Report (Rev.3)

File Name: NWMO_BIS_2020_BPD Report_IG (R003)

BIODIVERSITY IMPACT STUDIES - NORTHWESTERN ONTARIO REGION: BASELINE PROGRAM DESIGN

July 29, 2021

PREPARED BY Zoetica Environmental Consulting Services

SUBMITTED TO Melissa Mayhew
Nuclear Waste Management Organization
22 St. Clair Avenue East
Fourth Floor, Toronto, ON
M4T 2S3, Canada

ZOETICA ENVIRONMENTAL CONSULTING SERVICES

OFFICE 102-22351 St Anne Ave, Maple Ridge, BC, V2X 2E7
PHONE 604 467 1111
WEBSITE www.zoeticaenvironmental.com

Revision History

Project Title: NWMO Biodiversity Impact Studies

Document Title: Biodiversity Impact Studies – Northwestern Ontario Region: Baseline Program Design

Document File Name: NWMO_BIS_2020_BPD Report_IG (R003)

Rev. #	Issue Date	Description	Prepared By	Reviewed By	Approved By
R000	15-Sep-2020	BIS Year 1 final submission to NWMO	C. Chui, D. MacKinnon, T. Taylor, J.B. Allen	A. Buckman	H. Bears
R001	17-Dec-2020	- Additions of maps and reach tables for Aquatic Habitat Mapping SOP. Additions of 2 forms to Aquatic Habitat Mapping SOP and updates to methods in Aquatic Habitat Mapping SOP to supplement forms. - Changes in BPD Report to Sections 2.3.2.3.1.2 and 2.3.2.3.1.3 for desk-based methods of reach selection for field sampling. - Additions of maps and lists of field survey points for eDNA (in eDNA SOP) and TEM (in TEM and Habitat Suitability SOP). - Edited number of habitat groupings for eDNA study design from 7 to 6 (Section 2.6.2.3).	D. MacKinnon, C. Chui	A. Buckman	H. Bears
R002	21-Apr-2021	**eDNA Studies** - Updated with new best practices and guidelines (2.6.1.3). - Corrected sample sizes from GRTS and added Table 2-14 (2.6.2.3). - Changed Year 1 plan (2.6.3.1); updated survey crew and roles (2.6.3.2, 2.6.3.3). - Adjusted seasonal timing windows based on local information (2.6.3.1; Tables 2-15, 2-16, 2-17). - Noted additional laboratory controls (2.6.3.6). - See revision history table in SOP. **Terrestrial Ecosystem Mapping** - Clarified that 55% of ecosites will be surveyed in Year 1 for TEM (2.1.2.3.2). - Removed specific field gear (2.1.3.3); refer to TEM SOP. - See revision history table in SOP. **Aquatic Habitat Mapping**	C. Chui, D. MacKinnon	A. Buckman	H. Bears

		- Moved wetland descriptions from 2.4.2.3.1.3 into Glossary. - Removed specific field gear (2.4.3.3); refer to Aquatic Habitat Mapping SOP. - See revision history table in SOP. **Identification of SWH** - Separated SWH from Habitat Suitability Modelling; new Sections 2.3, 2.7.3 with more details. - Added field data entry and management steps; clarification on field data transfer and QA/QC steps (1.9.1). - Removed Figure 2-1 to focus on Tier 1 studies; removed Drone Pilot Program from Year 1 plan in Table 2-1. - Minor edits for language, timing, clarity; copyedits and formatting (throughout). - Replaced Figure 1-3(a) with an updated figure.			
R003	29-Jul-2021	**Potential Project Interactions** - Updated matrix (Table 1-3). **Data Management** - Added brief instructions for digital field data forms. **Identification of SWH** - Clarified definitions of candidate and confirmed SWH and plan for Tier 1 vs. Tier 2 studies. **eDNA Studies** - Added more details about site information to record, field equipment, receiving laboratory. - Revised plan for mobile sampling based on field logistics in NW Ontario. **SOPs** - Updated SOPs for AHM, TEM/HSM/SWH, and eDNA to reflect changes from feedback received during field training and to provide clarification. Updated report sections where needed. **General** - Updated SAR statuses as applicable. - Minor edits for language, timing, clarity; copyedits and formatting (throughout).	A. Buckman, D. MacKinnon, C. Chui	H. Bears	H. Bears

Signature Page

Section	Written By	Reviewed By	Senior Reviewed and Approved by
1.0-1.2	H. Bears, D. MacKinnon	A. Buckman	A. Buckman
1.3	A. Buckman	H. Bears	H. Bears
1.4	T. Taylor, D. MacKinnon	A. Buckman	H. Bears
1.5-1.8	H. Bears	A. Buckman	A. Buckman
1.9	D. MacKinnon, C. Chui	H. Bears	H. Bears
1.10	C. Chui	H. Bears	H. Bears
2.0-2.1	J.B. Allen, D. MacKinnon	C. Chui	H. Bears
2.2	A. Buckman	H. Bears	H. Bears
2.3	D. MacKinnon, C. Chui	A. Buckman	H. Bears
2.4	A. Buckman	H. Bears	H. Bears
2.5	T. Taylor	H. Bears	H. Bears
2.6	C. Chui	A. Buckman	H. Bears
2.7	T. Taylor, D. MacKinnon	A. Buckman	H. Bears
3.0	T. Taylor, A. Buckman	C. Chui	H. Bears
Appendix A	See Revision History tables in SOPs		

Signatures:

Heather Bears
Principal, Senior Ecologist (M.Sc., Ph.D., R.P.Bio.)

Andrea Buckman
Senior Ecologist (Ph.D., R.P.Bio.)

Celia Chui
Wildlife Biologist (M.Sc., R.P.Bio.)

Deanna MacKinnon
GIS Specialist (B.Sc. Phys. Geog.)

Tomas Taylor
Wildlife Biologist (M.Sc.)

Jimmy Brett Allen
Senior Vegetation & Ecosystem Biologist
(R.P.Bio., R.P.P., M.C.I.P.)

