



**Sisson Project: Revised  
Information Requirements in  
Support of the Application for  
Fisheries Act Authorization, and  
Offsetting Plan**

May 28, 2019

Prepared for:

The Sisson Partnership  
212 Queen Street, Suite 211  
Fredericton, NB E3C 1N8

Prepared by:

Stantec Consulting Ltd.  
845 Prospect Street,  
Fredericton, NB E3B 2T7

Project No. 121811420



# Sign Off Sheet

This document entitled *Sisson Project: Revised Information Requirements in Support of the Application for Fisheries Act Authorization, and Offsetting Plan* was prepared by Stantec Consulting Ltd. ("Stantec") for the account of The Sisson Partnership (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.



## About the Proponent

After submission of the Sisson Project EIA Report to governments in July 2013, Northcliff Resources Ltd. and Todd Minerals Ltd. entered into a limited partnership agreement to advance the development of the Sisson Project. As a result of this agreement, the Sisson Project is now being developed and advanced by Sisson Mines Ltd., on behalf, and as general partner, of the Sisson Project Limited Partnership. Thus, the Proponent of the Sisson Project is now Sisson Mines Ltd., and all references to Northcliff Resources Ltd. (Northcliff) in this document or in previous documentation relating to the Sisson Project can be read as referring to Sisson Mines Ltd.



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

May 28, 2019

**Table of Contents**

**1.0 INTRODUCTION..... 1**

1.1 REGULATORY CONTEXT AND SCOPE OF APPLICATION..... 1

1.2 LOCATION..... 3

1.3 CONTACT INFORMATION ..... 13

1.4 DESCRIPTION OF PROPOSED UNDERTAKING ..... 13

    1.4.1 Project Summary..... 13

    1.4.2 Major Project Components and Activities ..... 14

    1.4.3 Construction Methods ..... 21

    1.4.4 Project Schedule ..... 23

**2.0 DESCRIPTION OF FISH AND FISH HABITAT (AQUATIC ENVIRONMENT) .....23**

2.1 FISH AND FISH HABITAT CHARACTERIZATION METHODS ..... 23

    2.1.1 Watershed Area and Location ..... 24

    2.1.2 General Aquatic Habitat Characteristics ..... 24

    2.1.3 Water Quality ..... 24

    2.1.4 Benthic Invertebrate Community ..... 25

    2.1.5 Fish Community ..... 25

2.2 FISH AND FISH HABITAT RESULTS ..... 26

    2.2.1 Bird Brook ..... 26

    2.2.2 Sisson Brook..... 27

    2.2.3 McBean Brook ..... 28

    2.2.4 Tributary A to West Branch Napadogan Brook ..... 29

    2.2.5 West Branch Napadogan Brook ..... 30

**3.0 DESCRIPTION OF POTENTIAL ENVIRONMENTAL EFFECTS ON FISH AND FISH HABITAT .....31**

3.1 POTENTIAL ENVIRONMENTAL EFFECTS ON FISH HABITAT ..... 31

    3.1.1 Direct Environmental Effects ..... 32

    3.1.2 Indirect Environmental Effects..... 34

    3.1.3 Bird Brook and Tributary a to West Branch Napadogan Brook..... 35

    3.1.4 Sisson Brook and Lower Napadogan Brook ..... 35

3.2 POTENTIAL ENVIRONMENTAL EFFECTS ON FISH..... 36

3.3 POTENTIAL ENVIRONMENTAL EFFECTS ON FISH PRODUCTION ..... 38

**4.0 MEASURES AND STANDARDS TO AVOID OR MITIGATE SERIOUS HARM TO FISH.....40**

4.1 MEASURE TO AVOID SERIOUS HARM TO FISH..... 40

    4.1.1 Tailings Storage Facility Site Selection and Design..... 40

    4.1.2 Mine Waste and Water Management ..... 42

    4.1.3 Construction Methods and Timing ..... 42

    4.1.4 Fish Relocation ..... 47

    4.1.5 Fish Habitat Offsetting Plan..... 48

4.2 MONITORING MEASURES TO AVOID SERIOUS HARM ..... 49

4.3 CONTINGENCY MEASURES FOR MITIGATING SERIOUS HARM ..... 49



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

May 28, 2019

4.4	RESIDUAL SERIOUS HARM TO FISH .....	50
<b>5.0</b>	<b>OFFSETTING PLAN/FISH HABITAT COMPENSATION PLAN .....</b>	<b>53</b>
5.1	IMPLEMENTATION OF MEASURES TO OFFSET SERIOUS HARM.....	53
5.1.1	Upper Nashwaak Lake Water Control Structure Replacement .....	57
5.1.2	Lower Nashwaak Lake Dam Removal.....	58
5.1.3	Conservation-focused Alewife Reintroduction Plan .....	60
5.2	DETERMINATION OF OFFSETTING PLAN ECOLOGICAL VALUE .....	70
5.2.1	Suitability of Proposed Offsetting Plan .....	70
5.2.2	Estimate of the Offsetting/Habitat Compensation Credit.....	71
5.3	MEASURES TO AVOID ADVERSE ENVIRONMENTAL EFFECTS ON FISH DURING OFFSETTING PLAN IMPLEMENTATION .....	73
5.4	PROPOSED MONITORING MEASURES TO ASSESS OFFSETTING .....	73
5.4.1	Upper Nashwaak Lake Water Control Structure Replacement .....	73
5.4.2	Lower Nashwaak Lake Dam Removal.....	73
5.4.3	Conservation-focused Alewife Reintroduction Plan .....	74
5.5	CONTINGENCY MEASURES FOR THE OFFSETTING PLAN .....	74
5.5.1	Contingency Option 1: Hargrove Dam (Monquart River Watershed) .....	75
5.5.2	Contingency Option 2: Pinder Dam (Nackawic River Watershed) .....	75
5.6	COST AND TIMELINE OF IMPLEMENTING THE OFFSETTING PLAN .....	76
5.7	LAND ACCESS .....	77
<b>6.0</b>	<b>CONCLUSION .....</b>	<b>77</b>
<b>7.0</b>	<b>REFERENCES.....</b>	<b>78</b>

**LIST OF TABLES**

Table 1.1	Description of Project Phases, Activities, and Physical Works.....	14
Table 3.1	Direct Fish Habitat Loss by Major Project Component.....	33
Table 3.2	Indirect Fish Habitat Loss by Major Project Component .....	34
Table 3.3	Direct Fish Production Loss by Major Project Component.....	37
Table 3.4	Indirect Fish Production Loss by Major Project Component .....	37
Table 3.5	Direct Fish Production Loss by Major Project Component.....	39
Table 3.6	Indirect Fish Production Loss by Major Project Component .....	39
Table 4.1	Summary of Mitigation, Recommended Follow-up and Monitoring, and Required Offset by Project Phase .....	51
Table 5.1	Summary of Lower Nashwaak Lake Dam Upstream Fish Passage Analysis .....	59
Table 5.2	Incidental catches of Gaspereau at the Nashwaak River Counting Fence (Ross Jones, DFO Science, Personal Communication, September 17, 2018) .....	65
Table 5.3	The number of spawning adult alewife released and the subsequent return estimates in a subwatershed of the Penobscot River, Maine, USA (Data adapted from Jason Valliere, Maine Department of Marine Resources, Personal Communication, September 12, 2018). .....	68
Table 5.4	High Level Costs Associated with Implementing the Proposed Offsetting Plan .....	76



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

May 28, 2019

**LIST OF FIGURES**

Figure 1.1	Sisson Project Location.....	5
Figure 1.2	Sisson Project Development Area.....	7
Figure 1.3	Watersheds within the Local Assessment Area.....	11
Figure 1.4	End of Period Map, Production Year 27 (Life-of-Mine) .....	17
Figure 1.5	Typical Cross-Section of Tailings Storage Facility Embankments .....	20
Figure 4.1	Locations of Tailings Storage Facility Alternatives.....	45
Figure 5.1	Locations of the Proposed Fisheries Offsetting Fish Passage Barrier Removal Activities within the Nashwaak River Watershed. ....	55
Figure 5.2	Barrier to Fish Passage Structure at Entrance to Upper Nashwaak Lake. ....	57
Figure 5.3	The Lower Nashwaak Lake Dam of the Nashwaak River .....	58
Figure 5.4	The biogeography of alewife subpopulations within the Saint John River Watershed .....	61
Figure 5.5	Locations of incidental and anecdotal observation of adult alewife within the Nashwaak River subwatershed .....	63
Figure 5.6	The life cycle of anadromous alewife (From: Gibson et al. 2007) .....	67
Figure 5.7	The Hargrove Hydro Dam of the Monquart River, circa 1999 (Photo Credit: Ross Jones, DFO Science).....	75
Figure 5.8	The Pinder Dam of the Nackawic River (Photo Credit: Ross Jones, DFO Science) .....	76

**LIST OF APPENDICES**

**APPENDIX A DETAILED PLANS FOR THE CONSTRUCTION OF NASHWAAK STREAM BRIDGE REPLACEMENT**

**APPENDIX B GEOTECHNICAL INVESTIGATION**



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

May 28, 2019



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Introduction  
May 28, 2019

## 1.0 INTRODUCTION

This report is intended to fulfill the information requirements for authorization of the Sisson Project under the *Fisheries Act* and to provide information required for listing the tailings storage facility (TSF) in Schedule 2 of the *Metal and Diamond Mining Effluent Regulations (MDMER)*. The information requirements for a Section 35(2) *Fisheries Act* Authorization are described in Schedule 1 of the *Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations* under the *Fisheries Act*. The Sisson Project is a proposed tungsten-molybdenum open pit mine and associated facilities located on provincial Crown land near Napadogan, New Brunswick, approximately 60 km directly northwest of the city of Fredericton. The Proponent of the Sisson Project is Sisson Mines Ltd (hereafter referred to as “the Proponent”).

This report represents a revision of the previous application for a Paragraph 35(2)(b) *Fisheries Act* authorization, dated June 25, 2014. Specifically, this revision includes the additional information requirements requested from Fisheries and Oceans Canada (DFO) in letters sent to the Proponent on May 15, 2018 and September 24, 2018, and a meeting held on May 22, 2019.

## 1.1 REGULATORY CONTEXT AND SCOPE OF APPLICATION

Section 35 of the *Fisheries Act* prohibits the carrying out of a work, undertaking or activity that results in “serious harm to fish that are part of a commercial, recreational or Aboriginal fishery” (hereinafter referred to as “CRA fisheries”) without first obtaining an Authorization from Fisheries and Oceans Canada (DFO). “Serious harm to fish” is defined in the *Fisheries Act* as “the death of fish or any permanent alteration to, or destruction of, fish habitat”. Authorization under the Act requires that the proponent must offset any serious harm to fish that were part of, or supported, CRA fisheries such that the productivity of the fisheries is maintained or improved. An Offsetting Plan must accompany the application for authorization and is evaluated by DFO following the “Fisheries Productivity Investment Policy: A Proponent’s Guide to Offsetting” (DFO 2013a). Temporary alterations to fish habitat (e.g., construction of road culverts or reductions in mean annual flow less than about 10%) are no longer subject to the provisions of Section 35 and therefore no longer require a *Fisheries Act* authorization.

Additionally, under Section 36 of the *Fisheries Act*, “no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish” without authorization. For mines, the requirements of Section 36 of the *Fisheries Act* are further defined and regulated by the *Metal and Diamond Mining Effluent Regulations (MDMER)*. The depositing of deleterious substances produced by mines (e.g., tailings, waste rock) into waters frequented by fish is authorized through a regulatory amendment to Schedule 2 of *MDMER*, with associated compensation/offsetting.

There are fish within the Project area that currently support commercial (e.g., American eel (*Anguilla rostrata*)), recreational (e.g., brook trout (*Salvelinus fontinalis*)), and Aboriginal (e.g., brook trout) fisheries (collectively termed CRA fisheries). All fish species within the general area of the Project could be considered as Aboriginal fisheries. However, as defined by DFO (2013b), slimy sculpin, creek chub, pearl



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Introduction  
May 28, 2019

dace, blacknose dace, common shiner, longnose sucker, white sucker and sea lamprey do not support CRA fisheries (DFO 2013b). Historically, Atlantic salmon (*Salmo salar*) in the Saint John River system supported a commercial, recreational and Aboriginal fishery, but those fisheries have been closed (DFO 2012a).

In addition to the presence of the CRA species mentioned above, American eel and Outer Bay of Fundy (OBoF) Atlantic salmon may be present in watercourses near the Sisson Project. Both these species have been classified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC); American eel is listed by COSEWIC as “Threatened”, and OBoF Atlantic salmon is listed as “Endangered”. Neither American eel nor OBoF Atlantic salmon are listed on Schedule 1 of the federal Species at Risk Act (SARA). Only those species listed in Schedule 1 of SARA are subject to the prohibitions of Sections 32-36 and 58 of SARA.

The scope of this Application for Authorization under Section 35(2) of the Fisheries Act includes:

- Authorization for “serious harm to fish” arising from direct loss of portions of Bird Brook, Sisson Brook, an unnamed tributary to West Branch Napadogan Brook (identified as “Tributary A”), and a small portion of McBean Brook, and their tributaries, due to the construction and operation of Project facilities (e.g., open pit, TSF);
- Authorization for “serious harm to fish” arising from the indirect loss of residual segments of Bird Brook, Sisson Brook, and Tributary A to West Branch Napadogan Brook due to loss of catchment area upstream of these residual segments, and consequent reductions of stream flows in them, arising from the placement of Project facilities;
- Authorization for “serious harm to fish” arising from the reduction in downstream flow in Napadogan Brook associated with the withholding of mine contact water within the Project site, resulting in a reduction in the available habitat in Napadogan Brook;
- Authorization to carry out the removal of the existing water level control structure and road culvert at Upper Nashwaak Lake and its associated replacement with a bridge, as a component of an offsetting project to offset the “serious harm to fish” that will arise from the above alterations.
- Authorization to carry out a conservation-focused alewife, *Alosa pseudoharengus*, reintroduction plan in Upper Nashwaak Lake, as a component of an offsetting project to offset the “serious harm to fish” that will arise from the above alterations, and;
- Authorization to carry out the removal of the existing remnant dam structure at Lower Nashwaak Lake (i.e. Lower Lake Dam or Irving Dam) as a component of an offsetting project to offset the “serious harm to fish” that will arise from the above alterations.

Additionally, this application is also intended to initiate and inform the regulatory amendment process to add the Sisson Project TSF (referred to as a tailings impoundment area, or TIA, in the MDMER) to Schedule 2 of MDMER. Other information requirements for this process will be submitted separately to Environment and Climate Change Canada in support of this process.

Finally, this Application also contains the information required for an Offsetting Plan to offset serious harm arising from the Sisson Project, as required under Section 35 of the Fisheries Act. The same information



# **SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Introduction  
May 28, 2019

is also relevant to habitat compensation/offsetting that is required under the MDMER Schedule 2 regulatory amendment process.

## **1.2 LOCATION**

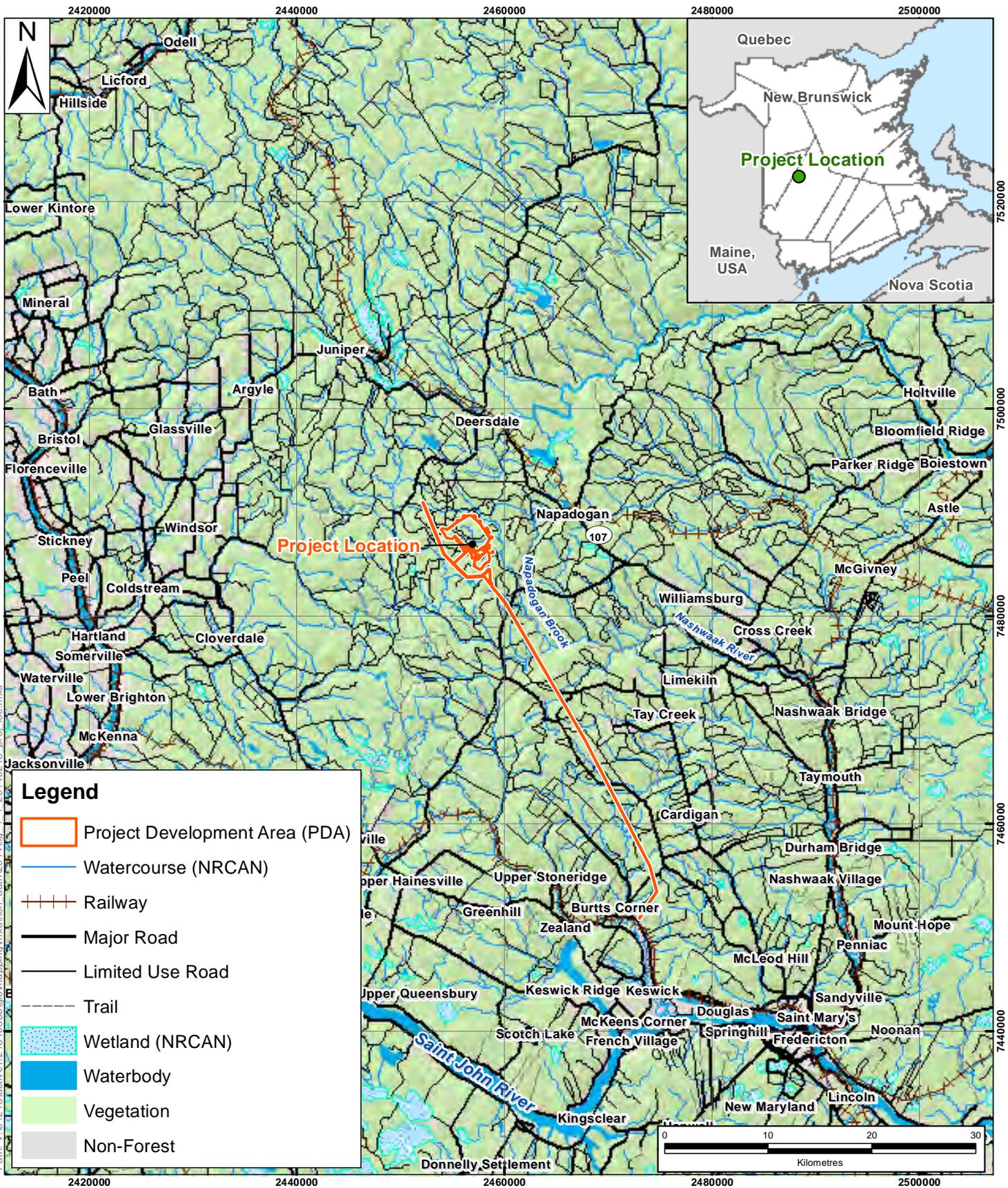
The Project site is approximately 10 km southwest of the community of Napadogan, York County, in east-central New Brunswick, approximately 60 km directly northwest of the city of Fredericton (Figure 1.1). The Project site is located on provincial Crown Land at approximately N46.36667 W67.05000 and is located within the Napadogan Brook watershed. A more detailed site plan of the Project Development Area (PDA) for the Project is shown in Figure 1.2.



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Introduction  
May 28, 2019





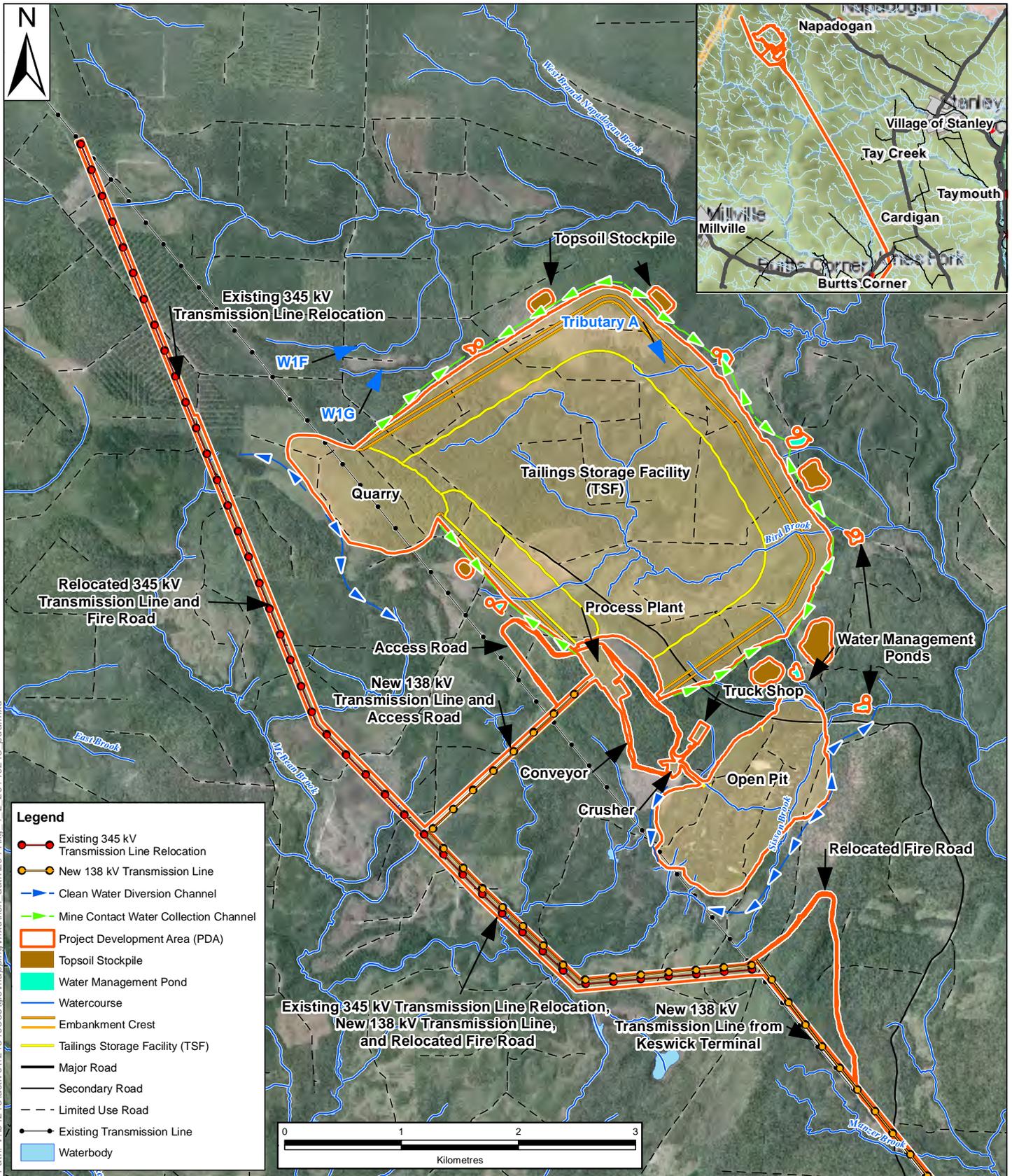
NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

<h2 style="text-align: center;">Sisson Project Location</h2> <p style="text-align: center;">Sisson Project: Napadogan, N.B.</p>		Scale: 1:500,000		Project No.: 121810356		Data Sources: SNB NRCAN, ESRI		Fig. No.: 1.1	
		Date: (dd/mm/yyyy) 22/03/2014	Dwn. By: JAB	Appd. By: DLM					
Client: Northcliff Resources Ltd.									

**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Introduction  
May 28, 2019





Path: V:\012\18\active\12-18-10356\gis\mapping\mxd\fish\_auth\2014\fig\_1\_2\_201402-18\_pda.mxd

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

<h2>Sisson Project Development Area</h2> <p>Sisson Project: Napadogan, N.B.</p>	Scale: 1:45,000		Project No.: 121810356		Data Sources: SNB NRCAN, ESRI		Fig. No.: 1.2	
	Date: (dd/mm/yyyy) 22/03/2014		Dwn. By: JAB		Appd. By: DLM			
Client: Northcliff Resources Ltd.								

