9375 ha Headwater pond; approximately 0.0396 ha of Headwater stream and 0.0476 ha of Headwater beaver impoundments; both pond and stream are fishless. Empties into Lynxhead Bay.	■ No useable habitat will be lost through the destruction of API #13 for purposes of Support and Ancillary Structure development.
Waste rock Stockpile	■ API #11	■ 2.7777 ha Headwater pond; approximately 0.0787 ha of Headwater stream including (several) 0.1030 ha of beaver impoundments; empties into Lynxhead Bay; supports finescale dace, northern redbelly dace, fathead minnow.	■ API#11 will be destroyed through the construction of the Waste Rock Stockpile. 32 HU of useable low gradient stream, 13 m of useable high gradient stream, 58 HU of useable pond, 173 HU of useable littoral and 1701 HU of useable open water habitat will be lost.

DRAFT

Table 9: Aquatic APIs affected by Project Footprint (Continued)

Infrastructure Feature	Aquatic API	Description	Description of Potential Impact
Tailings Management Facility	■ API #47	■ Approximately 0.0762 ha of Lower Reaches – Inlet stream and 2.9944 ha of beaver impoundments; supports finescale dace, pearl dace (*Margariscus margarita),* and northern redbelly dace.	■ The streams and beaver impoundments of API #47 will be impacted by the proposed Tailings Management Facility. This will result in a loss of 11 HU of useable low gradient habitat, 34 HU of useable high gradient habitat and 1824 m^2 of useable pond habitat.
	■ API #48	■ Approximately 0.0123 ha of Headwater - ephemeral/seasonal stream, 0.0430 ha of Headwater - permanent stream and several Headwater beaver ponds (1.0198 ha total); approximately 0.2051 ha Headwater pond; no hydraulic connection to downstream aquatic features. Finescale dace captured in one of the beaver ponds.	■ The outlet stream and associated beaver impoundments will be impacted by the proposed TMF. This will result in the loss of 239 HU of useable pond habitat.
	■ API #1	■ Approximately 0.0894 ha of Lower Reaches – inlet stream, including 0.5836 ha of beaver impoundments; empties into Sawbill Bay; upper sections support pearl dace, finescale dace and fathead minnow; juvenile and young-of-the-year (YOY) white sucker captured in lower sections.	■ API #1 is entirely contained within the footprint of the TMF and, thus, will be destroyed. This will result in the loss of 266 HU of useable low gradient habitat, 21 HU of useable high gradient habitat, and 2722 HU of useable pond habitat.
	■ API #7	■ 1.0962 ha Headwater pond; partially in-filled; fishless; connected to API #6 by a series of small, Headwater beaver ponds (approximately 0.0721 ha).	■ Though API #7 will be destroyed by the proposed TMF, no useable habitat will be eliminated since the feature is fishless and isolated from API #6.

DRAFT

Table 9: Aquatic APIs affected by Project Footprint (Continued)

Infrastructure Feature	Aquatic API	Description	Description of Potential Impact
	■ API #6	■ 0.5385 ha pond, 0.0437 ha of Lower Reahes – inlet stream, and 0.1004 ha of Lower Reaches - ephemeral stream; empties into Lizard Lake; pond and ephemeral stream are fishless; white sucker and Iowa dater captured in lower segment of stream.	■ API #6 is contained within the footprint of the proposed TMF. This will result in the loss of 21 HU of useable low gradient stream habitat.
	■ API #2	■ 12.4351 ha Headwater lake and 0.2217 ha of Headwater stream and 0.3808 ha of Headwater beaver impoundments; supports pumpkinseed (*Lepomis gibbosus)*, northern pike, yellow perch (*Perca flavescens)*, Iowa darter (*Etheostoma exile),* white sucker, blacknose shiner (*Notropis heterolepis)*.	■ The destruction of API #2 results in the loss of 632 HU of useable littoral habitat and 9476 HU of useable open water habitat.
Corridors	■ Water crossing locations along the Hardtack, Sawbill access roads, and site access road (API 20-23 and 63-68)	■ 14 Culvert locations; movement of fish between waterbodies located up/downstream of water crossings.	■ Impacts to surface water features contained within road crossing API include alteration of the stream channel at the location of the culvert. Potential for HADDs at each crossing will be assessed once culvert design specifications are developed

1 HU here refers to Weighted Useable Area (WUA) as calculated by the Habitat Accounting Model.

Table 9 presents the primary effects on aquatic habitat of the project. In summary, the following habitat losses result for each of the habitat VECs:

- Receivers: There is 0.8 ha of seasonal habitat within the drawdown zone of Sawbill Bay lost, representing about 1200 HUs of seasonal habitat for baitfish, northern pike and smallmouth bass.
- Lower Reaches: There are 3.9491 ha of inlet streams, 0 ha of lakes and 0.5385 ha of ponds that provide habitat for baitfish.
- Headwaters: there are 1.8635 ha of headwater streams, 29.7088 ha of lakes (API #12 and #2), and 3.7648 ha of ponds that provide habitat for baitfish and northern pike.
- There are 14 stream crossings or crossing upgrades on the proposed access road that will result in the loss of habitat within the footprint of the culvert/bridge structure. This represents habitat for baitfish and northern pike.
- There are also several ephemeral streams and a number of fishless headwater ponds and Headwater streams.

A fish Habitat NNLP was prepared to offset the effects of these habitat losses. A summary of the NNLP habitat offsets is presented in Section 7.0.

7.0 COMPENSATION APPROACHES

The selection of the habitat compensation approach was based upon the hierarchy of compensation preferences as outlined in DFO Policy for Management of Fish Habitat (DFO 1986) and the *Practitioners Guide to Habitat Compensation* for DFO Habitat Management Staff (DFO 2006). The preferences for habitat compensation are summarized as follows, in order of priority:

- Creation of similar habitat at or near the Project site within the same ecological unit; that is, replace natural habitat with the same type of habitat at or near the Project.
- Create similar habitat in a different ecological unit that supports the same stock or species.
- Increase the productive capacity of existing habitat at or near the development site and within the same ecological unit.
- Increase the productive capacity of a different ecological unit that supports the same stock or species.
- Increase the productive capacity of existing habitat for a different species of fish either on or off site.

The Project NNLP is consistent with management direction provided in various existing management planning documents. The Hammond Peninsula and Marmion Lake watershed lie within MNRs current Fisheries Management Zone (FMZ) 5, which supports important First Nation, recreational, commercial and tourism based

DRAFT

fisheries. The MNR and the FMZ 5 Fisheries Advisory Council are currently developing a Fisheries Management Plan (FMP) that will include fisheries objectives to ensure resource sustainability and optimize angling opportunities. It is unlikely that the FMP objectives will be finalized in time for inclusion in the NNLP. However, if the development of additional habitat compensation measures is required in the future, FMP objectives will be taken into account.

The Atikokan District FMP, 1988 to 2000, provided management direction for sport fisheries within the former MNR Atikokan Administrative District (MNR 1989). Although this plan has expired and fisheries management objectives have not been updated, it continues to provide MNR fisheries management guidance to address issues and mitigate impacts until a new Fisheries Management Zone 5 plan is prepared. Habitat compensation options adopted in the Project NNLP will be consistent with the direction provided by this plan.

Fish community objectives for the Seine River system have been developed by the MNR to identify objectives for known and potential fish species that may be affected by current and future development on the Seine River, including the Project (MNR 2012). The broad objective for the Seine River system is ***to maintain or enhance a healthy aquatic ecosystem structure and function that supports a diverse and sustainable fish community in the Seine River, thereby providing for optimum contribution of fish, fishing opportunities and associated cultural, social, and economic benefits to society.***

The fish community objective is ***to protect, maintain, or enhance genetic, species, and aquatic ecosystem diversity in the Seine River characterized by healthy, sustainable, naturally-reproducing native fish populations and viable fisheries.*** This fish community objective is consistent with existing goals and concepts outlined in both Ontario's Crown Land Use Policy Atlas (MNR 2007), the Atikokan District FMP (MNR 1989) and the Fort Frances District FMP (MNR 1987),which are relevant until replaced by management planning in FMZ 5.

Assessment of potential onsite and near-site locations for compensation projects was completed in 2012. The anticipated HUs gained through habitat compensation were calculated using the methods described above.

Assessment of compensation options included the following:

- Potential for impoundment of former beaver ponds that have reverted to meadows to create pond habitat and the potential to introduce large and small bodied fish species into ponds that were determined to be fishless, during baseline studies. Several options for these forms of habitat enhancement have been identified on and offsite (Figure 7);
- Assessment of onsite APIs found to be fishless during baseline studies to determine their potential for fish introduction; and
- Examination of existing water crossings to determine if fish passage or adjacent habitat can be enhanced/ created.

DRAFT

610000 620000 630000

5430000

5420000

N

Serpent Lake

Cornell Lake

EXPLORATION CAMP

Sawbill Bay

Mitta Lake

Lynxhead Bay

Marmion Reservoir

Light Lake

Upper Seine Bay

Hawk Bay

1,000 0 1,000 2,000 3,000
METRES

LEGEND

- Pond Creation
- Fish Introduction
- Watercrossing Enhancement
- Raft Lake Cut Location
- Trail
- Road
- On-Site Road
- Raft Lake Access Road Alternative 2
- Project Access Road
- Project Transmission Line
- River/Stream
- Lake
- Wetland
- Project Footprint
- TMF Alternatives

DRAFT

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

SCALE 1:80,000

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
POTENTIAL FISH HABITAT COMPENSATION WORKS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. 2.0
DESIGN	CGE	14 Nov. 2008	FIGURE: 7	
GIS	RRD	10 Aug. 2012		
CHECK	JS	10 Aug. 2012		
REVIEW	JS	10 Aug. 2012		

Path: G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXD\dDraftAquatics\Figure7_footprint_API.mxd

Within the LSA, the key Commercial, Recreational and Aboriginal fishery's that may be affected by the Project are as follows:

- Receiving waterbodies: Upper Marmion Reservoir, including Sawbill Bay, Lynxhead Bay and Lizard Lake.
- Streams and lakes within the Project footprint that may support fisheries within receiving waterbodies, provide seasonal habitats for Commercial, Recreational and Aboriginal species and that may provide potential baitfish opportunities.

7.1 Compensation Calculations

Habitat losses were accounted for based on the species present, habitat unit types present within each API and their areas. Losses were calculated using the same weight for each characteristic (Table 9).

In the case of fishless lakes, it was assumed that the following species could successfully be stocked to establish self-sustaining populations: finescale dace; northern redbelly dace; white sucker; yellow perch; fathead minnow; and pumpkinseed. This is consistent with the species supported in the catchments and in similar aquatic features where these fishless lakes are located and also consistent with the fish communities occupying features that were proposed for flooding to create additional habitat. In the case of features that may be impounded, the habitat areas calculated in Table 10 and shown in Figure 8 represent the net increase in habitat area (e.g., existing habitat in these features has been subtracted and is not accounted for in the overall compensation value).

Table 10: Example of Preliminary WUA Calculation of Two APIs Showing Estimates of Habitat Gains

Total Area	Available Habitat Area (HA)	Number of Species Present	Total Weighted Useable Area (WUA)	Ecotype Weighted Useable Area (EWUA)
API # 10 13,881 m^2				
Littoral	6763 m^2	7	936 HU	936 HU
Open Water	7118 m^2	7	537 HU	537 HU
API # 16 6,142 m^2				
Littoral	5032 m^2	7	696 HU	696 HU
Open Water	1109 m^2	7	84 HU	84 HU
API # 44 8,039 m^2				
Littoral	3652 m^2	7	505 HU	505 HU
Open Water	4387 m^2	7	331 HU	331 HU

DRAFT

Table 10: Example of Preliminary WUA Calculation of Two APIs Showing Estimates of Habitat Gains (Continued)

Total Area	Available Habitat Area (HA)	Number of Species Present	Total Weighted Useable Area (WUA)	Ecotype Weighted Useable Area (EWUA)
API # 43 28,954 m^2				
Littoral	13826 m^2	7	1,913 HU	1,913 HU
Open Water	15125 m^2	7	1,140 HU	1,140 HU
API # 14 33,163 m^2				
Littoral	17263 m^2	7	2,389 HU	2,389 HU
Open Water	15900 m^2	7	1,198 HU	1,198 HU
BM #2 75,125				
Littoral	38,120 m^2	7	5,275 HU	5,275 HU
Open Water	37,000 m^2	7	2789 HU	2789 HU
BM # 1 48,176				
Littoral	24,176 m^2	7	3,345 HU	3,345 HU
Open Water	24,000 m^2	7	1,809 HU	1,809 HU
Total			22,947 HU	

These estimates of habitat losses and gains are subject to further refinement, as further discussions with DFO/MNR are anticipated as part of finalizing the NNLP.

Additional terrestrial studies (i.e., species at risk assessments) may be required where proposed compensation works entail the alteration of terrestrial habitats.

The habitat compensation measures identified in Table 10 represent about 21 ha of surface water area and 22,947 HUs of like for like fish habitat.

DRAFT

610000 620000 630000

5430000

5420000

Serpent Lake

Cornell Lake

Sawbill Bay

Mitta Lake

Lynxhead Bay

Marmion Reservoir

Light Lake

Upper Seine Bay

Hawk Bay

N

LEGEND

- Pond Creation
- Fish Introduction
- Watercrossing Enhancement
- Trail
- Road
- River/Stream
- Raft Lake Cut Location
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000
METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
POTENTIAL FISH HABITAT COMPENSATION WORKS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008		
GIS	JO	15 Jan. 2013		
CHECK	BH	15 Jan. 2013		
REVIEW	GA	15 Jan. 2013		

FIGURE: 8

G:\Projects\2010\10-1118-0020_BrettResources_HammondReefGIS\MXDs\Draft\AquaticsTSD\Potential_Fish_Habitat_Compensation_Works_Appendix.mxd

7.2 Additional Mitigation and Compensation Measures

The compensation measures described above provide partial compensation for the lost habitat. MNR indicated that they would be interested in habitat enhancements to northern pike, walleye and smallmouth bass in Upper Marmion Reservoir, should additional onsite compensation be required. In addition, several other possible alternative onsite compensation measures have been developed as follows:

- Stream Crossings: a total of 15 stream crossings for the proposed access road will be required, of which 14 are considered to impact fish habitat. For each of these, compensation for the lost habitat associated with culvert installation will be provided, using one of the following approaches:
  - Installation of an open bottomed culvert to preserve aquatic habitat.
  - Remediate existing barriers in the stream being crossed to provide access by fish to more habitat area (equal to or greater than the area of habitat occupied by the culvert).
  - Undertake a channel restoration associated with the culvert installation to increase stream area (by increasing channel length and/or width) and offset the habitat lost to the culvert.
- Creation of northern pike spawning habitat: to enhance northern pike spawning habitat, which is currently impacted by water level fluctuations in the Upper Marmion Reservoir, several areas can be excavated to create the appropriate depths within or adjacent to the zone of water level fluctuations. The following areas have been identified:
  - An area of low lying shore near the proposed Helipad to the east side of the shallow embayment at the mouth of Sawbill Creek. This area would be excavated to a depth equal to the lower limit of the water level fluctuation to create about 1.5 ha of spawning and nursery habitat.
  - A series of northern pike spawning channels would be excavated along the shoreline of Snail Bay and Turtle Bay equivalent to an area of about 3.0 ha of spawning and nursery habitat.
  - There are a number of other similar locations where northern pike spawning habitat could be created, for example, the mouth of API 1, representing another 3.0 ha of spawning and nursery habitat.
  - The segment of Lumby Creek between Turtle Bay and Lizard Lake would be improved to allow passage by northern pike providing access to spawning habitat in Lizard Lake to Upper Marmion Reservoir northern pike populations. This would provide access to a substantial length of stream/floodplain habitat with suitable spawning, nursery and adult habitat.
  - The stream connection between Trap Bay and Lynxhead Bay would be improved to enhance passage by northern pike and improve access by Upper Marmion Reservoir northern pike into Trap Bay. This would provide access to a substantial length of stream/floodplain habitat with suitable spawning, nursery and adult habitat.

DRAFT

- Creation of walleye spawning habitat or access to spawning habitat:
  - Spawning habitat exists in Sawbill Creek (the creek adjacent to the mine camp Helipad); however, fish passage is an issue. Removal of barriers and improvement of spawning habitat (Inflow 1 and 2) will improve existing spawning areas for walleye and improve access by Upper Marmion Reservoir walleye into Sawbill Creek. This would provide access to a substantial length of stream/floodplain habitat with suitable spawning, nursery and adult habitat. Spawning habitat exists in Lumby Creek between the mouth (in Lynxhead Bay) at the outlet of Lizard Lake; currently fish passage is limited for walleye in the Upper Marmion Reservoir. Removal of barriers and improvement of spawning habitat will improve existing spawning areas for walleye and improve access by Upper Marmion Reservoir walleye into Sawbill Creek. This would provide access to a substantial length of stream/floodplain habitat with suitable spawning, nursery and adult habitat.

Additional terrestrial studies (i.e. species at risk assessments) may be required where proposed compensation works entail the alteration of existing terrestrial habitats.

The habitat compensation measures identified above are not easily comparable to the habitat losses, since they are species and life stage specific enhancements; however, for the northern pike spawning enhancement, they represent 7.5 ha of surface water area and 2625 HUs of like for like fish habitat (assuming the habitat is only used by northern pike). For the fish passage for walleye and northern pike in Lumby Creek, Sawbill Creek and between Turtle and Trap Bay, it was conservatively estimated that providing fish passage at these locations would provide access to an additional 0.5 ha of stream habitat, representing an additional 1687 HUs of like for like habitat.

A quantitative monitoring program will be established for all compensation works, based upon baseline conditions. The timing of monitoring activities will be linked to the rate of habitat change resulting from each compensation work. Monitoring events will measure compliance with the design of compensation works (i.e., the number of habitat units created) and physical and biological indicators of success (i.e., species utilization). For costing purposes, it has been assumed that all compensation works would be completed during the construction phase of the Project, and that five bi-annual surveys (a 10 year monitoring program) would be implemented to evaluate the success of the compensation.

7.2.1 Summary of Offsetting Compensation Measures

The habitat compensation measures identified in Table 8 represent about 21 ha of surface water area and 22,947 HUs of like for like fish habitat. At this time, the conceptual NNLP would consist of the measures in Table 8, plus the following:

- Stream crossings habitat enhancements
- Northern pike spawning habitat creation at the mouth of Sawbill Bay
- The fish salvage and rescue operations

DRAFT

The other measures outlined above are possible alternatives to these measures that would be discussed with DFO/MNR as the NNLP is finalized.

7.3 Steep Rock Mine Habitat Compensation

Additional compensation works will be evaluated for the final NNLP. These may include offsite compensation. The Steep Rock Mine closed and was abandoned in 1979 and there is a high likelihood for the outflow from the two large pit lakes located on the Steep Rock site to eventually impact downstream aquatic ecosystems. The development of a long-term rehabilitation plan for the Steep Rock Mine is currently underway. The rehabilitation plan will identify potential opportunities for site remediation that may contribute to the protection of aquatic life in downstream waters and/or the rehabilitation of on-site fish habitat. In discussions with regulatory agencies (see Section 2.2.1), MNR and DFO have expressed strong interest in pursuing an agreement with OHRG to provide funding for remediation activities at Steep Rock rather than undertake on-site compensation, once the cost of the on-site compensation for the Project has been determined. This is in acknowledgement of the greater public, agency and aboriginal interest in seeing the fisheries in the Steep Rock Site restored and mitigating risk to downstream fisheries.

The means of facilitating this offsite compensation would require an agreement between DFO, MNR and Osisko, for example, by securing letters of credit toward reclamation of the Steep Rock site.

8.0 MONITORING PROGRAMS AND COMMITMENTS

8.1 Aquatic Monitoring Program

A monitoring program will be designed and implemented to confirm water quality, flow and water level alteration predictions generated during surface water modelling. If this program establishes that Project-related effects on the aquatic environment are greater than predicted, fish habitat suitability and utilization studies will be triggered on aquatic features (APIs) and/or specific VECs.

Details of water quality, hydrology and aquatic sediment monitoring are provided in the Water and Sediment Quality TSD, Hydrology TSD, Site Water Quality TSD and Lake Water TSD.

The environmental monitoring program will include the EEM program during operations through to include post closure, details of which will follow EC/MOE requirements, as identified below.

In addition to the regular monitoring required under the EEM program, MNR has identified an opportunity to incorporate long term fisheries monitoring of Lizard Lake and Sawbill/Lynxhead Bay into their District Fisheries Assessment program. This program has recently been initiated and MNR has indicated a willingness to work in partnership with Osisko on collection and sharing of methodologies and data for the life cycle of the Project.

DRAFT

8.2 Final No Net Loss Plan

A final NNLP plan to offset habitat losses attributed to the Project will be completed and submitted along with the Fisheries Act Authorization Request. It will include adequate compensation (e.g., creation of new habitat units) to fully offset all direct and indirect effects to habitat. It is expected that the final NNLP will be somewhat of a living document as it may require amendment periodically. New HADDs may be added to list already generated in the conceptual NNLP, which will subsequently require compensation (e.g., if effects of a particular stream crossing cannot be completely mitigated). The final NNLP will include details of the timing and location of construction of compensation works, and a monitoring schedule for each form of compensation. Where monitoring determines that habitat gain objectives have not been met as planned, additional compensation measures will be designed and implemented. It is anticipated that a single final NNLP will be submitted to regulatory agencies to address requirements of Metal Mining Effluent Regulations (MMER) scheduling for API#2 and the other features within the TMF that are natural, fish-bearing waterbodies within the TMF/WRMF and all non-TMF related HADDs.

Bill C-38, passed in June 2012, amends the *Fisheries Act* to focus on the protection of fish that support commercial, recreational or Aboriginal fisheries and to more effectively manage activities that pose the greatest threat to these fisheries. It is unclear if/how amendments to the Act may affect current DFO policy. Habitat policy, including 'no net loss', is currently under review to ensure consistency with the Act's focus on managing threats to recreational, commercial and Aboriginal fisheries. When new direction regarding habitat management policy becomes available, it may require the final NNLP be amended.

At this time, the conceptual NNLP includes the habitat compensation measures identified in Table 3-7 representing about 21 ha of surface water area and 22,947 HUs of like for like fish habitat. The conceptual NNLP would consist of the measures in Table 3-7, plus the following:

- Stream crossings habitat enhancements
- Northern pike spawning habitat creation at the mouth of Sawbill Bay
- The fish salvage and rescue operations

The other measures outlined in Section 7 are possible onsite alternatives to these measures that would be discussed with DFO/MNR as the NNLP is finalized.

Alternative compensation works may be evaluated for the final NNLP, pending further discussions with DFO/MNR. These may include offsite compensation such as the Steep Rock work described previously. This is in acknowledgement of the greater public, agency and aboriginal interest in seeing the fisheries in the Steep Rock Site restored and mitigating risk to downstream fisheries.

The NNLP will also include compliance and effectiveness monitoring programs to evaluate if the compensation measures function as proposed.