Table of Contents

List of Figures

List of Tables

List of Appendices

GLOSSARY AND ABBREVIATIONS

AOI	Area of Interest
APM	Adaptive Phased Management
ATV	All-Terrain Vehicle
BACI	Before-After-Control-Impact
BIS	Biodiversity Impact Studies
BPD Report	Biodiversity Impact Studies – Northwestern Ontario Region: Baseline Program Design Report
BPPA Report	Biodiversity Impact Studies – Northwestern Ontario Region: Best Practices and Preferred Approach Report
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
COSSARO	Committee on the Status of Species at Risk in Ontario
CWD	Coarse Woody Debris
DGR	Deep Geological Repository
eDNA	Environmental DNA
ELC	Ecological Land Classification
EDMS	Electronic Document Management System
EMBP	Environmental Media Baseline Program
FRI / eFRI	Forest Resource Inventory / Enhanced Forest Resource Inventory
FWIS	Ontario Flowing Waters Information System
GIS	Geographic Information System
GPS	Global Positioning System
GRTS	Generalized Random Tessellation Stratified
IA	Impact Assessment
IK	Indigenous Knowledge
LIO	Land Information Ontario
LSA	Local Study Area
MAFA	Moose Aquatic Feeding Area
MNRF	Ontario Ministry of Natural Resources and Forestry
MTO	Ontario Ministry of Transportation
NHIC	Ontario Natural Heritage Information Centre
NWMO	Nuclear Waste Management Organization

PQP	Project Quality Plan
QA/QC	Quality Assurance/Quality Control
RIC / RISC	Resources Inventory Committee / Resources Information Standards Committee
RSA	Regional Study Area
SAR	Species at Risk
SARO	Species at Risk in Ontario
SOP	Standard Operating Procedure
SWH	Significant Wildlife Habitat (defined below)
TEM	Terrestrial Ecosystem Mapping
TISG	Tailored Impact Statement Guidelines for Designated Projects Subject to the *Impact Assessment Act and the Nuclear Safety and Control Act*
UTM	Universal Transverse Mercator
VC	Valued Component
WLON	Wabigoon Lake Ojibway Nation
A priori	"From what is before"; a theoretical deduction rather than empirical observation. With respect to the Biodiversity Impact Studies, *a priori* power analysis can be conducted prior to the study to estimate sufficient sample sizes to achieve adequate power.
Biodiversity value	All of the biotic environmental components that will be considered for study within the APM Project's Biodiversity Impact Studies. A subset of biodiversity values may ultimately be scoped into the Biodiversity Impact Assessment as Valued Components.
Bog	Peat covered areas or peat-filled depressions with a high water table and a surface carpet of mosses (primarily sphagnum). Raised peat hummocks are present in bogs and the wetland is ombrotrophic (i.e., dependent on atmospheric moisture for its nutrients). Bogs have low plant diversity with less than 14 species and few to no fen indicator plant species and few or no tamarack or eastern white cedar. Bog wetlands have organic soils with a water table at or near the surface. Soils are predominantly composed of poorly to moderately decomposed sphagnum moss peats. The bog surface is usually unaffected by groundwaters and thus waters are generally acidic and low in nutrients. Bogs are usually covered with sphagnum mosses and ericaceous shrubs and may be treed or treeless but with less than 25% tree cover.
Eft	The terrestrial juvenile phase of a salamander or newt.
Fen	Peatlands characterized by surface layers of poorly to moderately decomposed peat, often with well-decomposed peat near the base and less than 25% live tree cover. Fen peats usually consist of mosses and sedges. Two main types of fens exist: nutrient-rich fens are fed by groundwater, have a high pH, and can be dominated by sedges and grasses; and nutrient-poor fens are fed by less groundwater and have lower pH, and may consist of low shrubs or ericaceous (belonging to or similar to heath family, genus *Erica*) species. Fens have a higher diversity of plants compared to bogs. Fen wetlands have organic soils and a water table at or above the surface. Soils are primarily moderately to well-decomposed sedge and non-sphagnum moss peats. Waters are mainly nutrient-rich with a near neutral to slightly acidic pH. The vegetation consists

	primarily of sedges, grasses, reeds, mosses, and some shrubs. Scattered trees may be present.
Herpetofauna	The reptiles and amphibians of a particular region, habitat, or geological period.
In media res	“In the middle of things.” With respect to the Biodiversity Impact Studies, *in media res* analysis means testing statistical power or species detection saturation in real-time (e.g., at the end of each sampling day or each week of field work).
Lake	An open waterbody with a depth greater than 2 m and with less than 25% of its surface area covered with wetland vegetation.
Lek	A communal area where animals congregate during the breeding season and males engage in competitive displays and courtship rituals to attract females. A variety of species use a lek mating system; grouse are amongst the most well-known examples.
Lentic	The term lentic refers to standing water habitats such as lakes and ponds, or swamps and marshes.
Lotic	The term lotic refers to running or moving water habitats such as rivers and streams.
Marsh	Wet areas periodically inundated with standing or slowly moving water, and/or permanently inundated areas characterized by robust emergent, and to a lesser extent, anchored floating and submergent plants. Marsh wetlands have mineral and sometimes well-decomposed peat soils. When peat soils are present, they are often enriched with mineral materials. Waters are nutrient-rich with near neutral to basic pH. Surface water levels typically fluctuate seasonally with declining levels exposing matted vegetation or mudflats. Emergent vegetation includes grasses, cattails, sedges, rushes, and reeds that cover more than 25% of the wetland surface. Note: Shallow open water wetlands classified by the Canadian Wetland Classification System are grouped with marshes in the Ontario Wetland Evaluation System (MNRF 2014a).
Mast	Mast is the fruit of trees and shrubs, such as acorns and other nuts. Mast trees are important as food for certain wildlife, and Mast Producing Areas are considered Significant Wildlife Habitat in Ecoregion 5E and Ecodistrict 6E-14 in Ontario.
Midden (squirrel)	The preferred foraging location for squirrels, as indicated by a pile of leftover food such as cones. Middens tend to be centrally located in a squirrel’s territory.
Mitigation hierarchy	A tool designed to understand and reduce the negative impacts of development on biodiversity and ecosystem function and services. Involves a sequence of four key actions – avoid, minimize, restore, and offset - and provides a best practice approach to aid in the sustainable management of environmental resources by establishing a mechanism to balance conservation needs with development priorities.
Pond	A small body of still water formed naturally or by hollowing or embanking. Ponds differ from lakes in that they do not have an atrophic zone (an area deep enough that sunlight cannot reach the bottom).
Post hoc	“After the event.” With respect to the Biodiversity Impact Studies, *post hoc* power analysis can be conducted after a study has been completed, and uses the obtained sample size and effect size to determine the power that was achieved.
Revell Batholith Area	Used to describe the general area surrounding the Revell Batholith Withdrawal Area within which the APM Project may be located. The Revell Batholith Area is near the