**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Introduction  
May 28, 2019



# **SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Introduction  
May 28, 2019

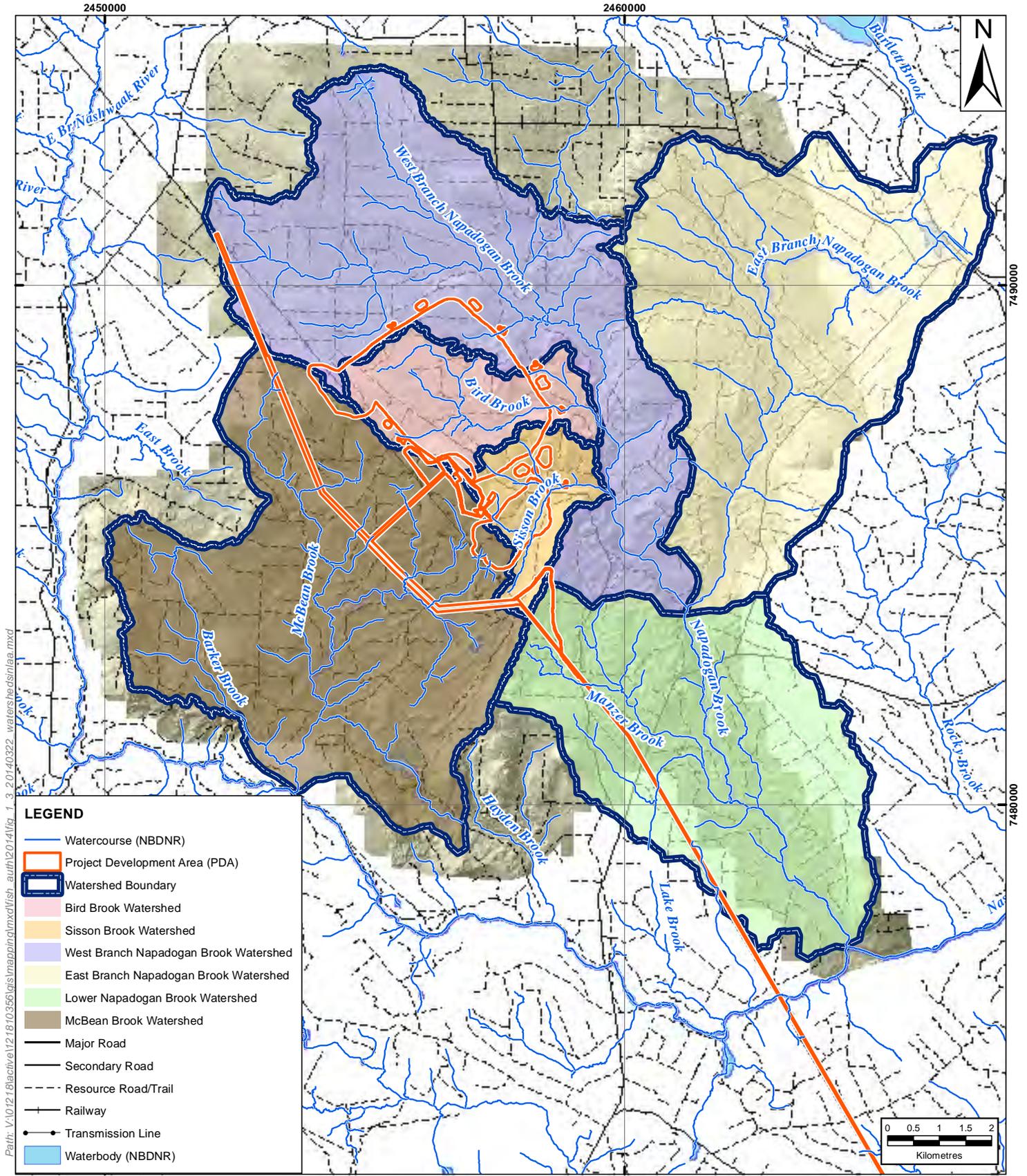
The watercourses that will be directly affected by the Project are Bird Brook, Sisson Brook, an unnamed tributary (“Tributary A”) to West Branch Napadogan Brook, and a small portion of McBean Brook, and some tributaries to these watercourses. Downstream of Bird Brook, West Branch Napadogan Brook and Napadogan Brook (hereinafter referred to as lower Napadogan Brook) will be indirectly affected by the Project due to downstream flow reductions that are associated with the withholding of water within the Project’s TSF. These watercourses flow into Napadogan Brook, and then into the Nashwaak River, and are part of the Saint John River system (Figure 1.3).



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Introduction  
May 28, 2019





Path: V:\10\12\18\active\121810356\gis\mapproj\mxd\fish\_auth\2014\fig\_1\_3\_20140322\_watersheds\laa.mxd

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.					
<b>Watersheds within the Local Assessment Area (LAA)</b>  Sisson Project: Napadogan, N.B.		Scale:	Project No.:	Data Sources:	Fig. No.:
		1:100,000	121810356	NBDNR Leading Edge Geomatics Ltd.	1.3
Client:	Northcliff Resources Ltd.	Date: (dd/mm/yyyy)	Dwn. By:	Appd. By:	
		22/03/2014	JAB	DLM	

**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Introduction  
May 28, 2019



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Introduction  
May 28, 2019

## 1.3 CONTACT INFORMATION

### **Applicant's Contact Information:**

Louise Steward, P.Eng.  
Vice President, Government and Regulatory Affairs  
The Sisson Partnership  
212 Queen Street, Suite 211  
Fredericton, NB E3C 1N8  
Tel: 1-506-455-2142, Fax: 1-506-455-0530  
Email: LouiseSteward@sissonpartnership.com

### **Authorized Representative's Contact Information:**

Not applicable.

## 1.4 DESCRIPTION OF PROPOSED UNDERTAKING

The sub-sections below provide a general description of the Sisson Project, its major components that may result in serious harm to fish in watercourses within the Project area, and the methods that will be used during Construction of the Project.

### 1.4.1 Project Summary

The Sisson Project is a proposed conventional, open pit tungsten and molybdenum mine located near the community of Napadogan, New Brunswick. The mine will operate for an estimated 27 years at an average mining rate of 30,000 metric tonnes per day (t/d) of tungsten- and molybdenum-containing ore. The processed ore will be sent to an ore processing plant to produce tungsten and molybdenum mineral products. The main activities associated with the Project include:

- Mining by conventional open pit methods, and storage of tailings and waste rock;
- Stockpiling of organics and overburden for future reclamation use;
- On-site processing of ore in an ore processing plant to produce mineral concentrates and tailings, and further processing of tungsten concentrate to a higher-value crystalline tungsten product (ammonium paratungstate) and solid precipitate waste products;
- Development and operation of a tailings storage facility (TSF), and associated storage of tailings;
- Diversion of clean surface water away from Project facilities (e.g., open pit, TSF);
- Collection and storage of all precipitation on the Project site and groundwater flows into the open pit (termed "mine contact water") for re-use in the ore processing plant, and discharge of surplus water, with treatment as needed to meet permitting conditions;
- Transportation of the mineral products to off-site buyers; and
- Decommissioning of facilities, and reclamation and closure of the site at the end of the Project life.



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Introduction  
May 28, 2019

## 1.4.2 Major Project Components and Activities

Major phases of Project development are discussed below:

- **Construction:** Construction will proceed for a period of up to 24 months, commencing as soon as the EIA is completed, and the applicable permits, approvals or other forms of authorization have been obtained. For the purpose of the Sisson Project Environmental Impact Assessment (EIA) Report (Stantec 2013a), it has been assumed that Construction will begin in the fourth quarter of 2014.
- **Operation:** Operation will commence immediately following Construction and will continue for an approximate period of 27 years. For the purpose of the Sisson Project EIA Report (Stantec 2013a) and this Application for authorization, it has been assumed that Operation will begin in the second half of 2016.
- **Decommissioning, Reclamation and Closure:** Decommissioning of Project facilities and Reclamation of the Project site will occur following the completion of Operation. Closure will commence during the Decommissioning and initial Reclamation period and will continue until the pit lake fills with water in about 12 years. Post-closure (i.e., after the pit lake is filled) will follow.

An overview of the major Project phases and activities is provided in Table 1.1, and Figure 1.4 shows the Project components at the end of the mine life. The major Project Components anticipated to affect watercourses, namely the open pit mine and tailings storage facility, are described in more detail below. Additional information on other Project components that are not anticipated to directly affect watercourses are described in more detail in Section 3.4 of the Sisson Project EIA Report dated July 2013 (Stantec 2013a).

**Table 1.1 Description of Project Phases, Activities, and Physical Works**

Project Phase	Activity Category	Project Activities and Physical Works
Construction	Site Preparation of Open Pit, Tailings Storage Facility (TSF), and Buildings and Ancillary Facilities	The Project-related activities associated with preparing the open pit, TSF, and buildings site for physical construction, including: <ul style="list-style-type: none"> <li>• surveying;</li> <li>• geotechnical investigations;</li> <li>• clearing;</li> <li>• grubbing;</li> <li>• removal and stockpiling of topsoil and overburden; and</li> <li>• grading/leveling.</li> </ul>
	Physical Construction and Installation of Project Facilities	The physical construction of buildings and structures associated with the Project, and installation of equipment associated with its operation, including: <ul style="list-style-type: none"> <li>• construction of surface facilities (e.g., processing plants, electrical substation, primary crusher, ore conveyor, maintenance shop, explosives storage);</li> <li>• quarrying, aggregate crushing, and concrete batch plant;</li> <li>• development of starter pit and initial ore stockpile;</li> <li>• establishment of overburden and soil stockpiles;</li> <li>• construction of engineered drainage and diversion channels;</li> <li>• loss of Bird and Sisson brooks;</li> <li>• TSF preparation;</li> </ul>



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Introduction  
May 28, 2019

**Table 1.1 Description of Project Phases, Activities, and Physical Works**

Project Phase	Activity Category	Project Activities and Physical Works
		<ul style="list-style-type: none"> <li>• construction of TSF starter embankments, water management ponds, and ponding of start-up water;</li> <li>• establishment of water management system; and</li> <li>• equipment installation.</li> </ul>
	Physical Construction of Transmission Lines and Associated Infrastructure	<p>The physical construction of electrical transmission-related facilities associated with the Project, including:</p> <ul style="list-style-type: none"> <li>• site preparation (e.g., clearing, development of access);</li> <li>• relocation of existing 345 kV transmission line (e.g., distribution of materials, foundation construction, erection of towers, stringing, reclamation);</li> <li>• construction of new 138 kV transmission line (e.g., distribution of materials, foundation construction, erection of towers, stringing, reclamation); and</li> <li>• construction of electrical substation.</li> </ul>
	Physical Construction of Realigned Fire Road, New Site Access Road, and Internal Site Roads	<p><b>The physical construction of roads associated with the Project, including:</b></p> <ul style="list-style-type: none"> <li>• site preparation (e.g., clearing, sedimentation and erosion control, grubbing, cutting and filling, grading);</li> <li>• relocation of Fire Road (e.g., road bed preparation, ditching, finishing);</li> <li>• construction of site access road and internal site roads (e.g., road bed preparation, ditching, finishing); and</li> <li>• construction of watercourse crossings.</li> </ul>
	Implementation of Fish Habitat Compensation/Offsetting Initiatives	<p>The physical construction and/or demolition activities associated with implementing various initiatives that form the basis of the Fish Habitat Compensation/Offsetting Plan for the Project, include:</p> <ul style="list-style-type: none"> <li>• Removal of Upper Nashwaak Lake Culvert (e.g., physical removal of the culvert and placement of a woods-road bridge).</li> <li>• Removal of remnant Lower Nashwaak Lake dam structures (e.g., removal of in-water concrete columns and sill and channel reconstruction)</li> </ul>
Operation	Mining	<p>The activities associated with open pit mining, including:</p> <ul style="list-style-type: none"> <li>• open pit mine operation (operation of explosives magazine, blasting, extraction of ore and waste rock, on-site transportation of ore to crusher, and, until last mining phase, on-site transportation of waste rock to TSF);</li> <li>• ore crushing and conveyance to processing plant; and</li> <li>• rock quarrying, trucking and crushing as needed.</li> </ul>
	Ore Processing	<p>The activities associated with the processing of ore in and production of products, including:</p> <ul style="list-style-type: none"> <li>• milling/grinding;</li> <li>• flotation;</li> <li>• concentrate dewatering;</li> <li>• tungsten refining; and</li> <li>• packaging.</li> </ul>



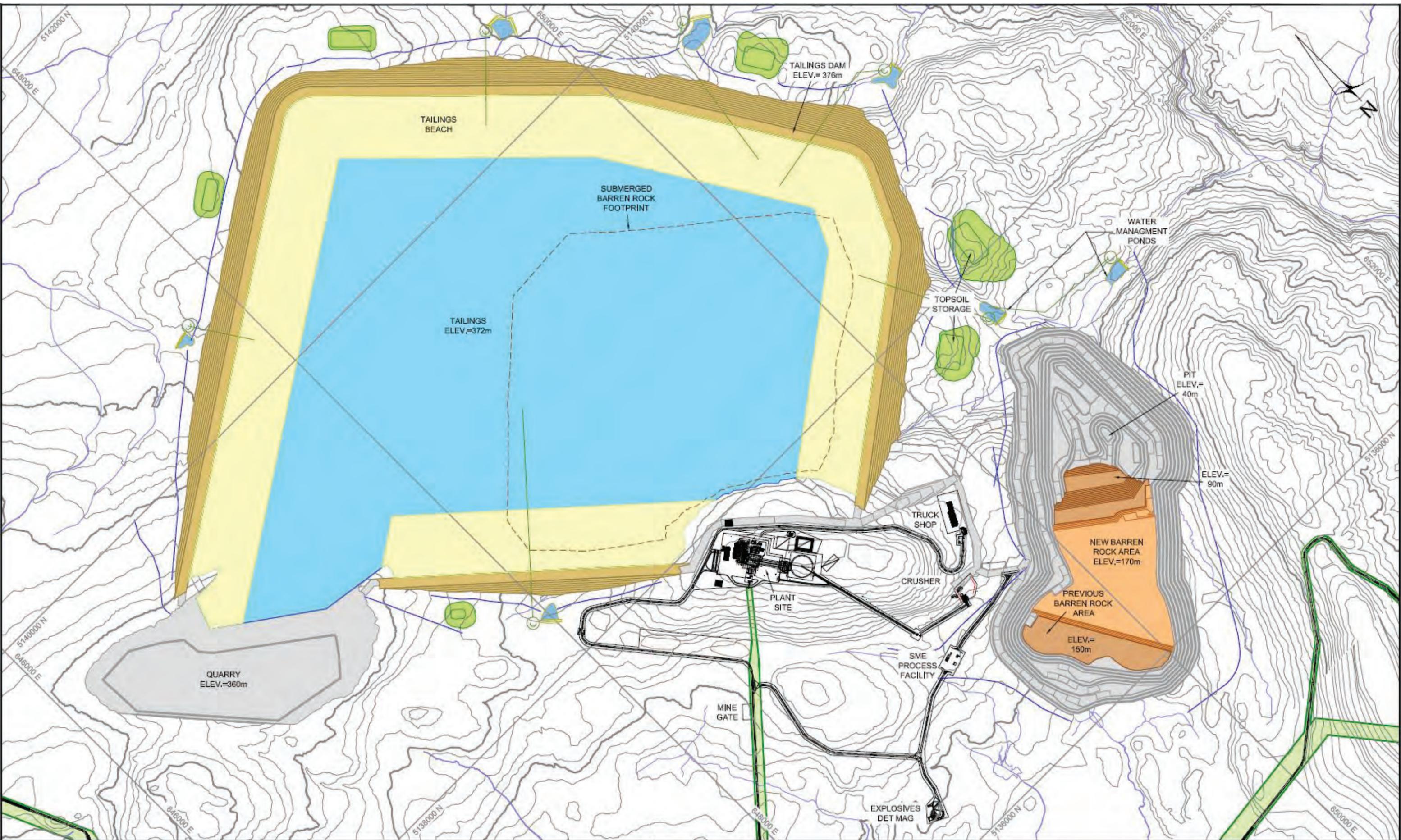
**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Introduction  
May 28, 2019

**Table 1.1 Description of Project Phases, Activities, and Physical Works**

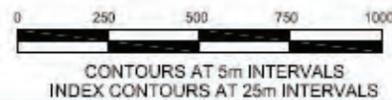
Project Phase	Activity Category	Project Activities and Physical Works
	Mine Waste and Water Management	The activities associated with the supply of water for the process operation, and the management and storage of surplus water and byproducts from the process operation including: <ul style="list-style-type: none"> <li>• dewatering of open pit;</li> <li>• tailings storage in TSF;</li> <li>• construction of TSF embankments over life of mine;</li> <li>• waste rock storage in TSF;</li> <li>• collection and management of on-site mine contact water; and</li> <li>• surplus water treatment, release, and monitoring.</li> </ul>
	Linear Facilities Presence, Operation, and Maintenance	The physical presence, and operation and maintenance, of Project-related linear facilities, including the 138 kV transmission line, substation, and site roads.
Decommissioning, Reclamation and Closure	Decommissioning	The activities associated with the decommissioning of Project components and facilities at the end of mine life, including: <ul style="list-style-type: none"> <li>• decommissioning and removal of equipment; and</li> <li>• removal of buildings and structures.</li> </ul>
	Reclamation	The activities associated with reclamation of the Project site at the end of mine life.
	Closure	The activities associated with closure of the mine, including the filling of the open pit with water from the TSF and precipitation.
	Post-Closure	The existence of the former TSF and open pit, now filled with water, in perpetuity, and the ongoing treatment and release of surplus water, as applicable.
<p><b>Note:</b> Construction and relocation of linear facilities (e.g., site access roads) are not included in the Authorization because those activities are not considered to be serious harm.</p>		





**NORTHCLIFF SISSON - FEASIBILITY STUDY  
END OF PERIOD YR\_27 LOM**

DATE:	2013/02/08	APPROVED BY:	RMG
SCALE:	1:16 000	FILE:	YR_27 (130208)
DRAWN BY:	DH	PROJECT:	NCS FS 2012



LEGEND			
	PIT		NEW MID GRADE STOCKPILE
	QUARRY		PREVIOUS MID GRADE STOCKPILE
	NEW BARREN ROCK AREA		NEW INFRASTRUCTURE
	PREVIOUS BARREN ROCK AREA		PREVIOUS INFRASTRUCTURE
	TAILINGS DAM		TAILINGS
	TAILINGS BEACH		TOPSOIL STORAGE
	UTILITY RIGHT OF WAY		WATER COURSE
			WATER DIVERSION
			CONTOUR LINES





# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Introduction  
May 28, 2019

## 1.4.2.1 Open Pit Mine

An open pit mine is an excavation in the ground for the purpose of extracting ore, and which is open to the surface for the duration of the mine's life. To expose and mine the ore it is necessary to remove surface soils (i.e., overburden), and excavate and relocate waste rock (i.e., material that does not contain economically recoverable amounts of the target minerals).

The open pit will cover an area of about 145 ha at its ultimate extent, and will be 300 to 370 m deep (compared to current elevations) upon completion of mining at approximately Year 27.

As currently designed, the open pit will intersect several headwater streams that are tributaries to Sisson Brook, as well as Sisson Brook itself. Some of the smaller headwater streams that are tributaries to McBean Brook to the south of the pit will also be directly affected once the open pit is fully developed. Engineered drainage channels around the open pit will divert some of the Sisson Brook catchment into McBean Brook. Figures of the phased design of the open pit can be found in Section 3.2 of the Sisson Project EIA Report (Stantec 2013a).

## 1.4.2.2 Tailing Storage Facility (TSF)

The base of the TSF embankments will be native overburden, compacted as required to minimize seepage. The engineered embankments, constructed of non-potentially acid generating (NPAG) quarried rock or local borrow materials, will retain the tailings. Potentially acid generating (PAG) tailings and all waste rock will be stored sub-aqueously in the TSF, encapsulated in the NPAG bulk tailings, to effectively mitigate potential oxidation, acid generation, and metal leaching in the TSF. The TSF embankments and operational procedures are designed to minimize seepage, and otherwise direct seepage to water management ponds (WMPs) located at low points around the TSF embankments. The TSF embankments will be designed and built to meet or exceed standards established in the Canadian Dam Association's "Dam Safety Guidelines" (Canadian Dam Association 2007) as discussed in Section 3.4 of the Sisson Project EIA Report (Stantec 2013a). Though unlikely to occur, a failure of the TSF embankment and resultant release of tailings or process water could adversely affect downstream watercourses and habitats that have substantial ecological and societal value; thus the hazard classification (as per the Dam Safety Guidelines) of the Sisson TSF was therefore set to provide a design that will protect these values. Technical drawings for the TSF embankment can be found in Figure 1.5. Additional Figures can be found in Section 3.2 of the Sisson Project EIA Report (Stantec 2013a).

The construction of the TSF embankments and infilling of these brooks from the storage of tailings within the TSF will result in the direct loss of fish habitat in parts of Bird Brook and part of a small unnamed tributary to West Branch Napadogan Brook (referred to as "Tributary A"), and will also reduce the catchment area of Bird Brook and Tributary A to West Branch Napadogan Brook.



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Introduction  
May 28, 2019

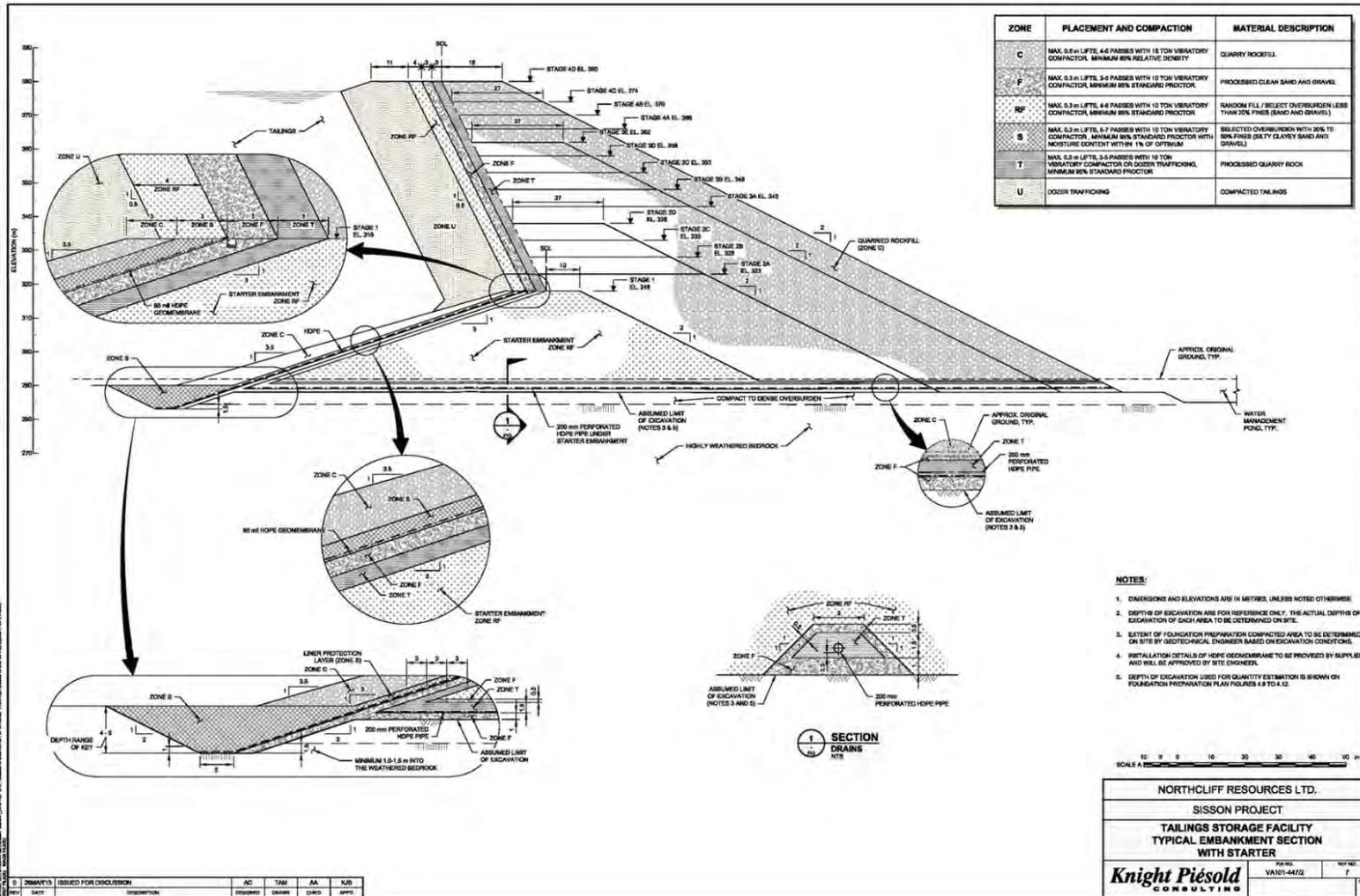


Figure 1.5 Typical Cross-Section of Tailings Storage Facility Embankments



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Introduction  
May 28, 2019

## 1.4.3 Construction Methods

The Construction phase will begin following approval of the EIA and the receipt of all required approvals, permits and authorizations for construction of the Project, as well as following the Proponent's decision to proceed to construction. Construction is expected to take place over a period of about 24 months and will be completed with the initial start-up of the ore processing plant—marking the beginning of the Operation phase.