DRAFT

8.3 Scheduling of Waterbodies Under Metal Mining Effluent Regulation

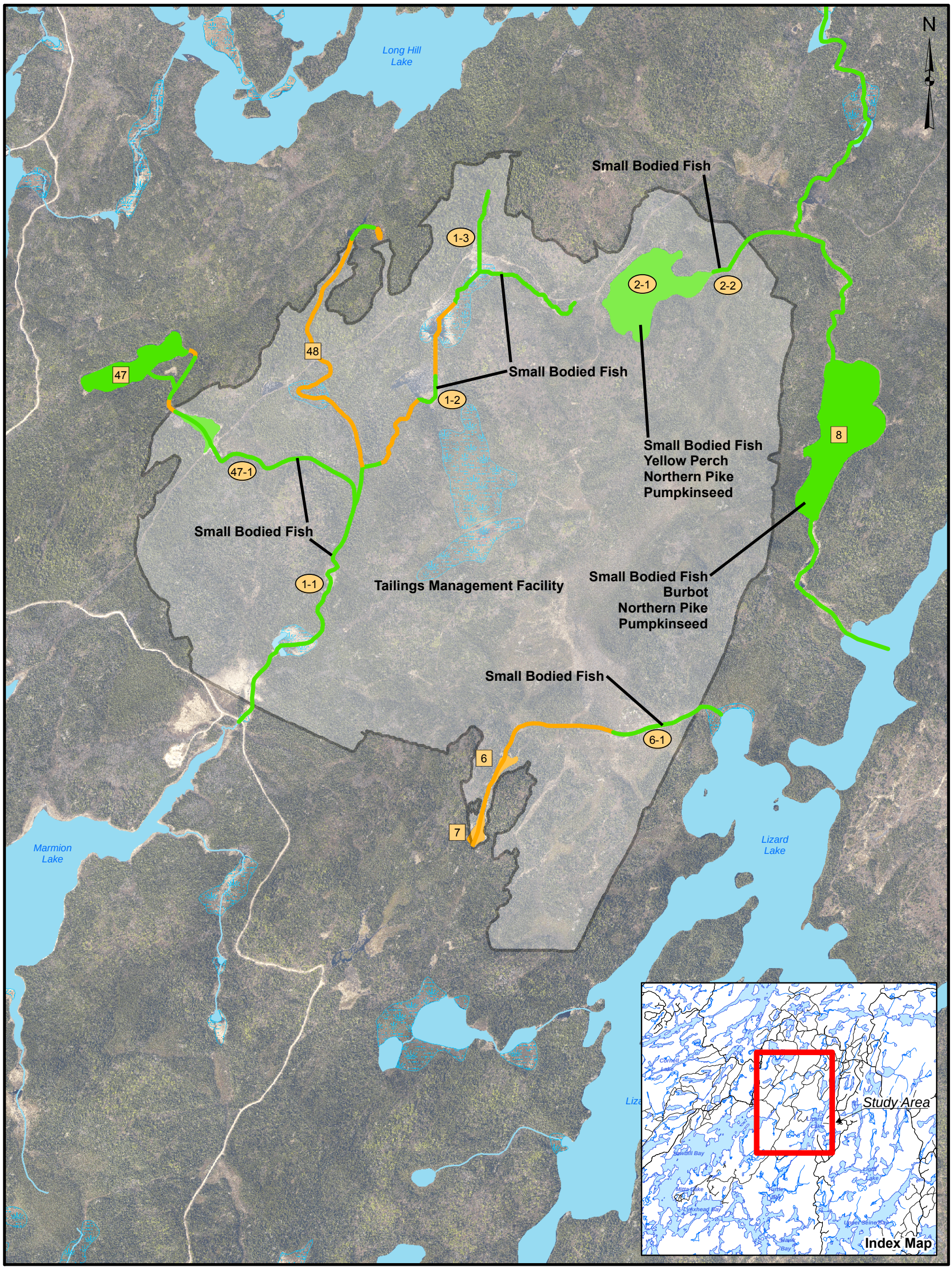
Using a natural water body frequented by fish for tailings disposal requires an amendment to the MMER, which is a federal legislative action. The MMER, enacted in 2002, were developed under subsections 34(2), 36(5) and 38(9) of the *Fisheries Act* to regulate the deposit of mine effluent, waste rock and tailings into natural waters frequented by fish. These regulations, administered by Environment Canada, apply to the TMF and the WRMF components of the Project. Environment Canada (2011) outlines a specific process that is required to utilize a natural water body for metal mine waste disposal. This process requires preparation of an assessment of alternatives for mine waste disposal for consideration (completed as part of the EA; Golder 2012), the preparation of a fish habitat compensation plan for consideration as part of the EA, and public and aboriginal consultations on the EA, including on possible amendments to the MMER. OHRG will be required to submit all required documentation to Environment Canada and may be asked to provide additional background information necessary in the preparation of the regulatory amendment package. Within the TMF, APIs #1, #2, #6, #47 and #48 will likely require scheduling under the Regulations, as shown in Figure 9. API #11, within the WRMF will also require scheduling, as shown in Figure 10.

8.4 Environmental Effects Monitoring (MMER)

The MMER under the Fisheries Act direct metal mines to conduct Environment Effects Monitoring (EEM) as a condition governing the authority to deposit effluent. EEM is a science-based performance measurement tool used to assess the adequacy of the regulations. EEM studies are designed to detect and measure changes in aquatic ecosystems (i.e., receiving environments). The metal mining EEM program is an iterative system of monitoring and interpretation phases that is used to assess the effectiveness of environmental management measures, by evaluating the effects of effluents on fish, fish habitat and the use of fisheries resources by humans. Long-term effects are assessed using regular cyclical monitoring and interpretation phases designed to investigate the impacts on the same parameters and locations. In this way, both a spatial and temporal characterization of potential effects to assess changes in receiving environments are obtained. Study elements include fish population and fish habitat assessments, benthic invertebrate surveys, fish tissue analyses, effluent characterization, sub-lethal toxicity and water quality monitoring.

The first EEM study design must be submitted not later than 12 months after the day on which the mine becomes subject to the Regulations. The first interpretative report must be submitted not later than 30 months after the date on which the mine becomes subject to the Regulations or not later than 42 months after the date on which it becomes subject to the Regulations, if the mine has submitted a report utilizing historical biological monitoring information. Subsequent interpretative reports are submitted 36 or 72 months after the day on which the most recent interpretative report was required to be submitted, depending on the results of the previous interpretative report.

DRAFT



LEGEND

- API Reach
- Area of Potential Impact
- Fish Bearing Waters
- Non Fish Bearing Waters
- Waterbody
- Wetland
- Water Segment
- Tailings Management Facility

REFERENCE

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15

490 0 490
SCALE 1:20,000 METRES

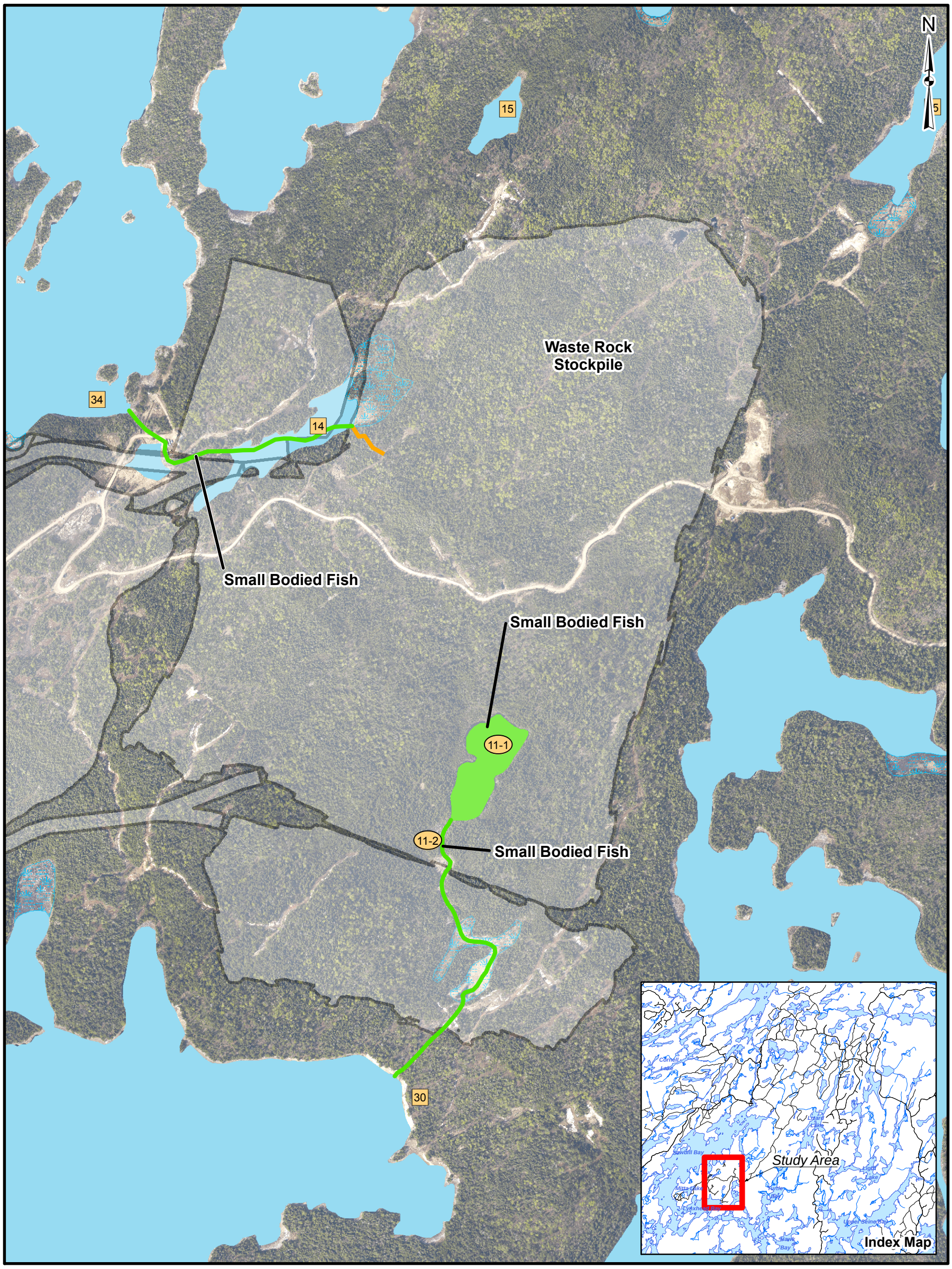
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
AREAS OF POTENTIAL IMPACT REQUIRING
METAL MINING EFFLUENT REGULATION LISTING

Golder Associates
Sudbury, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	RRD	Dec. 2010	FIGURE 9	
GIS	PJM	Nov. 2012		
CHECK	BH	11 Feb, 2013		
REVIEW	GA	11 Feb, 2013		

Path: N:\Active\GIS\Clients\OsiskoHammondReefGoldLtd\10-1118-0020\GIS\MXDs\Fish_Bearing_Waters\FishFrequentedWaters_BaseCase9.mxd



LEGEND

- API Reach
- Area of Potential Impact
- Fish Bearing Waters
- Non Fish Bearing Waters
- Waste Rock Stockpile
- Waterbody
- Wetland

REFERENCE

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15

400 0 400

SCALE 1:10,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

AREAS OF POTENTIAL IMPACT REQUIRING METAL MINING EFFLUENT REGULATION LISTING

Golder Associates
Sudbury, Ontario

PROJECT No. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	RRD	Dec. 2010	FIGURE 10	
GIS	PJM	Nov. 2012		
CHECK	BH	11 Feb. 2013		
REVIEW	GA	11 Feb. 2013		

Path: N:\Active\GISClients\OsiskoHammondReefGoldLtd\10-1118-0020\GIS\MXDs\Fish_Bearing_WatersFish...ers\FishFrequentedWaters_Stockpile10.mxd

8.5 Construction Monitoring

Field monitoring will be performed to ensure that the mitigation measures implemented during construction successfully minimize adverse environmental effects. Monitoring will focus on the effects of any sediment release and deposition during construction. Post-construction monitoring will be conducted in watercourses affected by the road culvert crossings to evaluate the effects of any sediment releases and deposition at crossing sites, and to evaluate fish passage potential (e.g., hydraulics) through culverts. The effectiveness of habitat reclamation following construction will also be evaluated. Monitoring will be adaptive in that, if changes to fish and fish habitat are detected, appropriate remedial actions will be implemented and subsequent monitoring programs adjusted to ensure the effectiveness of remedial actions and future operations.

A standardized monitoring procedure will be developed so that monitoring data can be used to validate impact predictions. Various environmental variables may be monitored during construction, depending on the concerns and crossing objectives:

- Suspended sediment load before, during and after construction to provide feedback to construction personnel and document the zone of influence and changes in water quality.
- Substrate composition before, during and after construction to document areas of sedimentation.
- Watercourse flows during construction to ensure that fish passage and minimum flows are maintained.
- Monitoring during blasting and diversion procedures.
- Confirm that specific crossing objectives have been achieved.
- Observe and document actual effects.
- Observe and document recovery.
- Determine the need for maintenance of structures and mitigation measures.
- Fulfil explicit mitigation and compensation requirements.

8.6 Blast Monitoring and Collection of Supplementary Fish Habitat Information (Sawbill Bay)

To assess potential for vibration impact as development of the open pits approaches the final pit design, blasting operations will be monitored during initial pit development to obtain site-specific data on the potential for damaging vibrations to affect adjacent aquatic habitats. Baseline studies on habitat use, specifically timing and locations of spawning, have not been completed. It is recommended that these studies be undertaken to effectively mitigate the effects of blast vibration on fish in Sawbill Bay. These data also will be useful in evaluating the effects of construction of the retaining wall adjacent to the pit, on fish habitat. Data from the fish and fish habitat studies will be combined with the site-specific blast monitoring data to develop guidance as to

DRAFT

when, if at all, blast designs should be altered to accommodate vibration levels at the nearest active spawning beds and to assess the effectiveness of blast mitigation on fish.

9.0 REFERENCES

Bradbury C., M.M. Roberge and C.K. Minns. 1999. Life History Characteristics of Freshwater Fishes Occurring in Newfoundland and Labrador, with Major Emphasis on Lake Habitat Requirements Can. MS Rpt. Fish. Aquat. Sci. 2485.

CEAA. 2011. Draft Guidelines for the Preparation of an Environmental Impact Statement Pursuant to the *Canadian Environmental Assessment Act* for the Hammond Reef Gold Mine Project. 72 p + references

Colby, P., R. E. McNicol and R. A. Ryder. 1979. Synopsis of biological data on the walleye *Stizostedion v. vitreum* (Mitchill 1818). FAO Fisheries Synopsis No. 119.

Draypack, Alexanda. 2012. Osisko Hammond Reef Gold Ltd. Personal communication. February 02, 2012

Edwards, E. A., G. Gebhart and O. E. Maughan. 1983. Habitat suitability information: Smallmouth bass. U.S. Department of the Interior, Fish and Wildlife Service FWS/OBS–82/10.36.

Fisheries and Oceans Canada. 1986. *Policy for the Management of Fish Habitat*. Ottawa, Canada: Department of Fisheries and Oceans.

Fisheries and Oceans Canada. 2006. Practitioners Guide to Compensation for DFO Habitat Management Staff. Version 1.1. Fisheries and Oceans Canada. Communications Branch 24 p.

Golder Associates Ltd. 2004. Fish Habitat Compensation Plan for the Northwest Peninsula of the De Beers Snap Lake Diamond Project. Prepared for De Beers Mining Canada Inc., Yellowknife, Northwest Territories.

Golder Associates Ltd. 2007. Kearl Oil Sands Project - Mine Development. No Net Loss Plan. Prepared for Imperial Oil Resources Ventures Limited.

Golder Associates Ltd. 2008. Fish Species Habitat Suitability Index Models for the Alberta Oil Sands Region. Version 2.0. October 2008.

Golder Associates Ltd. 2011. Meliadine Project Conceptual Fish Habitat Compensation Plan [DRAFT]. 44 p.

Golder Associates Ltd. 2012. Fish and Fish Habitat Baseline Studies Interim Report. Submitted to Osisko Hammond reef Gold Project. 20 p. + appendices.

Hall-Armstrong, J., A.G. Harris and R.F. Foster. 1996. Fish use of wetlands in northwestern Ontario: A literature review and bibliography. Northwest Science & Technology, Ontario Ministry of Natural Resources, Thunder Bay, Ont. TR-90.

DRAFT

Inskip, P. D. 1982. Habitat suitability index models: Northern pike. U.S. Department of the Interior, Fish and Wildlife Service. FWS/OBS–82/10.17.

Jackson, B. 2012. Ontario Ministry of Natural Resources, Atikoken, Ontario. Personal Communication. June 4, 2012.

Janacek, J. A. 1988. Literature review on fishes interactions with aquatic macrophytes with special reference to the Upper Mississippi River system. Upper Mississippi River Conservation Committee (UMRCC), Fisheries Section. Rock Island, Illinois.

Kerr S.J., B. W. Corbett, D. Kinsman, J. H. Leach, D. Puddister, L. Stanfield, N. Ward, and N. J. Hutchinson. 1997. Walleye Habitat: A Synthesis of Current Knowledge with Guidelines for Conservation Ontario Ministry of Natural Resources.

Langhorne, A.L., M. Neufeld, G. Hoar, V. Bourhis, D.A. Fernet and C.K. Minns. 2001. Life History Characteristics of freshwater Fishes Occurring in Manitoba, Saskatchewan and Alberta, with Major Emphasis on Lake Habitat Requirements. Can. MS Rrp. of Fish. Aquat. Sci. 2579.

McCarragher, D. B., and R. E. Thomas. 1972. Ecological significance of vegetation to northern pike, *Esox lucius*, spawning. Trans. Amer. Fish. Soc. 1972(3).

McMahon, T. E., J. W. Terrell and P. C. Nielson. 1984. Habitat suitability information: Walleye. U.S. Department of the Interior, Fish and Wildlife Service. FWS/OBS-82/10.56.

Minns, C.K., J, E. Moore, M. Stoneman, and B. Cudmore-Vokey1. 2001. Defensible Methods Of Assessing Fish Habitat: Lacustrine Habitats In The Great Lakes Basin - Conceptual Basis And Approach Using A Habitat Suitability Matrix (HSM) Method. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2559. 80 p. + appendices.

Minns, C.K. 2010a. Ontario Stream Fishes Habitat Associations and Derivation of a Simple Habitat Assessment Model. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2909. 39 p. + appendices

Minns, C.K. 2010b. An Introductory Guide to Preparing and Assessing No Net Loss Plans. Canadian Science Advisory Secretariat Research Document [draft]. Fisheries and Oceans Canada. 2010.

Ontario Ministry of Natural Resources. 1987. Fort Francis District Fisheries Management Plan 1988-2000.

Ontario Ministry of Natural Resources. 1989. Atikokan District Fisheries Management Plan 1988-2000.

Packman et. al. 2006. Review of Approaches for Estimating Changes in Productive Capacity from Whole-lake/Stream Destruction and related Compensation Projects. Canadian Technical Report of Fisheries and Aquatic Sciences 2664.

Portt, C.B., G. Coker, and C.K. Mins. 1999. Riverine Habitat Characteristics of Fishes of the Great Lakes Watershed. Can. MS Rep. Fish. Aquat. Sci. 2481:vi + 62 p.

DRAFT

U.S. Fish and Wildlife Service. 1980. Habitat Evaluations Procedures (HEP). ESM 102. U.S.D.I. Fish and Wildlife Service, Division of Ecological Services.

U.S. Fish and Wildlife Service. 1981. Standards for the Development of Habitat Suitability Index Models for Use in the Habitat Evaluation Procedures, USDI Fish and Wildlife Service. Division of Ecological Services. ESM 103.

10.0 CLOSURE

We trust that this report meets your requirements. If you have any questions, please do not hesitate to contact the undersigned.

DRAFT

Report Signature Page

GOLDER ASSOCIATES LTD.

DRAFT

John Seyler, H.B.Sc.
Associate/Senior Biologist

DRAFT

Serge Metikosh, H.B.Sc.
Principal/Senior Fish Habitat Biologist

JS/BH/ls

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

\\golder.gds\gal\missis~1\active\2010\1118\23sp000~\005env~1\1000se~1\01tsds~1\aquati~1\04appe~1\app2~1.iii\10-1118-0020v4 rpt 13feb06 draft4discussion osisko fish habitat acctng 20feb2013.docx

DRAFT

APPENDIX A

Definitions for Habitat Variables

October 16, 2012
Report No. 10-1118-0020V4

Golder Associates

DEFINITIONS FOR HABITAT VARIABLES

Lake Habitat Mapping

Limnetic Zone: The open-water region of a lake that is too deep to support rooted aquatic vegetation.

Littoral Zone: The shallow area of a lake that extends from the waterline to the lakeward limit of rooted aquatic vegetation.

Macrophytes: Macrophytes are aquatic plants which are large enough to be seen with the unaided eye, as opposed to phytoplanktonic organisms. Macrophytes are specifically adapted to aquatic habitats, growing either in the water or along the margins of waterbodies. Flooded terrestrial vegetation does not qualify. There are two basic types of macrophytes which are distinguished when habitat mapping lakes; emergent and submergent macrophytes.

> ***Emergent Macrophytes:*** Macrophytes which grow in wet or boggy areas or which are rooted in water but extend above the water surface. Typical examples include Cattails, Bulrushes and Sedges.
>
> ***Submergent Macrophytes:*** Macrophytes which are rooted and which grow under the water. This includes floating-leaved aquatic plants and plants which may have flower stalks that extend above the surface. Typical examples include pondweeds, Coontail and water lily.

Pinnacle: A small, isolated point of lake bottom, which is exposed above the water line and surrounded by a shoal. Can be thought of as a very small island or a shoal which has a small portion above water.

Shelf: Frequently observed in deep lakes; it is the area of the bottom located near shore, between the waterline and the drop-off. The distance between these points can be highly variable. In areas of shallow bottom slope, the shelf may be extensive, whereas, in areas of steep bottom slope the shelf may not exist. In deep, clear lakes, the shelf is typically the primary area that is habitat mapped since the bottom is visible and characteristics of substrate, cover and vegetation can be recorded.

Shoal: A shallow but submerged area isolated from the shorelines of a lake. Can be composed of a variety of materials depending upon regional geology. May be “clean” (free of fines) if shallow enough to be affected by wave action and may have a significant potential to provide spawning habitat. Therefore, shoal areas in large, deep lakes receive particular attention during habitat mapping.

Slope: The change in vertical height relative to the change in horizontal distance. For lakes, this measurement describes the steepness of the shoreline above and below the water surface.

> ***Bottom Slope:*** The slope of the lakebed on a line perpendicular to shore, from the waterline to the lakeward side.
>
> ***Shore Slope:*** The slope of the lake shore immediately above the waterline.

Substrate: The material which comprises the bottom of a water body. Can be highly variable depending on regional geology, weathering, location within the lake, etc. Described by substrate particle size. Particle sizes include fines (clay, silt and sand), gravel, cobble, boulder and bedrock. Golder employs specific criteria for particle size classes which are defined in this document.

DEFINITIONS FOR HABITAT VARIABLES

Substrate particle size classes used for both lake and watercourse mapping include:

- Organic material.
- Si – silt/clay (<0.06 mm in diameter).
- Sa – sand (0.06-2.0 mm).
- Gr – gravel (2-64 mm).
- Co – cobble (64-256 mm).
- Bo – boulder (>256 mm).
- Bd – bedrock.

Watercourse Habitat Mapping

Stream Pattern: Stream pattern describes the sinuosity of the channel or the degree to which the channel deviates from straightness. Sinuosity is the channels meander pattern which can range from straight to tortuously meandering. Sinuosity is expressed as the ratio of the length of channel between two points on the stream to the straight line distance between the same two points.

Substrate: Stream substrate is the material found on the bottom of the channel portion of the watercourse. It refers to the surficial deposits that can be seen when viewing the streambed. As part of the habitat evaluation process, the substrate is evaluated with respect to particle size composition. Particle size composition refers to the proportions of the substrate particles within each category from a series of size categories (Table C-1). These range from fine sediments (fines are particles <2 mm in size and include clay, silt and sand) through gravels, cobbles, boulders and bedrock. A substrate evaluation is conducted by visual observation. The observer estimates the percentage of the substrate particles, by surface area, in each of the size categories. Note: the term rubble is sometimes used for cobble sized particles – within this size class, cobble refers to rounded rock while rubble refers to angular rock.