	Township of Ignace in northwestern Ontario. It is located in Treaty #3 in the traditional territory of Wabigoon Lake Ojibway Nation, among other Indigenous communities.
Rights-holders	First Nation and Métis communities who have asserted and or hold recognized treaty and/or Indigenous rights and whose Traditional Territories include the project location.
Seral stage	In forested landscapes, seral stage refers to the vegetation communities formed through succession (i.e., the process of forest aging) and adapted to the abiotic and biotic conditions of a site. Following a disturbance, succession typically progresses through establishment (early/young seral), thinning or stem exclusion (mid-seral), transition (mature seral), and a shifting mosaic (old seral).
Significant Wildlife Habitat	Defined in the Ontario Provincial Policy Statement, 2020 as: *Wildlife habitat* – areas where plants, animals and other organisms live, and find adequate amounts of food, water, shelter and space needed to sustain their populations. Specific wildlife habitats of concern may include areas where species concentrate at a vulnerable point in their annual life cycle; and areas which are important to migratory and non-migratory species. *Significant* – in regard to wildlife habitat, ecologically important in terms of features, functions, representation or amount, and contributing to the quality and diversity of an identifiable geographic area or natural heritage system. Candidate SWH – areas that have the ecosite and habitat attributes for various SWH as outlined in the *SWH Criteria Schedules for Ecoregion 3W* (OMNRF 2017). Candidate SWH will first be identified through desk-based methods and can then be field-verified in Tier 2 studies. Confirmed SWH – areas that have been field-verified and have the ecosite and habitat attributes for various SWH as outlined in the *SWH Criteria Schedules for Ecoregion 3W* (OMNRF 2017) **and** also have been confirmed to be SWH through the criteria identified in that report (e.g., detection of the relevant species or species groups and abundance criteria required to confirm SWH status).
Stream reach	A relatively homogenous length of a stream, that flows on a perennial or seasonal basis, having a continuous channel bed and demonstrating fluvial processes (e.g., flowing water has scoured the channel bed or deposited any amount of mineral alluvium within the channel).
Swamp	Wooded wetlands with 25% cover or more trees or tall shrubs. In swamps standing or gently flowing water occurs seasonally or may persist for long periods, and have an abundance of pools and channels. Many are typically flooded in spring, and dry with relict pools later in the season. Swamps include forest swamps (having mature trees) and thicket swamps (having shrub-carrs characterized by thick growths of tall shrubs such as willow, red-osier dogwood, buttonbush and speckled alder). There is a pronounced internal water movement from adjacent mineral areas, making the water nutrient-rich. If peat is present, it is mainly well-decomposed wood and occasional sedges. The vegetation is typically dominated by coniferous or deciduous trees or dense shrubs and herbaceous species.
The APM Project	The Deep Geological Repository and other required infrastructure for the safe, long-term management of Canada's used nuclear fuel.
Waterbody	A waterbody is an accumulation of water in an area and includes lakes, ponds, and wetlands that do not have a defined channel that flows through them.

Watercourse	A watercourse is a natural or artificial channel through which water flows and includes stream, rivers and wetlands that include a defined channel that flows through them.
Wetland	An area where the water table is at, near, or above the surface, or where soils are saturated with water for sufficient time such that the principal determinants of vegetation and soil development are excess water and low oxygen.

1.0 INTRODUCTION AND STUDY DESIGN CONSIDERATIONS

In 2002, the Nuclear Waste Management Organization (NWMO) was established in accordance with the *Nuclear Fuel Waste Act* (S.C. 2002, c. 23). Under the *Nuclear Fuel Waste Act,* the NWMO is responsible for the safe, long-term management of Canada's used nuclear fuel in a manner that protects people and the environment.

The NWMO recommended Adaptive Phased Management (APM) and this approach was accepted by the Canadian government in June 2007. APM is a combination of technical methods and a management system; the various components are summarized in Table 1-1 of the *Biodiversity Impact Studies – Northwestern Ontario Region: Best Practices and Preferred Approach* ('BPPA Report'; Zoetica Environmental Consulting Services 2020). The APM includes a site selection phase that aims to find a suitable location to host a Deep Geological Repository (DGR), which will store used nuclear waste deep below the earth's surface along with other required infrastructure ('the APM Project'). The APM Project will only proceed in an area with informed and willing hosts and with the involvement of the interested community, Indigenous (First Nation and Métis) communities in the area, and surrounding communities, working together to implement it. The NWMO has retained Zoetica Environmental Consulting Services ('Zoetica'™) to design and implement Biodiversity Impact Studies (BIS) for the Revell Batholith Area near the Township of Ignace ('Ignace'), northwestern Ontario, and Wabigoon Lake Ojibway Nation (WLON).

This report presents the Baseline Program Design for establishing the current biodiversity, as well as ecosystem function and services, which exist at one of the potential sites, which is associated with a geologic formation zone called the Revell Batholith, near the community of Ignace in northwestern Ontario. Within this Revell Batholith, the NWMO has identified an "Area of Interest" (AOI) within which the project could be located. In this report, the term 'Revell Batholith Area' will be used to describe the area within which baseline studies will be conducted.

The current *Biodiversity Impact Studies – Northwestern Ontario Region: Baseline Program Design* ('BPD Report') serves the primary purpose of presenting the methods, both desk- and field-based, to be used in undertaking baseline data collection and data management. Methods included in this report will follow the decisions and preferences outlined in the BPPA Report.

1.1 Baseline Program Objectives

The baseline data collection methods and analyses were designed such that they can achieve the following goals:

1. Establish important biodiversity and ecosystem function and services present prior to the development and operation of a potential APM Project, which will enable predictions of potential APM Project-specific and cumulative impacts as defined in the Tailored Impact Statement Guidelines (TISG) for the APM Project or the TISG Template[1];
2. Provide information on key biodiversity values and ecosystem function and services in the area to inform the APM Project design, and to ensure that the APM Project could be built in compliance with applicable regulations;

[1] Since the APM Project-specific TISG will not be released until after the Project Description has been submitted, Zoetica will follow the general guidelines presented in the Template for Designated Projects Subject to the *Impact Assessment Act and the Nuclear Safety and Control Act* (IAAC 2020b), hereafter referred to as the 'TISG Template'.