The following is a brief description of Construction activities that are typical for an open pit mine and associated infrastructure that will affect fish and fish habitat. All Construction activities will be managed by the Environmental Protection Plan (EPP) for Construction as described in Chapter 2 of the Sisson Project EIA Report (Stantec 2013a).

During the first year of Construction, the site will be prepared for development of the open pit, TSF, buildings and ancillary facilities. Site preparation will include clearing, grading, and leveling of the site as required in preparation for foundations and equipment.

Erosion and sedimentation control techniques will be employed throughout the site preparation activities as required to minimize erosion of exposed areas and sedimentation in site surface water. Standard mitigation measures such as the use of silt fences, sediment traps and sedimentation ponds will be used to manage the potential release of sediment to streams. These measures will be implemented through the Environmental Protection Plan (EPP). More detailed information on construction activities and methods is provided below.

### 1.4.3.1 Clearing

Clearing of the areas for the open pit, primary crusher and ore conveyor, ore processing plant, stockpiles, TSF, site access road, internal site roads, and ancillary facilities will be completed using forest harvesting machinery. Clearing near watercourses will be conducted manually.

The TSF embankment areas will be locally sub-excavated to remove unsuitable material (e.g., soft, loose, or excessively wet soils). This material will be stockpiled for future site reclamation use. The TSF embankment foundation areas will be dewatered and any natural streams will be diverted in engineered channels.

### 1.4.3.2 Grubbing

Grubbing includes the removal and disposal of stumps and roots remaining after clearing. Grubbing will be conducted using a root rake or similar equipment that is able to remove the roots and stumps of cleared vegetation and leaves the topsoil for salvage. The areas associated with the ore processing plant, the TSF embankments, and other surface facilities (e.g., roadways) will be grubbed, whereas the TSF area itself will not be prepared further beyond clearing and removal of merchantable timber.



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Introduction  
May 28, 2019

## 1.4.3.3 Removal and Stockpiling of Topsoil and Overburden

The overburden in the open pit area generally consists of a veneer of organic matting and topsoil over till. The overburden thicknesses generally range from 0.90 to 4.0 m in depth below ground surface. Topsoil will be an organic material, while overburden will typically be till (i.e., silty sand and gravel).

Topsoil and overburden that must be removed (e.g., from over the mineral deposit and under the TSF embankments) will be stockpiled in various areas surrounding the TSF and other facilities, for reuse during re-vegetation activities associated with progressive reclamation of the site and ultimate site reclamation at the end of mine life. The amount of materials to be collected, construction and operation considerations, space availability, and future intended uses will determine the exact location and size of these stockpiles. The material will be used at closure to provide a growth medium on the tailings beach, TSF embankments, and any other appropriate areas.

## 1.4.3.4 Grading and Leveling

Once clearing is completed, the Project site (including ore storage areas, ore processing plant and the TSF embankment foundations) will be prepared by grading and leveling of the areas using heavy equipment such as graders, dozers and scrapers.

The ore storage pads will be graded to create the desired grade for drainage capture. The foundation zone will be prepared, and drainage collection works will be installed.

## 1.4.3.5 Construction of Engineered Drainage and Diversion Channels for the Site

Engineered drainage and diversion channels will be constructed to divert non-contact surface water away from Project facilities wherever possible and generally divert it into another location within the same watershed (e.g., as in Figure 1.2). Water management during the Construction phase will consist of establishing collection ponds, coffer dams, pumping systems, run-off collection ditches, and diversion channels. Some of the water management works will become long-term features of the Project site, and others will be temporary and removed when no longer needed for Construction purposes.

## 1.4.3.6 Overview of Tailings storage Facility Construction

Construction of the TSF will begin with the construction of small starter dams to collect the water required for the start of Operation. These dams will become encapsulated within the TSF embankments, and the embankments as well as the area inundated by water (and then tailings when Operation begins) will grow over the life of the Project.

Construction of the TSF cannot begin before creating access to and clearing the dam construction sites. Cofferdams will then be installed just upstream of the starter dam locations, and stream flows from above the cofferdams will be pumped around the construction site for discharge downstream. The cofferdams will be sized so that sediment generated upstream will settle out before the water is pumped around the construction sites. Construction of the starter dams, the downstream water management ponds, and then the initial TSF starter embankments, will follow. Within the TSF footprint, timber that is merchantable will



## **SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Description of Fish and Fish habitat (Aquatic Environment)  
May 28, 2019

be harvested and removed; timber that is not merchantable will be felled and gradually covered with water and then tailings. Other than for the construction of starter dams and embankments, no grubbing or other earth moving within the TSF footprint is required.

### **1.4.4 Project Schedule**

The Project schedule is subject to regulatory timelines that are not controlled by the Proponent; therefore, the schedule is subject to change as approval and permitting processes unfold.

Construction of the Project is estimated to take approximately 24 months following the receipt of required permits, approvals, and other forms of authorization. Operation of the Project will be initiated upon completion of construction activities, and will continue for an estimated 27 years, after which Decommissioning, Reclamation and Closure will be initiated.

The Environmental Impact Assessment Report was completed and submitted to both the federal and provincial governments in July 2013. The project received a provincial EIA approval in December 2015 and a positive federal EA decision in June 2017. Sisson continues to work through the various approvals, permits and EIA conditions required to move to project into the construction phase. The initiation of construction also depends on financing of the construction costs and a decision by the Proponent to proceed with the Project.

## **2.0 DESCRIPTION OF FISH AND FISH HABITAT (AQUATIC ENVIRONMENT)**

The information below presents a general description of the habitat within the Project area. A more detailed description of the fish habitat contained within the Project area can be found in Section 8.5 of the Sisson Project EIA Report (Stantec 2013a), and the report entitled "Sisson Project: Baseline Aquatic Environment Technical Report" (Stantec 2012a).

### **2.1 FISH AND FISH HABITAT CHARACTERIZATION METHODS**

The majority of the aquatic environment field program to characterize existing conditions for the Sisson Project EIA was undertaken in 2011 (Stantec 2012a), and focused primarily on Bird Brook, Sisson Brook, McBean Brook, and Tributary A to West Branch Napadogan Brook. The baseline aquatic technical report included watercourse and watershed analysis, fish habitat overview and rapid fish habitat bio-assessment, detailed fish habitat and qualitative fish surveys, quantitative fish population assessment, as well as other studies pertinent to the Sisson Project EIA Report (Stantec 2013a).

This Application includes a summary of the following pertinent information, sourced from Stantec (2012a) and Stantec (2013a):

- Watershed area and location;
- General aquatic habitat characteristics;



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Description of Fish and Fish habitat (Aquatic Environment)  
May 28, 2019

- Water quality;
- Benthic invertebrate community; and
- Fish community.

The methods and results for the above components are described in detail in Stantec (2012a).

### 2.1.1 Watershed Area and Location

Watershed areas and locations were determined from a light detection and ranging (LiDAR) dataset collected by Leading Edge Geomatics Ltd. The LiDAR dataset for the PDA and study area was imported into ESRI ArcGIS, and a site-specific topographic model was developed. Minimum catchment area polygons for the study area were created and aggregated to create watersheds and sub-watersheds for specific streams from the stream network (Figure 1.3; Stantec 2012a).

### 2.1.2 General Aquatic Habitat Characteristics

General aquatic habitat characteristics were determined using a “Rapid Fish Habitat Bio-assessment Survey” approach. These rapid fish habitat bio-assessments were conducted by walking all of the GIS-delineated reaches within the PDA between June 13 and June 29, 2011. The rapid fish habitat bio-assessment method used by the Study Team was based on the methodologies outlined in the United States Environmental Protection Agency (USEPA) publication “Rapid Bioassessment Protocols for use in Streams and Wadeable Rivers” (Barbour et al. 1999). The Study Team developed a standardized form based on the USEPA methodology (Barbour et al. 1999) to capture the characteristics important to fish habitat. These characteristics, which are consistent with the characteristics included in the standard DFO/NBDNR habitat classification method and data collection sheet (Hooper et al. 1995), and include:

- Substrate;
- Amount of woody debris;
- Embeddedness;
- Stream characteristics (e.g., bankfull depth and width); and
- Any indicators of fluvial change (e.g., braiding and sand on the stream channel banks).

These characteristics can be used to determine the quantity of fish habitat present (as habitat units, where 1 habitat unit equals 100 m<sup>2</sup>). The form also captured information on land use in the riparian zone (e.g., evidence of forestry, status of buffer vegetation).

### 2.1.3 Water Quality

Water Quality was determined via *in-situ* measurement and data logger methods. The field team collected *in situ* water quality data including dissolved oxygen (DO), pH, specific conductivity and water temperature, and took photographs of each reach during the rapid fish habitat bio-assessment surveys and qualitative and quantitative electrofishing. Temperature, DO, and specific conductivity were measured using a YSI 85 water quality meter. The pH of the water was measured using a Hanna pH tester. Both instruments were calibrated daily, or more frequently, following manufacturer’s instructions.



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Description of Fish and Fish habitat (Aquatic Environment)  
May 28, 2019

Water temperature loggers pertinent to this Authorization were also deployed in Sisson Brook (S2A3, 2011-2012), Bird Brook (B3A9, 2011-2012) and West Branch Napadogan Brook (W4A31, 2011-2012) during July and August 2011. *In situ* water quality data were used to characterize the tributaries affected in McBean Brook and Tributary A to West Branch Napadogan Brook, since temperature logger data was not available for these locations.

### 2.1.4 Benthic Invertebrate Community

Benthic invertebrate community replicate samples (five) were taken at each station where quantitative electrofishing was conducted (as discussed in the next sub-section). Each sample was comprised of a composite of three replicate sub-samples, and sent to a taxonomist for identification. Benthic invertebrate samples were collected using a standard D-frame kick net with 0.5 mm mesh. A standard time of one minute of sampling effort was applied for each sub-sample. The collected sub-samples were combined in a sieve box to remove fines and reduce the volume in the field (Stantec 2012a). The samples were preserved using 95% un-denatured ethanol. Individual indices were calculated, and the following endpoints were used to characterize the baseline condition of the benthic invertebrate community:

- Taxonomic richness (richness);
- Total invertebrate abundance (abundance, number of individuals per m<sup>2</sup>);
- Simpson's diversity index (diversity);
- Simpson's evenness index (evenness); and
- Bray-Curtis index of dissimilarity (Bray-Curtis Index).

High richness, abundance, diversity and evenness are all considered to be indicators of good environmental quality. A low Bray-Curtis index when two stations are compared would indicate that the benthic communities are similar (i.e., 0.1), whereas a high Bray-Curtis index would indicate differences between the benthic communities (i.e., 0.9).

### 2.1.5 Fish Community

Fish community was determined using qualitative and quantitative electrofishing. Qualitative electrofishing was undertaken at 30 stations using a Smith-Root Model LR-24 backpack electrofishing unit and accepted survey protocols (Hooper et al. 1995) to determine fish species present at each station. Catch per unit effort (CPUE) was calculated based on the time spent fishing (i.e., seconds of electrical current applied during the electrofishing effort). At two stations (M1M2, M1N1), fish were collected using minnow traps because the habitat was not conducive to electrofishing (i.e., soft substrate, deep water depths). Collected fish were identified to species, and fork lengths were recorded. Photographs were also taken of representatives of each species collected.

Quantitative electrofishing was undertaken using barrier nets to isolate an area of habitat at each station. Within this isolated area of habitat, electrofishing was undertaken as before, except that multiple passes through the habitat were completed and subsequently depleted (e.g., Zippin 1956). The number and characteristics of fish collected during each pass were recorded, so that quantitative fish population



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Description of Fish and Fish habitat (Aquatic Environment)  
May 28, 2019

estimates (i.e., number of fish per unit of habitat) and their associated confidence interval (CI) could be calculated (Hayne 1949). The total seconds of electrofishing effort were also recorded.

## 2.2 FISH AND FISH HABITAT RESULTS

### 2.2.1 Bird Brook

#### 2.2.1.1 Watershed Area and Location

Bird Brook (N46.38773 W67.03748) occupies a catchment area of 8.2 km<sup>2</sup> within the Napadogan Brook watershed (Figure 1.3). The watercourses within the Bird Brook catchment area include 55% first order streams (with a linear length of 7,048 m), 18% second order stream (2,254 m), and 27% third order streams (3,504 m).

#### 2.2.1.2 General Aquatic Habitat Characteristics

There are six first order tributaries to Bird Brook within the PDA. First order stream habitat was generally suitable as rearing habitat for brook trout outside of the headwater sections. Headwater habitats varied from wetland beaver ponds to steep rocky valleys. There are two second order sections of tributaries to Bird Brook within the PDA. Second order watercourses were a mix of habitat for feeding and rearing, and poor quality impounded habitat. The riparian vegetation is intact and provides overhead cover and stable banks.

The main stem of Bird Brook is a third order watercourse. Third order habitat within the PDA contains fish habitat suitable for spawning, feeding and rearing of cold and other fish species.

The substrate of Bird Brook is approximately 55% fines and sand, with the remaining 45% divided among the larger class size categories. The distribution and concentration of fines is determined by the reduced flow velocity caused by beaver dams. In general, the substrate of Bird Brook provides suitable habitat for small fish and eels.

#### 2.2.1.3 Water Quality

*In-situ* DO readings typically ranged from 7.1 to 9.5 mg/L with the majority of stations being slightly below the Canadian Council of Ministers of the Environment (CCME) Freshwater Aquatic Life (FAL) guideline of 9.5 mg/L for DO levels in early life stages of fish (CCME 1999). DO concentrations in Bird Brook were acceptable for other life stages of fish in every reach. The pH of Bird Brook ranged from 5.4 to 7.0, which is slightly below the CCME (1999) recommended range. Average daily water temperature in Bird Brook collected from temperature loggers was 15.1°C, with the minimum average daily water temperature being 13.1°C and the maximum daily water temperature being 18.1°C. This relatively cold water during summer provides suitable conditions for cold water fish species.



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Description of Fish and Fish habitat (Aquatic Environment)  
May 28, 2019

## 2.2.1.4 Benthic Invertebrate Community

In Bird Brook, the mean richness was 42, mean abundance was 2,491 individuals per m<sup>2</sup>, mean diversity was 0.86, mean evenness was 0.21, and the mean Bray-Curtis index was 0.54 (Stantec 2012a). The benthic invertebrate community in Bird Brook exhibits variability between sampling stations. Overall, it is typical of a healthy stream environment and provides a suitable food base for fish.

## 2.2.1.5 Fish Community

In Bird Brook, the fish assemblage consisted of brook trout, slimy sculpin (*Cottus cognatus*), American eel, and one juvenile Atlantic salmon observed just above the confluence of West Branch Napadogan Brook. The abundance of all fish species captured by qualitative electrofishing in Bird Brook ranged from 2.4 to 7.1 fish per 100 seconds, 1.5 to 7.1 brook trout per 100 seconds, and 0.1 Atlantic salmon per 100 seconds (Stantec 2012a). The density of all fish species captured by quantitative electrofishing in Bird Brook (2 stations) ranged from 56 (CI 54-57) to 99 (CI 91-106) fish per 100 m<sup>2</sup>, and 33 (CI 32-35) to 86 (CI 82-90) brook trout per 100 m<sup>2</sup>.

## 2.2.2 Sisson Brook

### 2.2.2.1 Watershed Area and Location

Sisson Brook (N46.37415 W67.03067) occupies a catchment area of 5.2 km<sup>2</sup> within the Napadogan Brook watershed (Figure 1.3). The watercourses within the Sisson Brook catchment area include 69% first order streams (with a linear length of 5,562 m), 18% second order stream (1,491 m), and 13% third order streams (1,016 m).

### 2.2.2.2 General Aquatic Habitat Characteristics

There are four first order tributaries to Sisson Brook located within the PDA. A large beaver pond encompasses the majority of the tributary that lies in the centre of the open pit location, with a partial fish passage barrier at its downstream extent. In general, however, fish habitat within the first order tributaries of Sisson Brook contain suitable rearing habitat for brook trout. There are two second order tributaries to Sisson Brook located within the PDA. Based on water quality and habitat measurements, second order tributaries of Sisson Brook contain brook trout habitat that is generally suitable for spawning, rearing and feeding. There is a single third order section of Sisson Brook. This approximately 900 m section of Sisson Brook occurs entirely outside of the PDA, is approximately 4 m wide with cobble and gravel dominated substrate and provides habitat that is generally suitable rearing and feeding habitat for brook trout. Fish passage upstream is impeded by a 5 m waterfall within 450 m of the confluence with West Branch Napadogan Brook.

The substrate of Sisson Brook is approximately 50% fines and sand, with the remaining 50% divided among the larger class size categories. The distribution and concentration of fines is largely the result of reduced flow velocity caused by beaver dams.



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Description of Fish and Fish habitat (Aquatic Environment)  
May 28, 2019

## 2.2.2.3 Water Quality

*In situ* DO concentrations typically ranged from 9.3 to 10.4 mg/L with the majority of stations being near or above the CCME FAL guideline of 9.5 mg/L for DO levels in early life stages of fish. DO was acceptable for other life stages of fish in every reach. The pH ranged from 5.6 to 6.7, which is below the CCME (1999) recommended range of 6.5 to 9.0. Average daily water temperature collected from temperature loggers in Sisson Brook was 14.9°C, with the minimum average daily water temperature being 12.5°C and the maximum daily water temperature being 17.8°C. This relatively cold water during summer provides suitable conditions for cold water fish species.

## 2.2.2.4 Benthic Invertebrate Community

In Sisson Brook, the mean richness was 44, mean abundance was 3,297 individuals per m<sup>2</sup>, mean diversity was 0.90, mean evenness was 0.24, and the mean Bray-Curtis index was 0.65 (Stantec 2012a). The benthic invertebrate community in Sisson Brook exhibits variability between sampling stations. Overall, it is typical of a healthy stream environment and provides a suitable food base for fish.

## 2.2.2.5 Fish Community

Sisson Brook had the lowest diversity of fish species, with only brook trout and American eel. In Sisson Brook, the abundance of all fish species captured by qualitative electrofishing ranged from 0.9 to 2.4 fish per 100 seconds, and 0.9 to 2.4 brook trout per 100 seconds (Stantec 2012a). The density of all fish species captured by quantitative electrofishing (2 sites) in Sisson Brook ranged from 7 (CI 6-8) to 26 (CI 21-30) fish per 100m<sup>2</sup> and 6.3 (CI 6.2-6.4) to 26 (CI 21-30) brook trout per 100m<sup>2</sup>.

## 2.2.3 McBean Brook

### 2.2.3.1 Watershed Area and Location

The three first order tributaries of McBean Brook (N46.36836 W67.06180) located within the PDA occupy a watershed area of 0.5 km<sup>2</sup> within the McBean Brook watershed which is 43 km<sup>2</sup> (Figure 1.3). There is a total length of 415 m of first order tributaries of McBean Brook within the PDA (excluding the linear facilities corridor, where serious harm is not anticipated).

### 2.2.3.2 General Aquatic Habitat Characteristics

Each of the three tributaries flows into a small beaver impoundment, and each is surrounded by wetland meadow. The channel substrate of these tributaries is primarily organic materials, fines and sand, consistent with the low gradient and slow flow conditions. Channel banks are stable and vegetated with grasses and shrubs and channel form is steady glide or pool except where watercourses are undefined or braided within a wetland.

The substrate of McBean Brook within the open pit portion of the PDA is approximately 92% fines and sand, with the remaining 8% divided among the larger class size categories. The distribution and concentration of fines is determined by the reduced flow velocity caused by beaver dams.



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Description of Fish and Fish habitat (Aquatic Environment)  
May 28, 2019

### 2.2.3.3 Water Quality

*In situ* DO levels of the tributaries to McBean Brook within the open pit area ranged from 8.0 to 9.2 mg/L with all stations having dissolved oxygen levels below the CCME FAL guideline of 9.5 mg/L for early life stages of fish. DO was acceptable for other life stages of fish in every reach. The pH ranged from 5.9 to 6.3, below the CCME (1999) recommended range of 6.5 to 9.0. *In situ* water temperatures at the time of sampling (dry summer conditions) ranged from 11.7 to 12.6°C. The water quality in the first order tributaries of the PDA portion of McBean Brook, were suitable for cold water and other fish species.

### 2.2.3.4 Benthic Invertebrate Community

No benthic studies were conducted on the three tributaries directly affected on McBean Brook because it will not be used as a site for future environmental effects monitoring.

### 2.2.3.5 Fish Community

In McBean Brook, creek chub (*Semotilus atromaculatus*) and pearl dace (*Semotilus margarita*) were observed in the PDA stations affected by the open pit. In the areas of the open pit, baited minnow traps were used where conditions were not suitable for backpack electrofishing due to water depth and/or soft substrate conditions in wetland or beaver impounded areas. The abundance of all fish species ranged from 0.4 fish per minnow trap hour. No quantitative studies were conducted on the three tributaries directly affected on McBean Brook because it will not be used as a future environmental effects monitoring site.

## 2.2.4 Tributary A to West Branch Napadogan Brook

### 2.2.4.1 Watershed Area and Location

Tributary A to West Branch Napadogan Brook (N.46.39972 W67.05570) occupies a watershed area of 0.9 km<sup>2</sup> within the West Branch Napadogan Brook watershed (Figure 1.3). There is a total length of 971 m of first order Tributary A of West Branch Napadogan Brook within the PDA where serious harm is anticipated to occur.

### 2.2.4.2 General Aquatic Habitat Characteristics

The tributary is mostly riffle and run, with several sections of dead water and evidence of beaver activity throughout. The upper 130 m of mapped watercourse for this tributary was steep grade with no defined channel. The channel substrate of this tributary is primarily boulder and rock. Channel banks are stable and vegetated by a mix of grasses and trees.

The substrate of the Tributary A to West Branch Napadogan Brook within the PDA is approximately 75% boulder and rock, with the remaining 25% divided among the smaller size categories.



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Description of Fish and Fish habitat (Aquatic Environment)  
May 28, 2019

## 2.2.4.3 Water Quality

The DO levels of the Tributary A to West Branch Napadogan Brook within the PDA ranged from 8.5 to 10.3 mg/L with the majority of stations having DO levels above the CCME FAL guideline of 9.5 mg/L for early life stages of fish. The pH ranged from 5.6 to 6.5, which is at or slightly below the CCME (1999) recommended range of 6.5 to 9.0. In situ water temperatures at the time of sampling (dry summer conditions) ranged from 9.8 to 12.0°C. Overall, habitat in the lower reaches was suitable for spawning and rearing of brook trout and other fish species.

## 2.2.4.4 Benthic Invertebrate Community

No benthic studies were conducted on Tributary A to West Branch Napadogan Brook because it will not be used as a future environmental effects monitoring site.

## 2.2.4.5 Fish Community

In Tributary A to West Branch Napadogan Brook brook trout and slimy sculpin were observed. In Tributary A to West Branch Napadogan Brook, the abundance of all fish species captured by qualitative electrofishing was 3.3 fish per 100 seconds, and 2.0 brook trout per 100 seconds (Stantec 2012a). No quantitative studies were conducted on Tributary A to West Branch Napadogan Brook because it will not be used as a future environmental effects monitoring site.

## 2.2.5 West Branch Napadogan Brook

### 2.2.5.1 Watershed Area and Location

The West Branch Napadogan Brook (N46.36901 W67.02250) occupies a catchment area of 38.9 km<sup>2</sup> within the Napadogan Brook watershed (Figure 1.3). The watercourses within the West Branch Napadogan Brook catchment area include 55% first order streams (with a linear length of 29,825 m), 19% second order stream (9,943 m), 7% third order streams (3,904 m), and 19% fourth order streams (10,459 m).