Undercut Bank: An undercut bank is a bank that has been eroded at the base by flowing water, allowing water to be present underneath a portion of the bank. Although undercutting usually adds to bank instability, it may also provide cover for fish. If the overhanging portion of the bank provides and effective with >9 cm over water with a depth of >0.15 m, it provides a cover feature and the location and extent should be recorded on the habitat map.

Unstable Bank: A portion of the stream bank that is unstable in that it has, or has potential to, shed material into the stream. Instability may be due to various factors such as slumping, gullying, erosion or undercutting. Record the location and extent of unstable banks on the habitat map.

DEFINITIONS FOR HABITAT VARIABLES

Wetted Width: The width of the water surface measured at right angles to the direction of flow. If an island(s) is present creating more than one channel, the total wetted width is the sum of the individual wetted widths. Wetted width is dependent on stream discharge and varies as water level varies.

Channel Unit (sometimes referred to as habitat type): Channel units are the hydraulic and morphological features of a stream channel. A channel unit is a section of channel which is homogeneous with respect to water depth, velocity and cover and is separated from other channel units by gradients in these parameters. Channel units are sometimes referred to as habitat types. The most common channel units are **pool**, **riffle** and **run**, although a total of 12 channel units have been defined (Table C-1).

Table C-1: List of Channel Units

Channel Unit	Description
Falls	Highest water velocity; involves water falling over a vertical drop; impassable to fish
Cascade	Extremely high gradient and velocity; extremely turbulent with entire water surface broken; may have short vertical sections but overall is passable to fish; armoured substrate; may be associated with chute
Chute	Area of channel constriction, usually due to bedrock intrusions; associated with channel deepening and increased velocity
Rapids	Extremely high velocity; deeper than riffle; substrate extremely coarse (large cobble/boulder); instream cover in pocket eddies and associated with substrate
Riffle	High velocity/gradient relative to run habitat; surface broken due to submerged or exposed bed material; shallow relative to other channel units; coarse substrate; usually limited instream or overhead cover for juvenile or adult fish (generally ≤0.5 m deep)
Run	Moderate to high velocity; surface largely unbroken; usually deeper than a riffle; substrate size dependent on specific hydraulics
Flat	Low gradient area characterized by low velocity and near-laminar flow; differentiated from pool habitat by high channel uniformity; more depositional than run habitat
Pool (Scour)	Discrete portion of channel featuring increased depth and reduced velocity relative to riffle/run habitats; formed by channel scour
Impoundment Pool	Includes pools which are formed behind dams; tend to accumulate sediment/organic debris more than scour pools; may have cover associated with damming structure; identify as Class 1, 2 or 3 as for scour pools; record dam type (e.g., debris, beaver, landslide)
Backwater	Discrete, localized area of variable size exhibiting reverse flow direction; generally produced by bank irregularities; velocities variable but lower than main flow; substrate similar to adjacent channel with higher percentage of fines – record large/significant backwater areas
Snye	Discrete section of non-flowing water connected to a flowing channel only at its downstream end; generally formed in a side-channel or behind a peninsula
Boulder Garden	Significant occurrence of large boulders providing significant instream cover; always in association with an overall channel unit such as a riffle or run

APPENDIX B

Fish Habitat Preference Tables

October 16, 2012
Report No. 10-1118-0020V4

Golder Associates

FISH HABITAT PREFERENCE TABLES

INTRODUCTION

The draft guidelines for the preparation of the Hammond Reef Mine Project (the Project) Environmental Impact Statement (EIS) requires that habitats for each potentially affected species identified be characterized as spawning, rearing/nursery, feeding, migratory corridor and overwintering/summer refuge habitats (Canadian Environmental Assessment Agency 2011). These habitat classes are proposed for No Net Loss (NNL) Planning and are defined as follows:

- spawning habitat is used by fish for the specific act of reproduction;
- nursery/rearing habitat is used by developing embryos and young-of-the-year (YOY) and sub-adult fish for foraging and refuge from predators;
- feeding habitat is used by adult fish for feeding or periods between feeding events;
- overwintering/summer refugia are used by YOY, sub-adult and adult fish to survive periods of hostile conditions (e.g. flows and water temperature extremes; and
- migratory corridors are used by fish to access important habitats described above.

Fish species considered in this report were identified during baseline studies completed in 2010 and 2011 (Table 1). Habitat suitability relationships describing spawning, rearing/nursery, feeding, migratory corridor and overwintering/summer refuge habitats for each of the species listed in Table 1 were derived using information obtained from published HSI models, technical papers and published literature.

Within each habitat class, information pertaining to habitat characteristics was divided between general information related to the type of habitat and specific information related to both lentic and lotic environments.

For many of the characteristics, strength of association (low, medium, high) between habitat and life stage was assessed in the literature. Definitions between sources were consistent and so where applicable, these strength associations and have been included as part of this review. The following provides a definition for each of the ratings used:

- High – Indicates that a fish species is always or nearly always associated with habitats possessing this character;
- Medium – indicates that a species is frequently or often associated with habitats possessing this character; and
- Low – Indicates a species is sometimes or infrequently associated with habitats possessing this character.

FISH HABITAT PREFERENCE TABLES

Table 1: Fish Species Captured During Baseline Studies

Family/Subfamily	Species Common Name	Species Scientific Name
Coregoninae	Lake Whitefish[1.] Cisco[1.]	*Coregonus clupeaformis* *Coregonus artedi*
Umbridae	Central Mudminnow	*Umbra limi*
Esocidae	Northern Pike	*Esox lucius*
Cyprinidae	Longnose Dace Blacknose Dace Northern Redbelly Dace Finescale Dace Pearl Dace Fathead Minnow Spottail Shiner[1.] Blacknose Shiner Brassy Minnow	*Rhinichthys cataractae* *Rhinichthys atratulus* *Chrosomus eos* *Chrosomus neogaeus* *Semotilus margarita* *Pimephales promelas* *Notropis hudsonius* *Notropis heterolepis* *Hybognathus hankinsoni*
Catostomidae	Common White Sucker	*Catostomus commersoni*
Gadidae	Burbot	*Lota lota*
Gasterosteidae	Ninespine Stickleback Brook Stickleback	*Pungitius pungitius* *Culaea inconstans*
Centrarchidae	Smallmouth Bass Pumpkinseed	*Micropterus dolomieu* *Lepomis gibbosus*
Percidae	Walleye Yellow Perch Iowa Darter	*Sander vitreus* *Perca flavescens* *Etheostoma exile*
Cottidae	Mottled Sculpin	*Cottus bairdi*

FISH HABITAT PREFERENCE TABLES

Table 2: Habitat Preferences, Lake Whitefish (*Coregonus clupeaformis*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Fall broadcast spawner with ideal water temperature range of 0.5 to 7.8 °C; flowing water not required for spawning (7) (11) **Lentic -** Spawning in shallow water over gravel, cobble, boulder and sometimes sand; infrequently over silt and clay substrate with emergent vegetation if slight current present (7) (8) (11) **Lotic -** Spawning from 0-5+m to 30 m over coarse substrates of boulder, cobble, rubble, gravel, sand (4) (7) (8) (11) (13)	**Lotic -** YOY with depth preference of 0-2 m in spring , no seasonal preference from 2-5 m, low association with emergent or submergent vegetation or over in-situ cover (5) (7) Juveniles associated with depths to 10 m with boulder, cobble, rubble and gravel substrate in association with vegetation and woody debris or in pelagic areas (7) (12)	**General -** YOY are initially limnetic feeders, switching to benthic feeding as fish learn local food availability (8) Adults benthic feeders on snails, clams, chironomid larvae and small fish (12)	**Lotic -** In summer, YOY in lotic environments leave shallow inshore waters as water temperature warms and move to deeper pelagic waters at depths of 5-10 m with substrate preference for boulder, cobble, gravel and sand (7) (12) Adults move into shallow waters in the fall to spawn on shoals or rocky ledges and return to deepwater habitat to overwinter (7) (12) Marked onshore movements into shallow water habitats at night, possibly to feed (12)	**General -** Late winter dissolved oxygen levels from 4 to >7 mg/L preferred (13) **Lentic -** associated with low velocity/pool habitat (10) **Lotic -** Typically associated throughout the year with depths of 5+m, below thermocline (6)

FISH HABITAT PREFERENCE TABLES

Table 3: Habitat Preferences, Cisco (*Coregonus artedi*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Fall broadcast spawners at water temperatures of 2 to 5°C with hatch occurring after ice break up (7) **Lentic -** Spawning over a range of depths from1 to 5+ m deep with primary preference for cobble, rubble, gravel or sand; secondary substrate of boulder, silt/clay or hard-pan clay (4) (7) (8) **Lotic -** Lacustrine areas of large rivers with spawning in pools at depths from 1 to 2+ m over boulder, cobble, rubble or gravel substrate (10)	**Lentic -** YOY in 0-2 m of water, in fall from 2 to 5+ m deep over boulder, boulder-cobble, rubble or gravel substrate (5) In spring, juveniles located in habitats of sparse vegetation over rock substrate, in fall in non-vegetated areas over rock (7) **Lotic -** Juveniles associated with pool or run habitats (10)	**General -** Adults feed in the water column on a wide variety of small prey including zooplankton, crustaceans, larval insects, algae and occasionally, small fish (9) Juveniles feed at or near bottom of nearshore areas, at night (8)	**Lentic -** YOY, juveniles and adults move below thermocline (from shallow to deep water) in spring and summer with movement in reverse direction when temperatures cool again (8)	**Lentic -** Adult habitat primarily the pelagic zone of lakes from 5 to 10+ m with late summer movement to just below thermocline and as upper waters cool, into shallower waters (6) (7) **Lotic -** Adults associated with pool or run habitats (10)

FISH HABITAT PREFERENCE TABLES

Table 4: Habitat Preferences, Central Mudminnow (*Umbra limi*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring spawners from mid to late April at water temperature of 13 °C along flooded stream and pond banks where eggs adhere to flooded vegetation (3) (7) **Lentic -** Spawning in 0-1 m in submergent/emergent vegetation (4) (7) **Lotic -** Spawning associated with pool habitat; strong association with flooded terrestrial vegetation (10)	**Lentic -** YOY with depth preference from 0-2 m; substrate preference of silt/clay or muck (organic detritus) and cover preference of submergent/emergent vegetation (7) **Lotic -** Depth preference from 0-0.2m, substrate preference for silt/clay and cover preference for vegetation; turbidity intolerant (10)	**General -** Nocturnal feeder on small crustaceans, insect larvae and molluscs near bottom in vegetation cover (3) (9) **Lentic -** YOY with depth preference from 0-2 m; substrate preference of silt/clay or muck (organic detritus) and cover preference of submergent/emergent vegetation (7) **Lotic -** Depth preference from 0-0.2m, substrate preference for silt/clay and cover preference for vegetation (10)	**General -** YOY move from flooded stream and pond banks back to main water body when approximately 30 mm in length (3)	**General -** Heavily vegetated ponds and pools of small creeks, including those with floating mat shores. Summer habitat of vegetated ponds or pools of small creeks where the bottom has a thick layer of organic material (3) (7) Tolerate of hypoxia and known to take atmospheric oxygen when dissolved oxygen levels are low allowing for survival in isolated pools which may become stagnant and warm (3) (7) Preferred substrate a thick layer of organic material and detritus to escape predation and survive drought **Lotic -** Adults in 0-2 m year round; high association with submergent and emergent vegetation (6)

FISH HABITAT PREFERENCE TABLES

Table 5: Habitat Preferences, Northern Pike (*Esox lucius*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring spawners, in colder areas, after ice break up at water temperatures between 4.4 to 12°C (8) Over flooded terrestrial vegetation in areas of calm, shallow water or weedy bays or backwaters (1) Optimum spawning habitat is a dense mat of flooded emergent vegetation such as sedges, cattails or grasses with a large basal coverage for egg adhesion (2) (3) Substrate preference for silt and sand although spawning-site preference is more related to adequate submergent vegetation (4) (7)	**General -** Shallow, vegetated areas such as flooded marshes, flooded terrestrial vegetation, or weedy bays (1) **Lentic -** Depth preference from 0-2 m in spring, 2-5 m in fall; over substrates of silt, clay or hardpan clay near submergent/emergent vegetation cover; specific preference by YOY for submerged vegetation versus other aquatic vegetation types (2) (5) (7) (8) Juveniles typically found along shorelines with adequate food and cover at depths of <2 m; same substrate preference as YOY, always in association with submergent vegetation (7)	**General -** Day active feeders with preference for ambush cover in the form of aquatic plants, tree stumps, fallen logs (1) YOY initial food preference for invertebrates such as Ephemeroptera, Isopoda, Cladocera with switch to vertebrate prey in fish ≥130 mm; habitat preference for submerged vegetation with rooted aquatic plants to offer cover and increased plankton and therefore the best food supply (2) (3)	**General -** From lakes and rivers up tributaries to flooded marshes, wetlands or shallow pools during spawning (1) **Lentic -** Adults usually found within shallow, vegetated regions of lakes in spring and fall, moving to deeper water as water temperature increases in summer and ice-cover forms in winter (7) (8) Movement by juveniles to areas of emergent vegetation in late summer where dissolved oxygen concentrations higher (3) **Lotic -** Avoidance for strong currents (>1.5 m/s) that can block spawning migrations (1)	**General -** Dissolved oxygen concentration important habitat variable affecting overwinter survival although NRPK more tolerant of low D.O. during winter than other temperate species; optimal temperature preference for adults between 19 and 21°C (1) (7) **Lotic -** Occur more frequently in lakes than rivers; summer habitat limited in some lakes by combination of high surface temperatures and low oxygen concentration in cooler, deeper strata (1) Adults at depths from 0-10 m throughout the year; along margins of vegetated areas or areas with in-situ materials (fallen logs, tree stumps, shoals, boulders) and substrates of mud, silt, or hardpan clay (6) (7)

FISH HABITAT PREFERENCE TABLES

Table 6: Habitat Preferences, Longnose Dace (*Rhinichthys cataractae*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring spawners, eggs settle in and adhere to substrate (4) (9) **Lentic -** Low association in lakes but where found spawning from 0 to 2 m over wave swept inshore areas with gravel, cobble, rubble and/or boulder substrates (4) (7) **Lotic –** Depth from 0-0.2 m over gravel in riffle habitat (10)	**Lentic -** Low association in lakes but where found nursery habitat in inshore shallow areas where YOY utilize overhanging vegetation for cover; juveniles in 0-2 m of water, low association with submergent/emergent vegetation (5) (7) **Lotic -** Juveniles in 0-0.6 m of water with high preference for boulder, cobble, rubble, gravel; low preference for bedrock, sand, silt/clay, detritus; not associated with emergent/submergent vegetation, algae, woody debris; in riffle or rapid habitat(10)	**General -** Night feeder on aquatic insects, worms, crustaceans and molluscs (9)	**Lentic -** Low association in lakes but where found movement off-shore to deeper areas of lakes after ~4 months (7)	**General -** Late winter dissolved oxygen levels of 2 mg/L considered ideal with pH range of 6 to 9 (13) **Lentic -** Low association in lentic environments, where found, adults in 0-2 m of water with preference for rubble, gravel, sand substrate (6) **Lotic -** Adults in 0-0.6 m of water with high preference for boulder, cobble, rubble, gravel; low preference for bedrock, sand, silt/clay, detritus; not associated with emergent/submergent vegetation, algae or woody debris; in riffle or rapid habitat(10)

FISH HABITAT PREFERENCE TABLES

Table 7: Habitat Preferences, Blacknose Dace (*Rhinichthys atratulus*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring spawner in water temperatures between 12 and 27°C; eggs pushed into substrate in shallow riffles, fertilized and guarded by male (9) **Lentic –** Low association with lake spawning but when present in 0-1 m of water with high association for rubble and gravel, medium association for sand (4) **Lotic –** High association for gravel substrate in the fast water of shallow riffles (1) (14)	**Lentic –** Low association with lake habitat for YOY, where present in 0-2 m water with no seasonal preference; high association with silt (5) **Lotic –** Juveniles with depth preference for 0-0.6 m; high substrate association for rubble, gravel, sand, silt/clay substrate, medium for boulder, cobble; low for bedrock; high association for wood, substrate and overhead cover; high association for pool, riffle and run habitat, low turbidity tolerance (10)	**General -** Benthic feeder, primarily aquatic insect larvae and to a lesser extent worms and algae; adults will prey on their own eggs during spawning (9)		**Lentic –** In water from 0-2 m deep with no seasonal preference (6) **Lotic –** Depth preference from 0-0.6 m, with high association for rubble, gravel, sand, silt/clay substrate, medium for boulder, cobble; low for bedrock; cover preference with high association for wood, substrate and overhead cover; velocity preference with high association for pool, riffle and run, low turbidity tolerance (10)

FISH HABITAT PREFERENCE TABLES

Table 8: Habitat Preferences, Northern Redbelly Dace (*Chrosomus eos*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring/summer broadcast spawner on masses of filamentous algae at water temperatures of 21-27°C (3) (4) **Lentic –** High association with lake habitats; high association for water depth of 0-2 m; medium association with gravel substrate, high association with sand and silt substrate; high association with submergent vegetative cover (4.) (7.) Lotic – High association for spawning locations with pool habitat and algae cover (10.)	**Lentic –** YOYs with high association for water depth from 0-2 m; high association for silt/clay and detritus substrate (5) (7) **Lotic –** Juveniles with high association for depth from 0-0.6 m; medium from 0.61 to 1 m; high association for silt and detritus substrates (10)	**Lentic -** Young feed on diatoms, algae, zooplankton and aquatic insects; in wetlands associated with open water marsh/marsh wetland with mixed organic substrates and floating leaved plants (3)	**General –** Adults inhabit depths of <2 m but move into deeper water following a diel migration pattern (6) (7)	**General -** Preference for boggy lakes, creeks, ponds and quiet pool-like expansions of streams over detritus and silt substrates (?) **Lentic –** Adults with high association for water depth of 0-2 m and medium association for 2-5 m; high association with substrates ranging from gravel, sand, silt-clay and detritus; high association with submergent/emergent vegetation (6) (7) **Lotic –** Adults with high association for depth of 0-0.6 m; medium association for 0.61 to 1 m; high association for silt and detritus substrates (10)

FISH HABITAT PREFERENCE TABLES

Table 9: Habitat Preferences, Finescale Dace (*Chrosomus neogaeus*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Late spring at water temperature between 13 and 18 °C, broadcast spawners, often within masses of filamentous algae(4) (7) (9) **Lentic –** High association in lakes at depths from 0-2 m; high association for sand and silt substrate, medium for gravel; cover preference for logs and brush (4) (7) **Lotic –** high association 0.21 to 1 m; high silt/clay and detritus substrate; high wood cover; high pool velocity class (10)	**Lentic –** Medium association in lakes, where present found year round to depths of 2 m; high association with silt substrate; in wetlands associated with open water marsh/marsh wetland with mixed organic substrates and floating leaved plants (3) (5) **Lotic –** High association with depth from 0.6 m; high association with silt/clay and detritus substrate; high association with pool habitat;(10)	**General -** Small molluscs, aquatic and terrestrial insects and algae; in wetlands associated with open water marsh/marsh wetland with mixed organic substrates and floating leaved plants (3) (9)		**General –** Cool heavily vegetated slow moving shallow waters of lakes and streams with bottoms of silt and detritus, often associated with “tea” stained waters (9) **Lentic -** Year round association from 0-5 m; high association with gravel, sand silt substrate; high association with submergent/emergent vegetation cover and logs; (6) **Lotic –** high association with depth from 0.6 m; high association with silt/clay and detritus substrate; high association with pool habitat (10)