3. Integrate and trace community feedback into the baseline program;
4. Inform project planning and facilitate the development of mitigation strategies to avoid and reduce negative impacts and identify opportunities for benefit to biodiversity values;
5. Establish baseline measures of biodiversity and ecosystem function and services against which select monitoring data, for effects that were evaluated with unacceptably low levels of certainty or for follow-up on select effects, can be compared to determine if the APM Project is having the type and degree of impacts predicted in the Impact Assessment (IA). Likewise, baseline data will enable the detection of unforeseen changes and adaptive management;
6. Inform environmental management performance monitoring and development of action levels; and,
7. Inform biodiversity conservation initiatives and regulatory and compliance monitoring programs.

1.2 Project Location and Context

Previous siting studies were conducted by the NWMO in collaboration with local communities and rights-holders[2]. These studies established an Area of Interest (AOI) for the APM Project, which is located approximately 20 km east of Wabigoon Lake Ojibway Nation (WLON), and 40 km west of Ignace, Ontario, within the northern portion of the Revell Batholith Temporary Withdrawal Area[3]. Through discussions with people in the area about a number of potential geologically suitable repository areas identified based on results of desktop technical studies and field investigations (e.g., airborne geophysical surveys and geological mapping), the NWMO identified the AOI as the area within which they would focus ongoing investigations for APM Project feasibility.

The Revell Batholith Area is located in the Kenora District of Ontario, which is the most sparsely populated (0.2 people/km^2) and largest district in Ontario (over approximately 400,000 km^2 with a population of 65,533; Statistics Canada 2017). The region has a long history of mining and forestry. Tourism in the district is a more recent industry that continues to grow. There are no active or abandoned mines in the Revell Batholith Withdrawal Area at present (ENDM 2019), but there is some active forestry. Popular activities for tourists are outdoor activities aimed at experiencing the natural beauty of the region, especially the abundant lakes. All of these activities could interact with the APM Project to create cumulative impacts, which will need to be considered in a cumulative effects assessment. For a more detailed review of past, current, and future activities, see Section 1.5 of Zoetica's BPPA Report (Zoetica 2020).

According to Ontario's Ecological Land Classification (ELC) System, the Revell Batholith Area and AOI developed for the APM Project are located within the Lake Wabigoon (4S) Ecoregion of the Ontario Shield Ecozone. The AOI, along with its context relative to various ecoregions, communities, roadways, and ecological features is presented in **Figure 1-1**.

---

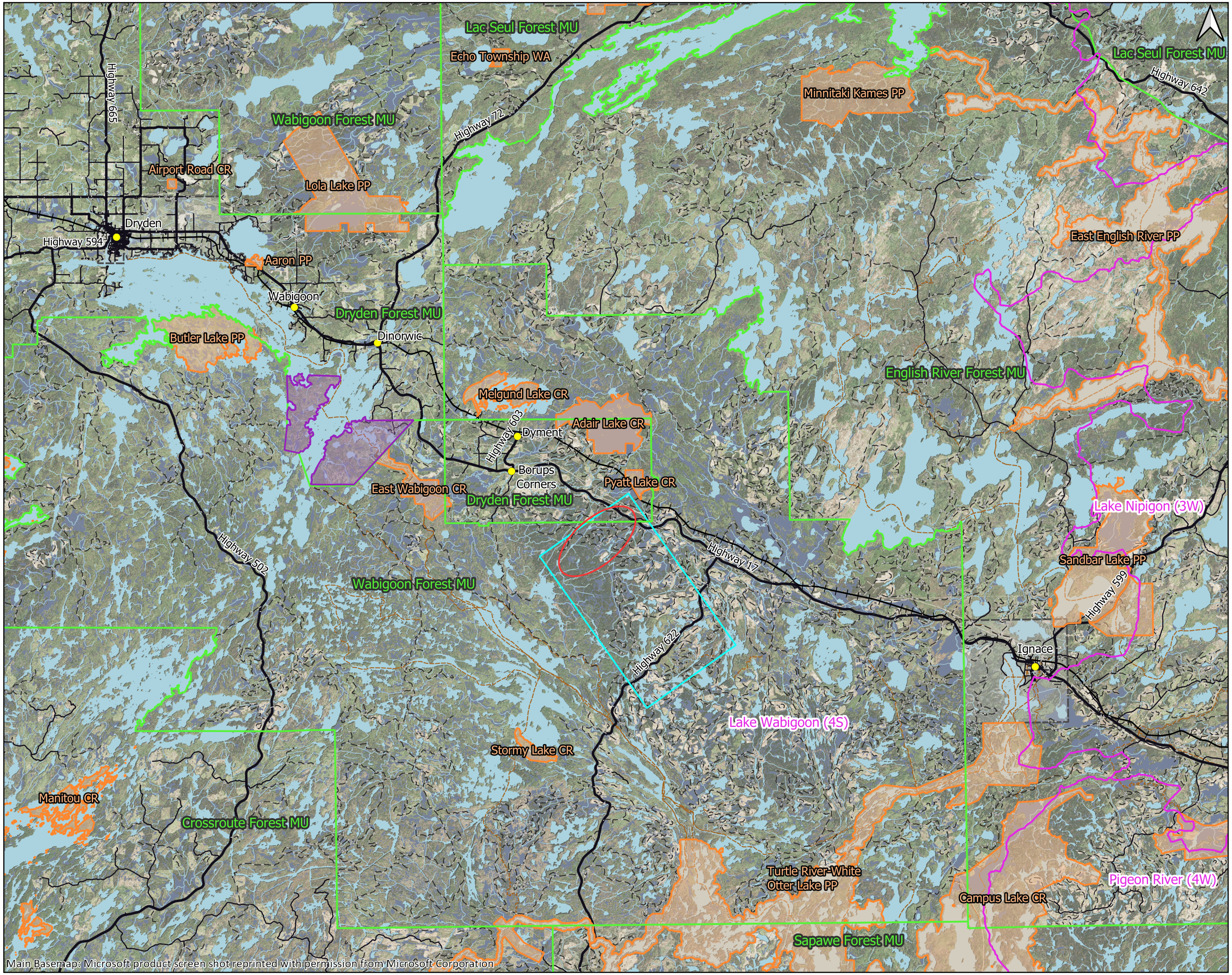
[2] As the NWMO has yet to identify a preferred site, it is acknowledged that the Impact Assessment process has not been initiated and the Duty to Consult has not been delegated. Throughout this document, the term stakeholder has been used to identify community members, agencies, private entities, etc., while rights-holder has been used to identify Indigenous peoples and communities (i.e., First Nations and Métis). These groups would be consulted in the event of an Impact Assessment.