### 2.2.5.2 General Aquatic Habitat Characteristics

The main stem of West Branch Napadogan Brook is mostly riffle-run habitat. The channel substrate is rock and boulder with minor components of small substrates. Channel banks are stable and vegetated with grasses and shrubs.

### 2.2.5.3 Water Quality

*In situ* DO levels on the main stem of West Branch Napadogan Brook downstream of Bird Brook ranged from 9.7 to 10.4 mg/L with all stations having DO levels above the CCME FAL guideline of 9.5 mg/L for early life stages of fish. The pH ranged from 6.4 to 7.0, two out of three stations were within the CCME (1999) recommended range of 6.5 to 9.0. Average daily water temperature in West Branch Napadogan Brook collected from temperature loggers was 15.9°C, with the minimum average daily water temperature



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Description of Potential Environmental Effects on Fish and Fish Habitat  
May 28, 2019

being 13.7°C and the maximum daily water temperature being 18.0°C. Overall, habitat in the lower reaches was suitable for spawning and rearing of brook trout and other cool water species.

## 2.2.5.4 Benthic Invertebrate Community

In West Branch Napadogan Brook downstream of Bird Brook, the mean richness was 44, mean abundance was 2,314 individuals per m<sup>2</sup>, mean diversity was 0.93, mean evenness was 0.33, and the mean Bray-Curtis index was 0.66 (Stantec 2012a). The benthic invertebrate community in West Branch Napadogan Brook downstream of Bird Brook exhibits variability between sampling stations. Overall, it is typical of a healthy stream environment and can provide a good food base for fish.

## 2.2.5.5 Fish Community

In the main stem of West Branch Napadogan Brook downstream of Bird Brook, Atlantic salmon, brook trout, slimy sculpin, American eel, white sucker (*Catostomus commersoni*), blacknose dace (*Rhinichthys atratulus*) and sea lamprey (*Petromyzon marinus*) were observed. The abundance of all fish species captured by qualitative electrofishing ranged from 2.4 to 4.4 fish per 100 seconds, 0.2 to 0.9 brook trout per 100 seconds, and 0.9 to 1.5 Atlantic salmon per 100 seconds (Stantec 2012a). The density of all fish species captured by quantitative electrofishing (2 sites) ranged from 18 to 30 (CI 27-33) fish per 100 m<sup>2</sup>, 1.1 (CI 0.9-1.3) to 3 brook trout per 100 m<sup>2</sup>, and 12 to 22 (CI 21-22) Atlantic salmon per 100 m<sup>2</sup>.

## 3.0 DESCRIPTION OF POTENTIAL ENVIRONMENTAL EFFECTS ON FISH AND FISH HABITAT

This section provides a description of the potential direct and indirect environmental effects on fish and fish habitat and the associated loss in fish production.

### 3.1 POTENTIAL ENVIRONMENTAL EFFECTS ON FISH HABITAT

The information below outlines the direct and indirect environmental effects of the Project that will result in serious harm to fish that are part of commercial, recreational or Aboriginal (CRA) fisheries. Direct loss arises from the permanent loss of fish habitat in a watercourse as it is replaced by a Project-related facility, feature, or component. Indirect loss is a temporary or permanent loss of a portion of a watercourse through means other than being covered by a Project-related facility, feature, or component; indirect loss can occur from a loss of catchment area, a reduction in flow, or other mechanism.

The direct and indirect loss of fish habitat was estimated using watershed and catchment area field and modeling data collected as part of extensive aquatic field surveys carried out in the PDA, as documented in the Baseline Aquatic Environment Technical Report (Stantec 2012a). As part of these programs, all watercourses within the PDA were surveyed in their entirety, and measurements of bankfull width, watercourse length, and other data were recorded for each reach of these watercourses. The total surface area of the watercourses within the PDA was calculated from these measurements and using a



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Description of Potential Environmental Effects on Fish and Fish Habitat  
May 28, 2019

geographic information system (GIS) supplemented by LiDAR data. The total direct loss of fish habitat was assumed to be represented by the total surface area of the watercourse lost.

To calculate the indirect loss of habitat area as a result of downstream flow reductions, a one-dimensional, steady-flow Hydrologic Engineering Centers River Analysis System (HEC-RAS) Model (USACE 2016) was developed to estimate the area of habitat that exists along the length of Napadogan Brook from above Bird Brook to its confluence with the Nashwaak River for a variety of baseline and projected future flow conditions. The model was created using 106 surveyed transects on West Branch Napadogan Brook and Napadogan Brook. The HEC-RAS model was run for seven flow scenarios for the baseline conditions case as well as for the future conditions case. Habitat areas were estimated for the flow simulations by multiplying the simulated wetted perimeter at each surveyed transect by half the upstream and downstream distance between transects. The changes to available fish habitat were calculated by summing the differences between the estimated areas for the baseline conditions case and the future conditions case (Conservation Ontario 2005). The methods presented are described in more detail in Stantec (2012b).

The construction of Project components will result in an 86% reduction in the catchment area of Bird Brook, a 90% reduction in the catchment area to Sisson Brook, a 26% reduction in the catchment area of Tributary A to the West Branch Napadogan Brook, and a 1% reduction in the catchment area of McBean Brook.

### 3.1.1 Direct Environmental Effects

There are fish residing in all of the watercourses where direct environmental effects are expected (i.e., Sisson Brook, Bird Brook, a portion of McBean Brook, and Tributary A to West Branch Napadogan Brook), with brook trout being the predominant species in all four watercourses. There is potential for Construction activities to result in the direct mortality of these fish, particularly during the Site Preparation of the TSF where the infilling of watercourses occurs. Direct mortality of fish may also occur in the watercourses within the open pit area as these are drained. The fish species and life stages that are part of a CRA fishery, and that are likely to be directly affected, are juvenile stages of OBoF Atlantic salmon, juvenile and adult stages of American eel, and all life stages of brook trout, creek chub, pearl dace and slimy sculpin.

Specifically, serious harm will result to fish that are part of a CRA fishery from the permanent destruction of fish habitat as a result of site preparation of the open pit and TSF during Construction. The construction of the TSF embankments and infilling of these brooks from the storage of tailings within the TSF will result in the direct loss of fish habitat area and therefore productive capacity, from parts of Bird Brook and Tributary A to West Branch Napadogan Brook. The areas occupied by the open pit will result in the direct loss, and therefore productive capacity in parts of Sisson Brook and three headwater tributaries to McBean Brook. Direct loss will also occur from the loss of various watercourse fragments of Sisson Brook between the TSF and the open pit. The confidence of the predictions for serious harm as a result of direct environmental effects to fish and/or fish habitat occurring is high. The magnitude of the environmental effect is high, as the fish habitat within the PDA will be permanently lost.



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Description of Potential Environmental Effects on Fish and Fish Habitat  
May 28, 2019

Construction activities will directly reduce brook trout, creek chub, pearl dace, and slimy sculpin nursery, rearing and spawning habitat areas and reduce juvenile and adult American eel rearing and habitat within the PDA.

Beyond that occurring during Construction of the Project, there is no further direct loss of fish habitat during the subsequent Operation or Decommissioning, Reclamation and Closure phases of the Project (Stantec 2013a).

The geographical extent of the direct environmental effects is expected to be 366 habitat units (1 habitat unit = 100 m<sup>2</sup>; Table 3.1).

**Table 3.1 Direct Fish Habitat Loss by Major Project Component**

Project Component	Affected Watercourse	Type of Loss	Area Lost, Requiring Compensation / Offsetting (100 m <sup>2</sup> )	Rationale	Offsetting and Authorization
Open Pit	Sisson Brook	Direct	112	Permanent direct habitat loss = serious harm.	<i>Fisheries Act</i> Section 35(2)
	McBean Brook	Direct	2	Permanent direct habitat loss = serious harm.	<i>Fisheries Act</i> Section 35(2)
Tailings Storage Facility (TSF)	Bird Brook	Direct	172	Permanent direct habitat loss from deposition of tailings = serious harm.	<i>MDMER</i> Schedule 2 amendment
	Bird Brook	Direct	72	Permanent direct habitat loss from construction of TSF embankment = serious harm.	<i>Fisheries Act</i> Section 35(2)
	Sisson Brook	Direct	2	Permanent direct habitat loss from construction of TSF embankment = serious harm.	<i>Fisheries Act</i> Section 35(2)
	Tributary A to West Branch Napadogan Brook	Direct	4	Permanent direct habitat loss from construction of TSF embankment = serious harm.	<i>Fisheries Act</i> Section 35(2)
	Tributary A to West Branch Napadogan Brook	Direct	2	Permanent direct habitat loss from deposition of tailings = serious harm.	<i>MDMER</i> Schedule 2 amendment
<b>Total Direct Habitat Loss, Required for Compensation/Offsetting (100 m<sup>2</sup>)</b>			<b>366</b>		



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Description of Potential Environmental Effects on Fish and Fish Habitat  
May 28, 2019

## 3.1.2 Indirect Environmental Effects

Indirect environmental effects resulting in serious harm to CRA fisheries are anticipated to result from the Project. Substantial reductions in catchment area within Sisson Brook, Bird Brook, and Tributary A of West Branch Napadogan Brook watersheds are expected to result in indirect environmental effects to the residual segments of these streams due to the substantial reduction of flows in them, arising from a loss of catchment area within these watersheds. The reduction in mean annual flow in lower Napadogan Brook at various phases of the Project life is also anticipated to pose indirect environmental effects. For the purposes of this assessment, reductions in mean annual flow that are less than 10% are assumed to not cause serious harm to CRA fisheries (DFO 2013c).

The indirect environmental effects on the residual stream segments of Bird Brook and Tributary A to West Branch Napadogan Brook will be permanent over the life of the Project. The indirect environmental effects in Sisson Brook and lower Napadogan Brook will change over the Project life, as described below. However, for the purposes of assessing serious harm to fish in Sisson Brook, the maximum predicted flow reductions have been assumed. Indirect environmental effects are expected to result in serious harm because of reductions in fish habitat as a result of reductions in overall stream flow and subsequent reductions in stream wetted perimeter (e.g., stream bottom to support aquatic processes).

The geographical extent of the combined indirect environmental effects is expected to be 178 habitat units (Table 3.2). It is anticipated that 123 habitat units will be lost to watercourses in the Project area as a result of reductions in catchment area, and 55 habitat units will be lost within lower Napadogan Brook as a result of reductions in mean annual flow.

There are fish residing in all of the watercourses where indirect environmental effects are expected, with brook trout being the predominant species in all four of the residual stream watercourses, and juvenile Atlantic salmon being the predominant species in the main stem of lower Napadogan Brook in areas where mean annual flow will be sufficiently reduced to cause serious harm.

The fish species and life stages that are likely to be indirectly affected are juvenile and adult stages of American eel, and all life stages of brook trout, white sucker, creek chub, pearl dace, slimy sculpin, Atlantic salmon and sea lamprey.

**Table 3.2 Indirect Fish Habitat Loss by Major Project Component**

Project Component	Affected Watercourse	Type of Loss	Area Lost, Requiring Compensation/Offsetting (100 m <sup>2</sup> )	Rationale	Offsetting and Authorization
Residual Stream Segments	Sisson Brook	Indirect	36	Serious harm due to substantial reduction in catchment area of residual stream segment.	<i>Fisheries Act</i> Section 35(2)
	Bird Brook	Indirect	77	Serious harm due to substantial reduction in catchment area of	<i>Fisheries Act</i> Section 35(2)



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Description of Potential Environmental Effects on Fish and Fish Habitat  
May 28, 2019

Project Component	Affected Watercourse	Type of Loss	Area Lost, Requiring Compensation/Offsetting (100 m <sup>2</sup> )	Rationale	Offsetting and Authorization
				residual stream segment.	
	Tributary A to West Branch Napadogan Brook	Indirect	10	Serious harm due to substantial reduction in catchment area of residual stream segment.	<i>Fisheries Act Section 35(2)</i>
Downstream Flow Reductions	Lower Napadogan Brook	Indirect	55	Serious harm due to indirect loss due to mean annual flow reductions downstream >10%.	<i>Fisheries Act Section 35(2)</i>
<b>Total Indirect Habitat Loss, Required for Compensation/Offsetting (100 m<sup>2</sup>)</b>			<b>178</b>		

**3.1.3 Bird Brook and Tributary a to West Branch Napadogan Brook**

During Operation and Closure, water management has the potential to result in serious harm to Bird Brook and Tributary A to West Branch Napadogan Brook residual watercourses by permanently altering flows, altering fish habitat area, water quality, productivity, the benthic macroinvertebrate community, fish passage, fish health, and fish populations. The primary environmental effects mechanisms on these residual stream segments are a result of reduction in catchment area, and consequent reduction in flows in the residual stream segments.

Operation and Closure activities will reduce the amount of brook trout and slimy sculpin rearing and spawning habitat in Tributary A to West Branch Napadogan Brook and the amount of brook trout and slimy sculpin rearing and spawning habitat, and American eel and Atlantic salmon rearing habitat in Bird Brook. Although one Atlantic salmon parr was found at the most downstream site on Bird Brook located approximately 350 m from the West Branch Napadogan Brook, it is unlikely that much spawning occurs within Bird Brook as no fry were observed during electrofishing surveys.

**3.1.4 Sisson Brook and Lower Napadogan Brook**

During Operation and Closure, water management has the potential to result in serious harm to fish habitat in the residual portion of Sisson Brook and in lower Napadogan Brook. Serious harm will likely result from altering flows, altering fish habitat area, water quality, productivity, the benthic macroinvertebrate community, fish passage, fish health, and fish populations. The primary environmental effects mechanisms on the residual stream segment of Sisson Brook and lower Napadogan Brook during Operation include:

- A reduction in catchment area of the watersheds due to the presence of Project facilities, thereby reducing flows in the residual segments of Sisson Brook, and consequently lower Napadogan Brook;
- The withholding of water within the TSF in Years 1 to 7 of Operation, thereby reducing flows in lower Napadogan Brook; and



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Description of Potential Environmental Effects on Fish and Fish Habitat  
May 28, 2019

- The re-direction of water from the TSF to the open pit during Closure in Years 28-39, such that there is no release of treated water during either of these time periods, thereby reducing flows in lower Napadogan Brook.

(Note: Year 1 means the first year of the Operation phase of the Project).

In Years 8 to 27 of Operation, lower Napadogan Brook and the residual segment of Sisson Brook will experience an increase in flow relative to other years as treated water will be released. Following Closure (Year 39 and in perpetuity), surplus water (treated as necessary) will again be released to the residual segment of Sisson Brook and lower Napadogan Brook. As noted above, for the purposes of assessing serious harm to fish in Sisson Brook and lower Napadogan Brook, the maximum predicted flow reductions have been assumed.

Operation activities will reduce brook trout, Atlantic salmon, creek chub, pearl dace, slimy sculpin, white sucker nursery, rearing and spawning habitat. They will also reduce American eel rearing habitat.

### 3.2 POTENTIAL ENVIRONMENTAL EFFECTS ON FISH

The information below outlines the environmental effects of the Project that will result in serious harm to fish that are part of commercial, recreational or Aboriginal (CRA) fisheries. The effects of the Project are estimated using the number of fish within the habitat area of direct and indirect effects as it influences fish production.

The loss of fish was calculated by multiplying an estimate of average fish density (# fish/100 m<sup>2</sup>) with the habitat area of each watercourse impacted by the Project. Fish densities were estimated with qualitative and quantitative electrofishing (Smith Root Model LR24) survey data conducted in the Napadogan Brook Watershed as part of baseline data collected in 2011 and 2012 to inform the Environmental Assessment of the Sisson Project and further baseline fisheries information collected in 2014. Specifically, fish density data were collected on 26 qualitative sites from July 20 to August 9, 2011, five qualitative sites from September 10 and 14, 2012, nine quantitative sites from September 8 and 29, 2011, and six quantitative sites from September 2 to 10, 2014. All fish species and life stages captured during the electrofishing efforts were included in the estimates of fish production including brook trout (*Salvelinus fontinalis*); blacknose dace (*Rhinichthys atratulus*); creek chub (*Semotilus atromaculatus*), common shiner (*Luxilus cornutus*); American eel (*Anguilla rostrata*); slimy sculpin (*Cottus cognatus*); sea lamprey (*Petromyzon marinus*); white sucker (*Catostomus commersonii*); pearl dace (*Semotilus margarita*); blacknose shiner (*Notropis heterolepis*); and longnose sucker (*Catostomus catostomus*).

Quantitative electrofishing methods are designed to provide a direct assessment of population size (#/m<sup>2</sup>), whereas qualitative surveys provide relative abundance (#/electrofishing seconds) and species composition. Population density estimates for the qualitative sites were approximated using the relationship between fish density over multiple sweeps (#/m<sup>2</sup>) and the catch per unit effort (CPUE) from the first sweep of the quantitative technique as described in Chaput et al. (2005). This relationship allows for a prediction of the population density estimate of fish at the qualitative sites where only one pass was completed.



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Description of Potential Environmental Effects on Fish and Fish Habitat  
May 28, 2019

To produce average fish density estimates, the quantitative electrofishing data from 2011 and 2014 were used to generate a scatterplot of total fish density relative to CPUE. The relationship between CPUE and density was different between the 2011 and 2014 so the quantitative electrofishing data from each year was fitted with a regression line of best fit (Chaput et al. 2005). The 2014 quantitative electrofishing best represented the trends observed in Chaput et al. (2005) (i.e., density and CPUE show an increasing trend at approximately 1:1 ratio). Therefore, the linear relationship produced with the 2014 data was then used to estimate the density of fish at the qualitative sites in 2011 and 2012. The use of this method increased the total number of site data available and provided a greater variation in the number of sites over the various stream orders and brooks where productivity may differ in the system.

The resulting estimates of fish loss are provided in Table 3.3 and Table 3.4. In total, the expected loss is estimated to be approximately 30,000 fish. This represents less than 1% of the productive capacity of the Napadogan brook subwatershed.

**Table 3.3 Direct Fish Production Loss by Major Project Component**

Project Component	Affected Watercourse	Type of Loss	Area Lost, Requiring Compensation/ Offsetting (100 m <sup>2</sup> )	Density (#fish per 100m <sup>2</sup> )	Number of Fish Lost
Open Pit	Sisson Brook	Direct	112	40.1	4,491
	McBean Brook	Direct	2	22.6	45
Tailings Storage Facility (TSF)	Bird Brook	Direct	172	69.0	11,868
	Bird Brook	Direct	72	69.0	4,968
	Sisson Brook	Direct	2	40.1	80
	Tributary A to West Branch Napadogan Brook	Direct	6	62.5	375
<b>Total Required for Compensation/Offsetting</b>			<b>366</b>	<b>-</b>	<b>21,828</b>

**Table 3.4 Indirect Fish Production Loss by Major Project Component**

Project Component	Affected Watercourse	Type of Loss	Area Lost, Requiring Compensation/Offsetting (100 m <sup>2</sup> )	Density (#fish per 100m <sup>2</sup> )	Number of Fish Lost
Residual Stream Segments	Sisson Brook	Indirect	36	17.9	644
	Bird Brook	Indirect	77	58	4,466
	Tributary A to West Branch Napadogan Brook	Indirect	10	62.5	625
Downstream Flow Reductions	Lower Napadogan Brook	Indirect	55	78.6	4,323
<b>Total Indirect Loss Required for Compensation/Offsetting</b>			<b>178</b>	<b>-</b>	<b>10,058</b>



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Description of Potential Environmental Effects on Fish and Fish Habitat  
May 28, 2019

## 3.3 POTENTIAL ENVIRONMENTAL EFFECTS ON FISH PRODUCTION

Given that the fish community in the offsetting plan is unlike the affected one, fish production was the metric selected (DFO 2017). For commercial fisheries, fish production is often described in metric tons, but given the scale of production within the area of effects, kilograms of fish was selected as the metric to measure direct and indirect effects of the Project on fish.

The estimate of fish production accounts for all life stages and all species of fish that reside within the area of disturbance. The area of direct and indirect effects is relatively undisturbed and is assumed to have relatively stable production of fish on a yearly basis. Therefore, the loss of fish production is assumed to be representative of existing fish production (i.e., on an annual basis) within these watercourses. As an example, if a year class fails in one year (i.e., 0+ brook trout) it is anticipated that older year classes (i.e., 1+ and 2+ brook trout) or other species occupying similar niches may have increased access to food and habitat resources and may experience an increase in overall production (e.g., growth), however total fish production (kg) will remain generally similar.

To calculate fish production within the area of loss, the average weight of fish (all species and life stages combined) for the area of interest (e.g., Bird Brook) was used. The average weight of fish was calculated by applying the site and species-specific length-weight curves obtained from the 2011 quantitative electrofishing data, included in the Baseline Aquatic Environment Technical Report for the Sisson Project (Stantec 2012a), to the length measurements obtained through the qualitative electrofishing program. Similar to density, this method increased the total amount of site data available and provided a greater variation in the number of sites over the various stream orders and brooks where productivity may differ in the system.

The resulting fish production lost estimates are provided in Table 3.5 and Table 3.6. In total, the expected loss in fish production is estimated to be 297 kg of fish production (approximately 300 kg).



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Description of Potential Environmental Effects on Fish and Fish Habitat  
May 28, 2019

**Table 3.5 Direct Fish Production Loss by Major Project Component**

Project Component	Affected Watercourse	Type of Loss	Area Lost, Requiring Compensation/Offsetting (100 m <sup>2</sup> )	Density (#fish per 100m <sup>2</sup> )	Number of Fish Lost	Average Weight Per Fish (g)	Fish Production Lost (kg) Requiring Compensation/Offsetting
Open Pit	Sisson Brook	Direct	112	40.1	4,491	9.8	44
	McBean Brook	Direct	2	22.6	45	13.4	1
Tailings Storage Facility (TSF)	Bird Brook	Direct	172	69.0	11,868	7.9	94
	Bird Brook	Direct	72	69.0	4,968	7.9	39
	Sisson Brook	Direct	2	40.1	80	10.0	1
	Tributary A to West Branch Napadogan Brook	Direct	6	62.5	375	5.7	2
<b>Total Required for Compensation/Offsetting</b>			<b>366</b>	<b>-</b>	<b>21,828</b>	<b>-</b>	<b>181</b>

**Table 3.6 Indirect Fish Production Loss by Major Project Component**

Project Component	Affected Watercourse	Type of Loss	Area Lost, Requiring Compensation/Offsetting (100 m <sup>2</sup> )	Density (#fish per 100m <sup>2</sup> )	Number of Fish Lost	Average Weight Per Fish (g)	Fish Production Lost (kg) Requiring Compensation/Offsetting
Residual Stream Segments	Sisson Brook	Indirect	36	17.9	644	12.0	8
	Bird Brook	Indirect	77	58	4,466	12.3	55
	Tributary A to West Branch Napadogan Brook	Indirect	10	62.5	625	6.0	4
Downstream Flow Reductions	Lower Napadogan Brook	Indirect	55	78.6	4,323	11.6	50
<b>Total Indirect Loss Required for Compensation/Offsetting</b>			<b>178</b>	<b>-</b>	<b>10,058</b>	<b>-</b>	<b>116</b>



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Measures and Standards to Avoid or Mitigate Serious Harm To Fish  
May 28, 2019

## 4.0 MEASURES AND STANDARDS TO AVOID OR MITIGATE SERIOUS HARM TO FISH

Throughout the feasibility design for the Project, the Proponent and its design consultants have considered various opportunities to minimize the magnitude and extent of the environmental effects of the Project on the aquatic environment and other valued environmental components (VECs), and further opportunities will continue to be considered as the detailed design and development of the Project are carried out.

### 4.1 MEASURE TO AVOID SERIOUS HARM TO FISH

The following mitigation measures (summarized in Table 8.5.8 of the EIA Report (Stantec 2013a)), through careful design and planning, have or will be employed to avoid or reduce the environmental effects of the Project on the Aquatic Environment:

- TSF Site Selection and Design;
- Mine Waste and Water Management;
- Construction Methodologies and Timing;
- Fish Relocation; and
- Fish Habitat Offsetting Plan.