FISH HABITAT PREFERENCE TABLES

Table 10: Habitat Preferences, Pearl Dace (*Semotilus margarita*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawner at water temperature between 13 and 18 °C; in northern lakes, spawn in tributary streams or in vegetation on the periphery of lakes in early spring, about the time of spring melt and ice-off occurs (3) (11) **Lentic –** Low lake affinity but where found in 0-1 m water, high association with gravel and sand substrate; in beaver ponds and small lakes typically over soft organic substrates; low association with submergent/emergent vegetation (4) (11) **Lotic –** High association with depth from 0.6-1.0 m; high association with gravel, sand substrate; high association with riffle habitat (10)	**Lentic –** YOY from 0-2 m deep year round; low association with emergent/submergent vegetation (5) **Lotic –** High association with gravel, sand, silt/clay substrate; medium boulder, cobble, rubble and detritus, low bedrock; high association with vegetative cover; high association with pool habitat, medium with run habitat, low with riffle habiatat; turbidity intolerant (10)	**General –** filamentous algae, small crustaceans, larval aquatic insects, molluscs and terrestrial insects that fall in the water; in wetlands in open water marshes with mixed organic substrate and floating leaved plants (3) (9)		**Lentic –** Low lake association but where found in 0-2 m water year round, high association with gravel, sand, silt substrate, medium with rubble low association with emergent/submergent vegetation; (6) **Lotic –** High association with gravel, sand, silt/clay substrate; medium with boulder, cobble, rubble, detritus, low with bedrock; high association with vegetative cover; high association with pool habitat, medium with run, low with riffle; turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 11: Habitat Preferences, Fathead Minnow (*Pimephales promelas*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawner in water temperatures of 16 to 29 C, nest builders under rock or wood (4) (9) **Lentic –** Medium association with lakes; high association for depth from 0-2 m; medium association for gravel, high rubble, sand and silt substrate; medium association for submergent/emergent vegetation; high association for overhead and in-situ cover (4) (7) (12) **Lotic –** High association for depth from 0.61-1.0 m; high association for wood, substrate and overhead cover; high association for pool habitat, turbidity tolerant, substrate irrelevant, except when it includes stones under which eggs may be laid (10)	**Lentic –** YOY medium association with lakes; high association with depths from 0-2 m; medium to high association with sand, silt/clay substrate; medium association with submergent/emergent vegetation; Juveniles, high association with depth from 0-2 m, low from 2-5 m; medium association with cobble, rubble, sand, silt/clay substrates, low with gravel; medium association with emergent vegetation and in-situ cover, high with no cover (5) (7) (12) **Lotic –** High association with depth from 0-0.6 m; high association for cobble, rubble, gravel, sand, silt/clay substrates; medium for boulder, detritus; low for bedrock; high association with pool and run habitat, turbidity tolerant (10)	**General –** feed on algae, organic detritus, aquatic insect larvae and zooplankton; in wetlands associated with open water marsh and marsh of mineral, organic or mixed substrate and submergent vegetation (3)		**Lentic –** Medium to high association with lakes; high association for depth from 0-2 m, low from 2-5 m; medium association with cobble rubble substrate, high for gravel, sand, silt/clay; high association for submergent/emergent vegetation, no cover and in-situ cover (6) (7) **Lotic –** High association with depth from 0-0.6 m; high association for cobble, rubble, gravel, sand, silt/clay substrate; medium for boulder, detritus; low for bedrock; high association for pool and run habitat,, turbidity tolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 12: Habitat Preferences, Spottail Shiner (*Notropis hudsonius*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spawning over open sand or gravel shoals in clear, cold or cool lakes and likely occurs in similar fashion in rivers (3) (4) (9) **Lentic –** Medium to high association with lakes; high association for depth from 0-2 m, medium from 2-5+ m; high association for gravel, sand substrate, medium to high for cobble, rubble substrate; medium to high association for submergent/emergent vegetation cover (4) (7) (8) (12) **Lotic –** High association for rubble, sand substrate; high association for pool, riffle, run habitats (10)	**Lentic –** YOY and juvenile with medium to high association for lake environment. YOY at depths from 0-10+ m with high association for rubble, cobble, gravel, sand substrate, medium for silt/clay; high association for submergent/emergent vegetation. Juveniles at depth to 2 m; with medium association for cobble and gravel substrates, high for sand, silt/clay; medium association for pelagic areas; medium association for submergent vegetation or no cover, high for emergent vegetation (5) (7) (12) **Lotic –** High association for depths from 0-1 m; high association for gravel, sand substrates; high association for vegetative cover; high association for pool and riffle habitat, turbidity intolerant (10)	**General –** Plankton, aquatic insect larvae(especially Chironomidae and Emphemeroptera), algae, crustaceans, eggs, young fish within open water marsh or marsh with mineral substrate and emergent vegetation (3)	**General –** Known observations of spottail shiner migrating short distances up tributary streams to spawn in riffle areas (10)	**Lentic –** Medium to high lake association; year round at depths of 0 to 10+ m; medium association for cobble, rubble, silt/clay substrate, high for gravel, sand, medium association with pelagic areas; medium association for in-situ cover and medium to high association for submergent/emergent vegetation(6) (7) (8) (12) **Lotic –** High association for depth from 0-1 m; high association with gravel, sand substrates; high association with vegetation cover; high association for pool and riffle habitat, turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 13: Habitat Preferences, Blacknose Shiner (*Notropis heterolepis*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
Lentic – High association with lake environs at depths from 0-1 m; medium association for gravel substrate, high for sand; high association with submergent/emergent vegetation (4) (7) **Lotic –**high association with sand substrate (10)	**Lentic –** High association with lakes; YOY and juveniles at depth from 0-2 m; medium association with silt substrate, high for gravel sand; high association for submergent /emergent vegetation (5) (7) **Lotic –** High association for depths from 0-0.6 m; high association with gravel, sand substrates; high association with vegetation cover; high association with pool habitat, turbidity intolerant (10)	**General –**Cladocera, insects and green algae off of aquatic plants in open water marsh/marsh with mixed mineral and organic substrate (3)		**Lentic –** High association with lakes; year round at depths from 0-2 m; high association with gravel, sand substrate; high association with submergent and emergent veg. cover (6) (7) **Lotic –** High association with depths from 0-0.6 m; high association with gravel, sand substrate; high association with vegetation cover; high association with pool habitat, turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 14: Habitat Preferences, Brassy Minnow (*Hybognathus hankinsoni*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring broadcast spawner in shallow areas depositing eggs near or on vegetation at water temperature of 10 to 13 °C (3) (8) **Lentic –** At depths from 0-1 m; medium association with gravel substrate, high with sand, silt/clay; medium to high association for submergent /emergent vegetation cover, high for in-situ cover (4) (7) **Lotic –** High association for silt/clay substrate; high association for pool habitat, turbidity intolerant (10)	**Lentic –** Low lake association.; YOY and juvenile with medium association at depths from 0-2 m; low association for rubble substrate, medium to high for gravel, sand, silt/clay; medium association with submergent/emergent vegetation cover for juveniles (5) (7) **Lotic –**High association for depths from 0-2 m; high association for gravel, sand, silt/clay substrates; medium for cobble, rubble; low for bedrock, boulder, detritus; high association for pool habitat (10)	**General –** In schools feeds on aquatic insect larvae, tiny crustaceans and algae from the bottom; associated with open water marsh, marsh and meadow marsh with mixed mineral or organic substrates and submergent/emergent vegetation (3) (9)	**General –** Schools often use shallow, flooded ground where water temperature is warmer than in deeper pools or channels, especially in late summer; return to main water body when temperature relationship is reversed (3)	**General –** Inhabit small, slow flowing weedy creeks, cool, acidic, boggy streams and shallow lakes (8) **Lentic –** Low lake association but where found at depths from at 0-2 m year round; medium to high association for gravel, sand, silt/clay substrate; medium association for submergent and emergent vegetation cover (6) (7) **Lotic –**At depths from 0-2 m; high association with gravel, sand, silt/clay substrates; medium with cobble, rubble; low with bedrock, boulder, detritus; high association with pool habitat (10)

FISH HABITAT PREFERENCE TABLES

Table 15: Habitat Preferences, Common White Sucker (*Catostomus commersoni*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spawning occurs in spring at water temperatures from 6 to 23 °C, broadcast spawning over sand or gravel in streams or along lake margins and shoals, with eggs adhering to the substrate (3) (4) Spawning habitat in inlets, outlets, small creeks and rivers with relatively swift shallow waters running over a gravel bottom. Stream populations reach maximum abundance in low to moderate gradient streams (15) **Lentic –** Low to medium association for lakes at depths from 0-2 m; medium association with rubble, and sand substrate, high for gravel; low association with submergent/emergent vegetation (4) (7) (12) **Lotic –** High substrate association with rubble and gravel, turbidity tolerant (10) (15)	**General –** Larvae 10-12 mm remain among sand and gravel in shallow water; 12-17 mm larvae feed at surface in moderate current, often in association with water weed (3) **Lentic** – YOY and juveniles with year round association at depths from 0-5 m; low association with boulder/cobble substrate, medium with silt, high with sand; high association with submergent vegetation (5) (7) (12) **Lotic –** Juveniles with high depth association from 0 - 0.6 m; low substrate association for boulder and rubble, medium for cobble, gravel, sand and detritus, high for bedrock and silt/clay; low cover association with substrate, medium for vegetation and high for wood and overhead cover; high association for riffle and run habitat (10)	**General –** Sac-fry feed on surface associated zooplankton, after yolk absorption to benthic organisms such as chironomids and fingernail clams, juveniles feed primarily on benthic organisms, adults on amphipods, gastropods and large immature aquatic insects (15). In wetlands consists of open water marsh with mixed mineral and organic substrates(3) (9)	**General –** Upstream spawning migration in spring to early summer, from lentic systems or stream pools to spawning riffles when daily maximum water temperature reaches 10°C (15)	**General –** Broad temperature tolerance with optimal summer temperature of 24°C (15) **Lentic –** Adults with medium lake presence and year round association for depths from 0-10+ m; low association for bedrock, boulder, cobble and silt; medium for rubble, high for gravel and sand; medium association with emergent vegetation, high for in-situ cover (6) (7) (12) **Lotic** – Adults with high depth association from 0-1.0 m; low substrate association for bedrock, boulder, cobble and silt/clay, medium for rubble and high for gravel, sand; high cover association with wood; high velocity association for pool and run, turbidity tolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 16: Habitat Preferences, Burbot (*Lota lota*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Winter broadcast spawners at water temperatures from 1-10 °C (4) **Lentic –** High association for lakes at depths from at least 0-5 m; medium association for sand and silt substrate, high for boulder, cobble, rubble and gravel; (4) (7) **Lotic –** High association for depth from 1 to >2 m; high substrate association with gravel and sand (10)	**Lentic –** YOY with high lake presence, in spring from 0-5 m, 5+ m in fall; YOY and juveniles with medium to high association for boulder, cobble, rubble, gravel and sand; medium association with submergent/emergent vegetation and overhead cover, high for in-situ cover (5) (7) **Lotic –** Juveniles with medium substrate association for boulder, cobble, gravel, silt/clay, high association for rubble and sand substrate; medium cover association for vegetation, high for wood; high association with pool and run	**General –** Forages at night on bottom for crustaceans and a wide variety of fishes (9)	**General** – Increased flow of water and oxygenation of eggs in riverine enviro. May influence tributary spawning migrations in lacustrine populations (12)	**Lentic –** Adults with high lake presence at depths from 5 to 10+ m year round; medium association with rubble and gravel, high with bedrock, boulder, cobble, sand, silt /clay and muck; medium association with submergent/emergent vegetation, overhead or no cover; high association with in situ cover(6) (7)

FISH HABITAT PREFERENCE TABLES

Table 17: Habitat Preferences, Ninespine Stickleback (*Pungitius pungitius*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawners at water temperatures from 9-17 °C, nest builders (4) **Lentic –** High association in lakes at depths from 0-5+m;medium association with cobble, sand and silt substrate, high for rubble and gravel; high association with submergent/emergent vegetation cover, and between rocks; (4) (7) **Lotic –** High substrate association for rubble; high cover association (10)	**Lentic** – YOY and juveniles with high lake presence; in spring from 0-2 m, in fall from 2 to 5+ m; low association with gravel substrate, high with cobble, rubble, sand and silt/clay; medium association with submergent /emergent vegetation and in-situ cover (5) (7) **Lotic** – High cover association for submerged vegetation and algae; high association for pool and run habitat	**General –** Feed on aquatic insects, crustaceans, fish eggs and fry in wetlands of open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3)		**Lentic –** Adults with high lake presence in summer at depths from 0-2 m, 2-10+ m year round; low association with gravel substrate, medium with pelagic zone, high with cobble, rubble, sand, silt/clay, hard-pan clay; medium association with submergent /emergent vegetation and in-situ cover medium association with gravel substrate, high with sand and silt; high association for submergent vegetation; (6) (7)

FISH HABITAT PREFERENCE TABLES

Table 18: Habitat Preferences, Brook Stickleback(*Culaea inconstans*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General –Spring spawners at water temperature of 8-19 °C in shallow water where they construct a nest of grass, green algae or reeds (3) (4) **Lentic –** High association with lakes at depths from 0-1 m; medium association with gravel substrate, high for sand and silt; high association with submergent/emergent cover and sticks (4) (7) (12)	**Lentic -** YOY and juveniles with medium to high presence in lakes; in spring from 0-2 m, in fall from 2 to 5+ m; high association with gravel substrate, medium with sand and silt/clay; medium to high association with submergent/emergent vegetation; (5) (7) (12) **Lotic –** Juveniles with medium association for depth from 1.0 to 2.0 m, high from 0 to 1.0 m; low substrate association for bedrock and detritus, medium for boulder, cobble, rubble, high for gravel, sand and silt/clay; high cover association for vegetation; high association for pool and run habitat, turbidity intolerant	**General –** Feed on aquatic insects, larvae and small crustaceans, fish eggs and fry, snails, worms and algae in wetlands of open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3)		**Lentic –** Adults with high lake presence in summer at depths from 0-2 m, 2-10+ m year round; Low association for muck and clay, medium for rubble substrate, high for gravel, sand and silt; medium association for in-situ cover, high for submergent /emergent vegetation; (6) (7) (12) **Lotic -** ; Medium association for depth from 1.0 to 2.0 m, high from 0 to 1.0 m Low substrate association for bedrock and detritus, medium for boulder, cobble, rubble, high for gravel, sand and silt/clay high association for pool and run habitat, turbidity intolerant, turbidity

FISH HABITAT PREFERENCE TABLES

Table 19: Habitat Preferences, Smallmouth Bass (*Micropterus dolomieu*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring spawners at water temperature from 13-24 °C, nest builders (4) **Lentic –** high association for lakes at depths from 0-2 m; medium association for bedrock, and sand substrate, high for rubble, and gravel; low association with submergent/emergent vegetation; with boulders, docks and logs; (4) (7) **Lotic –** High association for depth from 0.21 to >2 m; high association for rubble, gravel and sand	**Lentic –** YOY and juveniles with high presence in lakes at depths from 0-2 m in spring and 2-5+ m in fall; low association with silt substrates, medium with bedrock, gravel, sand, high with boulder and boulder/cobble;low association with submergent/emergent vegetation, medium with in-situ cover (5) (7) **Lotic –** Juveniles with low depth association from 0 to 0.2 m, medium from 0.21 to 0.6 m, high from 0.61 to >2.0 m; medium substrate association for gravel, high for boulder and cobble; high association for wood, substrate and overhead cover; high association for pool habitat, turbidity intolerant (10)	General – Feed on crayfish, aquatic insects, fish, tadpoles, frogs and plant material in wetlands of open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3) (9)		**Lentic –** Adults with high lake presence at depths from 0-2 m in summer, 2-10 m year round; low association with sand substrate, medium with hard-pan clay, high with boulder, cobble, rubble and gravel; low association with submergent/emergent vegetation, medium with in-situ cover (6) (7) **Lotic -** Adults with low depth association from 0.2 to 0.6 m, medium from 0.61 to 1.0 m, high from 1.0 to >2.0 m; low substrate association with sand, silt/clay and detritus, medium for bedrock and high for boulder, cobble, rubble and gravel; high association for wood, substrate and overhead cover; high association for pool and riffle habitat, turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 20: Habitat Preferences, Pumpkinseed (*Lepomis gibbosus*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spawning in late spring/early summer at water temperatures of 13-24°C in shallow inshore waters of ponds, lakes or slow moving rivers at depths from 0.15-0.30 m, nest builders using rocky, sandy or clay substrates, near or in submergent vegetation (3) (4) **Lentic –** High association with lakes at depths from 0-2 m; medium association with clay substrate, high for gravel and sand; high association with submergent/emergent vegetation cover; (4) (7) **Lotic –** Medium association with depth from 0-0.21 m, high for 0-0.2 m; high substrate association for gravel, sand, silt/clay and detritus	**General** – Often show distinct habitat segregation according to age class with younger fish amongst denser vegetation (3) **Lentic –** YOY and juveniles with high lake presence; year round at depths from 0-2 m; high association with sand and silt substrate; high association with submergent/emergent vegetation and overhead cover (5) (7) **Lotic –** Juveniles with high depth association from 0 to 1.0 m; low substrate association for bedrock, hard-pan, detritus, medium association for cobble, rubble and high association for gravel, sand, silt/clay; high cover association for vegetation and wood; high association for pool habitat, turbidity intolerant	**General** – Feed primarily on invertebrates living on aquatic plants although molluscs, small fish and aquatic vegetation also eaten; in wetlands in open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3) (9)		**Lentic –** Adults with high lake presence at depth of 0-2 m year round; low association with rubble substrate, medium for gravel, high for sand and silt; high association with submergent/emergent vegetation; (6) (7) **Lotic –** Adults with high depth association from 0 to 1.0 m; low substrate association for bedrock, hard-pan, detritus, medium association for cobble, rubble and high association for gravel, sand, silt/clay; high cover association for vegetation and wood; high association for pool habitat, turbidity intolerant

FISH HABITAT PREFERENCE TABLES

Table 21: Habitat Preferences, Walleye (*Sander vitreus*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General –Spring broadcast spawner at water temperatures from 4-12 °C, at night, on windswept, coarse gravelly to boulder shoals of lakes after ice-out, or in rocky riffles and rapids of rivers. Homing behaviour for repeat spawning locations has been reported in the literature (3) (16) (18) Submergent vegetation is rarely used for spawning but may be used, along with other types of substrate if gravel-rubble is not present (17) (18) **Lentic –** Medium association for lakes at depths from 0-5+ m; low to high association with bedrock, boulder, cobble, rubble, gravel, sand and hard-pan clay substrates; low to medium association with submergent/emergent vegetation; spawning locations have sufficient exchanges or movements of water to permit adequate oxygen supply to developing embryo (4) (7) (12) (18) **Lotic –** Medium association for depth from 0.2 to 0.6 m, high from 0.61 to 1.0 m; high substrate association for cobble and rubble ; many spawning sites are below barriers of some sort (either natural or man-made) spawning locations have sufficient exchanges or movements of water to permit adequate oxygen supply to developing embryo (10) (17) (18)	**General –** Inshore areas important as nursery habitat for YOY; strong schooling tendencies and often associated with Yellow Perch; (12) (17) (18) **Lentic –** YOY and juveniles with high lake presence; in spring at depths from 0-5 m, in fall from 5+ m; medium association with boulder, cobble substrate, high with gravel, sand, YOY also with muck, hard-pan clay and pelagic zone; medium association with submergent/emergent vegetation (5) (7) (12) (17) **Lotic –** Juveniles with low depth association from 0 to 0.6 m, medium 0.61 to 1.0 m, high from 1.0 to >2.0 m; low substrate association for boulder and detritus, medium association for cobble and rubble, high for gravel and sand; high cover association for vegetation, wood and substrate; medium association with run habitat, high with pool, turbidity intolerant (10) (17)	**General –** Fry eat zooplankton and aquatic insects before switching to fish at 1.5 to 2.5 cm in length; diet of juveniles and adults consists primarily of fish and to lesser extent on aquatic invertebrates such as mayfly larvae and crayfish(3) (9) (16) (18) Feeding occurs near or at the bottom In wetlands in open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation although not preferred habitat (3)	**Lentic –** YOY with movement pattern towards the bottom at depths of 3-9 m in late summer; larval movement and dispersion influenced by lake currents, prevailing winds and wave action (3) (17) Adults in lakes often migrate up rivers to spawn (16) **Lotic –** The drift of larvae fish has been documented in several river systems (17)	**General -** d **Lentic –** Adults with high lake presence at depths from 0-5 m year round, 5-10 m in summer; low association for hard-pan clay, medium for boulder, cobble and silt, high for rubble, gravel, sand, silt/clay and muck; low association with submergent/emergent vegetation, high overhead and in-situ cover (6) (7) (12) **Lotic –** Adults with low depth association from 0 to 0.6 m, medium 0.61 to 1.0 m, high from 1.0 to >2.0 m; low substrate association for boulder and detritus, medium association for cobble and rubble, high for gravel and sand; high cover association for vegetation, wood and substrate; medium association with run habitat, high with pool, turbidity intolerant (10)

FISH HABITAT PREFERENCE TABLES

Table 22: Habitat Preferences, Yellow Perch (*Perca flavescens)*

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring broadcast spawner at water temperatures from 7-22 °C (4) **Lentic –** High association with lakes at depths from 0-5+ m; medium association for rubble, silt/clay substrate, high for gravel and sand; medium association with submergent/emergent vegetation; (4) (7) **Lotic –** High association for depth from 0.21 to >2 m; high substrate association for gravel and sand (10)	**Lentic –** YOY and juveniles with high lake presence; in spring at depths from 0-5 m, 5+ m in fall; medium to high association with cobble rubble, gravel, sand and silt substrate; medium to high association with submergent/emergent vegetation, high with pelagic zone, YOY with medium association to overhead and in-situ cover (5) (7) **Lotic –** Juveniles with high depth association from 0 to 1.0 m;	**General –** Yellow Perch will occupy holes in dense vegetation and ambush prey; in wetlands feed in open water marsh and marsh with mineral or organic substrates and submergent/emergent vegetation (3)		**Lentic –** Adults with high lake presence at depths from 0-10+ m year round; low association with bedrock, boulder, cobble, rubble and clay, medium with gravel, high with sand, silt and muck; high association with submergent/emergent vegetation; (6) (7) **Lotic –** Adults with high depth association from 0 to >2.0 m; low substrate association with detritus, medium association with boulder, cobble, rubble and silt/clay, high association for gravel, sand; medium cover association for wood, high for vegetation; high association with pool habitat, turbidity intolerant

FISH HABITAT PREFERENCE TABLES

Table 23: Habitat Preferences, Iowa Darter (*Etheostoma exile)*

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General – Spring broadcast spawner at 12-15 °C in shallow waters near shore of lakes and streams on bottom organic debris, aquatic vegetation or fibrous root material; on sand or on organic material on sand when no undercut bank available (3) (4) (9) (14) **Lentic –** Medium association for lake environments in depths of 0-1 m; high association for rubble, gravel, sand and silt substrates (4) **Lotic –** High association for depth of 0.2-0.6 m; high association for gravel, sand substrate; high association for vegetation and overhead cover; high association for pool habitat (10)	**General -** Larval fish use pools 0.9-1.2 m deep (3) **Lentic –** YOY with medium association for lakes at depths from 0-5 m year round; high association for gravel, sand, silt substrate; medium association with submergent vegetation (5) **Lotic –** High association for depth of 0-0.61 m; high association for gravel and sand substrates, medium association for silt/clay and detritus, low for bedrock and boulder; High cover association for vegetation and algae; high association for pool habitat; low turbidity tolerance (10)	**General –** Bottom feeder on insect larvae of midge and mayfly, small crustaceans including amphipods, copepods and cladocerans; molluscs (3) (9) (14) **Lentic –** Wetland habitats of open water marsh and marsh with mixed mineral or organic substrates and submergent, floating, emergent vegetation (3)		**General –** Clear standing or slow moving waters of ponds, lakes or rivers at depths of<1.5 m (3) **Lentic –** Low association for lake environs, where found year round association at depths from 0-5 m; high association for gravel, sand, silt substrate; medium cover association for submergent vegetation; (6) **Lotic –** High association for depth from 0-0.6 m; high association for gravel, sand, medium silt/clay, detritus substrates; low for bedrock and boulder; high cover association for vegetation and algae; high association for pool habitat, low turbidity tolerance (10)

FISH HABITAT PREFERENCE TABLES

Table 24: Habitat Preferences, Mottled Sculpin (*Cottus bairdi*)

Spawning	Rearing/Nursery	Feeding	Migratory Corridor	Overwintering/Summer Refuge
General - Spring spawners at temperatures from 6-16 °C; nest builders (4) **Lentic –** Medium association with lake environments, where present in 0-1 m of water under rocks and logs; high association with boulder, cobble, rubble, gravel, sand, silt/clay substrates (4) (7) (11) **Lotic –** High association with depths from 0-0.2 m; high association with rubble or gravel substrates, medium with sand and silt/clay; high association for substrate and overhead cover (10)	**Lentic –** YOY typically inhabit 0-2 m, up to 5+ m in some cases with high association for boulder, cobble, rubble substrate, medium for gravel and sand; juveniles associated with substrates of boulder, rubble and sand and use in-situ cover under rocks and logs in littoral zone from summer through fall (5) (7) **Lotic –** Juveniles with high association for depth from 0-0.6 m; high association for gravel, sand, silt/clay substrates; medium for boulder, cobble, rubble, low for bedrock and detritus; high association with instream vegetation, substrate and overhead cover; high association for pool and riffle habitat (10)	**General -** Bottom substrates, feeds on aquatic insect larvae and occasionally worms and small crustaceans of streams and lakes (9) **Lentic –** at night in open sandy areas (11)		**General -** Intolerant of high water temperatures, occupy an average temperature of approx 17 °C **Lentic –** High association for depth from 0-2 m; high association for boulder, gravel, sand substrate; high association with use of substrate for cover (6) (7) **Lotic –** Adults with high association for depths from 0-0.6 m; high association for gravel, sand, silt/clay substrate; medium for boulder, cobble, rubble, low for bedrock and detritus; high association with instream vegetation, substrate and overhead cover; high association for pool and riffle habitat (10)

REFERENCES CITED

1 Inskip, P.D. 1982. Habitat suitability index models: Northern Pike. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.17. 40 p.

2 Holland, L.E. and M.L. Huston. 1984. Relationship of young-of-the-year Northern Pike to aquatic vegetation types in backwaters of the upper Mississippi River. North American Journal of Fisheries Management 4:514-522.

3 Hall-Armstrong, J, A.G. Harris and R.F. Foster. 1996. Fish use of wetlands in Northwestern Ontario: a literature review and bibliography. Northwest Sci. & Technol., Ont. Min. Natur. Resour., Thunder Bay, Ont. TR-90. 54 pp+.

4 Lane, J.A., C.B. Portt and C.K. Minns. 1996. Spawning habitat characteristics of Great Lakes fishes. Can. MS Rep. Fish. Aquat. Sci. 2368: v+48p.

5 Lane, J.A., C.B. Portt and C.K. Minns. 1996. Nursery habitat characteristics of Great Lakes fishes. Can. MS Rep. Fis. Aquat. Sci. 2338: v+42p.

6 Lane, J.A., C.B. Portt and C.K. Minns. 1996. Adult habitat characteristics of Great Lakes fishes. Can. MS Rep. Fis. Aquat. Sci. 2358: v+43p.