[3] Several geographically large areas (areas temporarily withdrawn from mineral staking, i.e., temporary withdrawal areas) within the vicinity of the Township of Ignace were identified as potentially suitable for the long-term management of used nuclear fuel based on readily available geological information evaluated during Phase 1 desktop studies.

NWMO Biodiversity Impact Studies

Overview of Revell Batholith Area

Figure 1-1



Area of Interest (AOI)
Revell Batholith Withdrawal Area
Provincial Park (PP), Conservation Reserve (CR), Wilderness Area (WA)
Ecoregion
Forest Management Unit (MU)
Wetland
Lake
Watercourse
Highway or Arterial Road
Local Road
Resource/Recreation Road
Trail
Railroad
Community
Municipal Boundary
Wabigoon Lake No. 27

1:350,000

0 5 10 km

ZOETICA

Data received from:
Ontario Geohub - EcoRegion (MNRF), Forest Management Unit (MNRF), Indian Reserve (MNRF), OHN Waterbody (MNRF), OHN Watercourse (MNRF), ORWN Railway (MNRF), MNRF Road Segments (MNRF), Municipal Boundary - Lower and Single Tier (MMAH), Wetlands (MNRF)
NWMO - AOI, Revell Batholith Withdrawal Area, Trail Segments (MNRF)
IBAT - World Database on Protected Areas (UNEP-WCMC and IUCN)

Project CRS: NAD83 / UTM zone 15N	
Author: DM	Verified by: CC
April 26, 2021	Map ID: NWMO_BIS_010

No detailed project description for the APM Project is currently available. However, a conceptual, preliminary design of the APM Project was prepared by the NWMO and can be found in *Deep Geological Repository Conceptual Design Report Crystalline/Sedimentary Rock Environment* (Noronha 2016). A more detailed summary of the APM Project Description is available in Section 1.6 of Zoetica's BPPA Report (Zoetica 2020).

1.3 Overall Baseline Study Approach

The baseline studies have been designed with the whole impact study process in mind, from project planning through to IA and follow-up programs. Considering the whole process ensures that the baseline program will be properly contextualized and maximally informative. Prior to completing the current BPD Report, Zoetica produced a BPPA Report (Zoetica 2020). The BPPA Report provided: initial scoping and rationale for potential biodiversity valued components (VCs), research and justification for best practices and preferred approaches for the BIS Program, and included a well-researched guidance document to select the most appropriate methods for conducting baseline data collection, the biodiversity IA, and the cumulative effects assessment. The BPPA Report is a living document that will be updated annually to reflect emerging technologies, continuing stakeholder and rights-holder feedback, and learning. As updates are made to the BPPA Report that are relevant to baseline methods, those updated details must also be reflected within the baseline program and BPD Report. A detailed description of the overarching process for the BIS Program is provided in the BPPA Report, Section 1.3 (Zoetica 2020).

The overall BIS Program includes a desk-based research exercise and iterative scoping, which will help to integrate new information and feedback annually as more is learned about the APM Project, community values and concerns, biodiversity values or ecosystem function and services that are likely or not likely to be impacted, and those requiring further study. Once baseline studies have progressed sufficiently, a VC (selection of biodiversity values likely to be included in the APM Project-specific TISG and carried through to an IA) and issues scoping exercise will be undertaken to focus studies to be undertaken for an IA. Next, impact predictions and decisions will be made based on whether predicted changes are likely to fall within ranges that are acceptable to affected local communities, rights-holders, scientific experts, the regulator and other federal and provincial agencies, and other interested parties. If changes are deemed not acceptable, mitigation is applied through the mitigation hierarchy[4] to reduce or limit changes. This mitigation hierarchy can be applied iteratively until technically achievable, socially acceptable, and economically feasible measures have been fully explored within an active adaptive management framework. After the full application of the mitigation hierarchy, any remaining residual effects (i.e., adverse impacts that remain after the application of the mitigation hierarchy) would be documented; however, the goal remains to, wherever possible, apply the mitigation hierarchy to the project to render it as resulting in no net negative impacts, and net positive impacts, to biodiversity.

Following the completion of the biodiversity impact assessment, follow-up monitoring programs would be proposed for selected valued components, focused on those predicted effects that are potentially significant and uncertain. The follow-up program will be designed to be suitable for detecting unanticipated impacts to enable adaptive management. While designing and implementing follow-up

[4] Mitigation Hierarchy is a set of guidelines that are nationally and internationally accepted as a best practice and provide a framework to follow a series of mitigation options in the order of avoidance, minimization, restoration, and offset to reduce development impacts and aim to achieve no net loss of biodiversity (BBOP 2012, IFC 2012, CSBI 2015).

programs are beyond the scope of this work, the baseline data collection, analysis, interpretation, and reporting processes will be conducted with the goal of ensuring that those future programs will be well-informed, capable of monitoring the effectiveness of mitigation applied (following the mitigation hierarchy), as well as possible enhancements, and supported by a transparent impact assessment process. In the event that a positive effect of the project is predicted during the Impact Assessment process, a similar follow-up monitoring process would be required to ascertain the accuracy of this prediction.

As outlined in Section 4.2 of the BPPA Report (Zoetica 2020), the biodiversity baseline program will follow a tiered approach. The baseline program will begin with the collection of broad-scale, foundational environmental data in Tier 1 (i.e., studies starting in Year 1), followed by more specific data collection in Tiers 2 and 3 (i.e., in future years). By using the results of Tier 1 studies to inform decision-making for later phases, this approach will enable the baseline program to move forward in a more efficient, focused, justified, transparent, and cost-effective manner. High quality data from the baseline study will allow for efficient issues scoping and VC selection for further assessment, which is the next step of the IA process.