Serious harm to fish and fish habitat could not be avoided for the open pit, as the Project location is fixed by the ore body. There are no technically and economically feasible alternative means of carrying out the Project using alternate locations and methods of mining. The ore body at the Project site is near surface, with only 0.9 m to 4.0 m of overburden, so that underground mining is not a technically and economically feasible alternative. The only technically and economically feasible means of mining this ore body is by open pit.

#### 4.1.1 Tailings Storage Facility Site Selection and Design

The site selection process for the TSF, and its design and construction methods, are considered as mitigation for the potential change in the Aquatic Environment; they are summarized below and described in more detail in Section 3.3.3 of the EIA Report (Stantec 2013a). Along with the various factors considered for selecting the TSF location as described in Section 3.3.3 of the EIA Report (Stantec 2013a), the selected TSF location had the added benefits of being entirely within a single watershed (Napadogan Brook), and did not affect any lakes. In addition, the northwestern embankment of the TSF was moved inward to avoid contact with two tributaries to the West Branch Napadogan Brook (W1F and W1G) (Figure 1.2), thereby avoiding these watercourses compared to the TSF footprint initially proposed in the CEAA Project Description (Stantec 2011).

A detailed evaluation of potential options for locating and managing tailings, waste rock, and other waste materials arising from the Project was completed in support of the feasibility study. As part of this work,



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Measures and Standards to Avoid or Mitigate Serious Harm To Fish  
May 28, 2019

Knight Piésold and other consultants evaluated various TSF site locations, tailings technologies, and TSF embankment construction materials (EIA Report Section 3.3.3, Stantec 2013a).

A TSF Site Alternatives Analysis was carried out using methods provided in Environment and Climate Change Canada's "Guidelines for the Assessment of Alternatives for Mine Waste Disposal" (Environment Canada 2013). The analysis examined the various TSF locations considered by the Proponent, and recommended a preferred location for the TSF in consideration of known environmental, socioeconomic, and engineering constraints. A standalone report to meet the requirements of these guidelines, was submitted and accepted by Environment and Climate Change Canada in September 2015.

As discussed in the CEEA Project Description (Stantec 2011), four main alternatives for locating the TSF were considered (EIA Report, Section 3.3.3.3, Stantec 2013a), as shown in Figure 4.1 and as summarized as follows.

- Bird Brook (Site 1) is relatively close (3.3 km) to the proposed ore processing plant. Compared to the other alternatives, it has a relatively large "footprint" but takes advantage of the natural topography and does not encroach on any lakes. It covers much of the upper reaches of Bird Brook and one arm of West Branch Napadogan Brook, but drains entirely to Napadogan Brook. Its proximity to the process plant means that the lengths of access roads, tailings and water pipelines, and power lines between the TSF and the plant site would be comparatively short.
- Barker Lake (Site 2), located approximately 5.8 km to the southwest of the proposed ore processing plant location, has the advantage of constraining hills on its west side. This alternative would be more costly to operate than Site 1 due to the distance from the process plant with the attendant additional environmental effects related to greater distances for trucking and infrastructure. More importantly, it would entail covering a lake and drains entirely to the Upper Nashwaak River watershed. Thus, Site 2 is undesirable relative to Site 1 due to greater environmental effects and higher costs.
- Trouser Lake (Site 3), located approximately 4.1 km to the south of the proposed ore processing plant location, has the advantage of constraining hills on the east side. However, it would result in the elimination of lakes (known to support a recreational fishery) and drains entirely to the Upper Nashwaak River watershed. This alternative would be more costly to operate than Site 1 due to the distance from the process plant with the additional environmental effects related to greater distances for trucking and infrastructure. These environmental effects, coupled with the location in the Upper Nashwaak River watershed and the covering of lakes, make this alternative undesirable relative to Site 1 due to greater environmental effects and higher costs. Additionally, the route of the relocated transmission line and relocated Fire Road will need to pass through the site.
- Chainy Lakes (Site 4), located approximately 6.1 km to the south of the proposed ore processing plant location, has the advantage of constraining hills on its northeast and southeast sides. However, it would result in the elimination of lakes (known to support a recreational fishery) and drains entirely to the Upper Nashwaak River watershed. This alternative would be more costly to operate than Site 1 due to the distance from the process plant with the attendant additional environmental effects related to a greater distance for trucking and infrastructure. These environmental effects, coupled with the location in the Upper Nashwaak River watershed and the covering of lakes, make this alternative undesirable relative to Site 1 due to greater environmental effects and higher costs.



## **SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Measures and Standards to Avoid or Mitigate Serious Harm To Fish  
May 28, 2019

Of these four alternatives, Bird Brook (Site 1) was preferred for environmental reasons, as well as technical and economic reasons. In early 2011, the Proponent refined this site into two alternatives, Site 1b and Site 1c (Figure 4.1), each of which takes up less land area than the initially envisaged Site 1 and affects much less aquatic habitat. As developed through the feasibility study, and as supported by the analysis of environmental, technical and economic factors (EIA Report, Section 3.3.3, Stantec 2013a), TSF Alternative 1b (Site 1b) was selected as the preferred location for the TSF.

### **4.1.2 Mine Waste and Water Management**

Water Management includes but is not limited to reclaiming and reuse of water contained in the TSF for ore processing, operation of a water treatment plant, and seepage management.

To mitigate serious harm from indirect environmental effects on residual stream segments and downstream flow reductions, the Proponent will maintain existing drainage patterns to the extent possible, comply with the Watercourse and Wetland Alteration (WAWA) permits, recycle water from the TSF for use in the ore processing to minimize Project demands on the environment for water, and to reduce the production of contact water, construct engineered drainage and diversion channels to divert non-contact water around the Project facilities wherever possible.

The water discharged from the TSF will be subject to regulated water quality discharge limits to ensure protection of the receiving waters and the project is obliged, by law, to meet these limits.

Part of Sisson Brook will be diverted into McBean brook and thereby partially restore some lost flow in the McBean Brook watershed as a result of the lost headwater portions of the small tributaries to McBean Brook (EIA Report, Section 8.4.4.3.1, Stantec 2013a).

### **4.1.3 Construction Methods and Timing**

Erosion and sedimentation control techniques will be employed throughout the site preparation activities as required to minimize erosion of exposed areas and sedimentation in site surface water which may affect fish and fish habitat. Standard mitigation measures such as the use of silt fences, sediment traps and sedimentation ponds will be used to manage the potential release of sediment to streams. Regular inspection and maintenance of erosion and sediment control measures and structures will occur during construction, and any damage to those structures will be repaired.

Engineered drainage and diversion channels will be constructed to divert non-contact surface water and precipitation away from the Project site wherever possible. This will reduce the amount of water being sequestered on the site and allow surface water input into nearby watercourses mitigating some of the water sequestration. Water management will consist of establishing collection ponds, coffer dams, pumping systems, run-off collection ditches, and diversion channels. Some of the temporary works such as coffer dams and by pass diversion channels will be removed once the initial starter embankments have been constructed. Some of the water management works will become long-term features of the Project site, and others will be temporary and removed when no longer needed for Construction purposes.



## **SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Measures and Standards to Avoid or Mitigate Serious Harm To Fish  
May 28, 2019

Construction of the TSF will first require creating access to and clearing the dam construction sites. Cofferdams will then be installed just upstream of the starter dam locations, and stream flows from above the cofferdams will be pumped around the construction site for discharge downstream. The cofferdams will be sized so that sediment generated upstream will settle out before the water is pumped around the construction sites to prevent effects on fish, and to prevent sediment from accumulating in spawning or rearing habitats. Construction of the starter dams, the downstream water management ponds, and then the initial TSF starter embankments, will follow. Other than for the construction of starter dams and embankments, no grubbing or other earth moving within the TSF footprint is required.

Machinery used in construction will be well maintained and free of fluid leaks and machinery will be refueled and fuel will be stored so as to prevent it from entering watercourses. Machinery will be operated in a way that protects stream beds and minimizes disturbances to the watercourses, until such a time as the fish are removed and appropriate sediment control structures are in place.

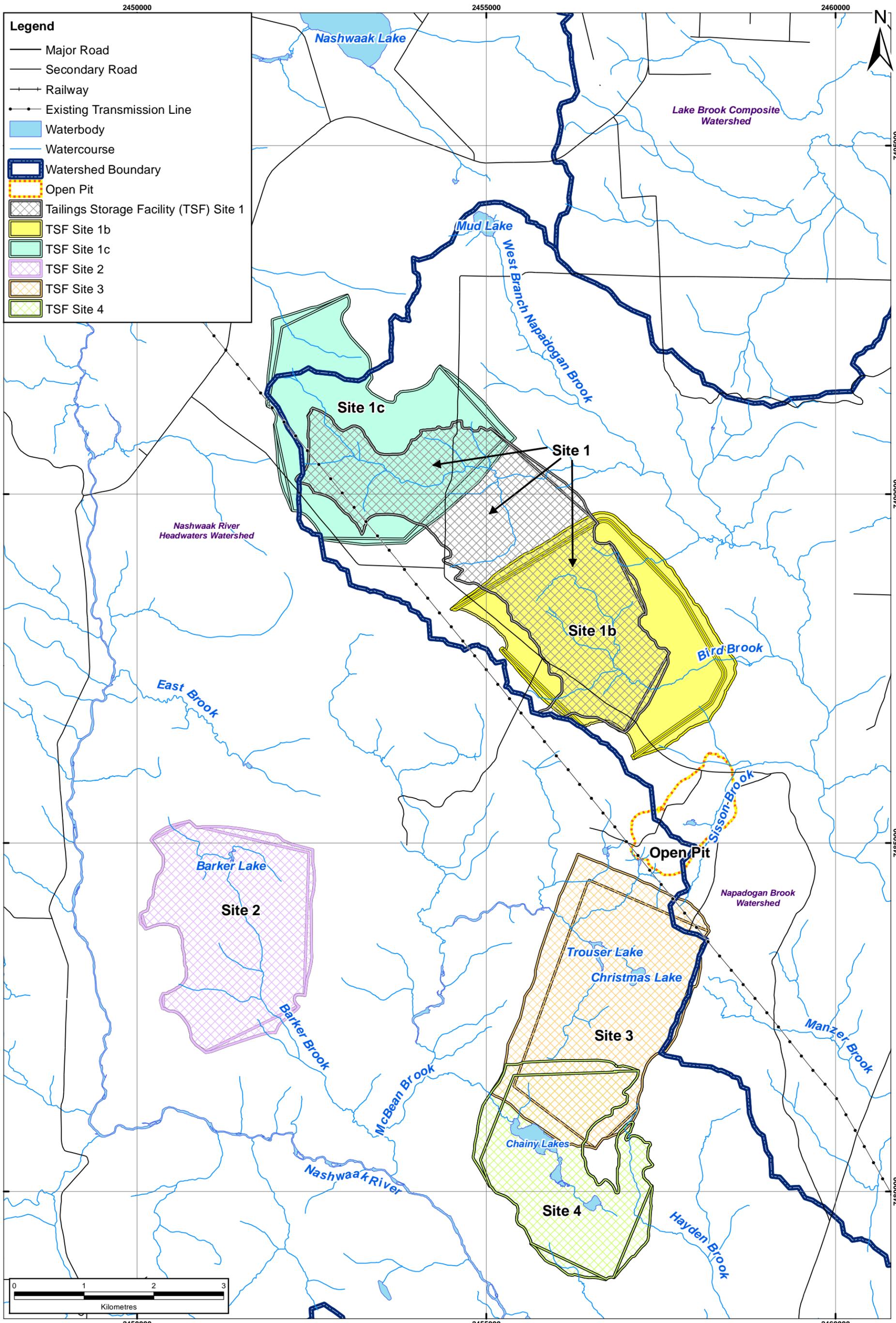
Additional information on Site Preparation Mitigation can be found in Section 3.4 of the EIA Report (Stantec 2013a).



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Measures and Standards to Avoid or Mitigate Serious Harm To Fish  
May 28, 2019





NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

<p><b>Location of Alternatives for the TSF</b></p> <p>Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.</p>		Scale:	Project No.:	Data Sources:	Fig. No.:
		1:50,000	121810356	NBDNR, SNB NHN, NB Aquatic Data Warehouse	4.1
Client:	Northcliff Resources Ltd.	Date: (dd/mm/yyyy)	Dwn. By:	Appd. By:	
		16/05/2013	JAB	DLM	



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Measures and Standards to Avoid or Mitigate Serious Harm To Fish  
May 28, 2019

### 4.1.4 Fish Relocation

During the early stages of the construction of the TSF and within the future area of the open pit, it will be necessary to relocate fish residing in Bird Brook, Sisson Brook, McBean Brook and Tributary A of West Branch Napadogan Brook, to the extent possible, to minimize the potential for direct mortality to occur from construction activities. Due to the large area, varying habitats where fish need to be removed, and difficulty removing fish from some areas, it is unlikely that every fish will be removed despite best efforts to do so. Fish removal will be prioritized, with fish removal focusing on SOCC and SAR species (i.e., Atlantic salmon and American eel) and fish of current recreational and aboriginal importance (i.e., brook trout), hereafter referred to as “priority” species. Other fish species within the PDA that do not support CRA fisheries (e.g., pearl dace and common shiner) will be removed if and when reasonably possible. All reasonable efforts will be made to relocate fish within the affected watercourses to nearby watercourses within the Napadogan or adjacent watersheds that contain suitable habitat, as appropriate. Construction activities within the PDA are not expected to affect habitat that is limiting for any of the fish species currently residing therein.

#### 4.1.4.1 Tailings Storage Facility Area

A TSF preparation plan has been prepared (Section 3.4.1.2.7 of the Sisson Project EIA Report, Stantec 2013a) which outlines methods that can be employed, subject to approval, to relocate fish from watercourses within the area of the TSF, and thus avoid direct fish mortality from construction activities. Removal of fish from the relevant brook sections will be undertaken when weather and hydrological conditions allow for safe and effective operation of the equipment while avoiding peak salmonid spawning periods. This removal activity will likely occur between June and September. Captured fish will be released downstream of the starter dam and water management pond sites, or into other release sites in the Napadogan Brook watershed or adjacent watersheds that contain suitable habitat. To prevent fish from returning upstream, and if the coffer dams are not in place by late September, barrier nets or other suitable means will be established just downstream of the locations of the water management ponds. Once the coffer dams are in place and the upstream brooks are deemed fish-free, the upstream brook beds within the TSF footprint will be filled in with non-deleterious materials such as local borrow or quarried material where access permits. Suitable means will be employed to allow groundwater discharge along the brook beds (e.g., the bottom layer of fill will be coarse material and/or a drainage pipe will be laid in the bed).

The fish removal approach outlined below assumes that the coffer dams will not be in place at the time of initiating fish removal activities. Should these be in place, the fish removal process will follow the same general approach but the execution will be considerably simpler as fish will not be able to ascend past the coffer dams. Fish will first be removed from the areas where the coffer dams will be placed prior to coffer dam construction. Fish removal will then take place directly above the coffer dams and proceed in an upstream fashion. If the coffer dams are not in place, fish removal will start in the headwaters of each watercourse and move in a downstream direction. Fish removal will entail isolating sections of watercourse using porous barriers (e.g., dams made of sand bags and fitted with a screened PVC pipe) to allow for continuous flow of water and to prevent fish returning to areas already fished out. These



## **SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Measures and Standards to Avoid or Mitigate Serious Harm To Fish  
May 28, 2019

porous barriers, and fish removal, will move sequentially downstream until each watercourse is determined to be free of fish.

It is anticipated that a minimum of three electrofishing passes will be required to remove fish from within each stretch of watercourse. Agreement will be required with DFO on what will be considered an acceptable “end point” (i.e., after what type and level of effort a section of watercourse will be deemed to be “fish-free”). In fish-bearing waters where electrofishing is not possible (e.g., flooded wetland), alternate methods of capture such as fyke nets, seine nets, dip nets, and minnow traps will be used.

Captured fish will be placed in buckets of water for transfer to oxygenated tanks of water mounted on transport vehicles stationed at access points nearby. These vehicles will convey the captured fish to approved discharge points below the construction sites for release downstream or into other release sites in the Napadogan Brook watershed or adjacent watersheds that contain suitable habitat. Data on fish species composition, length and weight will be collected at selected locations within the fish removal area to obtain an estimate of the fish populations and community composition within the PDA.

Electrofishing will be conducted by crews consisting of a lead biologist, electrofishing technicians, and “porters” to carry fish in buckets to vehicle access points. Other crews will be responsible for porous barrier placement, for verifying that watercourse sections are free of fish, and for transporting captured fish to the discharge locations and releasing them.

The fish removal activities outlined above will be resourced and scheduled to be complete by the end of September. The porous barriers, barrier nets, or other suitable measures, may need to be kept in place until the coffer dams are installed to that fish cannot return to the stretches of watercourses from which they have been removed. It is expected that installation of the coffer dams will be completed over the October-December period, and that the upstream, fish-free watercourses will be filled in during the winter months when flows are at a minimum and the ground is frozen enough that equipment can readily move around.

Fish will be relocated to areas outside of the PDA within the Napadogan watershed or adjacent watersheds that contain suitable habitat. A Scientific Collection Permit and Introduction and Transfers Permit for fish will be required from DFO to remove and relocate fish. Consultation with DFO and New Brunswick Department of Natural Resources (NBDNR) will be required to determine suitable release strategies and locations for captured fish.

### **4.1.4.2 Open Pit Area**

Fish removal from the area of the open pit will follow the same general procedures discussed above except that there will be no need to adjust the procedures to account for the timing of construction of coffer dams.

### **4.1.5 Fish Habitat Offsetting Plan**

Fish habitat compensation/offsetting is the primary mitigation for offsetting the unavoidable direct and indirect serious harm to fish due to the loss of fish habitat area. Compensation/offsetting is envisioned by



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Measures and Standards to Avoid or Mitigate Serious Harm To Fish  
May 28, 2019

the Fisheries Act where there are no alternative mitigation measures that are technically and economically feasible that would mitigate any significant adverse environmental effects of a project.

Section 5.0 contains the Offsetting Plan for fish habitat offsetting as a result of serious harm and loss of fish habitat within the PDA.

## 4.2 MONITORING MEASURES TO AVOID SERIOUS HARM

To confirm the residual environmental effects of Project-related changes in stream flows on the Aquatic Environment, the stream flow at the existing hydrometric stations will be observed. The measured flows will be compared to the equivalent pre-Project stream flow rates calculated from the Narrows Mountain Brook station operated by Environment and Climate Change Canada. Knight Piésold (2012) has demonstrated a strong correlation of pre-Project flows at the Project hydrometric stations to the Narrows Mountain Brook (NMB) station.

As part of the Water Resources Monitoring Program, monitoring will be conducted so that the Project meets applicable legislation, regulations and guidelines. Construction sites will generate TSS in run-off, and best management practices will be instituted to prevent the discharge of excess TSS to the streams as outlined in the EPP. Water quality monitoring in the TSF water management ponds (WMPs) and groundwater wells will begin during Operation, and continue Post-Closure until such time that the water quality is acceptable and the termination of monitoring can be justified.

In terms of the Aquatic Environment, all elements of the Metal Mining Effluent Regulations (MDMER) described below are part of the regulatory compliance monitoring. The Province of New Brunswick may impose other or additional requirements in permits and authorizations and these will be incorporated into the program as appropriate. The regulatory compliance monitoring studies will consist of three main components, pursuant to MDMER, as follows:

- Deleterious substance monitoring consisting of pH and acute lethality testing (MDMER Sections 12-17);
- Effluent and water quality monitoring studies comprising of effluent characterization, sub-lethal toxicity testing and water quality monitoring (MDMER, Schedule 5, Part 1); and
- Biological monitoring studies in the aquatic receiving environment to determine if mine effluent is affecting fish, fish habitat or the use of fisheries resources (MDMER, Schedule 5, Part 2).

## 4.3 CONTINGENCY MEASURES FOR MITIGATING SERIOUS HARM

Fish removal from the PDA is a measure that will mitigate serious harm to fish. If fish removal cannot be conducted before fall, it may be possible to carry out fish removals during the winter low flow period, since fish removal is a fish rescue activity that is generally permitted by DFO to be conducted at any time of year.

The mitigation measures described previously in this document are comprehensive and have been designed to mitigate serious harm to CRA fisheries. Reducing the environmental effects of the Project is a



## **SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Measures and Standards to Avoid or Mitigate Serious Harm To Fish  
May 28, 2019

combination of federal and provincial regulations, mitigation proposed in the EIA, an Offset Plan, and an EPP. Section 9.0 of the EIA report (Stantec 2013a) contains an extensive follow-up and monitoring program that will confirm environmental effects and contingency measures will be discussed with regulators at that time.

### **4.4 RESIDUAL SERIOUS HARM TO FISH**

Serious harm to CRA fisheries will result from the permanent destruction of fish habitat during the construction phase of the Project. Construction activities will result in the direct loss of fish habitat area in parts of Bird Brook, part of Sisson Brook, and part of a small unnamed tributary to West Branch Napadogan Brook (referred to as Tributary A) due to the construction of the TSF embankments and infilling of these brooks from the storage of tailings within the TSF during Operation. Construction activities will result in the direct loss of fish habitat area in Sisson Brook in areas occupied by the open pit, and the direct loss of some McBean Brook headwaters in the area of the open pit. Construction activities will also result in the loss of various watercourse fragments of Sisson Brook where they occur between the TSF and the open pit.

The direct environmental effects of serious harm, defined as the death of fish or any permanent alteration to, or destruction of, fish habitat to fish that are part of a CRA fishery, is expected to be 366 habitat units (Table 4.1).

Construction and operation activities will result in the indirect loss of 178 habitat units due to reduced stream flow in residual stream segments of Sisson Brook, Bird Brook and Tributary A of West Branch Napadogan Brook, and due to reductions in mean annual stream flow in lower Napadogan Brook (Table 4.1). In the residual stream segments, serious harm will result from the permanent reduction in upstream catchment areas, the consequent reduction of stream flows thus altering fish habitat area, water quality, productivity, the benthic macroinvertebrate community, fish passage, fish health, and fish populations. In lower Napadogan Brook, serious harm will likely occur as a result of mean annual flow reductions of greater than 10%. This flow reduction will alter fish habitat area, productivity, the benthic macroinvertebrate community, fish passage, fish health, and fish populations.

Under the Fisheries Act as amended in 2012, the focus is on sustaining the productivity of CRA fisheries, the amount of habitat units affected by a project, and in an offsetting project, remains an indicative metric. By this metric, the total required Offsetting arising as a result of the Sisson Project is 544 habitat units.