7 Langhorne, A.L., M. Neufeld, G. Hoar, V. Bourhis, D.A. Fernet, and C.K. Minns. 2001. Life history characteristics of freshwater fishes occuring in Manitoba, Saskatchewan, and Alberta, with major emphasis on lake habitat requirements. Can. MS Rpt. Fish. Aquat. Sci. 2579:xii+170p.

8 Roberge, M., T. Slaney and C.K. Minns. 2001. Life history characteristics of freshwater fishes occurring in British Columbia with major emphasis on lake habitat requirements. Can. MS Rpt. Fish. Aquat. Sci. 2574: i + 41 p.

9 Holm, E., N.E. Mandrak and M.E. Burridge. 2009. The ROM field guide to freshwater fishes of Ontario. Royal Ontario Museum, Friesens Printers , Altona, MB. 462p.

10 Portt, C.B., G. Coker and C.K. Minns. 1999. Riverine habitat characteristics of fishes of the Great Lakes watershed. Can. MS Rpt. Fish. Aquat. Sci. 2481:vi+62p.

11 Bradbury, C. M., M. Roberge and C.K. Minns. 1999. Life history characteristics of freshwater fishes occurring in Newfoundland and Labrador, with major emphasis on lake habitat characteristics. Can. MS Rep. Fish. Aquat. Sci. 2485:vii+150p.

12 Richardson, E.S., J.D. Resit and C.K. Minns. 2001. Life history characteristics of freshwater fishes occurring in the Northwest Territories and Nunavut, with major emphasis on lake habitat characteristics. Can. MS Rep. Fish. Aquat. Sci. 2569:vii+146p.

13 Fish Species Habitat Suitability Index Models for the Alberta Oil Sands Region (Golder 2008).

14 Scott, W.B. and E. J. Crossman, 1973. Freshwater fishes of Canada. Bulletin 184, Fisheries Research Board of Canada, Ottawa, ON. xviii + 966p.

15 Twomey, K.A., K.L. Williamson and P.C. Nelson. 1984. Habitat suitability index models and instream flow suitability curves: White Sucker. U.S. Fish Wildl. Serv. FWS/OBS-82/10.64. 56 pp.

16 McMahon, T.E., J.W. Terrell, and P.C. Nelson. 1984. Habitat suitability information: Walleye. U.S. Fish Wildl. Serv. FWS/OBS-82/10.56. 43 pp.

17 Kerr, S.J., B.W. Corbett, N.J. Hutchinson, D. Kinsman, J.H. Leach, D. Puddister, L. Stanfield and N. Ward. 1997. Walleye habitat: A synthesis of current knowledge with guidelines for conservation. Pecid Community Synthesis, Walleye Habitat Working Group, Ontario Ministry of Natural Resources, Peterborough, Ontario. 82 p.

18 Colby, P.J., R.E. McNicol and R.A. Ryder. 1979. FAO Fish. Synop. Synopsis of biological data on the walleye, *Stizostedion v. vitreum* (119): 139 p.

APPENDIX C
Habitat Accounting Model

October 16, 2012
Report No. 10-1118-0020V4

Golder Associates

AQUATIC ENVIRONMENT TSD
APPENDIX 2.III
VERSION 1

TABLE 1
No Net Loss Plan – Species Weights

Osisko Hammond Reef Gold Ltd.

Species Groupings and Weights		
Group	**Species**	**Weight**
Group 1: Cold + A1 - Lake: Non-Pisc	lake whitefish	0.050
	lake ciscoe	0.050
Group 2: Cold + A1 - Stream: Non-Piscivore	pearl dace	0.030
Group 3: Cold + A1 - Stream: Piscivore	burbot	0.015
Group 4: Cold + B: Non- Piscivore	ninespine stickleback	0.015
	brook stickleback	0.015
	mottled sculpin	0.015
Group 5: Cool + A1: Non-Piscivore	blacknose dace	0.015
	brassy minnow	0.015
	finescale dace	0.030
	redbelly dace	0.030
	golden shiner	0.015
	longnose dace	0.015
	white sucker	0.015
	iowa darter	0.015
	yellow perch	0.030
Group 6: Cool + A1: Piscivore	yellow walleye	0.200
	northern pike	0.100
Group 7: Warm + A: Non-Piscivore	blacknose shiner	0.015
	emerald shiner	0.030
	spottail shiner	0.030
	central mudminnow	0.015
Group 8: Warm + B: Non-Piscivore	fathead minnow	0.030
	pumpkinseed	0.030
Group 9: Warm + B: Piscivore	smallmouth bass	0.200
Total		**1.020**

Ecotype Weightings	
Ecotype	**Ecotyp Weight - Productive Capacity Index**
Receiver Ecotype Habitat	1.5
Lake Ecotype Habitat	1
Headwater Pond Ecotype Habitat	1
Inlet Stream Ecotype Habitat	2.5
Warmwater Stream Ecotype Habitat	2.5
Intermittent Stream Ecotype	0.75

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are 4 (0-6 species present); 3 (7-12 species present);
2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA,

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 2
No Net Loss Plan – Habitat Summary by Ecotype

Ecotype	Units	HA - Total Area of Habitat Feature	Habitat Expansion Factor (<7 sp=4; 7-12=3; 13-18=2;>18=1)	Total Weighted Useable Area	Ecotype Productive Capacity Index	Ecotype Weighted Useable Area
Receiver Ecotype Habitat	m^2	19,551,783.69	1	9,607,708.96	1.5	14,411,563.44
Lake Ecotype Habitat	m^2	297,088.78	1	17,817.02	1	17,817.02
Headwater Pond Ecotype Habitat	m^2	48,082.43	1	2,437.84	1	2,437.84
Inlet Stream Ecotype Habitat	m	92,657.67	1	4,312.83	2.5	10,782.06
Warmwater Stream Ecotype Habitat	m	216,355.01	1	12,978.82	2.5	32,447.06
Intermittent Stream Ecotype	m	1,964.09	1	24.04	0.75	18.03
Totals excluding Receiver		656,147.98		37,570.55		63,502.01
	Totals	20,207,931.67		9,645,279.51		14,538,567.47

TABLE 3
No Net Loss Plan – Receiver Ecotype Habitat

			Group 1: Cold + A1 - Lake: Non-Pisc							Group 1: Cold + A1 - Lake: Non-Piscivore							Group 3: Cold + A1 - Stream: Piscivore						
			Lake whitefish HSI Factor Score (0 - 1)							lake ciscoe HSi Factor Score (0 - 1)							burbot HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score
Sawbill Bay	Littoral (1 - 3 m)	2,412,200.055	0.05	1	1	0.75	0.75	1	0.9														
API 34 and 49	Open Water/Profundal (> 3 m)	13,028,357.95	0.05	1	1	0.75	0.75	1	0.9														
Lynxhead Bay and Turtle Bay	Littoral (1 - 3 m)	46,827.33063																					
API 29 and 31	Open Water/Profundal (> 3 m)	1,955,173.746																					
Lizard Lake	Littoral (1 - 3 m)	66,600.197								0.05	0.75	0.5	0.5	1	1	0.75							
API 38 and 39	Open Water/Profundal (> 3 m)	1,863,088.026								0.05	0.75	0.5	0.5	1	1	0.75							
API 8	Littoral (1 - 3 m)	6,568.26568															0.015	1	1	1	1	n/a	
	Open Water/Profundal (> 3 m)	172,968.1247															0.015	1	1	1	1	n/a	

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

TABLE 3
No Net Loss Plan – Receiver Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore							Group 5: Cool + A1: Non-Piscivore						
			golden shiner HSI Factor Score (0 - 1)							white sucker HSI Factor Score (0 - 1)							iowa darter HSi Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score
Sawbill Bay	Littoral (1 - 3 m)	2,412,200.055	0.015	0.5	1	1	1	n/a	0.875	0.015	0.25	0.25	0.5	0.75	0.25	0.4	0.015	0.5	0.5	0.5	0.75	n/a	0.563
API 34 and 49	Open Water/Profundal (> 3 m)	13,028,357.95	0.015	0.5	1	1	1	n/a	0.875	0.015	0.25	0.25	0.5	0.75	0.25	0.4	0.015	0.5	0.5	0.5	0.75	n/a	0.563
Lynxhead Bay and Turtle Bay	Littoral (1 - 3 m)	46,827.33063								0.015	0.25	0.25	0.5	0.75	0.25	0.4							
API 29 and 31	Open Water/Profundal (> 3 m)	1,955,173.746								0.015	0.25	0.25	0.5	0.75	0.25	0.4							
Lizard Lake	Littoral (1 - 3 m)	66,600.197								0.015	0.25	0.25	0.5	0.75	0.25	0.4	0.015	0.5	0.5	0.5	0.75	n/a	0.563
API 38 and 39	Open Water/Profundal (> 3 m)	1,863,088.026								0.015	0.25	0.25	0.5	0.75	0.25	0.4	0.015	0.5	0.5	0.5	0.75	n/a	0.563
API 8	Littoral (1 - 3 m)	6,568.26568	0.015	0.5	1	1	1	n/a	0.875														
	Open Water/Profundal (> 3 m)	172,968.1247	0.015	0.5	1	1	1	n/a	0.875														

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

TABLE 3
No Net Loss Plan – Receiver Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore							Group 6: Cool + A1: Piscivore							Group 6: Cool + A1: Piscivore						
			yellow perch HSI Factor Score (0 - 1)							Yellow Walleye HSI Factor Score (0 - 1)							northern pike HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score
Sawbill Bay	Littoral (1 - 3 m)	2,412,200.055	0.03	1	1	1	1	n/a	1	0.2	0.75	1	0.75	0.75	0.5	0.75	0.1	0.5	0.75	0.75	0.75	0.25	0.6
API 34 and 49	Open Water/Profundal (> 3 m)	13,028,357.95	0.03	1	1	1	1	n/a	1	0.2	0.75	1	0.75	0.75	0.5	0.75	0.1	0.5	0.75	0.75	0.75	0.25	0.6
Lynxhead Bay and Turtle Bay	Littoral (1 - 3 m)	46,827.33063	0.03	1	1	1	1	n/a	1	0.2	0.75	1	0.75	0.75	0.5	0.75	0.1	0.5	0.75	0.75	0.75	0.25	0.6
API 29 and 31	Open Water/Profundal (> 3 m)	1,955,173.746	0.03	1	1	1	1	n/a	1	0.2	0.75	1	0.75	0.75	0.5	0.75	0.1	0.5	0.75	0.75	0.75	0.25	0.6
Lizard Lake	Littoral (1 - 3 m)	66,600.197	0.03	1	1	1	1	n/a	1	0.2	0.75	1	0.75	0.75	0.5	0.75	0.1	0.5	0.75	0.75	0.75	0.25	0.6
API 38 and 39	Open Water/Profundal (> 3 m)	1,863,088.026	0.03	1	1	1	1	n/a	1	0.2	0.75	1	0.75	0.75	0.5	0.75	0.1	0.5	0.75	0.75	0.75	0.25	0.6
API 8	Littoral (1 - 3 m)	6,568.26568															0.1	0.5	0.75	0.75	0.75	0.25	0.6
	Open Water/Profundal (> 3 m)	172,968.1247															0.1	0.5	0.75	0.75	0.75	0.25	0.6

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

TABLE 3
No Net Loss Plan – Receiver Ecotype Habitat

			Group 7: Warm + A: Non-Piscivore							Group 7: Warm + A: Non-Piscivore							Group 8: Warm + B: Non-Piscivore						
			blacknose shiner HSI Factor Score (0 - 1)							spottail shiner HSi Factor Score (0 - 1)							pumpkinseed HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score
Sawbill Bay	Littoral (1 - 3 m)	2,412,200.055	0.015	1	1	1	1	n/a	1	0.03	0.75	0.75	0.5	0.25	0.25	0.5							
API 34 and 49	Open Water/Profundal (> 3 m)	13,028,357.95	0.015	1	1	1	1	n/a	1	0.03	0.75	0.75	0.5	0.25	0.25	0.5							
Lynxhead Bay and Turtle Bay	Littoral (1 - 3 m)	46,827.33063																					
API 29 and 31	Open Water/Profundal (> 3 m)	1,955,173.746																					
Lizard Lake	Littoral (1 - 3 m)	66,600.197	0.015	1	1	1	1	n/a	1	0.03	0.75	0.75	0.5	0.25	0.25	0.5	0.03	0.5	0.75	0.75	0.75	n/a	0.688
API 38 and 39	Open Water/Profundal (> 3 m)	1,863,088.026	0.015	1	1	1	1	n/a	1	0.03	0.75	0.75	0.5	0.25	0.25	0.5	0.03	0.5	0.75	0.75	0.75	n/a	0.688
API 8	Littoral (1 - 3 m)	6,568.26568															0.03	0.5	0.75	0.75	0.75	n/a	0.688
	Open Water/Profundal (> 3 m)	172,968.1247															0.03	0.5	0.75	0.75	0.75	n/a	0.688

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

TABLE 3
No Net Loss Plan – Receiver Ecotype Habitat

			Group 9: Warm + B: Piscivore										
			smallmouth bass HSI Factor Score (0 - 1)										
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	**Habitat Expansion Factor (<7 sp=4; 7-12=3;13-18=2;>18=1)**	**Total Weighted Useable Area (m^2 or ha)**	**Ecotype Productive Capacity Index**	**Ecotype Weighted Useable Area (m^2 or ha)**
Sawbill Bay	Littoral (1 - 3 m)	2,412,200.055	0.2	1	0.75	0.75	0.75	n/a	0.813	1	1,218,311.79	1.5	1,827,467.69
API 34 and 49	Open Water/Profundal (> 3 m)	13,028,357.95	0.2	1	0.75	0.75	0.75	n/a	0.813	1	6,580,135.04	1.5	9,870,202.556
Lynxhead Bay and Turtle Bay	Littoral (1 - 3 m)	46,827.33063	0.2	1	0.75	0.75	0.75	n/a	0.813	1	19,128.96456	1.5	28,693.44684
API 29 and 31	Open Water/Profundal (> 3 m)	1,955,173.746	0.2	1	0.75	0.75	0.75	n/a	0.813	1	798,688.4752	1.5	1,198,032.713
Lizard Lake	Littoral (1 - 3 m)	66,600.197	0.2	1	0.75	0.75	0.75	n/a	0.813	1	33,637.262	1.5	50,455.893
API 38 and 39	Open Water/Profundal (> 3 m)	1,863,088.026	0.2	1	0.75	0.75	0.75	n/a	0.813	1	940,975.8961	1.5	1,411,463.844
API 8	Littoral (1 - 3 m)	6,568.26568								1	615.7749075	1.5	923.6623613
	Open Water/Profundal (> 3 m)	172,968.1247								1	16,215.76169	1.5	24,323.64254

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 1: Cold + A1 - Lake: Non-Pisc Lake whitefish HSI Factor Score (0 - 1)							Group 1: Cold + A1 - Lake: Non-Piscivore lake ciscoe HSi Factor Score (0 - 1)							Group 2: Cold + A1 - Stream: Non-Piscivore pearl dace HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**
API 12 - Mitta	Littoral (0 - 3 m))	8,891.417048	0.05	0	0	0	0	0	0	0.05	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
s.a.= 172,737	Open Water/Profundal (= Littoral)	163,846.1897	0.05	0	0	0	0	0	0	0.05	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
API 2	Littoral (0 - 3 m))	5,989.703878	0.05	0	0	0	0	0	0	0.05	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0
s.a.= 124,351	Open Water/Profundal (= Littoral)	118,361.4678	0.05	0	0	0	0	0	0	0.05	0	0	0	0	0	0	0.03	0	0	0	0	n/a	0

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 3: Cold + A1 - Stream: Piscivore burbot HSI Factor Score (0 - 1)							Group 4: Cold + B: Non- Piscivore ninespine stickleback HSI Factor Score (0 - 1)							Group 4: Cold + B: Non- Piscivore brook stickleback HSi Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**
API 12 - Mitta	Littoral (0 - 3 m))	8,891.417048	0.015	0	0	0	0	0	0	0.015	0.5	0.5	0.25	0.5	n/a	0.438	0.015	0.5	0.5	0.25	0.5	n/a	0.438
s.a.= 172,737	Open Water/Profundal (= Littoral)	163,846.1897	0.015	0	0	0	0	0	0	0.015	0.5	0.5	0.25	0.5	n/a	0.438	0.015	0.5	0.5	0.25	0.5	n/a	0.438
API 2	Littoral (0 - 3 m))	5,989.703878	0.015	0	0	0	0	0	0														
s.a.= 124,351	Open Water/Profundal (= Littoral)	118,361.4678	0.015	0	0	0	0	0	0														

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 4: Cold + B: Non- Piscivore mottled sculpin HSi Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore blacknose dace HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore brassy minnow HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score
API 12 - Mitta	Littoral (0 - 3 m))	8,891.417048	0.015	0.5	0.5	0.25	0.5	n/a	0.438	0.015	0	0	0	0	n/a	0	0.015	0	0	0	0	0	0
s.a.= 172,737	Open Water/Profundal (= Littoral)	163,846.1897	0.015	0.5	0.5	0.25	0.5	n/a	0.438	0.015	0	0	0	0	n/a	0	0.015	0	0	0	0	0	0
API 2	Littoral (0 - 3 m))	5,989.703878								0.015	0	0	0	0	n/a	0	0.015	0	0	0	0	0	0
s.a.= 124,351	Open Water/Profundal (= Littoral)	118,361.4678								0.015	0	0	0	0	n/a	0	0.015	0	0	0	0	0	0

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore finescale dace HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore redbelly dace HSi Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore golden shiner HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**
API 12 - Mitta	Littoral (0 - 3 m))	8,891.417048	0.03	0.25	0.25	0.25	0.25	n/a	0.25	0.03	0	0	0	0	0	0	0.015	0	0	0	0	n/a	0
s.a.= 172,737	Open Water/Profundal (= Littoral)	163,846.1897	0.03	0.25	0.25	0.25	0.25	n/a	0.25	0.03	0	0	0	0	0	0	0.015	0	0	0	0	n/a	0
API 2	Littoral (0 - 3 m))	5,989.703878								0.03	0	0	0	0	0	0	0.015	0	0	0	0	n/a	0
s.a.= 124,351	Open Water/Profundal (= Littoral)	118,361.4678								0.03	0	0	0	0	0	0	0.015	0	0	0	0	n/a	0

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore longnose dace HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore white sucker HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore iowa darter HSi Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**
API 12 - Mitta	Littoral (0 - 3 m))	8,891.417048	0.015	0	0	0	0	0	0	0.015	0.5	0.25	0.5	0.5	0	0.35	0.015	0.25	0.25	0.5	0.25	n/a	0.313
s.a.= 172,737	Open Water/Profundal (= Littoral)	163,846.1897	0.015	0	0	0	0	0	0	0.015	0.5	0.25	0.5	0.5	0	0.35	0.015	0.25	0.25	0.5	0.25	n/a	0.313
API 2	Littoral (0 - 3 m))	5,989.703878	0.015	0	0	0	0	0	0	0.015	0.5	0.25	0.5	0.5	0	0.35	0.015	0.25	0.25	0.5	0.25	n/a	0.313
s.a.= 124,351	Open Water/Profundal (= Littoral)	118,361.4678	0.015	0	0	0	0	0	0	0.015	0.5	0.5	0.5	0.5	0	0.4	0.015	0.25	0.25	0.5	0.25	n/a	0.313

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 5: Cool + A1: Non-Piscivore yellow perch HSI Factor Score (0 - 1)							Group 6: Cool + A1: Piscivore Yellow Walleye HSI Factor Score (0 - 1)							Group 6: Cool + A1: Piscivore northern pike HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**
API 12 - Mitta	Littoral (0 - 3 m))	8,891.417048								0.2	0	0	0	0	0	0							
s.a.= 172,737	Open Water/Profundal (= Littoral)	163,846.1897								0.2	0	0	0	0	0	0							
API 2	Littoral (0 - 3 m))	5,989.703878	0.03	0.5	0.25	0.5	0.5	n/a	0.438	0.2	0	0	0	0	0	0	0.1	0.5	0.75	0.75	0.5	0.5	0.6
s.a.= 124,351	Open Water/Profundal (= Littoral)	118,361.4678	0.03	0.5	0.25	0.5	0.5	n/a	0.438	0.2	0	0	0	0	0	0	0.1	0	0.5	0.75	0.5	0.5	0.45

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 7: Warm + A: Non-Piscivore blcknose shiner HSI Factor Score (0 - 1)							Group 7: Warm + A: Non-Piscivore central mudminnow HSI Factor Score (0 - 1)							Group 7: Warm + A: Non-Piscivore emerald shiner HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**
API 12 - Mitta	Littoral (0 - 3 m))	8,891.417048	0.015	0	0	0	0	n/a	0	0.015	0	0	0	0	0	0	0.03	0	0	0	0	0	0
s.a.= 172,737	Open Water/Profundal (= Littoral)	163,846.1897	0.015	0	0	0	0	n/a	0	0.015	0	0	0	0	0	0	0.03	0	0	0	0	0	0
API 2	Littoral (0 - 3 m))	5,989.703878	0.015	0.5	0.5	0.5	0.5	n/a	0.5	0.015	0	0	0	0	0	0	0.03	0	0	0	0	0	0
s.a.= 124,351	Open Water/Profundal (= Littoral)	118,361.4678	0.015	0	0	0	0	n/a	0	0.015	0	0	0	0	0	0	0.03	0	0	0	0	0	0

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 7: Warm + A: Non-Piscivore spottail shiner HSi Factor Score (0 - 1)							Group 8: Warm + B: Non-Piscivore fathead minnow HSI Factor Score (0 - 1)							Group 8: Warm + B: Non-Piscivore pumpkinseed HSI Factor Score (0 - 1)						
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**
API 12 - Mitta	Littoral (0 - 3 m))	8,891.417048	0.03	0	0	0	0	0	0	0.03	0.25	0.25	0.25	0.25	n/a	0.25							
s.a.= 172,737	Open Water/Profundal (= Littoral)	163,846.1897	0.03	0	0	0	0	0	0	0.03	0.25	0.25	0.25	0.25	n/a	0.25							
API 2	Littoral (0 - 3 m))	5,989.703878	0.03	0	0	0	0	0	0								0.03	0.5	0.5	0.5	0.5	n/a	0.5
s.a.= 124,351	Open Water/Profundal (= Littoral)	118,361.4678	0.03	0	0	0	0	0	0								0.03	0	0.5	0.5	0.5	n/a	0.375

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
No Net Loss Plan – Lake Ecotype Habitat

			Group 9: Warm + B: Piscivore smallmouth bass HSI Factor Score (0 - 1)											
API Number	**Habitat Unit Ref.**	**HA (m^2 or ha)**	**Species Weighting**	**Spawning**	**Nursery**	**Feeding**	**Overwinter/Summer Refuge**	**Migration**	**HU Score**	**Habitat Expansion Factor (<7 sp=4; 7-12=3;13-18=2;>18=1)**	**Total Weighted Useable Area (m^2 or ha)**	**Ecotype Productive Capacity Index**	**Ecotype Weighted Useable Area (m^2 or ha)**
API 12 - Mitta	Littoral (0 - 3 m))	8,891.417048	0.2	0	0	0	0	n/a	0	1	396.7795	1	396.7795
s.a.= 172,737	Open Water/Profundal (= Littoral)	163,846.1897	0.2	0	0	0	0	n/a	0	1	7,311.636215	1	7,311.6362
API 2	Littoral (0 - 3 m))	5,989.703878	0.2	0	0	0	0	n/a	0	1	632.2881156	1	632.288116
s.a.= 124,351	Open Water/Profundal (= Littoral)	118,361.4678	0.2	0	0	0	0	n/a	0	1	9,476.315016	1	9,476.315016

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
No Net Loss Plan –
Hdwater Pond Ecotype Habitat