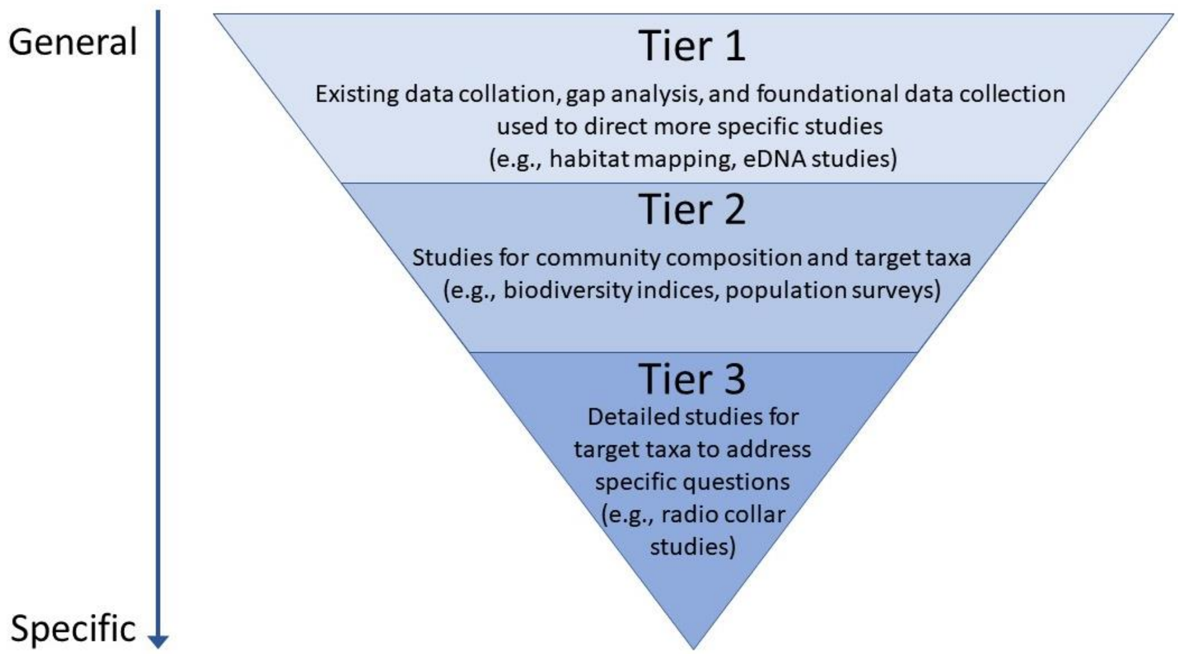


Figure 1-2. Graphical representation of the tiered approach for planning the BIS Baseline Program. Tier 1 studies involve more general information collection with increasing specificity and focus in Tiers 2 and 3. Tier 1 studies will focus on collecting foundational and broadly applicable data that will be used to support, justify, inform, and plan Tier 2 and 3 studies.

The overall process described herein is designed following a western science approach and interweaves Indigenous Knowledge (IK) and local input that has been made available. However, certain Indigenous communities, whose Traditional Territories fall within the study areas, may undertake their own studies that combine principles, values, and traditional approaches to arrive at their own conclusions about potential project impacts and mitigation options. At key points along this pathway, understanding and information from both processes will be interwoven to strengthen the APM Project, predictions, and mitigation, and to enhance positive outcomes.

The baseline program will make use of multiple sources of information, including available large datasets, desk-based research, IK consistent with the NWMO's IK policy, community input, previous work conducted for the APM Project, future field work proposed for other programs, and field work designed for the BIS. A key objective in the design of the baseline studies is to ensure that data on biodiversity values of importance to surrounding communities, stakeholders, and rights-holders are collected, analyzed, and interpreted such that any potential effects of the APM Project on these biodiversity values can be effectively monitored over the long term, and will support an adaptive management program. The BIS Program will also be designed to collect evidence to support a 4-pillar sustainability-based IA framework (*Impact Assessment Act*, S.C. 2019, c. 28, s.1), which includes the following pillars: Environment, Social, Economic, and Health. The social pillar under the *IAA* framework also includes cultural considerations, which were discussed as a separate (fifth) pillar within the "Building a Common Ground" (2017) review of the Canadian Environmental Assessment Process but is also integrated throughout the remaining four pillars where possible (*Impact Assessment Act,* S.C. 2019, c. 28, s.1). A key recommendation of the expert panel that reviewed the Canadian Environmental Assessment process was to interweave IK and community knowledge with the best evidence from science as a collaborative exercise between Indigenous communities, knowledge holders, and scientists (Gélinas *et al.* 2017). The BIS Program is designed such that it enables the interweaving of IK and community knowledge into the baseline studies, wherever possible, following the NWMO IK policy (NWMO 2016).

At this stage of the APM Project, the baseline program will focus on collecting data on biodiversity values that must be collected to ensure that the APM Project can be built without violating existing Acts or regulations and to show due diligence, and to examine ways in which the APM Project could be built to achieve "no net loss"[5] via application of the mitigation hierarchy to project planning.

The baseline program will also focus on biodiversity values likely to be required for study as valued components (VCs) by the APM Project-specific TISG or based on community concerns not captured in the TISG, to support the biodiversity IA process. VCs are defined by the Impact Assessment Agency of Canada (IAAC) as "environmental, health, social, economic or additional elements or conditions of the natural and human environment that may be impacted by a proposed project and are of concern or value to the public, Indigenous peoples, federal authorities and interested parties. Valued components may be identified as having scientific, biological, social, health, cultural, traditional, economic, historical, archaeological and/or aesthetic importance." (IAAC 2020a). The conversion of a biodiversity value to a VC is particularly likely where the element represents a key value of interest to communities or to conservation (e.g., Species at Risk (SAR)), when it is present in the area, and where it can reasonably be expected to be impacted by the project, under certain circumstances. However, for the purposes of this BPD Report, elements to be studied are generally referred to as biodiversity values.

[5] In the case of biodiversity values for the Biodiversity Impact studies, "no net loss" value would be defined as no acceleration in a stable or declining trajectory that is more pronounced than would be predicted to occur due to factors unrelated to the project. In the case that an area is improving over time from a downgraded condition, no net loss to biodiversity would also be defined as the avoidance of any interference with this improvement or recovery, and a net benefit in this case would be defined as an improving condition that is put on a more positive or timely trajectory by beneficial actions of the project proponent.

1.4 Inclusion of Stakeholder and Rights-holder Feedback

The development of the BIS is viewed as a collaborative process that involves engagement with, and input from affected local communities, rights-holders, scientific experts, the regulator, other federal and provincial agencies, and other interested parties. The development of the BIS will rely heavily on the incorporation of community concerns and knowledge. Indigenous Knowledge and local knowledge provide unique insight into the value of biodiversity and ecosystem functions for human well-being outside of knowledge that can be gained from a western science approach alone (Tengö *et al.* 2014). An understanding of the local environment provides clarity about locally cherished biodiversity values (e.g., fishing areas and favoured fish species, hunted and trapped species, valued plants and natural medicines, areas identified as sacred). Indigenous Knowledge and local knowledge can also identify holistic ecological interrelationships and observed changes in the local environment over a long period of collective memory. As IK has been transmitted through stories, ceremony, songs, cultural tradition, and art since time immemorial, this knowledge system is founded on a collective experiential basis that spans a much longer time frame than data collected through western science.