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Measures and Standards to Avoid or Mitigate Serious Harm To Fish  
May 28, 2019

**Table 4.1 Summary of Mitigation, Recommended Follow-up and Monitoring, and Required Offset by Project Phase**

Project Phases, Activities, and Physical Works	Mitigation / Compensation Measures	Recommended Follow-up or Monitoring	Residual Serious Harm to Fish Requiring Authorization and Offsetting (100 m2)
<p>Construction</p> <ul style="list-style-type: none"> <li>• Site Preparation of Open Pit, TSF, and Buildings and Ancillary Facilities.</li> <li>• Physical Construction and Installation of Project Facilities.</li> <li>• Physical Construction of Realigned Fire Road, New Site Access Road and Internal Site Roads.</li> </ul>	<ul style="list-style-type: none"> <li>• Fish habitat offsetting.</li> <li>• Relocation of fish.</li> <li>• Maintain existing drainage patterns to the extent possible.</li> <li>• Comply with the Wetland and Watercourse Alteration (WAWA) permit.</li> <li>• Implement erosion and sedimentation control during Construction.</li> <li>• Siting of Project facilities.</li> </ul>	<ul style="list-style-type: none"> <li>• Monitor TSS in discharge from construction sites to verify predictions and confirm compliance and identify need for further mitigation.</li> <li>• Monitor water quality of discharge from starter pit dewatering to evaluate treatment requirements, if any.</li> </ul>	<p>Direct loss of 366 habitat units</p>
<p>Operation</p> <ul style="list-style-type: none"> <li>• Mine Waste and Water Management.</li> </ul>	<ul style="list-style-type: none"> <li>• Fish habitat offsetting.</li> <li>• Erosion and sedimentation control during earth moving activities.</li> <li>• Design water management structures to reduce erosion and assure adequate water conveyance in extreme events. Recycle water from the TSF for use, and to reduce the production of contact water.</li> <li>• Treat (as required) surplus mine contact water</li> <li>• Construct engineered drainage collection channels to collect TSF embankment run-off and seepage.</li> <li>• Install and operate groundwater pump-back wells to collect some groundwater seepage for return to the TSF.</li> </ul>	<ul style="list-style-type: none"> <li>• Monitor to verify the seepage from the TSF.</li> <li>• Monitor WTP effluent for compliance.</li> <li>• Verify water temperature modeling.</li> <li>• Observe stream flow at the existing hydrometric stations and compare to the equivalent pre-Project stream flow rates.</li> <li>• Undertake comparative fish passage survey during low-water conditions.</li> <li>• Carry out a spawner survey for adult Atlantic salmon in Napadogan Brook.</li> </ul>	<p>Indirect loss of 178 habitat units</p>



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Measures and Standards to Avoid or Mitigate Serious Harm To Fish  
 May 28, 2019

**Table 4.1 Summary of Mitigation, Recommended Follow-up and Monitoring, and Required Offset by Project Phase**

Project Phases, Activities, and Physical Works	Mitigation / Compensation Measures	Recommended Follow-up or Monitoring	Residual Serious Harm to Fish Requiring Authorization and Offsetting (100 m2)
	<ul style="list-style-type: none"> <li>• Implement an adaptive management plan integrated with Follow-up and Monitoring Program to identify the need for and install groundwater monitoring wells below the TSF WMPs to monitor the groundwater quality.</li> <li>• Construct engineered drainage and diversion channels to divert non-contact water.</li> <li>• Construct and operate a water treatment facility to treat surplus water from the Project before discharge, as required.</li> <li>• Adaptive management measures to further reduce seepage in the event that Follow-up and Monitoring Program identifies further mitigation is required.</li> </ul>	<ul style="list-style-type: none"> <li>• Deleterious substance, pH, and acute lethality testing (<i>MDMER</i> Sections 12-17).</li> <li>• Effluent characterization, sub-lethal toxicity testing and water quality monitoring (<i>MDMER</i>, Schedule 5, Part 1).</li> <li>• Biological monitoring studies of fish, fish habitat, benthic macroinvertebrates, and the usability of fisheries resources (<i>MDMER</i>, Schedule 5, Part 2).</li> </ul>	

Source: Stantec (2013a).



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

### 5.0 OFFSETTING PLAN/FISH HABITAT COMPENSATION PLAN

The following represents the information that is required to offset “serious harm to fish” as defined under Section 35(2) of the Fisheries Act and the Fish Habitat Compensation Plan as specified in Section 27.1 of MDMER, for Schedule 2 tailings impoundment areas. The irrevocable letter of credit in the agreed amount to complete the Upper Nashwaak Water Control Structure Replacement Offsetting Plan was provided to DFO in 2014. An additional letter of credit for the Lower Lake Dam project will be provided following the issuance of Gazette 2 of the MDMER amendment process.

#### 5.1 IMPLEMENTATION OF MEASURES TO OFFSET SERIOUS HARM

The proposed Fisheries Offsetting Plan intends to remove the last remaining upstream fish passage barriers on the Nashwaak River leading to Upper Nashwaak Lake to facilitate the reestablishment of a self-sustaining alewife (*Alosa pseudoharengus*) population. This will be accomplished by:

1. The removal and replacement of the water control structure at the outlet of Upper Nashwaak Lake;
2. The removal of the remnants of Lower Nashwaak Lake Dam (i.e. Lower Lake Dam or Irving Dam), and;
3. The implementation of a 5-year conservation-focused alewife Upper Nashwaak Lake reintroduction plan.

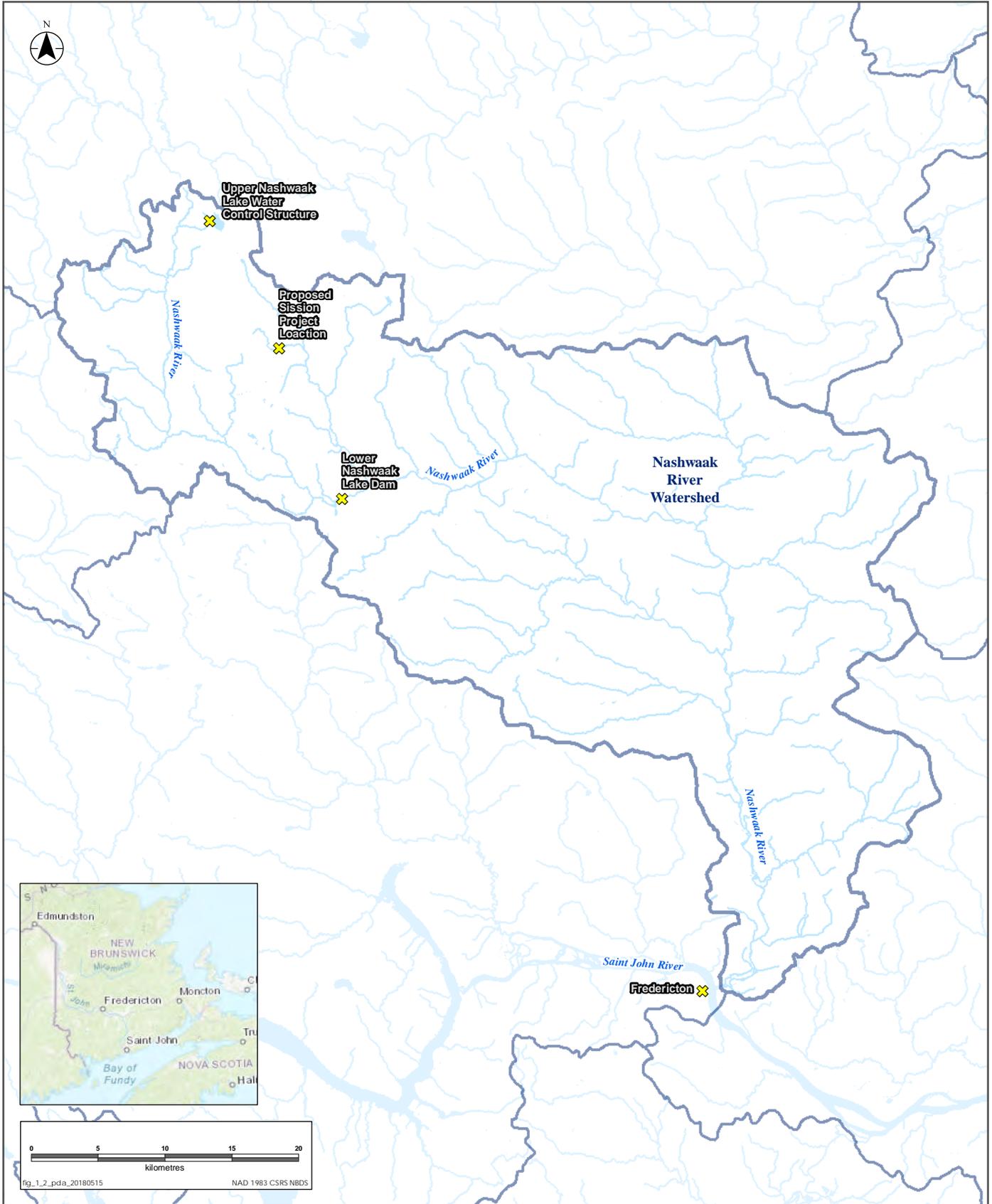
The location of the Upper Nashwaak Lake water control structure and remnants of the Lower Nashwaak Lake Dam are shown in Figure 5.1. Both structures are presently owned by the New Brunswick Department of Natural Resources (NBDNR).



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019





Sources: Base Data - From the government of New Brunswick and Canada  
Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL

Locations of the Proposed Fisheries Offsetting Fish Passage Barrier Removal Activities within the Nashwaak river Watershed.

Sisson Project, Napadogan, N.B.

Figure 5.1



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

### 5.1.1 Upper Nashwaak Lake Water Control Structure Replacement

The Proponent proposes to remove and replace an existing water-level control structure and road culvert on the Nashwaak River just below its exit from Upper Nashwaak Lake to facilitate the upstream passage of various fish species – principally, alewife. The existing Upper Nashwaak Lake water control structure is a timber box culvert measuring approximately 3.5 m high x 3.4 m wide x 6 m long (Figure 5.2). The river deck extends 3.1 m downriver to a boulder falls, making the total length of the structure 9.1 m. The structure was likely constructed to allow for temporary damming of the upriver waters, as is evident by a “C-channel” section in the middle of the structure to accept stoplogs. The bottom of the structure is wood; however, it is possible that a concrete or clay base exists under the timber in order to seal around the box.



**Figure 5.2 Barrier to Fish Passage Structure at Entrance to Upper Nashwaak Lake.**

Stantec undertook a fish passage analysis of the Upper Nashwaak Lake water control structure (the structure) in 2018 (Stantec 2018a) to determine the potential utility of its replacement as a fisheries offsetting measure. In this analysis, the hydraulic requirements for fish passage were simulated for the structure using a Hydrologic Engineering Centers River Analysis System (HEC-RAS) Model (USACE 2016) and assessed using fish passage criteria for alewife, brook trout, and Atlantic salmon obtained from available literature (Katopodis and Gervais 2016).

The results of the fish passage analysis suggest that the structure represents a complete passage barrier for some life stages of some fish species during their main migration periods, and acts as a partial migration barrier to other species and life stages. Specifically, the HEC-RAS Model results suggest the structure is a complete migration barrier to alewife, resident and sea run brook trout and juvenile Atlantic salmon at all flows because of the jump height (i.e., height between the pool and water surface in the



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

water control structure). There was a very small range of flow conditions (<10%) that were suitable for the passage of adult Atlantic salmon passage, although it is not expected that salmon would utilize this lake habitat. Therefore, the structure contributes to the habitat fragmentation for these populations in the Nashwaak River watershed. Both jump height, water depth and velocity were concluded to present either complete or partial barrier conditions to fish migration for some of the assessed species at the structure.

It is proposed that the existing water-level control dam and road culvert be removed and replaced with a standard “woods road” bridge. The detailed construction plans are included in Appendix A. The Report of the Geotechnical Investigation, which was used to develop the construction plans, is provided in Appendix B.

### 5.1.2 Lower Nashwaak Lake Dam Removal

The Proponent proposes to remove the remnants of the Lower Nashwaak Lake Dam and reconstruct the river channel, as required to improve fish passage. The Lower Nashwaak Lake Dam (also known as the Lower Lake Dam or the Irving Dam) is a dilapidated structure that was historically used for log driving operations (Smith 1969). It is located at the outlet of Lower Nashwaak Lake, which is located in close proximity to the proposed Sisson Project site - approximately 3 km upstream of the confluence of Nashwaak River and Napadogan Brook (Figure 5.1; Figure 5.3). River flow and upstream fish passage at this location are partially obstructed by the presence of the remaining concrete piers and sill of the dam. Removal of this dam would improve upstream fish passage at this location, especially during high flow conditions when the downstream water velocity is increased by the narrow gate openings, and during low-flow conditions when water flowing over the apron is potentially too shallow for upstream passage of some fish species.



**Figure 5.3** The Lower Nashwaak Lake Dam of the Nashwaak River



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Offsetting Plan/Fish Habitat Compensation Plan  
 May 28, 2019

Stantec undertook a fish passage analysis of the Lower Nashwaak Lake dam (the dam) in 2013 (Stantec 2013b). In this analysis, the hydraulic requirements for fish passage were simulated for the structure using a HEC-RAS Model and assessed using fish passage model FishXing (FishXing 2013) for five fish species including Atlantic salmon, brook trout, alewife, blueback herring (*Alosa aestivalis*), and American shad (*Alosa sapidissima*) (Stantec 2013b). The results of this effort suggest that the structure does indeed impede the upstream movement of several fish species during sensitive spawning migration periods (Table 5.1).

**Table 5.1 Summary of Lower Nashwaak Lake Dam Upstream Fish Passage Analysis**

Fish Species	Percent Migration Time Period Impassable
Adult Atlantic Salmon (≤ 55 cm, length)	0%
Adult Atlantic Salmon (56-78 cm, length)	52%
Adult Atlantic Salmon (≥100 cm, length)	76%
Juvenile Atlantic Salmon (parr)	100%
Adult Brook Trout	19%
Juvenile Brook Trout	100%
Alewife	27%
Blueback Herring	27%
American Shad	0%

A partial, seasonal barrier, such as Lower Nashwaak Lake Dam, can severely influence the productivity of migrating species because the barrier may delay activities such as spawning and exhaust individuals as they attempt to pass upstream of the structure (Fjeldstad 2012; Larinier 2001). While it is likely that under typical conditions, migrating fish will ultimately pass through the structure by awaiting suitable conditions, it is also likely that there will be years when suitable conditions do not occur. Similarly, although not considered in the Stantec (2013b) study, it is possible that trees and/or other debris will become entrained on the structure and will further impede fish passage. Thus, the removal of Lower Nashwaak Lake Dam improves fisheries productivity by increasing the likelihood that migrating fish will be able to reach their intended spawning destination in good physiological condition and at the appropriate biological timing window.

The Lower Nashwaak Lake Dam consists of a concrete trapezoidal column structure constructed on a concrete sill and is approximately 8 m in height. The concrete deck that spans between the columns likely supported a gantry system for removal of gates and/or stop logs. An overflow spillway is located on the left bank and consists of a concrete cap overlying earthen fill supported by sheet piling driven to bedrock. Currently direct access to the dam via the left bank is not possible other than by foot, though this would be the preferred access point given the closer proximity to the existing former access road. The old road near the right bank is in very poor condition for approximately 2.0 km. Upgrades to approximately 500 m of access road leading to the left bank would be required to accomplish demolition activities.



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

The configuration of the Lower Nashwaak Lake Dam (i.e., with no impounded water) lends itself to staged removal as water can flow freely through one gate opening while others are removed. Demolition activities would consist of breaking up the concrete with the use of an excavator equipped with a rock breaker, and debris would be loaded on haul trucks for disposal at a suitable site. Following removal of debris, the stream bed and shoreline will be restored to match the existing conditions, and to provide long-term stability against erosion.

The detailed design of the Lower Nashwaak Lake Dam removal and channel reconstruction will be initiated following the completion of the MDMER process and will be prioritized along with other project engineering requirements. The Proponent is committed to undertaking these activities and providing DFO with this information before the start of construction.

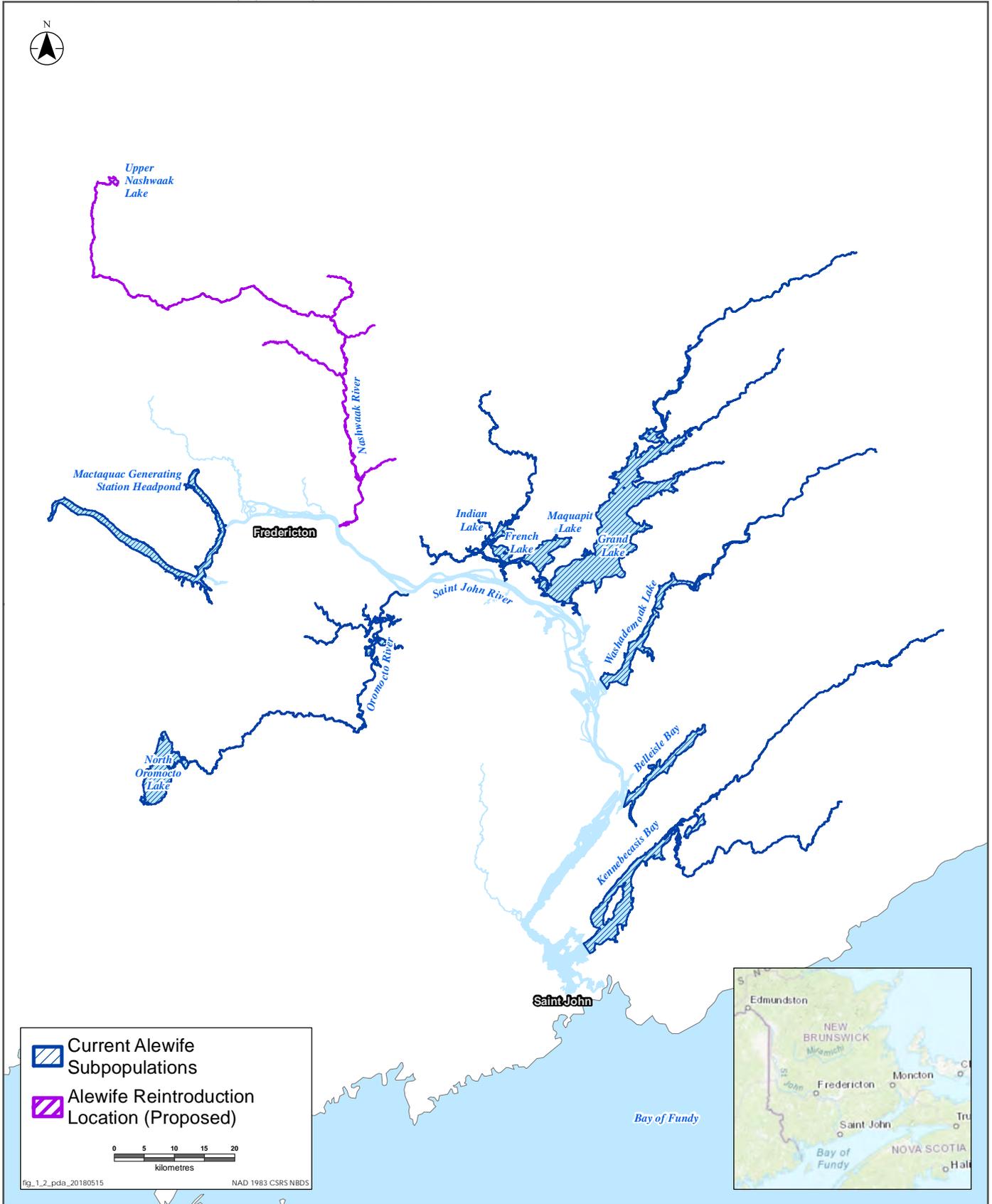
### 5.1.3 Conservation-focused Alewife Reintroduction Plan

#### 5.1.3.1 The Status of Alewife in the Nashwaak River Subwatershed

With respect to the Saint John River watershed, subpopulations of alewife currently occur above and below the Nashwaak River subwatershed. Specifically, subpopulations occur in six areas including Kennebecasis Bay, Bellisle Bay, Washademoak Lake, the Grand Lake system, North Oromocto Lake, and the Mactaquac Generating Station headpond (Figure 5.4; Jessop 1986). Based on an understanding of alewife ecology and habitat suitability, Upper Nashwaak Lake has similar characteristics to known alewife populations such as the North Oromocto Lake population (Saint John River Watershed) and the nearby Miramichi Lake population (Miramichi River Watershed) – which is located less than 20 km away from Upper Nashwaak Lake. However, to our knowledge, there is no record that historically confirms the presence of alewife in Upper Nashwaak Lake prior to the downstream development of water control dams and road crossing structures in the 18th and 19th centuries, though based on the habitat present and the regional distribution of alewife, it is likely alewife were present in Upper Nashwaak Lake before barriers were constructed.

To our knowledge, there has been no formal scientific effort to characterize the abundance and distribution of alewife in the Nashwaak River system. However, incidental catch data and anecdotal observations suggest that alewife and/or blueback herring, a closely-related sympatric species, are present. Specifically, DFO Science has provided a multi-year data set documenting incidental adult gaspereau (colloquial term for both alewife and blueback herring) observations at their Nashwaak River Atlantic salmon Counting Fence at Durham Bridge (Table 5.2; Figure 5.5). This information suggests that these fish are spawning in the system; however, it does not indicate where in the watershed spawning activity may be occurring nor does it clarify whether alewife and/or blueback herring are represented. Further, these data do not provide insight into population abundance because the spacing of the counting fence is wide enough to allow through passage for gaspereau. The New Brunswick Department of Transportation and Infrastructure (NBDTI) was also contacted regarding the presence/absence of alewife in the Nashwaak River. While no data is available, multiple anecdotal accounts of gaspereau have been noted, including observations upstream of the old Barker Dam site and Lower Nashwaak Lake (Ed Torenvliet, Biologist, NBDTI, Personal Communication, September 06, 2018).





Sources: Base Data - From the government of New Brunswick and Canada  
 Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL,

The biogeography of alewife subpopulations within the Saint John River Watershed

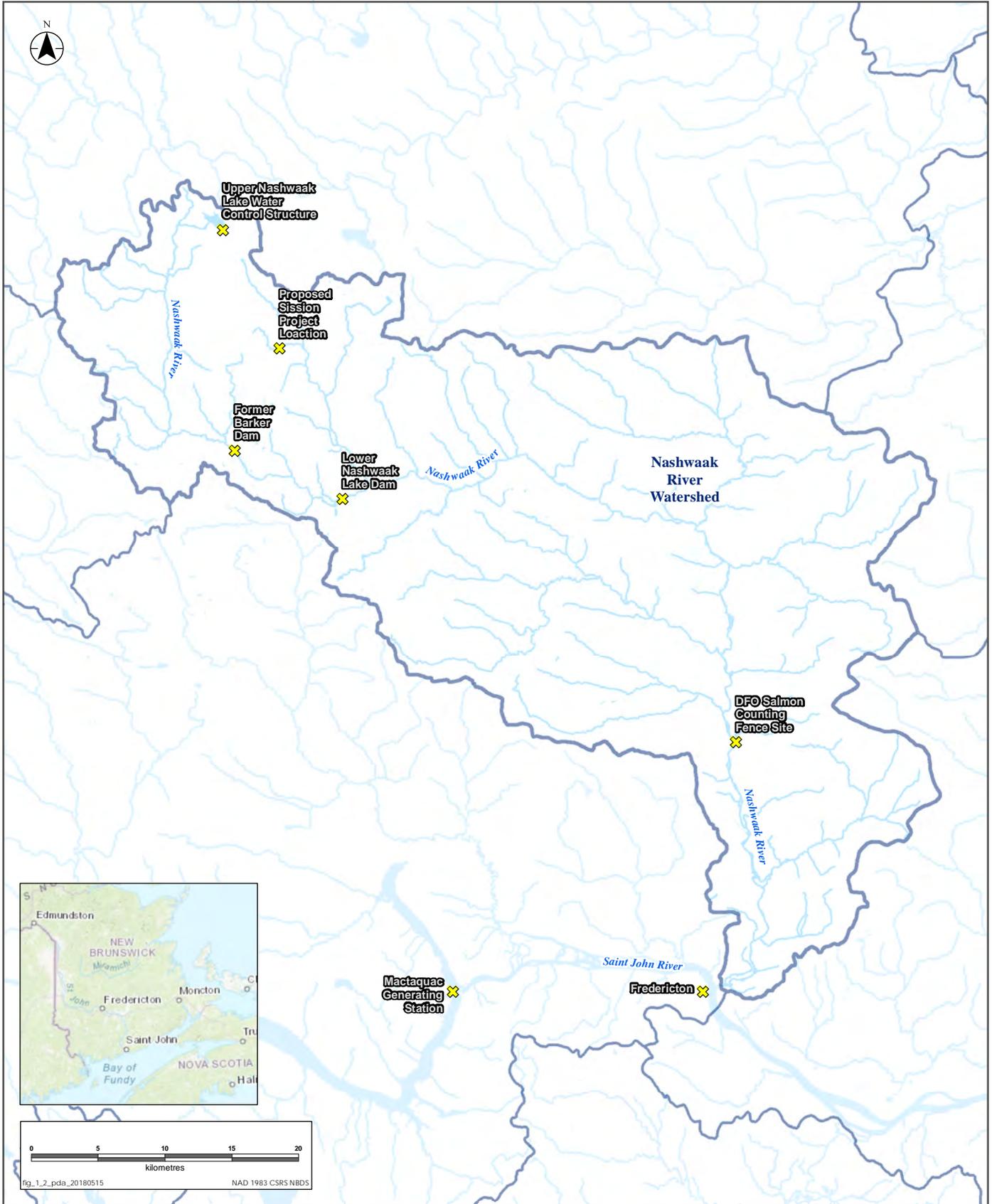
Sisson Project, Napadogan, N.B.