				Group 2: Cold + A1 - Stream: Non-Piscivore pearl dace HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore brassy minnow HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore finescale dace HSI Factor Score (0 - 1)						
	API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score
No catch	API 6	Littoral (1 - 3 m)	1,198.118891																					
No catch		Open Water/Profundal (> 3 m)	4,637.49105																					
No catch	API 7	Littoral (1 - 3 m)	2,224.111416																					
No catch		Open Water/Profundal (> 3 m)	8,737.95333																					
	API 11	Littoral (1 - 3 m)	2,563.887351															0.03	0.25	0.75	0.75	1	-	0.688
		Open Water/Profundal (> 3 m)	25,213.67332															0.03	0.25	0.75	0.75	1	-	0.688
No catch	API 13	Littoral (1 - 3 m)	2,054.367803																					
No catch		Open Water/Profundal (> 3 m)	17,320.88549																					
	API 69	Littoral (1 - 3 m)	1,695.555	0.03	0.75	1	0.75	0.75	n/a	0.813	0.015	0.75	1	0.75	0.75	0.75	1	0.03	0.25	0.75	0.75	1	n/a	0.688
		Open Water/Profundal (> 3 m)	8,175.904	0.03	0.75	1	0.75	0.75	n/a	0.813	0.015	0.75	1	0.75	0.75	0.75	1	0.03	0.25	0.75	0.75	1	n/a	0.688
No catch	API 48	Littoral (1 - 3 m)	610.23																					
No catch		Open Water/Profundal (> 3 m)	1,440.95																					
	API 17	Littoral (1 - 3 m)	1,810.73779															0.03	0.25	0.75	0.75	1	n/a	0.688
		Open Water/Profundal (> 3 m)	14,973.80087															0.03	0.25	0.75	0.75	1	n/a	0.688

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
No Net Loss Plan –
Hdwater Pond Ecotype Habitat

				Group 5: Cool + A1: Non-Piscivore redbelly dace HSi Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore white sucker HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore iowa darter HSi Factor Score (0 - 1)						
	API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score
No catch	API 6	Littoral (1 - 3 m)	1,198.118891																				
		Open Water/Profundal (> 3 m)	4,637.49105																				
No catch	API 7	Littoral (1 - 3 m)	2,224.111416																				
		Open Water/Profundal (> 3 m)	8,737.95333																				
	API 11	Littoral (1 - 3 m)	2,563.887351	0.03	0.75	0.75	0.75	1	0.75	1													
		Open Water/Profundal (> 3 m)	25,213.67332	0.03	0.75	0.75	0.75	1	0.75	1													
No catch	API 13	Littoral (1 - 3 m)	2,054.367803																				
No catch		Open Water/Profundal (> 3 m)	17,320.88549																				
	API 69	Littoral (1 - 3 m)	1,695.555	0.03	0.75	0.75	0.75	1	0.75	1	0.015	0.25	0.25	0.25	0.25	-	0.25	0.015	0.75	0.75	0.75	0.75	n/a	0.75
		Open Water/Profundal (> 3 m)	8,175.904	0.03	0.75	0.75	0.75	1	0.75	1	0.015	0.25	0.25	0.25	0.25	-	0.25	0.015	0.75	0.75	0.75	0.75	n/a	0.75
No catch	API 48	Littoral (1 - 3 m)	610.23																				
No catch		Open Water/Profundal (> 3 m)	1,440.95																				
	API 17	Littoral (1 - 3 m)	1,810.73779	0.03	0.75	0.75	0.75	1	0.75	1													
		Open Water/Profundal (> 3 m)	14,973.80087	0.03	0.75	0.75	0.75	1	0.75	1													

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
No Net Loss Plan –
Hdwater Pond Ecotype Habitat

				Group 7: Warm + A: Non-Piscivore blcknose shiner HSI Factor Score (0 - 1)							Group 7: Warm + A: Non-Piscivore central mudminnow HSI Factor Score (0 - 1)							Group 8: Warm + B: Non-Piscivore fathead minnow HSI Factor Score (0 - 1)						
	API Number	Habitat Unit Ref.	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score
No catch	API 6	Littoral (1 - 3 m)	1,198.118891																					
No catch		Open Water/Profundal (> 3 m)	4,637.49105																					
No catch	API 7	Littoral (1 - 3 m)	2,224.111416																					
No catch		Open Water/Profundal (> 3 m)	8,737.95333																					
	API 11	Littoral (1 - 3 m)	2,563.887351															0.03	0.75	0.5	0.75	0.25	-	0.563
		Open Water/Profundal (> 3 m)	25,213.67332															0.03	0.75	0.5	0.75	0.25	-	0.563
No catch	API 13	Littoral (1 - 3 m)	2,054.367803																					
No catch		Open Water/Profundal (> 3 m)	17,320.88549																					
	API 69	Littoral (1 - 3 m)	1,695.555	0.015	0.75	0.75	0.75	0.75	n/a	0.75	0.015	1	0.75	0.75	1	0.75	1.063							
		Open Water/Profundal (> 3 m)	8,175.904	0.015	0.75	0.75	0.75	0.75	n/a	0.75	0.015	1	0.75	0.75	1	0.75	1.063							
No catch	API 48	Littoral (1 - 3 m)	610.23																					
No catch		Open Water/Profundal (> 3 m)	1,440.95																					
	API 17	Littoral (1 - 3 m)	1,810.73779															0.03	0.75	0.5	0.75	0.25	-	0.563
		Open Water/Profundal (> 3 m)	14,973.80087															0.03	0.75	0.5	0.75	0.25	-	0.563

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
No Net Loss Plan –
Hdwater Pond Ecotype Habitat

	API Number	Habitat Unit Ref.	HA (m^2 or ha)	Habitat Expansion Factor (<7 sp=4; 7-12=3;13-18=2;>18=1)	Total Weighted Useable Area (m^2 or ha)	Ecotype Productive Capacity Index	Ecotype Weighted Useable Area (m^2 or ha)
No catch	API 6	Littoral (1 - 3 m)	1,198.118891	1	0	1	0
		Open Water/Profundal (> 3 m)	4,637.49105	1	0	1	0
No catch	API 7	Littoral (1 - 3 m)	2,224.111416	1	0	1	0
		Open Water/Profundal (> 3 m)	8,737.95333	1	0	1	0
	API 11	Littoral (1 - 3 m)	2,563.887351	1	173.0624	1	173.0624
		Open Water/Profundal (> 3 m)	25,213.67332	1	1,701.9229	1	1,701.9229
No catch	API 13	Littoral (1 - 3 m)	2,054.367803	1	0	1	0
No catch		Open Water/Profundal (> 3 m)	17,320.88549	1	0	1	0
	API 69	Littoral (1 - 3 m)	1,695.555	1	224.131177	1	224.131177
		Open Water/Profundal (> 3 m)	8,175.904	1	1,080.75231	1	1,080.75231
No catch	API 48	Littoral (1 - 3 m)	610.23	1	0	1	0
No catch		Open Water/Profundal (> 3 m)	1,440.95	1	0	1	0
	API 17	Littoral (1 - 3 m)	1,810.73779	1	122.2248008	1	122.2248008
		Open Water/Profundal (> 3 m)	14,973.80087	1	1,010.731559	1	1,010.731559

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are
4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA.

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 6
No Net Loss Plan – Inlet Stream Ecotype Habitat

				Group 2: Cold + A1 - Stream: Non-Piscivore pearl dace HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore brassy minnow HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore finescale dace HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	fish?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score
API 1	Low gradient	y	894.13	0.03	0.75	0.5	0.25	0.5	n/a	0.5								0.03	0.5	0.25	0.25	0.25	n/a	0.313
access to Sawbill	High gradient	-	-	0.03	0.75	0.5	0.25	0.5	n/a	0.5								0.03	0.5	0.25	0.25	0.25	n/a	0.313
	pond	y	5,835.61	0.03	0.75	0.5	0.25	0.5	n/a	0.5								0.03	0.5	0.25	0.25	0.25	n/a	0.313
API 6	Low gradient	y	437.212																					
lower end accessible but no link to API 6 and 7	High gradient	-	-																					
	pond	n	5,835.61																					
API 14	Low gradient	n	86																					
	Low gradient	y	280.32								0.015	0.75	0.75	0.5	0.75	0.75	0.7	0.03	0.5	0.25	0.25	0.25	n/a	0.313
	High gradient	n	70.62																					
	High gradient	y	731.61								0.015	0.75	0.75	0.5	0.75	0.75	0.7	0.03	0.5	0.25	0.25	0.25	n/a	0.313
	pond	-	-								0.015	0.75	0.75	0.5	0.75	0.75	0.7	0.03	0.5	0.25	0.25	0.25	n/a	0.313
API 47	Low gradient	y	194.16	0.03	0.75	0.5	0.25	0.5	n/a	0.5								0.03	0.5	0.25	0.25	0.25	n/a	0.313
	High gradient	y	568.27	0.03	0.75	0.5	0.25	0.5	n/a	0.5								0.03	0.5	0.25	0.25	0.25	n/a	0.313
	pond	y	29,944.7	0.03	0.75	0.5	0.25	0.5	n/a	0.5								0.03	0.5	0.25	0.25	0.25	n/a	0.313

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA,

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 6
No Net Loss Plan – Inlet Stream Ecotype Habitat

				Group 5: Cool + A1: Non-Piscivore redbelly dace HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore white sucker HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore iowa darter HSI Factor Score (0 - 1)						
API Number	Habitat Unit Ref.	fish?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score
API 1	Low gradient	y	894.13								0.015	1	0.75	0.5	0.5	1	0.75							
access to Sawbill	High gradient	-	-								0.015	1	0.75	0.5	0.5	1	0.75							
	pond	y	5,835.61								0.015	1	0.75	0.5	0.5	1	0.75							
API 6	Low gradient	y	437.212								0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.75	0.75	0.25	n/a	0.563
lower end accessible but no link to API 6 and 7	High gradient	-	-								0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.75	0.75	0.25	n/a	0.563
	pond	n	5,835.61																					
API 14	Low gradient	n	86																					
	Low gradient	y	280.32	0.03	0.25	0.5	0.25	0.75	0.5	0.45	0.015	1	0.75	0.5	0.5	1	0.75							
	High gradient	n	70.62																					
	High gradient	y	731.61	0.03	0.25	0.5	0.25	0.75	0.5	0.45	0.015	1	0.75	0.5	0.5	1	0.75							
	pond	-	-	0.03	0.25	0.5	0.25	0.75	0.5	0.45	0.015	1	0.75	0.5	0.5	1	0.75							
API 47	Low gradient	y	194.16																					
	High gradient	y	568.27																					
	pond	y	29,944.7																					

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA,

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 6
No Net Loss Plan – Inlet Stream Ecotype Habitat

				Group 8: Warm + B: Non-Piscivore fathead minnow HSI Factor Score (0 - 1)										
API Number	Habitat Unit Ref.	fish?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Habitat Expansion Factor (<7 sp=4; 7-12=3;13-18=2;>18=1)	Total Weighted Useable Area (m^2 or ha)	Ecotype Productive Capacity Index	Ecotype Weighted Useable Area (m^2 or ha)
API 1	Low gradient	y	894.13	0.03	1	0.75	0.25	0.75	n/a	0.688	1	50.29481	2.5	125.737
access to Sawbill	High gradient	-	-	0.03	1	0.75	0.25	0.75	n/a	0.688	1	0	2.5	0
	pond	y	5,835.61	0.03	1	0.75	0.25	0.75	n/a	0.688	1	328.2531	2.5	820.6327
API 6	Low gradient	y	437.212								1	8.607611	2.5	21.51903
lower end accessible but no link to API 6 and 7	High gradient	-	-								1	0	2.5	0
	pond	n	5,835.61								1	0	2.5	0
API 14	Low gradient	n	86								1	0	2.5	0
	Low gradient	y	280.32	0.03	1	0.75	0.25	0.75	n/a	0.688	1	18.29088	2.5	45.7272
	High gradient	n	70.62								1	0	2.5	0
	High gradient	y	731.61	0.03	1	0.75	0.25	0.75	n/a	0.688	1	47.73755	2.5	119.3439
	pond	-	-	0.03	1	0.75	0.25	0.75	n/a	0.688	1	0	2.5	0
API 47	Low gradient	y	194.16								1	4.73265	2.5	11.83163
	High gradient	y	568.27								1	13.85158	2.5	34.62895
	pond	y	29,944.7								1	729.9021	2.5	1824.755

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good; 1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA,

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

TABLE 7
No Net Loss Plan – Wmwater Stream Ecotype Habitat

					Group 2: Cold + A1 - Stream: Non-Piscivore pearl dace HSI Factor Score (0 - 1)							Group 4: Cold + B: Non- Piscivore ninespine stickleback HSI Factor Score (0 - 1)							Group 4: Cold + B: Non- Piscivore brook stickleback HSi Factor Score (0 - 1)							Group 4: Cold + B: Non- Piscivore mottled sculpin HSi Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore blacknose dace HSI Factor Score (0 - 1)						
	API Number	Habitat Unit Ref.	fish?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
	API 1	Ponds	y	20745.021	0.03	0.75	0.5	0.25	0.5	n/a	0.5																													
		High gradient	y	165	0.03	0.75	0.5	0.25	0.5	n/a	0.5																													
		Low gradient	y	2026.22	0.03	0.75	0.5	0.25	0.5	n/a	0.5																													
	API 2	Ponds	y	3808.79515																																0.015	1	0.75	0.75	0.75	n/a	0.813
		High gradient	-	0																																0.015	1	0.75	0.75	0.75	n/a	0.813
		Low gradient	y	2217.84																																0.015	1	0.75	0.75	0.75	n/a	0.813
stream incorporated in intermittant and inlet.	**API 6**	Low gradient	y	0																																					
	lower end accessible but no link to API 6 and 7	High gradient	-	0																																					
		pond	n	0																																					
NO Catch	**API 7**	Ponds	n	721.138																																					
NO Catch		High gradient	n	0																																					
NO Catch		Low gradient	n	0																																					
	API 11	Low gradient	y	559.59																																					
	NO ACCESS	High gradient	y	227.44																																					
		pond	y	1030.51																																					
NO Catch	**API 13**	Low gradient	n	307.72																																					
NO Catch	**NO ACCESS**	High gradient	n	89.03																																					
NO Catch		pond	n	475.75																																					
	API 69	Low gradient	-	0	0.03	0.75	0.5	0.25	0.5	n/a	0.5																										0.015	1	0.75	0.75	0.75	n/a	0.813
	NO ACCESS	High gradient	n	165.19																																					
		pond	-	0	0.03	0.75	0.5	0.25	0.5	n/a	0.5																										0.015	1	0.75	0.75	0.75	n/a	0.813
	API 12	Low gradient	y	84.99								0.015	0	0.75	0.5	0	n/a	0.313	0.015	0	0.25	0.5	0.5	n/a	0.313	0.015	0.5	0.75	0.75	0.75	n/a	0.688							
	NO ACCESS		n	67.95																																					
		High gradient	y	272.56								0.015	0	0.75	0.5	0	n/a	0.313	0.015	0	0.25	0.5	0.5	n/a	0.313	0.015	0.5	0.75	0.75	0.75	n/a	0.688							
			n	23.97																																					
		pond	y	172737.6067								0.015	0	0.75	0.5	0	n/a	0.313	0.015	0	0.25	0.5	0.5	n/a	0.313	0.015	0.5	0.75	0.75	0.75	n/a	0.688							
NO Catch	**API 48**	Low gradient	n	131																																					
NO Catch		High gradient	n	298.77																																					
		pond	n	10198.92																																					
I think this it is impacted	**API 10**																																								
stream incorporated in intermittant and inlet.	**API 14**			-																																					
stream incorporated in intermittant and inlet.	**API 47**																																								

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present);
1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA,

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

TABLE 7
No Net Loss Plan – Wmwater Stream Ecotype Habitat

					Group 5: Cool + A1: Non-Piscivore brassy minnow HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore finescale dace HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore redbelly dace HSi Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore white sucker HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore iowa darter HSi Factor Score (0 - 1)						
	API Number	Habitat Unit Ref.	fish?	HA (m^2 or ha)	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/ Summer Refuge	Migration	HU Score
	API 1	Ponds	y	20745.021								0.03	0.5	0.25	0.25	0.25	n/a	0.313								0.015	1	0.75	0.5	0.5	1	0.75							
		High gradient	y	165								0.03	0.5	0.25	0.25	0.25	n/a	0.313								0.015	1	0.75	0.5	0.5	1	0.75							
		Low gradient	y	2026.22								0.03	0.5	0.25	0.25	0.25	n/a	0.313								0.015	1	0.75	0.5	0.5	1	0.75							
	API 2	Ponds	y	3808.79515																						0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.5	0.5	0.25	n/a	0.438
		High gradient	-	0																						0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.5	0.5	0.25	n/a	0.438
		Low gradient	y	2217.84																						0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.5	0.5	0.25	n/a	0.438
stream incorporated in intermittant and inlet.	**API 6**	Low gradient	y	0																						0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.5	0.5	0.25	n/a	0.438
	lower end accessible but no link to API 6 and 7	High gradient	-	0																						0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.5	0.5	0.25	n/a	0.438
		pond	n	0																						0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.5	0.5	0.25	n/a	0.438
NO Catch	**API 7**	Ponds	n	721.138																																			
NO Catch		High gradient	n	0																																			
NO Catch		Low gradient	n	0																																			
	API 11	Low gradient	y	559.59								0.03	0.5	0.25	0.25	0.25	n/a	0.313	0.03	0.25	0.5	0.25	0.75	0.5	0.45														
	NO ACCESS	High gradient	y	227.44								0.03	0.5	0.25	0.25	0.25	n/a	0.313	0.03	0.25	0.5	0.25	0.75	0.5	0.45														
		pond	y	1030.51								0.03	0.5	0.25	0.25	0.25	n/a	0.313	0.03	0.25	0.5	0.25	0.75	0.5	0.45														
NO Catch	**API 13**	Low gradient	n	307.72																																			
NO Catch	**NO ACCESS**	High gradient	n	89.03																																			
NO Catch		pond	n	475.75																																			
	API 69	Low gradient	-	0	0.015	0.75	0.75	0.5	0.75	0.75	0.7	0.03	0.5	0.25	0.25	0.25	n/a	0.313	0.03	0.25	0.5	0.25	0.75	0.5	0.45	0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.5	0.5	0.25	n/a	0.438
	NO ACCESS	High gradient	n	165.19																																			
		pond	-	0	0.015	0.75	0.75	0.5	0.75	0.75	0.7	0.03	0.5	0.25	0.25	0.25	n/a	0.313	0.03	0.25	0.5	0.25	0.75	0.5	0.45	0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.5	0.5	0.25	n/a	0.438
	API 12	Low gradient	y	84.99								0.03	0.5	0.25	0.25	0.25	n/a	0.313								0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.5	0.5	0.25	n/a	0.438
	NO ACCESS		n	67.95																																			
		High gradient	y	272.56								0.03	0.5	0.25	0.25	0.25	n/a	0.313								0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.5	0.5	0.25	n/a	0.438
			n	23.97																																			
		pond	y	172737.6067								0.03	0.5	0.25	0.25	0.25	n/a	0.313								0.015	1	0.75	0.5	0.5	1	0.75	0.015	0.5	0.5	0.5	0.25	n/a	0.438
NO Catch	**API 48**	Low gradient	n	131																																			
NO Catch		High gradient	n	298.77																																			
		pond	n	10198.92								0.03	0.5	0.25	0.25	0.25	n/a	0.313																					
I think this it is impacted	**API 10**																																						
stream incorporated in intermittant and inlet.	**API 14**			-																																		
stream incorporated in intermittant and inlet.	**API 47**																																						

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present);
1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA,

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

TABLE 7
No Net Loss Plan – Wmwater Stream Ecotype Habitat

	API Number	Habitat Unit Ref.	fish?	HA (m^2 or ha)	Group 6: Cool + A1: Piscivore northern pike HSI Factor Score (0 - 1)							Group 7: Warm + A: Non-Piscivore central mudminnow HSI Factor Score (0 - 1)							Group 8: Warm + B: Non-Piscivore fathead minnow HSI Factor Score (0 - 1)							Group 8: Warm + B: Non-Piscivore pumpkinseed HSI Factor Score (0 - 1)							Habitat Expansion Factor (<7 sp=4; 7-12=3;13-18=2;>18=1)	Total Weighted Useable Area (m^2 or ha)	Ecotype Productive Capacity Index	Ecotype Weighted Useable Area (m^2 or ha)
					Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score				
	API 1	Ponds	y	20745.021															0.03	0.75	0.5	0.75	0.25	n/a	0.563								1	1089.114	2.5	2722.784
		High gradient	y	165															0.03	0.75	0.5	0.75	0.25	n/a	0.563								1	8.6625	2.5	21.65625
		Low gradient	y	2026.22															0.03	0.75	0.5	0.75	0.25	n/a	0.563								1	106.3766	2.5	265.9414
	API 2	Ponds	y	3808.79515	0.1	0.5	0.5	0.5	0.5	0.75	0.55															0.03	0.5	0.5	0.5	0.5	n/a	0.5	1	380.8795	2.5	952.1988
		High gradient	-	0	0.1	0.5	0.5	0.5	0.5	0.75	0.55															0.03	0.5	0.5	0.5	0.5	n/a	0.5	1	0	2.5	0
		Low gradient	y	2217.84	0.1	0.5	0.5	0.5	0.5	0.75	0.55															0.03	0.5	0.5	0.5	0.5	n/a	0.5	1	221.784	2.5	554.46
stream incorporated in intermittant and inlet.	API 6	Low gradient	y	0																													1	0	2.5	0
	lower end accessible but no link to API 6 and 7	High gradient	-	0																													1	0	2.5	0
		pond	n	0																													1	0	2.5	0
NO Catch	API 7	Ponds	n	721.138																													1	0	2.5	0
NO Catch		High gradient	n	0																													1	0	2.5	0
NO Catch		Low gradient	n	0																													1	0	2.5	0
	API 11	Low gradient	y	559.59																													1	12.80062	2.5	32.00155
	NO ACCESS	High gradient	y	227.44																													1	5.20269	2.5	13.00673
		pond	y	1030.51																													1	23.57292	2.5	58.93229
NO Catch	API 13	Low gradient	n	307.72																													1	0	2.5	0
NO Catch	NO ACCESS	High gradient	n	89.03																													1	0	2.5	0
NO Catch		pond	n	475.75																													1	0	2.5	0
	API 69	Low gradient	-	0								0.015	0.25	0.5	0.5	0	0.75	0.4															1	0	2.5	0
	NO ACCESS	High gradient	n	165.19																													1	0	2.5	0
		pond	-	0								0.015	0.25	0.5	0.5	0	0.75	0.4															1	0	2.5	0
	API 12	Low gradient	y	84.99															0.03	0.75	0.5	0.75	0.25	n/a	0.563								1	5.418113	2.5	13.54528
	NO ACCESS		n	67.95																													1	0	2.5	0
		High gradient	y	272.56															0.03	0.75	0.5	0.75	0.25	n/a	0.563								1	17.3757	2.5	43.43925
			n	23.97																													1	0	2.5	0
		pond	y	172737.6067															0.03	0.75	0.5	0.75	0.25	n/a	0.563								1	11012.02	2.5	27530.06
NO Catch	API 48	Low gradient	n	131																													1	0	2.5	0
NO Catch		High gradient	n	298.77																													1	0	2.5	0
		pond	n	10198.92																													1	95.61488	2.5	239.0372
I think this it is impacted	API 10																																1	0	2.5	0
stream incorporated in intermittant and inlet.	API 14			-																																
stream incorporated in intermittant and inlet.	API 47																																			

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are 4 (0-6 species present); 3 (7-12 species present); 2 (13-18 species present);
1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA,

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

TABLE 8
No Net Loss Plan – Intermt Stream Ecotype Habitat

	API Number	Habitat Unit Ref.	Fish within segment?	HA (m^2 or ha)	Group 2: Cold + A1 - Stream: Non-Piscivore Pearl Dace HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore Finescale Dace HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore Redbelly Dace HSi Factor Score (0 - 1)						
					Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score
	API 1	Ephemeral	Y	613.18	0.03	0.25	0.25	0.5	0.5	n/a	0.375	0.03	0.25	0.25	0.25	0.25	n/a	0.25							
	API 47	Ephemeral	N	110.94																					
No catch	API 48	Ephemeral	N	123.00																					
	API 12	Ephemeral	N	82.58																					
		Ephemeral	Y	30.68								0.03	0.25	0.25	0.25	0.25	n/a	0.25	0.03	0.25	0.25	0.25	0.25	0	0.2
	API 6	Ephemeral	N	1,003.71																					

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are 4 (0-6 species present); 3 (7-12 species present);
2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA,

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

TABLE 8
No Net Loss Plan – Intermt Stream Ecotype Habitat

	API Number	Habitat Unit Ref.	Fish within segment?	HA (m^2 or ha)	Group 5: Cool + A1: Non-Piscivore White Sucker HSI Factor Score (0 - 1)							Group 5: Cool + A1: Non-Piscivore Iowa Darter HSi Factor Score (0 - 1)							Group 8: Warm + B: Non-Piscivore Fathead Minnow HSI Factor Score (0 - 1)							Habitat Expansion Factor (<7 sp=4; 7-12=3;13-18=2;>18=1)	Total Weighted Useable Area (m^2 or ha)	Ecotype Productive Capacity Index	Ecotype Weighted Useable Area (m^2 or ha)
					Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score	Species Weighting	Spawning	Nursery	Feeding	Overwinter/Summer Refuge	Migration	HU Score				
	API 1	Ephemeral	Y	613.18	0.015	0.5	0.25	0.25	0.25	0.75	0.4								0.03	0.5	0.5	0.25	0.5	n/a	0.438	1.0	23.22419	0.75	17.418144
	API 47	Ephemeral	N	110.94																						1.0	0	0.75	0
No catch	API 48	Ephemeral	N	123.00																						1.0	0	0.75	0
	API 12	Ephemeral	N	82.58																						1.0	0	0.75	0
		Ephemeral	Y	30.68															0.03	0.5	0.5	0.25	0.5	n/a	0.438	1.0	0.816855	0.75	0.612641
	API 6	Ephemeral	N	1,003.71																						1.0	0	0.75	0

Notes:

Each Habitat Unit is consider a homogenous unit of habitat and is scored for each species.