The development of the baseline studies and IA will involve continued and ongoing engagement and dialogue with interested and potentially affected communities to ensure that the program adequately reflects and incorporates feedback received. Inclusion of the results of engagement with communities into the APM Project from an early stage will strengthen the APM Project in the future, will ensure that studies required for the APM Project will be conducted in a culturally appropriate manner (e.g., inclusion of ceremony, where appropriate, or focusing on non-lethal sampling wherever possible), and will ensure that the NWMO remains accountable to the community. Ongoing dialogue will also help identify how community members participate in the baseline studies and the future IA. The results of the BIS Program will be discussed with stakeholders and rights-holders such that there is a better understanding of potential effects of the APM Project on biodiversity and ecosystem function and services as they relate to ecology and community values. The discussion of results with these groups will also provide for the ongoing improvement of knowledge about the environment associated with the APM Project.

The NWMO has been actively engaging with interested parties in the area since the Township of Ignace voluntarily joined the site selection process. Some of these engagement meetings were conducted to learn what types of questions and concerns stakeholders and rights-holders had regarding their environment, to gather information on the current stressors acting in their environment, and elements they felt were needed to develop a trustworthy and open environmental monitoring program (CanNorth 2020). Workshops to answer questions specifically related to the Environmental Media Baseline Program (EMBP) were initiated in 2018. A second round of workshops was conducted to present results from prior workshops and to present information on, and inform, the planning of the EMBP. Results from the first workshop were shared in a way that linked the community input to aspects of the draft program to maintain accountability of design decisions to the community. Workshop participants were asked if they could see their input in the program, and whether anything was missing. In some cases, where gaps were identified, the design was modified. Information gathered during these workshops that was relevant to the BIS Program was used to help inform the design of the biodiversity studies.

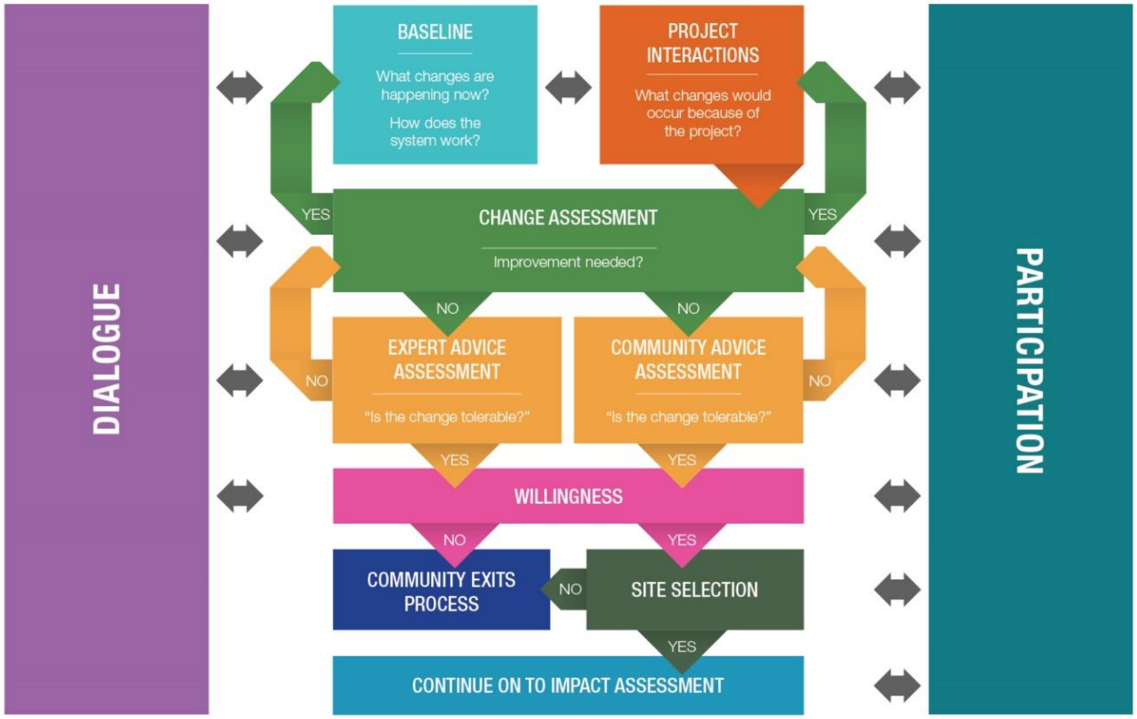
Zoetica reviewed all available community input collected to date from various past workshops held by the NWMO and stakeholders/rights-holders and will continue to do so as engagement continues. In developing this Baseline Design Report, Zoetica reviewed information collected through previous workshops, including:

- The NWMO Environmental Media Baseline Program Design – Appendix B.1: Stakeholder and rights-holder input from Round 1 Workshops (CanNorth 2020)
- The NWMO Environmental Media Baseline Program Design – Appendix B.2: Stakeholder and rights-holder input from Round 2 Workshops (CanNorth 2020)
- The NWMO Adaptive Phased Management Project – Northwestern Ontario Region Environmental Media Baseline Program – Preliminary Sample Design Feasibility Assessment (Appendix F, CanNorth 2019a)
- Technical Memorandum (Final) – Conceptual Site Model for the Deep Geological Repository (January 24, 2020) (Appendix C, CanNorth 2020)
- Phase 1 Preliminary Community Well-Being Assessment – Township of Ignace, Ontario (SENES Consultants 2013)
- Phase 1 Preliminary Assessments, Summary Findings and Decisions: Creighton, Saskatchewan; Ear Falls, Ontario; English River First Nation, Saskatchewan; Hornepayne, Ontario; Ignace, Ontario; Pinehouse, Saskatchewan; Schreiber, Ontario; Wawa, Ontario (NWMO 2013)

Further, early engagement with stakeholders and rights-holders was conducted in April and May 2020 to solicit feedback on proposed baseline work for the BIS Program (summarized in Appendix B of the BPPA Report). Feedback received from these engagement sessions has been integrated into the studies and study design to be conducted in the Revell Batholith Area starting in Year 1. Not all stakeholder and rights-holder groups were available to participate during the April and May 2020 engagement events, due to issues related to the COVID-19 pandemic, and additional information will be sought using a meeting venue (online, telephone, or in person) and a time period that is acceptable to these individuals, groups, and communities.