Figure 5.4

**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019





Sources: Base Data - From the government of New Brunswick and Canada  
Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL,

Locations of incidental and anecdotal observations of adult alewife within the Nashwaak River Subwatershed

Sisson Project, Napadogan, N.B.

Figure 5.5

**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

**Table 5.2 Incidental catches of Gaspereau at the Nashwaak River Counting Fence (Ross Jones, DFO Science, Personal Communication, September 17, 2018)**

Year	Observation Period	Count†	Mortalities‡
1993	Aug 19 - Oct 12	0	0
1994	July 15 - Oct 25	0	0
1995	Jul 12 - Oct 18	0	0
1996	Jun 13 - Oct 18	0	3
1997	Jun 18 - Nov 2	0	0
1998	Jun 8-Oct 27	0	2
1999	Jun 3 - Oct 13	0	0
2000	Jun 19 - Oct 26	0	0
2001	Jun 21 - Nov 1	0	0
2002	Jun 10 - Oct 28	0	21
2003	Jun 5 - Oct 26	2	16
2004	Jun 3 - Oct 26	2	4
2005	Jun 9 - Oct 7	0	2
2006	Jun 1 - Oct 20	0	0
2007	May 30 - Oct 30	0	8
2008	May 30 - Oct 22	0	0
2009	May 29 - Oct 4	0	0
2010	May 28 - Oct 27	3	7
2011	Jun 3 - Oct 16	0	3
2012	Jun 1 - Oct 12	1	5
2013	Jun 21 - Oct 7	0	22
2014	Jun 11 - Oct 10	0	0
2015	May 25 - Sept 30	1	10
2016	May 27 - Oct 11	0	39
2017	Jun 1 - Oct 10	0	24
2018	Jun 1 -	0	0

†Counts - fish caught in trap  
‡Mortalities - washed up on the upstream side of fence

While it does appear that gaspereau are utilizing some spawning habitat within the Nashwaak River watershed, Stantec was unable to demonstrate the presence of alewife in the upper watershed (upstream of Barker Dam) in the spring of 2018. The sparse evidence of gaspereau in the river suggests that the current population is well below the carrying capacity of the Nashwaak River system.



## **SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

The Nashwaak River subwatershed contains a small number of lakes and wetlands that could serve as spawning and juvenile-rearing habitat for alewife (NWA, 2017). Specifically, of the 20 lakes within the system, most are small (2-5 ha) and shallow ( $\leq 2$  m). The focus of the Offsetting Plan, Upper Nashwaak Lake, is the largest (112 ha) in the watershed and in the extreme upper reaches of the system. Therefore, if populations of alewife are spawning in the watershed, they are likely spawning in accessible small lakes and/or low flow river sections in the lower portion of the system.

Given that the prime alewife spawning habitat within the Nashwaak River watershed, Upper Nashwaak Lake, has been inaccessible for many years it is not surprising that there would be few migrating alewife in the system currently. Alewife demonstrate a high degree of spawning site fidelity; meaning adults generally return from sea to their natal spawning grounds (Jessop 1986). Given that the average generation time of alewife is 4-5 years (Jessop 1986; Figure 5.6), it is likely that over 40 alewife generations have passed with little to no accessible spawning habitat in the upper Nashwaak River system. Therefore, since alewife tend to home to their natal spawning grounds, it would be unexpected to find large numbers of alewife homing into the upper Nashwaak River watershed at present.

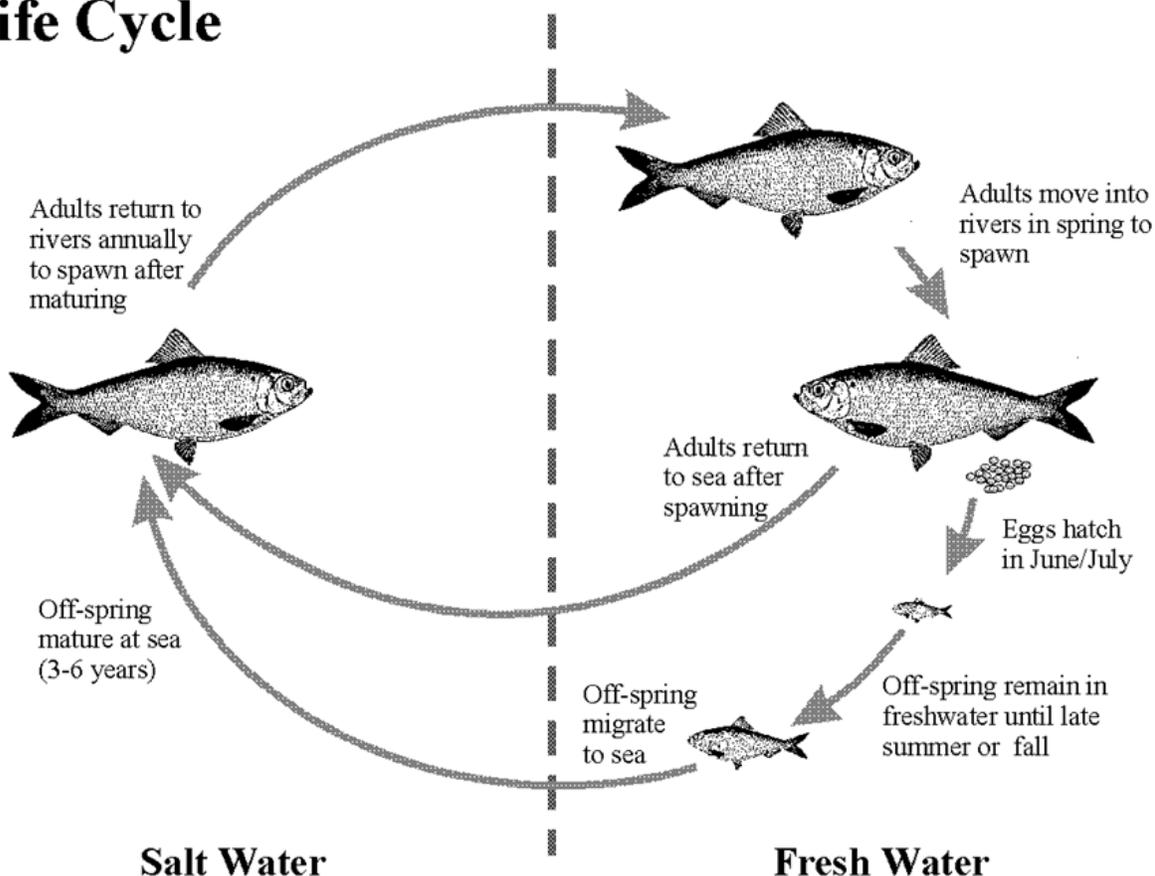
The previous Offsetting Plan (Stantec 2014) suggests that alewife will recolonize Upper Nashwaak Lake naturally following the removal of the water control structure. However, given the natural stray rate of alewife is low (Jessop 1986) and Upper Nashwaak Lake represents a substantial detour from current spawning locations, a reliance on natural recolonization is not anticipated to align with the timeline of Fisheries Authorization requirements to demonstrate the effectiveness of the Offsetting Plan. By reintroducing alewife into Upper Nashwaak Lake directly, the time at which we can anticipate evidence of a self-sustaining population is reduced, relative to natural recolonization, and the effectiveness monitoring could be planned around a predictable timeframe. Specifically, a returning adult spawning population would be expected 3-5 years after the first year of reintroduction (Jessop 1986; Gibson et al. 2007). Therefore, a conservation-focused alewife reintroduction plan is proposed in this Fisheries Offsetting Plan.



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

## Life Cycle



**Figure 5.6 The life cycle of anadromous alewife (From: Gibson et al. 2007)**

### 5.1.3.2 A Blueprint for Success - Alewife Reintroduction Programs in Maine

Alewife reintroduction programs have been successfully implemented in Maine, USA over the last several decades. Specifically, both the Penobscot River and Kennebec River Restoration Programs have utilized conservation-focused alewife reintroductions to facilitate restoration objectives because of similar concerns over natural recolonization timelines (MSPO 1993; MDMR 2009; Michael Bailey, US fish and Wildlife Service, Personal Communication, August 28, 2018). Over the last approximately 20 years, the Maine Department of Marine Resources has overseen alewife stocking initiatives in over 50 lakes (Mitch Simpson, Maine Department of Marine Resources, Personal Communication, September 24, 2018). While these initiatives have been overwhelmingly successful at reintroducing self-sustaining alewife populations, success has largely been measured by anecdotal observations of adult alewife returning to the lakes 3-5 years after stocking was implemented. However, there are data available for the Blackman Stream subwatershed of the Penobscot River, which provides scientifically defensible evidence of the productivity benefits of an alewife reintroduction program (Table 5.3). Prior to the construction of a fishway around an old dam on Blackman stream in 2009, alewives were not able to access the three



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Offsetting Plan/Fish Habitat Compensation Plan  
 May 28, 2019

upstream pond habitats. After stocking each pond for four consecutive years and providing fish passage, over half a million alewives are now spawning within this subwatershed. As Table 5.3 shows, adult alewife returned to spawn 4 years after they were first introduced, which is very much in line with the typical life cycle of alewife that includes 3-5 years at sea.

**Table 5.3 The number of spawning adult alewife released and the subsequent return estimates in a subwatershed of the Penobscot River, Maine, USA (Data adapted from Jason Valliere, Maine Department of Marine Resources, Personal Communication, September 12, 2018).**

Year	Adults Released (# Alewife)	Release Location†	Returning Adult Estimate (# Alewife) ‡
2010	7,548	Chemo Pond	---
2011	1,210	Chemo Pond	---
2012	7,171	Chemo Pond	---
2013	7,370	Chemo Pond	---
2014	4,110	Davis Pond, Holbrook Pond	187,004
2015	4,242	Davis Pond, Holbrook Pond	309,128
2016	4,104	Davis Pond, Holbrook Pond	468,656
2017	4,200	Davis Pond, Holbrook Pond	591,720
2018	---	---	540,003

† A subwatershed featuring Chemo, Davis and Holbrook Ponds that connect to the Penobscot River via Blackman Stream  
 ‡ Adult estimates based upon counts migrating up Blackman stream

**5.1.3.3 Conservation-focused Alewife Reintroduction Plan**

Methods and logistics of the proposed alewife reintroduction plan for Upper Nashwaak Lake are provided below. Fisheries and Oceans Canada has considered gaspereau stocking as an offsetting measure in recent years (DFO 2016), and advice therein has informed the development of this reintroduction plan. Further, the experiences of the State of Maine have also been considered during the development of this plan (MSPO 1993; MDMR 2009; Mitch Simpson, Maine Department of Marine Resources, Personal Communication, October 29, 2018).

The alewife reintroduction plan includes capturing wild returning adult alewife from the Mactaquac Generating Station fish lift and transporting them to Upper Nashwaak Lake over a period of five consecutive years. Juvenile alewife spend 3-5 years at sea prior to returning to their native lakes to spawn. A 5-year reintroduction program will facilitate continual juvenile production and develop a natural age distribution in the alewife population structure of Upper Nashwaak Lake (DFO 2016).

Sourcing the alewife for reintroduction from the Mactaquac Generating Station fish lift is desirable from both practical and ecological perspectives. From a practical perspective, this fish lift is already used to capture and transport large numbers of alewife and, therefore, provides a quick, reliable method to obtain



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

alewife for transport. From an ecological perspective, the alewife captured at this fish lift inhabit the same watershed as Upper Nashwaak Lake; limiting concerns regarding evolutionary compatibility and disease transfer. In fact, should Nashwaak Lake be recolonized naturally, it would likely be accomplished predominantly by straying individuals from the population migrating to the Mactaquac Generating Station headpond.

The proposed reintroduction target number for the 5-year plan is 15,000 alewife or 3,000 alewife per year. This target is estimated to represent 6% of the adult alewife carrying capacity of Upper Nashwaak Lake (Jessop 1999; Gibson et al. 2007; DFO 2016); providing a sufficient founder population to stimulate natural population growth. This estimate was produced by assuming the average adult alewife weighs 240 g (Jessop 1999) and that the carrying capacity of Upper Nashwaak Lake is consistent with the median value derived by Gibson et al. (2007) of 51.4 mt/km<sup>2</sup>.

The proposed reintroduction target number compares favourably with the successful reintroduction programs in the State of Maine. In Maine, the alewife stocking target is 6 fish per surface acre per year for a minimum of 4 years (MSPO 1993; MDMR 2009 Mitch Simpson, Maine Department of Marine Resources, Personal Communication, October 29, 2018). Given that the surface area of Upper Nashwaak Lake is approximately 275 acres, the State of Maine stocking target would be 1,650 fish per year. Therefore, the proposed reintroduction target of 3,000 fish per year is nearly double that which has been successfully used to reintroduce alewife in over 50 lakes in the State of Maine.

### Alewife Capture, Transport and Release

The alewife capture, transport and release plan, described below, is subject to change based upon the acquisition of new knowledge and experience that may maximize efficiencies and fish welfare. If, for any reason, alewife are not available from the Mactaquac Generating Station fish lift, other sources for the fish will be investigated, including obtaining them through the local commercial fishery.

While there is considerable overlap in the migration periods of alewife and blueback herring (approximately May 1 – July 1), alewife arrive in freshwater systems a few weeks earlier than blueback herring. Therefore, the proposed alewife reintroduction plan will be completed in early May each year to reduce the potential of incidental transfers of blueback herring.

Alewife will be transported by truck in oxygenated totes (insulated containers) or round tanks equipped with water pumps to provide circulation. These fish will be transferred by hand nets from the Mactaquac Generating Station fish lift facility into the transport totes. Following the experiences of the State of Maine, transport totes will not exceed a density of 1.5 fish/gallon (Mitch Simpson, Maine Department of Marine Resources, Personal Communication, October 29, 2018). To promote fish survival and welfare, both oxygen and temperature will be monitored in the totes during the approximately 2-hour transport period from the Mactaquac Generating Station fish lift to Upper Nashwaak Lake. Upon arrival, alewife will be released into Upper Nashwaak Lake with hand nets and buckets.



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

## 5.2 DETERMINATION OF OFFSETTING PLAN ECOLOGICAL VALUE

The proposed Fisheries Offsetting Plan intends to remove the last remaining anthropogenic upstream fish passage barriers (i.e. the Upper Nashwaak Lake water control structure and Lower Nashwaak Lake Dam) on the Nashwaak River leading to Upper Nashwaak Lake to facilitate the reestablishment of a self-sustaining alewife population. Alewife are a commercially important species, used fresh or salted for human consumption, and used as bait, fish meal and fish oil (Pardue 1983). Alewives spawn in large rivers, small streams, ponds and lakes (Pardue 1983). Further, the removal of upstream fish passage barriers has the potential to benefit other species, such as brook trout, by facilitating two-way habitat access, gene transfer, and increased prey availability. This section provides a justification of the proposed offsetting measures and their value as outlined in the Fisheries Productivity Investment Policy (DFO 2013a).

### 5.2.1 Suitability of Proposed Offsetting Plan

The Fisheries Productivity Investment Policy provides guidance on undertaking effective measures to offset serious harm to fish that are part of or support a commercial, recreational and/or aboriginal (CRA) fishery (DFO 2013a). Under this policy, four guiding principles are used to assess a proposed offsetting measure for fisheries protection. These principles are provided below with a commentary as to how the proposed offsetting plan aligns with this policy.

- *Offsetting measures must support fisheries management objectives or local restoration priorities.*  
The Project is located in the same watershed as the proposed offsetting measures. At this time, no well-defined fisheries management objectives for New Brunswick have been identified; however, local priorities do include the removal of anthropogenic barriers to fish migration, such as the removal of the two structures proposed herein. Further, as part of the Federal consultation process for the Sisson Mine Project, the Wolastqey Nation in New Brunswick (WNNB) expressed an interest in the removal of the anthropogenic barriers to fish migration proposed as part of this offsetting plan.
- *Offsetting measures benefits must balance project impacts.*  
It is anticipated that the Project will result in a loss of approximately 300 kg of fish production in a given year within the area of direct and indirect Project effects. This estimate of fish production accounts for all life stages and all species of fish within the area of disturbance which reside there. The area of direct and indirect effects is relatively undisturbed. Therefore, the loss of fish production is assumed to be representative of current fish production within these watercourses. The reintroduction of alewife into Upper Nashwaak Lake is anticipated to increase fish production (i.e., kg of fish produced). It is anticipated that juvenile alewife may fulfill a relatively untapped resource niche within Upper Nashwaak Lake as they feed on zooplankton within the pelagic zone. Through access to underutilized habitat in the pelagic zone it is anticipated that the offsetting plan will result in an increase in fish production within Upper Nashwaak Lake (i.e., increase in kg of fish) that will be greater than the loss as a result of the Project. This is discussed in more detail in Section 5.2.2.
- *Offsetting measures must provide additional benefits to the CRA fishery.*  
The reintroduction of alewife into Upper Nashwaak Lake is expected to facilitate an annual influx of marine-derived nutrients into the Nashwaak River watershed ecosystem. Such an influx is expected to positively affect nutrient cycling with reverberations throughout the freshwater food web (Best et al. 2018; Samways et al. 2018; Samways et al. 2015; Walters et al. 2009; Kircheis et al. 2002). Further,



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

early life stages of alewife provide a substantial food source for other fish species in the ecosystem, such as brook trout (Bolster 2008). Increased freshwater production of alewife also translates into more forage fish in the coastal marine environment. Therefore, the removal of the Upper Nashwaak Lake water control structure and Lower Nashwaak Lake Dam are anticipated to eventually enhance fisheries productivity in a large portion of the Nashwaak River watershed ecosystem, the Saint John River ecosystem, and the local marine coastal ecosystem within the Bay of Fundy.

- *Offsetting measures must generate self-sustaining benefits over the long term.*  
The removal of the Upper Nashwaak Lake water control structure and Lower Nashwaak Lake Dam will permanently remove anthropogenic barriers to fish passage in the Nashwaak River subwatershed. Further, under the Fisheries Productivity Investment Policy, the reintroduction program would be classified as a biological manipulation (DFO 2013a). Biological manipulations are acceptable under the Fisheries Productivity Investment Policy if DFO-FPP deem that the activity aligns with the guiding principles. The self-sustaining principle is frequently used as a case against stocking programs. However, in the case of the proposed reintroduction program, it is expected that a self-sustaining population will develop following the reintroduction program. Importantly, stocking in this case is a temporary effort to rapidly reintroduce a self-sustaining alewife population into presumed historical habitat.

### 5.2.2 Estimate of the Offsetting/Habitat Compensation Credit

In DFO's Fisheries Productivity Investment Policy (DFO 2013a), there are two different approaches that can be taken for offsetting measures: in-kind approaches, and out-of-kind approaches; both of which attempt to generate equivalency metrics to balance fisheries productivity offsetting gains with project losses (Bradford et al. 2016; DFO 2017). The in-kind approach aims to replace similar habitat (habitat type per unit area) that is destroyed or permanently altered due to a project with habitat of equivalent quantity and quality. The out-of-kind approach aims to identify equivalency metrics that are more directly linked to fisheries productivity such as habitat or ecosystem function, habitat suitability or capacity for selected species, fish abundance, fish production, fishery yield benefits, and/or monetary or other valuations (Bradford et al. 2016). The out-of-kind approach is most applicable for offsetting Projects that focus on differing species or habitat (i.e., brook trout habitat compared to alewife habitat). Under this proposed offsetting plan, an out-of-kind approach was considered to be the most appropriate; the riverine habitat (e.g., mostly brook trout) within the area of direct and indirect loss is proposed to be offset with primarily lake habitat (i.e., for alewife). Given that the fish community in the offsetting plan is unlike the affected one, fish production was the metric selected (DFO 2017). For commercial fisheries, fish production is often described in metric tons, but given the scale of production within the area of effects kilograms of fish was selected as the metric.

The offsetting plan is focused on increased fish production from juvenile alewife. It is acknowledged that other fish (e.g., sea-run brook trout) within the Nashwaak Watershed will likely benefit through increased marine derived nutrients, increased availability of prey and access to additional habitat, however these increases in overall fish production are more difficult to quantify and are not discussed below. It is noted that the presence of adult alewife will likely improve productivity within Nashwaak Lake through the addition of marine derived nutrients and provide food for other organisms though adult mortalities associated with spawning. The offsetting plan does not include consideration of the relocation of fish from



## **SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

the PDA prior to construction (i.e., transfer of production to another area), it only considers the loss of fish productivity in subsequent years following development of the Project.

### **5.2.2.1 Background**

The total surface area of Upper Nashwaak Lake is estimated as 1,123,800 m<sup>2</sup>.

There is currently no production of alewife within Upper Nashwaak Lake. The suitable habitat area that adult alewife will use for spawning in the lake is likely a fraction of the total area. However, juvenile alewife are planktivorous feeders in the pelagic zone of lakes and, therefore, may utilize the entire pelagic zone of the lake for foraging. Therefore, through decomposition and predation, the reintroduction of alewife is expected to enhance the availability of nutrients in the lake for use by all components of the ecosystem (Walters et al. 2009; Kircheis et al. 2002). It is also anticipated that juvenile alewife will likely fulfill a relatively untapped niche within Upper Nashwaak Lake as they feed on zooplankton within the pelagic zone. Access to underutilized habitat in the pelagic zone it is anticipated to result in an increase in alewife production within Upper Nashwaak Lake (i.e., increase in fish production measured by kg of fish).

### **5.2.2.2 Out-of-kind Offsetting Approach**

The project is anticipated to result in the loss of fish production (DFO 2017) equivalent to approximately 300 kg. The fish production estimate accounts for all life stages and species of fish which reside within the Project Area.

To estimate the amount of out-of-kind offsetting credit that would be achieved under the proposed offsetting plan, the fish production of alewife (kilograms of fish production lost) was determined by calculating the spawning adult carrying capacity and subsequent sea-bound juvenile production of Upper Nashwaak Lake, as they are related.

The spawning adult carrying capacity represents the maximum predicted number of spawning alewife that Upper Nashwaak Lake can support. Using a total surface area of 1,123,800 m<sup>2</sup> for Upper Nashwaak Lake, the spawning adult carrying capacity estimate was produced by assuming the average adult alewife weighs 240 g (Jessop 1999) and that the carrying capacity of Upper Nashwaak Lake is consistent with the median value derived by Gibson et al. (2007) of 51.4 mt/km<sup>2</sup>. Sea-bound juvenile production represents the number of juveniles that are estimated to migrate out of Upper Nashwaak Lake per year. Sea-bound juvenile production estimates were calculated using the relationships established among alewife history stages by Walton (1987); where spawning adult carrying capacity was used to estimate the maximum juvenile production for Upper Nashwaak Lake. An average weight of 3 g per juvenile emigrating alewife (~70 mm in length) was used to determine fish production (kilograms) of juvenile alewife from Upper Nashwaak Lake. The average weight of 3 g was based on previous field experience.

The maximum annual fish production in Upper Nashwaak Lake is estimated to be approximately 311,716 kg of juvenile alewife assuming the lake reaches its carrying capacity.



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

## 5.3 MEASURES TO AVOID ADVERSE ENVIRONMENTAL EFFECTS ON FISH DURING OFFSETTING PLAN IMPLEMENTATION

During the replacement of the Upper Nashwaak Lake water control structure and the removal of the remnants of Lower Nashwaak Lake dam, construction and erosion and sedimentation control methods will follow the Guidelines for Roads and Watercourse Crossing (NBDNR 2004). Attempts will be made to eliminate or reduce sediment-related problems by using erosion control (e.g., silt barriers, hay bales, erosion control blankets), and preventing deleterious substances from entering streams during removal and replacement activities, minimizing disturbance to the stream channel, retaining existing vegetation, re-vegetating, and stabilizing the site to prevent post-construction erosion (e.g., riprap).

To avoid adverse environmental effects during alewife reintroduction fish oxygen and temperature will be monitored during the approximately 2-hour transport period from the Mactaquac Generating Station fish lift to Upper Nashwaak Lake to promote fish survival and welfare.

## 5.4 PROPOSED MONITORING MEASURES TO ASSESS OFFSETTING

The proposed monitoring measures were developed in consideration of the guidance provided by DFO (2012b). The proponent will strive to engage First Nations and local stakeholder groups as appropriate to deliver aspects of the offsetting monitoring plan proposed below.