HSI Score: this has values of 0 - n/a; 0.25 - poor; 0.5 - moderate; 0.75 - good;
1.0 - excellent. Note that some species do not have a migration component to their HSI calculations.

Habitat Expansion Factor: This recognizes that in species-poor habitats, that individual species may occupy more of the habitat present in a habitat unit than they would if more competing species or predator species were present. Scores are 4 (0-6 species present); 3 (7-12 species present);
2 (13-18 species present); 1 (>18 species present).

HU Score: this is determined by multiplying the average of the HSI factor scores x the species weighting. This value will never exceed 1.0 for each species. If a species guild is not present, then it receives a HU of zero, which also reduces the overal Total Weighted Useable Area Score.

Total Weighted Useable Area: this is the sum of the HU Scores for all the guilds (present or not) and will not exceed the HA,

Ecotype Weighted Useable Area: this is the product of the total weighted useable area and the Ecotype Productive Capacity Index for the Ecotype it recognises that some habitats are more productive per unit area than others, for example streams are more productive than lakes. This designation includes both ephemeral streams and segments with no defined channels (underground flow/sheet flow through forests etc) that do not provide fish habitat.

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 – 1656263

TABLE 9
No Net Loss Plan – Area and Length calculations

API 1	Stream Segment	Type	Group	Category	Accessible?[1]	Fish Presence?	Sum of Stream Segment			
1	5,463.13	IP3(1)	warm	pond	y	no	**47**	**Ephemeral**	n	110.94
1	218.96	FL(2)	intermittant	ephemeral	y	assume no		**High Gradient**	y	568.27
1	634.901	IP3(2)	warm	pond	y	finescale dace, fathead minnow		**Low Gradient**	y	194.16
1	369.49	FL(3)	warm	Low Gradient	y	finescale dace, fathead minnow		**Pond**	y	29,944.7
1	112.71	FL(1)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow	**69**	**High Gradient**	n	165.19
1	894.13	Sawbill Bay Inlet	inlet	Low Gradient	y	finescale dace, white sucker, burbot		**littoral**	y	
1	145.62	FL(1)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow	**Lynxhead Bay**	**littoral**	y	46,827.33063
1	5.00	RF(1)	warm	High Gradient	y	white sucker, finescale dace, fathead minnow		**Profundal**	y	1,955,173.746
1	157.00	R3(1)	warm	High Gradient	y	white sucker, finescale dace, fathead minnow	**Lizard Lake**	**littoral**	y	66,600.197
1	42.43	FL(2)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow		**Profundal**	y	1,863,088.026
1	7.00	culvert	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow	**13**	**High Gradient**	n	89.03
1	308.78	FL(1)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow		**Low Gradient**	n	307.72
1	6,609.89	IP3(1)	warm	pond	y	white sucker, finescale dace, fathead minnow		**Pond**	n	475.75
1	33.00	FL(2)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow		**littoral**	n	2,054.367803
1	3.00	CA(1)	warm	High Gradient	y	white sucker, finescale dace, fathead minnow		**Profundal**	n	17,320.88549
1	174.86	FL(3)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow	**12**	**Ephemeral**	n	82.58
1	1,348.70	IP3(2)	warm	pond	y	white sucker, finescale dace, fathead minnow			y	30.68
1	224.73	FL(4)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow		**High Gradient**	n	23.97
1	483.91	(FL(1)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow			y	272.56
1	412.22	No defined channel	intermittant	Ephemeral	y	assume no		**Low Gradient**	n	67.95
1	6,688.40	IP3(1)	warm	pond	y	white sucker, finescale dace, fathead minnow			y	84.99
1	123.69	FL(2)	warm	Low Gradient	y	white sucker, finescale dace, fathead minnow		**Pond**	y	
2	124,351.17	Lake	Lake	full	y	pumpkinseed, yellow perch, northern pike, white sucker, Iowa darter, blacknose shiner		**littoral**	y	8,891.417048
2	5,989.703878	Lake	Lake	Littoral	y	pumpkinseed, yellow perch, northern pike, white sucker, Iowa darter, blacknose shiner		**Profundal**	y	163,846.1897
2	118,361.4678	Lake	Lake	Profundal	y	pumpkinseed, yellow perch, northern pike, white sucker, Iowa darter, blacknose shiner	**2**	**Low Gradient**	y	2,217.84
2	1,979.84	FL(1)	warm	Low Gradient	y	central mudminnow		**Pond**	y	3,808.79515
2	205.29	FL(2)	warm	Low Gradient	y	central mudminnow		**littoral**	y	5,989.703878
2	3,808.79515	IP3(1)	warm	pond	y	central mudminnow		**Profundal**	y	118,361.4678
2	32.71	FL(1)	warm	Low Gradient	y	assume yes	**7**	**Pond**	n	
6	418.20	FL(1)	inlet	Low Gradient	y	Iowa darter, white sucker		**lake**	?	10,962.06472
6	19.012	undefined on map	inlet	Low Gradient	y	assume no	**48**	**Ephemeral**	n	123
6	1,003.71	No defined channel	intermittant	Ephemeral	n	No		**High Gradient**	n	298.77
6	5,835.61	pond	headwater	pond	n	no		**Low Gradient**	n	131
7	10,962.06472	lake	headwater	lake	?	No	**17**	**littoral**	(blank)	1,810.7399
7	721.138	IP3(1)	warm	pond	n	No		**Profundal**	(blank)	14,973.80087
7		IP3(2)	warm	pond	n	No	**Grand Total**			**17,646,957.57**
7		IP3(3)	warm	pond	n	No				
7		IP3(4)	warm	pond	n	No				
7		IP3(5)	warm	pond	n	No				
7		IP3(6)	warm	pond	n	No				
11	4.00	CA(1)	inlet	High Gradient	n	finescale dace, northern redbelly dace				
11	20.00	IP3(1)	inlet	Low Gradient	n	finescale dace, northern redbelly dace				
11	13.00	CA(2)	inlet	High Gradient	n	finescale dace, northern redbelly dace				
11	70.82	FL(1)	inlet	Low Gradient	n	finescale dace, northern redbelly dace				
11	82.80	CA(3)	inlet	High Gradient	n	finescale dace, northern redbelly dace				
11	67.47	R3(1)	inlet	High Gradient	n	finescale dace, northern redbelly dace				
11	29.87	CA(4)	inlet	High Gradient	n	finescale dace, northern redbelly dace				
11	697.97	IP3(2)	inlet	Pond	n	finescale dace, northern redbelly dace				
11	224.15	FL(2)	inlet	Low Gradient	n	finescale dace, northern redbelly dace				
11	30.30	CA(5)	inlet	High Gradient	n	finescale dace, northern redbelly dace				
11	30.00	FL(3)	inlet	Low Gradient	n	finescale dace, northern redbelly dace				

TABLE 9
No Net Loss Plan – Area and Length calculations

API 1	Stream Segment	Type	Group	Category	Accessible?[1]	Fish Presence?	Sum of Stream Segment
11	52.48	IP3(3)	inlet	Low Gradient	n	finescale dace, northern redbelly dace	
11	332.54	IP3(4)	inlet	Pond	n	finescale dace, northern redbelly dace	
11	86.73	FL(4)	inlet	Low Gradient	n	finescale dace, northern redbelly dace	
11	75.41	IP3(5)	inlet	Low Gradient	n	finescale dace, northern redbelly dace	
11	27,777.56067	Lake	headwater	full	y	finescale dace, northern redbelly dace, fathead minnow	
11	2,563.887351	Lake	headwater	Littoral	y	finescale dace, northern redbelly dace, fathead minnow	
11	25,213.67332	Lake	headwater	Profundal	y	finescale dace, northern redbelly dace, fathead minnow	
47	103.47	FL(2)	inlet	Low Gradient	y	assume yes	
47	1,423.70	P3(1)	inlet	Pond	y	finescale dace, pearl dace,	
47	15,521.00	IP3(1)	inlet	Pond	y	finescale, northern redbelly dace, pearl dace	
47	90.69	FL(1)	inlet	Low Gradient	y	assume yes	
47	110.94	SH1 and SH2	intermittant	Ephemeral	n	assume no	
47	568.27	R3(1)	inlet	High Gradient	y	assume yes	
47	60,016.00	Lake	Headwater pond	lake		finescale dace, pearl dace,	
48	30.00	FL(1)	warm	Low Gradient	n	no	
48	67.00	R3(1)	warm	High Gradient	n	no	
48	54.00	dry	intermittant	Ephemeral	n	no	
48	24.00	CA(1)	warm	High Gradient	n	no	
48	101.00	FL(2)	warm	Low Gradient	n	no	
48	69.00	undefined on map	intermittant	ephemeral	n	no	
48	91.00	R3(2)	warm	High Gradient	n	no	
48	45.00	CA(2)	warm	High Gradient	n	no	
48	71.77	R3(3)	warm	High Gradient	n	no	
48	10,198.00	IP3(1)	beaver pond	pond		finescale dace	
14	1,018.91	R3/CA/P2/P3/FL	warm	mixed		finescale dace, white sucker, northern redbelly dace, fathead minnow, brassy minnow	
14	156.62	CA/R3/FL/IP3	warm	mixed		no	

Notes:
[1] Y or N determined by barriers to fish movement as per Jay Dickinson (cascades, subsurface flow etc.).

TABLE 10
No Net Loss Plan –
TMA-WRST Impacted Watercourses

API	Reach	Area of fish bearing waters (m^2)	Fish species present
TMA impacted watercourses			
1	1-1	1,592.4	white sucker
			finescale dace
			fathead minnow
			burbot
	1-2	204.07	white sucker
			fathead minnow
			finescale dace
	1-3	1,250.45	finescale dace
			fathead minnow
47	47-1	1,196.14	finescale dace
			pearl dace
			northern redbelly dace
2	2-1	124,351.1717	pumpking seed
			yellow perch
			northern pike
			white sucker
			Iowa darter
			blacknose dace
	2-2	249.72	central mudminnow
6	6-1	523.39	Iowa darter
			white sucker
Waste Rock Stockpile impacted watercourses			
11	11-1	27,777.56067	finescale dace
			northern redbelly dace
			fathead minnow
	11-2	154.56	finescale dace
			northern redbelly dace

AQUATIC ENVIRONMENT TSD
VERSION 1

APPENDIX 3.I

Aquatic Environment Valued Ecosystem Components Interactions Table

February 2013
Project No. 10-1118-0020
Hammond Reef Gold Project

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 1
VEC Interactions – Construction Phase

Infrastructure Feature	API	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species	Water Management System: Dewatering of Mitta Lake including fish rescue and discharge of water to Marmion Reservoir	Water Management System: Construction of ditches, and ponds (processing plant collection pond, emergency spill pond, seepage collection ponds)	Water Management System: Construction of treatment facilities including effluent treatment, potable water treatment and sewage treatment	Water Management System: Construction of pumping stations (mine water, surface water, fire water, potable water)	Water Management System: Construction of site discharge lines and diffuser	Linear Infrastructure: Upgrading/ construction of access road	Linear Infrastructure: Construction of project transmission line	Linear Infrastructure: Construction of fibre optic line	Mine: Clearing and grubbing	Mine: Strip haul and stockpile topsoil and overburden	Mine: Construction of haul roads	Mine: Blasting and excavation of pre-strip material and haul to WRMF	Mine: Set up open pit dewatering system (including use of portable generators where necessary)	Ore Processing Facility: Site grading	Ore Processing Facility: Construction of foundation, superstructure and process components including delivery and assembly	Ore Processing Facility: Construction and surfacing of crushed ore pad	Ore Processing Facility: Construction of ore crushers, grinders and conveyers
Lower Reaches																						
TMF	1				x																	
TMF	2	x			x																	
TMF	6																					
TMF	7																					
	8	x			x																	
Waste Rock Stock Pile	11				x									Y			x					
Open Pit	12	x			x	xY								xY								
Mine Water Spill Emergency	13						xy		xy										x	x		
WRSP	14				x		xy	xy	xy					xy								
Road	20										x											
Road	21				x						x											
Road	22				x						x											
Road	23				x						x											
TMF	47																					
TMF	48																					
Road	63				x						x											
Road	64	x			x						x											
Road	65										x											
Road	66	x									x											
Road	67	x									x											
Road	68	x	x	x							x											
Open Pit	69				x									x								
Sawbill/Lynxhead API																						
Effects due to changes in drainage and runoff	30	x	x			x								x	x		x					
	32		x	x	x	x								x			x					
	33	x	x	x		x	x							x			x					
	34	x	x	x	x	x	x							x			x					
	35	x	x		x																	
	37																					
	49				x																	
Support and Ancillary	15	x	x																			
Support and Ancillary	16																					
Support and Ancillary	17				x																	
Lizard Lake API																						
Effects due to changes in drainage and runoff	38	x		x	x									x								
	39	x	x	x	x									x								
Too far any to be indirectly affected?	42																					
	43																					
	44				x																	
TMF	46				x																	
TMF	3	x			x																	
TMF	4				x																	
TMF	5				x																	
TMF	2	x			x																	
TMF	8	x			x																	

Notes:
= direct impact
= indirect
= road crossings
"x" = direct interaction
"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 1
VEC Interactions – Construction Phase

						Stockpiles			TMF								Waste Rock Mgt Facility		
Infrastructure Feature	**API**	**Northern Pike**	**Walleye**	**Smallmouth Bass**	**Baitfish Species**	Clearing and grubbing	Set up seepage collection ditches sumps and pump system	Trucking, dumping and dozing of overburden	Construction of TMF service road and pipeline access roads	Clearing, grubbing and installation of temporary sediment control measures	Construction of pipelines (tailings and water reclaim)	Installation of pump stations and power to pump stations	Strip topsoil from dam foundations and truck to stockpile	Construct first stage perimeter containment (include construction of coffer dams, dewatering of foundation, and preparation of dam foundations)	Construction of seepage collection system and pumping stations	Installation of tailings distribution system	Clearing and grubbing	Set up seepage collection ditches sumps and pump system	Trucking, dumping and dozing of waste rock
Lower Reaches																			
TMF	1				x					x			x						
TMF	2	x			x					x			x						
TMF	6									x			x						
TMF	7									x			x						
	8	x			x														
Waste Rock Stock Pile	11				x	xY	x										xY		
Open Pit	12	x			x														
Mine Water Spill Emergency	13																		
WRSP	14				x	x											x		
Road	20																		
Road	21				x														
Road	22				x														
Road	23				x														
TMF	47									x			x						
TMF	48									x			x						
Road	63				x														
Road	64	x			x														
Road	65																		
Road	66	x																	
Road	67	x																	
Road	68	x	x	x															
Open Pit	69				x														
Sawbill/Lynxhead API																			
Effects due to changes in drainage and runoff	30	x	x				x	x											
	32		x	x	x														
	33	x	x	x															
	34	x	x	x	x														
	35	x	x		x														
	37																		
	49				x														
Support and Ancillary	15	x	x																
Support and Ancillary	16																		
Support and Ancillary	17				x														
Lizard Lake API																			
Effects due to changes in drainage and runoff	38	x		x	x														
	39	x	x	x	x														
Too far any to be indirectly affected?	42																		
	43																		
	44				x														
TMF	46				x														
TMF	3	x			x														
TMF	4				x														
TMF	5				x														
TMF	2	x			x														
TMF	8	x			x														

Notes:

= direct impact

= indirect

= road crossings

"x" = direct interaction

"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 1
VEC Interactions – Construction Phase

Infrastructure Feature	API	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species	Support and Ancillary Facilities: Hazardous and non-hazardous waste management	Control of dust	Fuel and chemical transportation handling and storage	Clearing and grubbing of development areas	Stripping and stockpiling of topsoil	Preparation of construction facilities (offices, shops, dry, cafeteria and nursing station)	Grading and granular surfacing of laydown areas	Grading of development areas	Operation of concrete batch plant	Construction of facilities	Construction of on-site roads	Construction of piping and electrical between buildings	Construction of diversion ditching and linking water management systems from various facilities	Construction of suppot and ancillary infrastructure (explosive storage area, assay laboratory, fuel storage areas, propane farm, parking areas, sewage, permanent worker camp, truck shop, warehouses, backup power generation, other facilities to be determined as part of detailed design)	Haulage of waste from Project Site to disposal in appropriately licensed facilities when required
Lower Reaches																				
TMF	1				x															
TMF	2	x			x															
TMF	6																			
TMF	7																			
	8	x			x															
Waste Rock Stock Pile	11				x															
Open Pit	12	x			x															
Mine Water Spill Emergency	13								xy	x		xy	y							
WRSP	14				x															
Road	20																		x	
Road	21				x															
Road	22				x															
Road	23				x															
TMF	47																			
TMF	48																			
Road	63				x															
Road	64	x			x															
Road	65																			
Road	66	x																		
Road	67	x																		
Road	68	x	x	x																
Open Pit	69				x															
Sawbill/Lynxhead API																				
Effects due to changes in drainage and runoff	30	x	x																	
	32		x	x	x															
	33	x	x	x					x	x		x								
	34	x	x	x	x															
	35	x	x		x															
	37																			
	49				x															
Support and Ancillary	15	x	x																	
Support and Ancillary	16																			
Support and Ancillary	17				x															
Lizard Lake API																				
Effects due to changes in drainage and runoff	38	x		x	x															
	39	x	x	x	x															
Too far any to be indirectly affected?	42																			
	43																			
	44				x															
TMF	46				x															
TMF	3	x			x															
TMF	4				x															
TMF	5				x															
TMF	2	x			x															
TMF	8	x			x															

Notes:
= direct impact
= indirect
= road crossings
"x" = direct interaction
"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 1
VEC Interactions – Construction Phase

Infrastructure Feature	API	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species	Borrow Sites: Clearing, grubbing and installation fo temproary sediment control measures	Borrow Sites: Stripping and stockpiling of topsoil and overburden as necessary	Borrow Sites: Operation of mobile crushing and screening plant	Borrow Sites: Excavation crushing and screening borrow material	Borrow Sites: Hauling and transporting material as required
Lower Reaches										
TMF	1				x					
TMF	2	x			x					
TMF	6									
TMF	7									
	8	x			x					
Waste Rock Stock Pile	11				x					
Open Pit	12	x			x					
Mine Water Spill Emergency	13									
WRSP	14				x					
Road	20									
Road	21				x					
Road	22				x					
Road	23				x					
TMF	47									
TMF	48									
Road	63				x					
Road	64	x			x					
Road	65									
Road	66	x								
Road	67	x								
Road	68	x	x	x						
Open Pit	69				x					
Sawbill/Lynxhead API										
Effects due to changes in drainage and runoff	30	x	x							
	32		x	x	x					
	33	x	x	x						
	34	x	x	x	x					
	35	x	x		x					
	37									
	49				x					
Support and Ancillary	15	x	x							
Support and Ancillary	16									
Support and Ancillary	17				x					
Lizard Lake API										
Effects due to changes in drainage and runoff	38	x		x	x					
	39	x	x	x	x					
Too far any to be indirectly affected?	42									
	43									
	44				x					
TMF	46				x					
TMF	3	x			x					
TMF	4				x					
TMF	5				x					
TMF	2	x			x					
TMF	8	x			x					

Notes:
= direct impact
= indirect
= road crossings
"x" = direct interaction
"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 2
VEC Interactions – Operations Phase

						Water Management System	Linear Infrastructure			Mine						Ore Processing Facility			
Infrastructure Feature	API	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species	Operation of seepage collection ponds, pumping water to open pits until water is suitable for direct discharge	Maintaining access road (Hardtack/ Sawbill)	Maintain project transmission line	Maintain fibre optic line	Ongoing removal and stockpile of topsoil and overburden	Ongoing dewatering of open pits	Drilling, loading of explosives and blasting	Loading of ore, low-grade ore, and waste rock	Hauling of ore to the crusher	Hauling of waste rock to the WRMF	Crushing, grinding and concentration of ore	Leaching of concentrate	Electro-winning and smelting of gold	Operation of cyanide destruction plant and tailings thickener
Lower Reaches																			
TMF	1				x														
TMF	2	x			x														
TMF	6																		
TMF	7																		
	8	x			x														
Waste Rock Stock Pile	11				x														
Open Pit	12	x			x					x	x								
Mine Water Spill Emergency	13																		
WRSP	14				x														
Road	20						x												
Road	21				x		x												
Road	22				x		x												
Road	23				x		x												
TMF	47																		
TMF	48																		
Road	63				x		x												
Road	64	x			x		x												
Road	65						x												
Road	66	x					x												
Road	67	x					x												
Road	68	x	x	x			x												
Open Pit	69				x														
Sawbill/Lynxhead API																			
Effects due to changes in drainage and runoff	30	x	x			x						x							
	32		x	x	x	x						x							
	33	x	x	x								x							
	34	x	x	x	x							x							
	35	x	x		x														
	37																		
	49				x														
Support and Ancillary	15	x	x																
Support and Ancillary	16																		
Support and Ancillary	17				x														
Lizard Lake API																			
Effects due to changes in drainage and runoff	38	x		x	x														
	39	x	x	x	x														
Too far any to be indirectly affected?	42																		
	43																		
	44				x														
TMF	46				x														
TMF	3	x			x														
TMF	4				x														
TMF	5				x														
TMF	2	x			x														
TMF	8	x			x														
		x																	

Notes:
= direct impact
= indirect
= road crossings
"x" = direct interaction
"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 2
VEC Interactions – Operations Phase

						TMF				Waste Rock Mgt Facility	Support and Ancillary Facilities								
Infrastructure Feature	**API**	**Northern Pike**	**Walleye**	**Smallmouth Bass**	**Baitfish Species**	Deposition of tailings from processing plant	Staged raising and extension of TMF dams	Pumping of water from the reclaim pond back to the processing plant	Operation of the seepage collection ponds and pump back to TMF	Trucking dumping and dozing of material	General operation of support and ancillary structure and facilities	Operation fuelling and maintenance of vehicles	Transportation of people and materials	Operation and maintenance of backup power generation facilities	Hazardous and non-hazardous waste management	Control of dust and erosion	Fuel and chemical transportation handling and storage	Explosive preparation, handling and storage	Haulage of waste from Project Site to disposal in appropriately licensed facilities when required
Lower Reaches																			
TMF	1				x														
TMF	2	x			x														
TMF	6																		
TMF	7																		
	8	x			x														
Waste Rock Stock Pile	11				x														
Open Pit	12	x			x														
Mine Water Spill Emergency	13																		
WRSP	14				x														
Road	20																		
Road	21				x														
Road	22				x														
Road	23				x														
TMF	47																		
TMF	48																		
Road	63				x														
Road	64	x			x														
Road	65																		
Road	66	x																	
Road	67	x																	
Road	68	x	x	x															
Open Pit	69				x														
Sawbill/Lynxhead API																			
Effects due to changes in drainage and runoff	30	x	x																
	32		x	x	x														
	33	x	x	x															
	34	x	x	x	x														
	35	x	x		x														
	37																		
	49				x														
Support and Ancillary	15	x	x																
Support and Ancillary	16																		
Support and Ancillary	17				x														
Lizard Lake API																			
Effects due to changes in drainage and runoff	38	x		x	x														
	39	x	x	x	x														
Too far any to be indirectly affected?	42																		
	43																		
	44				x														
TMF	46				x														
TMF	3	x			x														
TMF	4				x														
TMF	5				x														
TMF	2	x			x														
TMF	8	x			x														
		x																	

Notes:

= direct impact

= indirect

= road crossings

"x" = direct interaction

"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 2
VEC Interactions – Operations Phase

Infrastructure Feature	API	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species	Borrow Sites?						Stock Piles		
						Clearing, grubbing and installation of temporary sediment control measures	Stripping and stockpiling of topsoil and overburden as necessary	Operation of mobile crushing and screening plant	Excavation crushing and screening borrow material	Hauling and transporting material as required	Decommission following appropriate guidelines once they are no longer required	Trucking dumping and dozing of material	Excavation and trucking of marginal ore to the mill	Use overburden and topsoil for progressive reclamation
Lower Reaches														
TMF	1				x									
TMF	2	x			x									
TMF	6													
TMF	7													
	8	x			x									
Waste Rock Stock Pile	11				x									
Open Pit	12	x			x									
Mine Water Spill Emergency	13													
WRSP	14				x									
Road	20													
Road	21				x									
Road	22				x									
Road	23				x									
TMF	47													
TMF	48													
Road	63				x									
Road	64	x			x									
Road	65													
Road	66	x												
Road	67	x												
Road	68	x	x	x										
Open Pit	69				x									
Sawbill/Lynxhead API														
Effects due to changes in drainage and runoff	30	x	x											
	32		x	x	x									
	33	x	x	x										
	34	x	x	x	x									
	35	x	x		x									
	37													
	49				x									
Support and Ancillary	15	x	x											
Support and Ancillary	16													
Support and Ancillary	17				x									
Lizard Lake API														
Effects due to changes in drainage and runoff	38	x		x	x									
	39	x	x	x	x									
Too far any to be indirectly affected?	42													
	43													
	44				x									
TMF	46				x									
TMF	3	x			x									
TMF	4				x									
TMF	5				x									
TMF	2	x			x									
TMF	8	x			x									
		x												

Notes:

= direct impact

= indirect

= road crossings

"x" = direct interaction

"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 3
VEC Interactions – Closure Phase

Infrastructure Feature	API	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species	Linear Infrastructure: Decommissioning of Project facilities	Linear Infrastructure: Site reclamation	Linear Infrastructure: Tailings pond management	Borrow Sites: Closure and decommission following appropriate guidelines once they are no longer required
Lower Reaches									
TMF	1				x			x	
TMF	2	x			x			x	
TMF	6							x	
TMF	7							x	
	8	x			x				
Waste Rock Stock Pile	11				x				
Open Pit	12	x			x				
Mine Water Spill Emergency	13								
WRSP	14				x				
Road	20								
Road	21				x				
Road	22				x				
Road	23				x				
TMF	47							x	
TMF	48							x	
Road	63				x				
Road	64	x			x				
Road	65								
Road	66	x							
Road	67	x							
Road	68	x	x	x					
Open Pit	69				x				
Sawbill/Lynxhead API									
Effects due to changes in drainage and runoff	30	x	x						
	32		x	x	x				
	33	x	x	x					
	34	x	x	x	x				
	35	x	x		x				
	37								
	49				x				
Support and Ancillary	15	x	x						
Support and Ancillary	16								
Support and Ancillary	17				x				
Lizard Lake API									
Effects due to changes in drainage and runoff	38	x		x	x				
	39	x	x	x	x				
Too far any to be indirectly affected?	42								
	43								
	44				x				
TMF	46				x				
TMF	3	x			x				
TMF	4				x				
TMF	5				x				
TMF	2	x			x				
TMF	8	x			x				
		x							

Notes:
= direct impact
= indirect
= road crossings
"x" = direct interaction
"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 3
VEC Interactions – Closure Phase

						Support and Ancillary Infrastructure														
Infrastructure Feature	API	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species	Decommissioning of Project facilities	Operation of temporary offices during closure	Operation fuelling and maintenance of vehicles during closure activities	Transportation of people and materials	Hazardous and non-hazardous waste management	Control of dust	Fuel transportation handling and storage	Removal of re-useable supplies and materials	Salvage of equipment and sale of scrap where economical	Remediation of hydrocarbon impacts as per applicable guidelines if necessary	Demolition of facilities and disposal in licences landfills	Project Site reclamation	Close (scarify and vegetate) all non-essential site roads	Return applicable portions of access road (Hardtack/ Sawbill) to MNR control	Implement closure monitoring programs	Haulage of waste from Project Site to disposal in appropriately licensed facilities when required
Lower Reaches																				
TMF	1				x															
TMF	2	x			x															
TMF	6																			
TMF	7																			
	8	x			x															
Waste Rock Stock Pile	11				x															
Open Pit	12	x			x															
Mine Water Spill Emergency	13																			
WRSP	14				x															
Road	20																			
Road	21				x															
Road	22				x															
Road	23				x															
TMF	47																			
TMF	48																			
Road	63				x															
Road	64	x			x															
Road	65																			
Road	66	x																		
Road	67	x																		
Road	68	x	x	x																
Open Pit	69				x															
Sawbill/Lynxhead API																				
Effects due to changes in drainage and runoff	30	x	x																	
	32		x	x	x															
	33	x	x	x																
	34	x	x	x	x															
	35	x	x		x															
	37																			
	49				x															
Support and Ancillary	15	x	x																	
Support and Ancillary	16																			
Support and Ancillary	17				x															
Lizard Lake API																				
Effects due to changes in drainage and runoff	38	x		x	x															
	39	x	x	x	x															
Too far any to be indirectly affected?	42																			
	43																			
	44				x															
TMF	46				x															
TMF	3	x			x															
TMF	4				x															
TMF	5				x															
TMF	2	x			x															
TMF	8	x			x															
		x																		

Notes:
= direct impact
= indirect
= road crossings
"x" = direct interaction
"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 3
VEC Interactions – Closure Phase

Infrastructure Feature	API	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species	Ore Processing Facility	Mine					Stockpiles			WRMF	
						Decommissioning of processing plant as per general activities	Undertake appropriate studies to establish a "safe line" around open pits	Construct a fence or boulder wall around safe line to prevent inadvertent public access	Cease pumping and allow the open pits to flood back	Pump water from the TMF reclaim pond and seepage collection to the open pits	Excavate a trench (spillway) connecting the east pit, west pit, and Marmion Reservoir such that the flooded open pits will eventually overflow through a spillway to Marmion Reservoir	Excavation and use of overburden and topsoil for reclamation	Allow surface to revegetate naturally	Provide erosion protection and drainage channels as necessary	Operation of seepage collection ponds, pumping water to open pits until water is suitable for direct discharge	Construct erosion protection drainage channels as necessary
Lower Reaches																
TMF	1				x											
TMF	2	x			x											
TMF	6															
TMF	7															
	8	x			x											
Waste Rock Stock Pile	11				x											
Open Pit	12	x			x											
Mine Water Spill Emergency	13															
WRSP	14				x											
Road	20															
Road	21				x											
Road	22				x											
Road	23				x											
TMF	47															
TMF	48															
Road	63				x											
Road	64	x			x											
Road	65															
Road	66	x														
Road	67	x														
Road	68	x	x	x												
Open Pit	69				x											
Sawbill/Lynxhead API																
Effects due to changes in drainage and runoff	30	x	x								x	x	x	x	x	x
	32		x	x	x						x					
	33	x	x	x							x					
	34	x	x	x	x						x					
	35	x	x		x						x					
	37										x					
	49				x						x					
Support and Ancillary	15	x	x													
Support and Ancillary	16															
Support and Ancillary	17				x											
Lizard Lake API																
Effects due to changes in drainage and runoff	38	x		x	x											
	39	x	x	x	x											
Too far any to be indirectly affected?	42															
	43															
	44				x											
TMF	46				x											
TMF	3	x			x											
TMF	4				x											
TMF	5				x											
TMF	2	x			x											
TMF	8	x			x											
		x														

Notes:
= direct impact
= indirect
= road crossings
"x" = direct interaction
"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 3
VEC Interactions – Closure Phase

Infrastructure Feature	API	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species	TMF: Decommission	TMF: Decommissioning and removal of tailings pumping and pipeline system	TMF: Direct revegetation to stabilize the tailings surface in the TMF	TMF: Providing erosion protected drainage channels in TMF as necessary	TMF: Monitoring and maintaining the TMF dams	TMF: Operation of seepage collection ponds, pumping water to open pits until water is suitable for direct discharge	TMF: Decommissioning and removal of reclaim pumping and pipeline system	Water Management System: Operation of seepage collection ponds, pumping water to open pits until water is suitable for direct discharge
Lower Reaches													
TMF	1				x								
TMF	2	x			x								
TMF	6												
TMF	7												
	8	x			x								
Waste Rock Stock Pile	11				x								
Open Pit	12	x			x								
Mine Water Spill Emergency	13												
WRSP	14				x								
Road	20												
Road	21				x								
Road	22				x								
Road	23				x								
TMF	47												
TMF	48												
Road	63				x								
Road	64	x			x								
Road	65												
Road	66	x											
Road	67	x											
Road	68	x	x	x									
Open Pit	69				x								
Sawbill/Lynxhead API													
Effects due to changes in drainage and runoff	30	x	x										
	32		x	x	x								
	33	x	x	x									
	34	x	x	x	x								
	35	x	x		x								
	37												
	49				x								
Support and Ancillary	15	x	x										
Support and Ancillary	16												
Support and Ancillary	17				x								
Lizard Lake API													
Effects due to changes in drainage and runoff	38	x		x	x								
	39	x	x	x	x								
Too far any to be indirectly affected?	42												
	43												
	44				x								
TMF	46				x								
TMF	3	x			x								
TMF	4				x								
TMF	5				x								
TMF	2	x			x								
TMF	8	x			x								
		x											

Notes:
= direct impact
= indirect
= road crossings
"x" = direct interaction
"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
VEC Interactions – Post Closure Phase

						Support and Ancillary Infrastructure	Mine			WRMF	
Infrastructure Feature	API	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species	Haulage of waste from Project Site to disposal in appropriately licensed facilities when required	Periodically maintain fence or boulder wall if necessary	Monitor open pits water quality	Allow the flooded open pits to discharge to Marmion Reservoir, with in-pit or passively treatment if necessary	Operation of seepage collection ponds, pumping water to open pits until water is suitable for direct discharge	Monitor for erosion and repair if necessary
	Lower Reaches										
TMF	1				x						
TMF	2	x			x						
TMF	6										
TMF	7										
	8	x			x						
Waste Rock Stock Pile	11				x						
Open Pit	12	x			x						
Mine Water Spill Emergency	13										
WRSP	14				x						
Road	20										
Road	21				x						
Road	22				x						
Road	23				x						
TMF	47										
TMF	48										
Road	63				x						
Road	64	x			x						
Road	65										
Road	66	x									
Road	67	x									
Road	68	x	x	x							
Open Pit	69				x						
	Sawbill/Lynxhead API										
effects due to changes in drainage and runoff	30	x	x						x		
	32		x	x	x				x		
	33	x	x	x					x		
	34	x	x	x	x				x		
	35	x	x		x						
	37										
	49				x						
Support and Ancillary	15	x	x								
Support and Ancillary	16										
Support and Ancillary	17				x						
	Lizard Lake API										
effects due to changes in drainage and runoff	38	x		x	x						
	39	x	x	x	x						
Too far any to be indirectly affected?	42										
	43										
	44				x						
TMF	46				x						
TMF	3	x			x						
TMF	4				x						
TMF	5				x						
TMF	2	x			x						
TMF	8	x			x						
		x									

Notes:

= direct impact

= indirect

= road crossings

"x" = direct interaction

"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 4
VEC Interactions – Post Closure Phase

Infrastructure Feature	API	Northern Pike	Walleye	Smallmouth Bass	Baitfish Species	TMF: Operation of seepage collection ponds, pumping water to open pits until water is suitable for direct discharge	TMF: Monitor for erosion and repair if necessary	TMF: Direct revegetation to stabilize the tailings surface in the TMF	Water Management System: Operation of seepage collection ponds, pumping water to open pits until water is suitable for direct discharge
	Lower Reaches								
TMF	1				x				
TMF	2	x			x				
TMF	6								
TMF	7								
	8	x			x				
Waste Rock Stock Pile	11				x				
Open Pit	12	x			x				
Mine Water Spill Emergency	13								
WRSP	14				x				
Road	20								
Road	21				x				
Road	22				x				
Road	23				x				
TMF	47								
TMF	48								
Road	63				x				
Road	64	x			x				
Road	65								
Road	66	x							
Road	67	x							
Road	68	x	x	x					
Open Pit	69				x				
	Sawbill/Lynxhead API								
effects due to changes in drainage and runoff	30	x	x						
	32		x	x	x				
	33	x	x	x					
	34	x	x	x	x				
	35	x	x		x				
	37								
	49				x				
Support and Ancillary	15	x	x						
Support and Ancillary	16								
Support and Ancillary	17				x				
	Lizard Lake API								
effects due to changes in drainage and runoff	38	x		x	x				
	39	x	x	x	x				
Too far any to be indirectly affected?	42								
	43								
	44				x				
TMF	46				x				
TMF	3	x			x				
TMF	4				x				
TMF	5				x				
TMF	2	x			x				
TMF	8	x			x				
		x							

Notes:

= direct impact
= indirect
= road crossings
"x" = direct interaction
"y" = indirect interaction

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
VEC Interactions – Fish by API and Guild

				TMF														
				1	2		3	4		5			6		7		8		9
FHG Defined	Fish Habitat groupings (Habitat Compensation)	VEC	Species		Lake	Stream	Pond	Pond	Stream	Pond	Inflow Stream	Outflow Stream	Pond	Outflow Stream	Pond	Stream	Pond	Upstream of Beaver Dam	Stream
Warm + A: Non-pisc	7	Baitfish	Blacknose Shiner		1														
Warm + B: Non-pisc	8	Baitfish	Fathead Minnow	1															1
Cool + A1: Non-Pisc	5	Baitfish	Finescale Dace	1			1	1	1	1	1	1						1	
Cool + A1: Non-Pisc	5	Baitfish	Golden Shiner														1	1	
Cool + A1: Pisc	6	Northern Pike	Northern Pike		x		x						No catch		No catch	No catch	x	x	
Cold +A1 - Stream: Non-pisc	2	Baitfish	Pearl Dace	1															
Cool + A1: Non-Pisc	5	Baitfish	Redbelly Dace				1	1		1		1							
Warm + B: Pisc	9	Smallmouth Bass	Smallmouth Bass																
Warm + A: Non-pisc	7	Baitfish	Spottail Shiner																
Cool + A1: Pisc	6	Walleye	Walleye																

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
VEC Interactions – Fish by API and Guild

				Waste Rock 2		Ore	Pit		Pit	Pit	Other		Other		Waste Rock	Ore		Ore	
				10		11	12		13	14	15		16		17	18		19	
FHG Defined	Fish Habitat groupings (Habitat Compensation)	VEC	Species	Pond	Outlfow Stream		Mitta Lake	Outflow Stream		Stream	Pond	Stream	Pond	Outflow Stream	Pond	Stream	Beaver Pond	Stream	Beaver Pond
Warm + A: Non-pisc	7	Baitfish	Blacknose Shiner																
Warm + B: Non-pisc	8	Baitfish	Fathead Minnow			1	1	1		1					1			1	1
Cool + A1: Non-Pisc	5	Baitfish	Finescale Dace			1	1	1		1					1	1	1	1	1
Cool + A1: Non-Pisc	5	Baitfish	Golden Shiner																
Cool + A1: Pisc	6	Northern Pike	Northern Pike	No catch	x				No catch		No catch	x	No catch	No catch					
Cold +A1 - Stream: Non-pisc	2	Baitfish	Pearl Dace																
Cool + A1: Non-Pisc	5	Baitfish	Redbelly Dace			1		1		1					1				
Warm + B: Pisc	9	Smallmouth Bass	Smallmouth Bass																
Warm + A: Non-pisc	7	Baitfish	Spottail Shiner																
Cool + A1: Pisc	6	Walleye	Walleye									1							

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
VEC Interactions – Fish by API and Guild

				Stream Crossing Locations					Other					Ore	Other	Pit	Stream Crossings	Pit	Waste Rock	Waste Rock 2
				20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
FHG Defined	Fish Habitat groupings (Habitat Compensation)	VEC	Species	Stream	Stream	Pond	Pond		West Dam	Spillway Dam	Middle Dam	East Dam	Lynxhead Narrows		Lynxhead Bay		Marmion Lake	Sawbill Bay	Snail Bay	Turtle Bay
Warm + A: Non-pisc	7	Baitfish	Blacknose Shiner			1						1			1				1	1
Warm + B: Non-pisc	8	Baitfish	Fathead Minnow			1	1													
Cool + A1: Non-Pisc	5	Baitfish	Finescale Dace		1	1	1													
Cool + A1: Non-Pisc	5	Baitfish	Golden Shiner																	
Cool + A1: Pisc	6	Northern Pike	Northern Pike					x	x		x		x	x	x		x	x	x	x
Cold +A1 - Stream: Non-pisc	2	Baitfish	Pearl Dace			1	1													
Cool + A1: Non-Pisc	5	Baitfish	Redbelly Dace		1	1														
Warm + B: Pisc	9	Smallmouth Bass	Smallmouth Bass						1	1	1	1	1		1	1	1	1		1
Warm + A: Non-pisc	7	Baitfish	Spottail Shiner													1		1		
Cool + A1: Pisc	6	Walleye	Walleye						1			1		1	1	1	1	1	1	1

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
VEC Interactions – Fish by API and Guild

				Ore	TMF		TMF											
				37	38		39		40		41		42	43	44		45	46	
FHG Defined	Fish Habitat groupings (Habitat Compensation)	VEC	Species		Lizard Lake	Stream	Lizard Lake	Stream	Stream	Turtle Bay	Turtle Bay	Stream	Narrows	Pond	Pond	Stream	Lake	Lake	Stream
Warm + A: Non-pisc	7	Baitfish	Blacknose Shiner		1					1									
Warm + B: Non-pisc	8	Baitfish	Fathead Minnow															1	
Cool + A1: Non-Pisc	5	Baitfish	Finescale Dace													1		1	1
Cool + A1: Non-Pisc	5	Baitfish	Golden Shiner																
Cool + A1: Pisc	6	Northern Pike	Northern Pike	No catch	x	x	x	No catch	x		x	x		No catch	No catch		x		
Cold +A1 - Stream: Non-pisc	2	Baitfish	Pearl Dace																1
Cool + A1: Non-Pisc	5	Baitfish	Redbelly Dace																
Warm + B: Pisc	9	Smallmouth Bass	Smallmouth Bass		1		1				1								
Warm + A: Non-pisc	7	Baitfish	Spottail Shiner				1												
Cool + A1: Pisc	6	Walleye	Walleye				1				1								

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
VEC Interactions – Fish by API and Guild

				Ore				Waste Rock		Stream Crossing								
				47		48		49	50	51	52	53	54		55		56	
FHG Defined	Fish Habitat groupings (Habitat Compensation)	VEC	Species	Lake	Beaver Pond Below 47	Pond	Beaver Pond Downstream of 48	Sawbill Bay		Lake	Stream	Stream	Stream	Lake	Lake	Stream	Stream	Lake
Warm + A: Non-pisc	7	Baitfish	Blacknose Shiner					1		1					1			
Warm + B: Non-pisc	8	Baitfish	Fathead Minnow											1				1
Cool + A1: Non-Pisc	5	Baitfish	Finescale Dace	1	1		1					1		1				1
Cool + A1: Non-Pisc	5	Baitfish	Golden Shiner					1										
Cool + A1: Pisc	6	Northern Pike	Northern Pike			No catch		x	x	x	No catch				x	No catch		x
Cold +A1 - Stream: Non-pisc	2	Baitfish	Pearl Dace	1	1									1				
Cool + A1: Non-Pisc	5	Baitfish	Redbelly Dace		1													
Warm + B: Pisc	9	Smallmouth Bass	Smallmouth Bass															
Warm + A: Non-pisc	7	Baitfish	Spottail Shiner															
Cool + A1: Pisc	6	Walleye	Walleye															1

Submitted as part of the Version 3 HRGP Amended EIS/EA Documentation
January 2018 - 1656263

TABLE 5
VEC Interactions – Fish by API and Guild

					Stream Crossing														TOTAL
				57	58		59	60	61		62	63	64		65	66	67	68	69	70
FHG Defined	Fish Habitat groupings (Habitat Compensation)	VEC	Species		Lake	Stream	Lake	Lake	Stream	Lake	Stream		Stream	Lake	Stream					
Warm + A: Non-pisc	7	Baitfish	Blacknose Shiner				1												1	13
Warm + B: Non-pisc	8	Baitfish	Fathead Minnow					1					1	1						17
Cool + A1: Non-Pisc	5	Baitfish	Finescale Dace		1	1		1			1	1	1	1					1	37
Cool + A1: Non-Pisc	5	Baitfish	Golden Shiner																	3
Cool + A1: Pisc	6	Northern Pike	Northern Pike				x			x				x		x	x	x		
Cold +A1 - Stream: Non-pisc	2	Baitfish	Pearl Dace			1													1	9
Cool + A1: Non-Pisc	5	Baitfish	Redbelly Dace																1	12
Warm + B: Pisc	9	Smallmouth Bass	Smallmouth Bass															1		14
Warm + A: Non-pisc	7	Baitfish	Spottail Shiner																	3
Cool + A1: Pisc	6	Walleye	Walleye							1								1		15