### 5.4.1 Upper Nashwaak Lake Water Control Structure Replacement

Following the removal and replacement of the Upper Nashwaak Lake Water Control Structure, *functional* and *effectiveness* monitoring is proposed. With respect of *functional* monitoring, a topographical survey of the reconstructed channel will be collected, and these data will be input into a HEC-RAS model (USACE 2010) to predict water velocity and depth. This information will then be used to validate the initial fish passage assessment predictions. The proponent will prepare a memo for DFO that summarizes the results of this effort. This component of the offsetting plan will be considered successful if the velocities from the fish passage evaluation are suitable for the passage of alewife during flows typical of those experienced during the adult spawning migration (i.e. May and June).

Further, the success of alewife upstream passage will be *effectively* monitored by providing direct evidence of adult alewife passing into Upper Nashwaak Lake 3-5 years following the initiation of the conservation-focused alewife reintroduction plan. Specifically, physical evidence documenting spawning adult alewife entering Upper Nashwaak Lake will be provided through photographic or video evidence.

### 5.4.2 Lower Nashwaak Lake Dam Removal

Following the removal of the remnant Lower Nashwaak Lake Dam structures and channel reconstruction, *functional* and *effectiveness* monitoring is proposed. With respect of *functional* monitoring, a topographical survey of the reconstructed channel will be collected, and the data will be input into a HEC-RAS model (USACE 2010) to predict water velocity and depth and verify fish passage. The proponent will prepare a memo for DFO that summarizes the results of this effort. This component of the offsetting plan



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

will be considered successful if the velocities from the fish passage evaluation are suitable for the passage of Atlantic salmon, brook trout, alewife, blueback herring, and American shad.

Further, the success of alewife upstream passage will be *effectively* monitored by providing direct evidence of adult alewife passing into Upper Nashwaak Lake 3-5 years following the initiation of the conservation-focused alewife reintroduction plan. Specifically, physical evidence documenting spawning adult alewife entering Upper Nashwaak Lake will be provided through photographic or video evidence. The presence of alewife entering Upper Nashwaak Lake provides evidence of successful passage at the previous Lower Nashwaak Lake location because the latter is further downstream.

### 5.4.3 Conservation-focused Alewife Reintroduction Plan

The alewife reintroduction plan will be assessed using *effectiveness* monitoring measures. The reintroduction plan includes capturing wild returning adult alewife from the Mactaquac Generating Station fish lift and transporting them to Upper Nashwaak Lake over a period of five consecutive years. The *effectiveness* monitoring of the reintroduction plan will demonstrate the presence of both returning adult alewife in the spring (i.e. May and June) and the presence of sea-bound juvenile alewife in the late summer (i.e. August and September) for three consecutive years. Presence will be determined by physically documenting alewife in Upper Nashwaak Lake at both adult and juvenile life-history stages through photographic evidence. If required, trapping methods (e.g. fyke or gill netting) will be used to demonstrate the presence of alewife. Each year of the plan, the Proponent will provide DFO with a brief report documenting the results of the *effectiveness* monitoring.

The goal of the *effectiveness* monitoring plan for the alewife reintroduction program is to demonstrate the successful creation of a self-sustaining alewife population. Therefore, the timing of this *effectiveness* monitoring plan must account for the lifecycle of alewife. The 5-year reintroduction plan is anticipated to overlap with the natural return of earlier cohorts of alewife that were produced in the lake because juveniles spend 3-5 years at sea prior to returning to their native lakes to spawn. Therefore, to provide evidence of a self-sustaining population, it is proposed that the three-year adult and juvenile monitoring plan be initiated the year following the final year of adult alewife stocking.

## 5.5 CONTINGENCY MEASURES FOR THE OFFSETTING PLAN

The proponent presented DFO with three potential contingency measures for the Offsetting Plan on September 7, 2018. Among these was the removal of the remnant Lower Nashwaak Lake Dam structures. Through discussions with DFO and upon recognition that, through consultation, the Wolastqey Nation in New Brunswick (WNNB) have recommended Lower Nashwaak Lake Dam as a desirable offsetting option, the proponent has included this activity within the current proposed Offsetting Plan. The proponent understands that DFO considers the inclusion of the removal of the remnant Lower Nashwaak Lake Dam to be a proactive activity that may be considered as a contingency measure should the alewife reintroduction plan fail.

Should further contingency measures be required, further research and investigation into the following two projects will be considered.



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Offsetting Plan/Fish Habitat Compensation Plan  
May 28, 2019

### 5.5.1 Contingency Option 1: Hargrove Dam (Monquart River Watershed)

The Hargrove Dam is a small, privately owned hydroelectrical station on the Monquart River upstream of Bath, NB (46.517212°N, 67.595713°W). The facility was built in the early 1960's and remains in operation to date (Figure 5.4). The facility contains no upstream or downstream fish passage. In 1965, a netting and truck transfer system was established for Atlantic salmon (Smith 1969). However, no fish passage has been offered at this site for many years and as a result the dam acts a complete barrier to the upstream movement of all fish species. Returning habitat connectivity to the Monquart River system is expected to benefit the fish assemblage by facilitating the return of diadromous fish species. For example, productive juvenile Atlantic salmon habitat above Hargrove Dam is estimated at 5,110,000 m<sup>2</sup> (Marshall et al. 1997). The Sisson Mine development would impact 54,400 m<sup>2</sup> of fish habitat, suggesting that the Hargrove Dam removal would provide sufficient fisheries productivity offsetting. Further, DFO Science estimates that the habitat above the Hargrove Dam is among the most productive Atlantic salmon juvenile habitat in the Saint John River watershed (Ross Jones, DFO, Personal Communication, September 04, 2018).

A key unknown element with respect to the eligibility of the Hargrove Dam as a contingency Offsetting Plan is the interest of current ownership in making the facility available. Based on Figure 1, the Hargrove Dam does not appear to be a good candidate for the retrofit of upstream and downstream passage. Therefore, dam removal is expected to be the only viable option. Discussions with ownership would be required as a prerequisite to further exploration of the Hargrove Dam removal as a viable contingency Offsetting Plan.



**Figure 5.7 The Hargrove Hydro Dam of the Monquart River, circa 1999 (Photo Credit: Ross Jones, DFO Science)**

### 5.5.2 Contingency Option 2: Pinder Dam (Nackawic River Watershed)

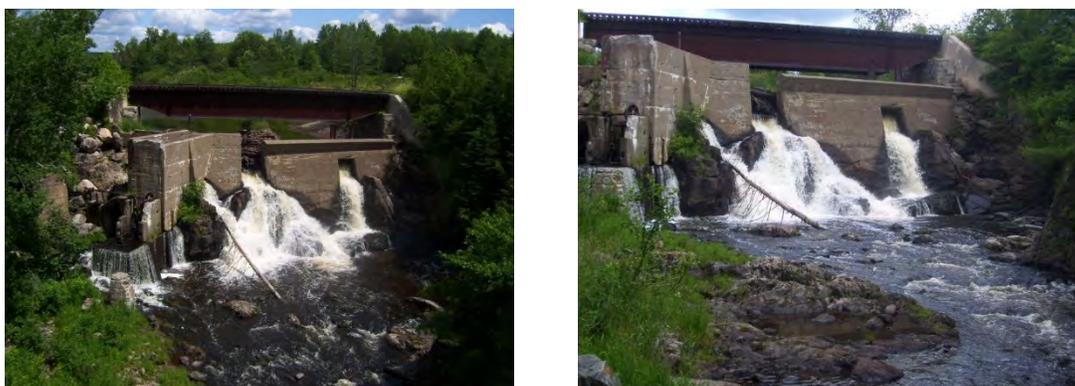
The Pinder Dam is a dilapidated structure formerly used for the operation of an old mill (Smith 1969) and it is located on the east branch of the Nackawic River. Although this needs to be confirmed, it is believed to be under the ownership of the Province of New Brunswick. The facility does not provide dedicated upstream or downstream fish passage (Figure 5.5) and could be considered a complete barrier to the upstream movement of all fish species. Similar to Option 1, returning habitat connectivity to the east branch of the Nackawic River system is expected to benefit the fish assemblage by facilitating the return



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

Offsetting Plan/Fish Habitat Compensation Plan  
 May 28, 2019

of diadromous fish species. For example, productive juvenile Atlantic salmon habitat above Pinder Dam is estimated at 5,104,000 m<sup>2</sup> (Marshall et al. 1997). This compares favourably with the 54,400m<sup>2</sup> that would be lost as part of the Sisson Mine development would impact 54,400 m<sup>2</sup> of fish habitat, suggesting that the Pinder Dam removal would provide sufficient fisheries productivity offsetting (Marshall et al. 1997). Further, DFO Science estimates that the habitat above the Pinder Dam provides Atlantic salmon juvenile habitat that is above average, in terms of productivity, relative to other systems in the Saint John River watershed (Mr. Ross Jones, DFO, Personal Communication, September 04, 2018).



**Figure 5.8 The Pinder Dam of the Nackawic River (Photo Credit: Ross Jones, DFO Science)**

**5.6 COST AND TIMELINE OF IMPLEMENTING THE OFFSETTING PLAN**

The proposed offsetting plan will be implemented during Construction of the Project, after the Fisheries Act Authorization and other required approvals has been obtained. The proposed schedule to complete the various activities associated with the FHCP are subject to the timing of other necessary construction permits, market conditions, project financing, and a final approval by the Proponent to proceed. Assuming these approvals are obtained by June 30, 2019 estimated costs and timeline associated with the implementation of the offsetting plan are provided in Table 5.6.

**Table 5.4 High Level Costs Associated with Implementing the Proposed Offsetting Plan**

Activity	Estimated Cost	Proposed Schedule
Upper Nashwaak Lake Water Control Structure Removal and Replacement	\$185,000	2019
Lower Nashwaak Lake Dam Remnants Removal	\$602,000	2020
Conservation-focused Alewife Reintroduction Program	\$107,000	2020-2025
Fisheries Offsetting Monitoring Plan	\$60,000	2026-2029
<b>Total</b>	<b>\$954,000</b>	<b>-----</b>



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

Conclusion  
May 28, 2019

## 5.7 LAND ACCESS

The Upper Nashwaak Lake water control structure (PID 13003473) and the remnants of Lower Nashwaak Lake dam (PID 75140541) are located on Crown land. Land access will be managed in consultation with NBDNR and the Crown Timber Licensee for the property. Licenses of Occupation will be obtained from NBDNR to enable each of these works. Notice of the construction will be provided to the residents/camp owners in the area prior to commencement.

## 6.0 CONCLUSION

This information contained within this report represents the information requirements for authorization of the Sisson Project under the *Fisheries Act* and support the listing the Project tailings storage facility (TSF) in Schedule 2 of the *Metal and Diamond Mining Effluent Regulations*. The information requirements for a Section 35(2) *Fisheries Act Authorization* are described in Schedule 1 of the Applications for Authorization under Paragraph 35(2)(b) of the *Fisheries Act Regulations* under the *Fisheries Act*.

The Sisson Project is an open-pit molybdenum and tungsten mine located near Napadogan, New Brunswick and proposed by Sisson Mines Ltd. The Sisson Project is expected to result in serious harm to fish and fish habitat in Sisson Brook, Bird Brook, Tributary A to West Branch Napadogan Brook, lower Napadogan Brook, and three small headwater tributaries in McBean Brook. There are fish residing in all the watercourses where effects are expected. Serious harm will result to fish and fish habitat that are part of CRA fisheries from the permanent destruction of fish habitat during the Construction phase from site preparation of the Open Pit and TSF, and due to flow reductions during the Construction and Operation phases in residual streams and lower Napadogan Brook. The Project is anticipated to result in serious harm arising from the loss of 54,400 m<sup>2</sup> of fish habitat and an approximate loss of approximately 300 kg of fish production. The species that will be affected are common to watersheds throughout New Brunswick and include brook trout; blacknose dace; creek chub, common shiner; American eel; slimy sculpin; sea lamprey; white sucker; pearl dace; blacknose shiner; and longnose sucker.

The Offsetting Plan contained within this document proposes to offset the serious harm resulting from the Project by:

- The removal and replacement of the water control structure at the outlet of Upper Nashwaak Lake;
- The removal of the remnants of Lower Nashwaak Lake Dam (i.e. Lower Lake Dam or Irving Dam), and;
- The implementation of a 5-year conservation-focused alewife Upper Nashwaak Lake reintroduction plan.

The proponent has estimated that this offsetting plan could result in 311,716 kg of fish production from juvenile alewife alone. Further, the reintroduction of alewife into Upper Nashwaak Lake is expected to facilitate an annual influx of marine-derived nutrients and increased prey (juvenile or adult gaspereau) into the Nashwaak River watershed ecosystem. Such an influx is expected to positively affect nutrient cycling with reverberations throughout the freshwater food web that has the potential to increase the productivity



# SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

## References

May 28, 2019

of other fish species in the Nashwaak river watershed (Best et al. 2018; Samways et al. 2018; Samways et al. 2015; Walters et al. 2009; Bolster 2008; Kircheis et al. 2002). Thus, the proposed offsetting plan is anticipated to exceed the project losses.

## 7.0 REFERENCES

- Almeda, H. 2018. Re: Milltown Dam Anadromous Fish Count Weekly Report July 12-18. Message to Ron Neathway. August 1, 2018. Email.
- Bailey, Michael. Personal communication. August 28, 2018. Assistant Project Leader, US Fish and Wildlife Service.
- Best, B.L., Gibson, A.J., O'Malley, A.J., and J. Zydlewski. 2018. Does what goes up also come down? Using a recruitment model to balance alewife nutrient import and export. *Marine and Coastal Fisheries*. 10(2): 236-254.
- Bolster W.J. 2008. Putting the ocean in Atlantic history: Maritime communities and marine ecology in the northwest Atlantic, 1500–1800. *The American Historical Review* 113: 19–47.
- Bradford, M.J., Smokorowski, K.E. Clarke, K.D., Keatley, B.E. and Wong, M.C. 2016. Equivalency metrics for the determination of offset requirements for the Fisheries Protection Program. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/046. vi+32 p.
- Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish*, Second Edition. EPA 841-B-99-002. US Environmental Protection Agency; Office of Water; Washington, D.C.
- CCME. 1999. *Water Quality Guidelines for the Protection of Aquatic Life*. In: *Canadian Environmental Quality Guidelines*. Updated, 2001, 2002, 2003, 2005, 2006, and 2007. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba. Available online at: <http://ceqg-rcqe.ccme.ca/>.
- Chaput, G., D. Moore, and D. Peterson. 2005. Predicting Atlantic Salmon (*Salmo salar*) Juvenile Densities Using Catch Per Unit Effort Open Site Electrofishing. *Canadian Technical Report of Fisheries and Aquatic Sciences* 2600.
- Conservation Ontario. 2005. *Establishing Environmental Flow Requirements*. Synthesis Report. <http://www.conservation-ontario.on.ca/projects/pdf/Synthesis.pdf>
- DFO (Fisheries and Oceans Canada). 2012a. Status of Atlantic salmon in Salmon Fishing Areas (SFAs) 19-21 and 23. DFO Canadian Science Advisory Secretariat Science Response. 2012/014.



## **SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

### References

May 28, 2019

- DFO (Fisheries and Oceans Canada). 2012b. Assessing the effectiveness of fish habitat compensation activities in Canada: monitoring design and metrics. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/060.
- DFO (Fisheries and Oceans Canada). 2013a. Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting. Department of Fisheries and Oceans Canada. Available online at: <http://www.dfo-mpo.gc.ca/pnw- ppe/offsetting-guide-compensation/index-eng.html>.
- DFO (Fisheries and Oceans Canada). 2013b. Science Advice to Support Development of a Fisheries Protection Policy for Canada. DFO Canadian Science Advisory Secretariat Science Advisory Report. 2012/063.
- DFO (Fisheries and Oceans Canada). 2013c. A Science-Based Framework for Assessing the Response of Fisheries Productivity to State of Species or Habitats. DFO Canadian Science Advisory Secretariat Science Advisory Report. 013/067.
- DFO (Fisheries and Oceans Canada). 2016. Habitat, Passage and Stocking Considerations for Gaspereau at Sandy Lake, Nova Scotia. DFO Can. Sci. Advis. Sec. Sci. Resp. 2016/005
- DFO (Fisheries and Oceans Canada). 2017. Science advice on the determination of offset requirements for the fisheries protection program. DFO Can. Sci. Advis. Sec. Rep. 2017/009.
- Environment Canada. 2013. Guidelines for the Assessment of Alternatives for Mine Waste Disposal. Environment Canada, Mining and Processing Division, Ottawa, Ontario. March 2011.
- FishXing Version 3, 2013. FishXing and Learning Systems for Fish Passage through Culverts. Available online at: <http://stream.fs.fed.us/fishxing/download.html>. Last accessed May 21, 2013.
- Fjeldstad, H.P. 2012. Atlantic Salmon Migration Past Barriers. Ph.D. Dissertation. Norwegian University of Science and Technology, Faculty of Engineering Science and Technology, Department of Hydraulic and Environmental Engineering.
- Gibson, A.J.F., Bowlby, H.D., and Keyser, F.M. 2017. A Framework for the Assessment of the Status of River Herring Populations and Fisheries in DFO's Maritimes Region. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/105. vi + 69 p.
- Goreham, R. and H. Almeda. 2017. 2017 Milltown Fishway Research Trap Report. Prepared by the St. Croix International Waterway Commission.
- Hayne, D.W. 1949. Two methods of estimating population from trapping records. *Journal of Mammology*. 30:399-411.
- Hooper, W.C., L. McCabe, and T. Robertson. 1995. A Standardized Fisheries Stream Survey Approach for Atlantic Canada. Department of Natural Resources and Energy. Fredericton, New Brunswick.



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

### References

May 28, 2019

- Jessop, B. M. 1986. The Status of the Alewife and Blueback Herring Trap-net Fishery of the Saint John River, New Brunswick. Canadian Atlantic Fisheries Scientific Advisory Committee. Research Document 86/12. Available at: <http://www.dfo-mpo.gc.ca/library/90426.pdf>.
- Jessop, B.M. 1999. The Status (1960-1997) of Alewife and Blueback Herring Stocks in the Scotia-Fundy Area as Indicated by Catch-effort Statistics. DFO Can. Sci. Advis. Sec. Res. Doc. 99/117.
- Jones, Ross, Personal communication, September 04, 2018. Salmon Assessment Biologist, Fisheries and Oceans Canada.
- Jones, Ross. Personal communication. September 17, 2018. Salmon Assessment Biologist, Fisheries and Oceans Canada.
- Katopodis, C. and R. Gervais. Fish swimming performance database and analysis. Canadian Science Advisory Secretariat (CSAS). Research Document 2016/002.
- Kircheis, F.W., Trial, J.G., Boucher, D.P., Mower, B., Squires, T., Gray, N., O'Donnell, M., and J. Stahlnecker. 2002. Analysis of Impacts Related to the Introduction of Anadromous Alewives into a Small Freshwater Lake in Central Maine, USA. Maine Department of Inland Fisheries and Wildlife.
- Knight Piésold 2012. 2011 Hydrometeorology Report. Prepared for Northcliff Resources, July 31, 2012.
- Larinier, M. 2001. Environmental issues, dams and fish migration. Dams, fish and fisheries: opportunities, challenges and conflict resolution. FAO Fish Tech Pap 419:45–90.
- NBDNR (New Brunswick Department of Natural Resources). 2004. Guidelines for Roads and Watercourse Crossings. New Brunswick Department of Natural Resources. April 20, 2004.
- NWAI (Nashwaak Watershed Association Inc.). 2017. State of the Nashwaak River Watershed. Available at: <https://www.nashwaakwatershed.ca/wp-content/uploads/STATE-OF-THE-NASHWAAK-RIVER-WATERSHED-Corrected-MAY.pdf>.
- Marshall, T.L. Jones, R.A., and T. Pettigrew. 1997. Status of Atlantic salmon stocks of southwest New Brunswick, 1996. Department of fisheries and Oceans. Canadian Stock Assessment Secretariat. Research Document 97/27.
- MDMR (Maine Department of Marine Resources). 2009. Operational plan for the restoration of diadromous fishes to the Penobscot River, Maine Department of Marine Resources.
- MSPO (Maine State Planning Office). 1993. Kennebec River Resource Management Plan". Maine State Planning Office. Paper 78. [http://digitalmaine.com/spo\\_docs/78](http://digitalmaine.com/spo_docs/78).
- Pardue. 1983. Habitat Suitability Index Models: Alewife and Blueback Herring. U.S. Dept. Int. Fish. Wildl. Serv. FWS/OBS-82/10.58. 22 pp.



## SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN

### References

May 28, 2019

- Samways, K.M., Quinones-Rivera, Z.J., Leavitt, P.R., and R.A. Cunjak. 2015. Spatiotemporal responses of algal, fungal, and bacterial biofilm communities in Atlantic rivers receiving marine-derived nutrient inputs. *Freshwater Science*. 34(3): 881-896.
- Samways, K.M., Soto, D.X., and R.A. Cunjak. 2018. Aquatic food-web dynamics following incorporation of nutrients derived from Atlantic anadromous fishes. *Journal of Fish Biology*. 92(2): 399-419.
- Simpson, Mitch. Personal Communication. September 24, 2018. Marine Resource Scientist 2, Maine Department of Marine Resources.
- Simpson, Mitch. Personal Communication. October 29, 2018. Marine Resource Scientist 2, Maine Department of Marine Resources.
- Stantec. 2011. Project Description: Sisson Project. Prepared for Northcliff Resources Ltd. By Stantec Consulting Ltd., Fredericton, New Brunswick. April 15, 2011.
- Stantec. 2012a. Sisson Project: Baseline Aquatic Environment Technical Report. Prepared for Northcliff Resources Ltd. by Stantec Consulting Ltd., Fredericton, New Brunswick. June 1, 2012.
- Stantec. 2012b. Sisson Project: Development of Potential HADD Areas Along Napadogan Brook (Wetted Perimeter Modelling). Prepared for Northcliff Resources Ltd. by Stantec Consulting Ltd., Fredericton, New Brunswick. December 18, 2012.
- Stantec. 2013a. Sisson Project: Environmental Impact Assessment Report. Prepared for Northcliff Resources Ltd. by Stantec Consulting Ltd., Fredericton, New Brunswick. July, 2013.
- Stantec. 2013b. Sisson Project: Lower Lake Dam Fish Passage Evaluation Report (Revision 1). Preliminary Draft for DFO Review. Prepared for Northcliff Resources Ltd. by Stantec Consulting Ltd., Fredericton, New Brunswick. November 26, 2013.
- Stantec. 2014. Sisson Project: Information Requirements in Support of the Application for *Fisheries Act* Authorization, and Offsetting Plan. Prepared for Sisson Mines Limited by Stantec Consulting Limited, Fredericton, New Brunswick. June 13, 2014.
- Smith, K.E.H. 1969. Compendium: St. John River System, NB. Environment Canada, Resource Development Branch. Manuscript Report No. 69.6.
- Torenvliet, Ed. Personal communication. September 06, 2018. Biologist, New Brunswick Department of Transportation and Infrastructure.
- USACE (United States Army Corps of Engineers). 2016. HEC-RAS River Analysis System. Hydraulic Reference Manual. Version 5.0. February 2016. CDP-69pp.
- Valliere, Jason. Personal communication. September 12, 2018. Marine Resource Scientist 1, Maine Department of Marine Resources.



**SISSON PROJECT: REVISED INFORMATION REQUIREMENTS IN SUPPORT OF THE APPLICATION FOR FISHERIES ACT AUTHORIZATION, AND OFFSETTING PLAN**

References

May 28, 2019

- Walters, A.W., R.T. Barnes, and D.M. Post. 2009. Anadromous alewives (*Alosa pseudoharengus*) contribute marine-derived nutrients to coastal stream food webs. *Canadian Journal of Fisheries and Aquatic Sciences*. 66:439-448.
- Walton, C. J. 1987. Parent-progeny relationship for an established population of anadromous alewife in a Maine lake. *American Fisheries Society Symposium* 1: 451-454.
- Zippin, C. 1956. An evaluation of the removal method of estimating animal populations. *Biometrics*. 12:163-189.