Interweaving previous and ongoing feedback received during stakeholder and rights-holder engagements into baseline programs is imperative to the success of satisfying requirements of communities, and for informing studies that include and assess community concerns. Feedback received from affected local communities, rights-holders, scientific experts, and other interested parties at previous engagement workshops, prior to the initiation of the BIS contract, identified several shared concerns. These concerns centred on the need for honesty and transparency of activities and studies conducted on behalf of the NWMO, facilitated by publicly accessible data, engagement with and involvement of local communities (especially with regard to engagement, training, and employment opportunities), the consideration of local input and knowledge in the design of the environmental baseline programs, potential impacts on various environmental and biodiversity values (including air, water, soil, fish, vegetation, and wildlife), the need for the involvement of experts, and the need to respect the land and Spirit (CanNorth 2020). **Figure 1-3** presents how the BIS fits into the various environmental components of the overall APM Project IA and how stakeholder and rights-holder engagement and participation will be sought during all phases and programs of the IA.

(a)



(b)

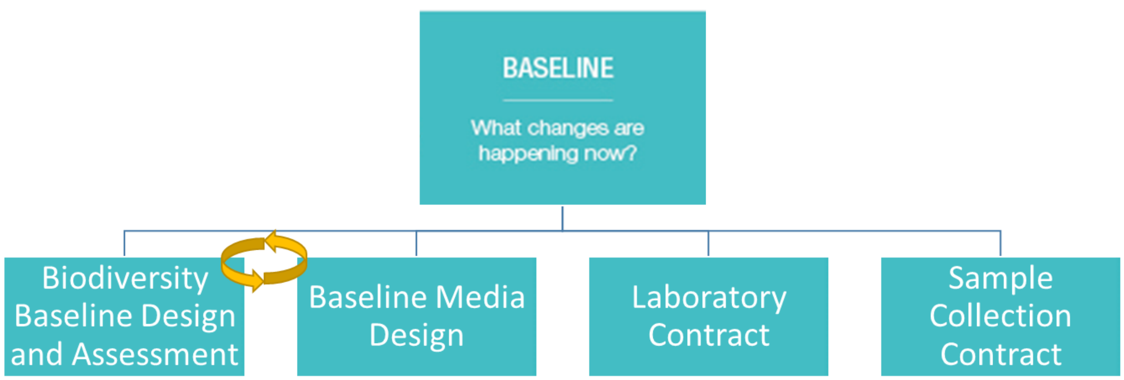


Figure 1-3. (a) Relationships between environmental components of the APM Project IA, along with continual and ongoing stakeholder and rights-holder engagement and participation. (b) Boxes indicate separate but related contracts for the work program. For example, Zoetica is responsible for the Biodiversity Baseline Design and Assessment (i.e., BIS), which focuses on the biotic environment (including ecosystem function and services), whereas CanNorth is responsible for the Baseline Media Design, which is mostly focused on the abiotic environment (e.g., water quality). However, the biotic and abiotic environments are inter-dependent and potential projects on one may affect the other. Therefore, close collaboration is needed to ensure the success of both programs and to enable a comprehensive IA.

Zoetica took stock of important values and observations of stakeholders and rights-holders that need to be considered as part of the BIS, and for making decisions in the BPPA Report (Zoetica 2020). Zoetica understands that Indigenous communities in the Revell Batholith Area depend on the area for health, food security, and cultural/spiritual well-being. Zoetica also understands that communities and economies in the area rely heavily on the resource sector (e.g., forestry, mining), tourism (largely based on the outdoor opportunities in the region), and fish and guide-outfitting (key fished species: walleye, northern pike, and lake trout; key hunted wildlife: moose, black bear, white-tailed deer, and small game such as grouse and snowshoe hare). The key fished and hunted species will be considered as part of the biodiversity baseline studies as biodiversity values (see Zoetica's BPPA Report, Section 3.1; Zoetica 2020). There is local recognition of the importance in maintaining a functional, balanced, and healthy ecosystem in the AOI and surrounding environment. Appropriate methods and study designs for capturing these values have been examined in Zoetica's BPPA Report (Zoetica 2020).

As part of the BIS, important "ecosystem services" that benefit humans must also be considered, such that the NWMO can apply the mitigation hierarchy to project planning and implementation. Healthy ecosystem functions provide many, varied benefits ('services') to humans, such as tree and plant roots that filter and clean surface water runoff before it enters waterbodies and stabilize soils to reduce erosion risk; merchantable timber that can be used for building or economic gain; wetlands that store water and mitigate against extreme weather events like floods and droughts; large riparian trees that provide shade and maintain cooler water temperatures for fish; habitat that supports wildlife and fish that are favoured by hunters, trappers, and people who fish; plants for consumption and medicinal purposes; and outdoor opportunities that provide for mental, cultural, spiritual, recreational, and physical well-being (i.e., cultural services). Healthy ecosystems are also key to maintaining ecosystem functions and biodiversity.

Ecosystem function and services are considered as part of the BIS because in an IA they are largely examined based on patterns found in relevant biodiversity values (e.g., studies of fish, vegetation, and wildlife, including species of importance to communities), and the functioning of ecosystems, alongside a growing understanding of the human uses of the area (i.e., cultural services, to be studied as part of social, economic and/or health impact studies; and via discussions with Indigenous communities and local stakeholders). As ecosystem function and services are largely interdisciplinary, focusing the ecosystem function and services studies for the BIS will require thorough coordination and communication between potentially affected Indigenous communities and local stakeholders and other APM Project teams (e.g., health, social, economic, physical sciences). The ecosystem function and services that will ultimately be focused on will rely heavily on values of importance to the rights, title, and culture of Indigenous communities; what local stakeholders share as important; and services in the environment that could be negatively impacted by the APM Project.

Community concerns that are relevant to the biodiversity program are outlined in **Table 1-1**. The methods proposed by Zoetica to study each of the listed values/concerns can be found in the sections noted in the table; however, the current BPD Report focuses on Tier 1 studies and detailed designs for Tier 2 and 3 studies will be developed at a later date to account for learning from Tier 1 studies. Additional information about community feedback is available in Section 1.4 and Appendix B of the BPPA Report (Zoetica 2020).

Table 1-1. Community concerns and values reflected in the Biodiversity Impact Studies.

Value/Concern	**Description of how it is reflected/considered in the BIS**	**Baseline Study Section where Value will be Captured**
Important Country Foods Vegetation	Several vegetation species such as wild rice, various berry species, wild mushrooms (lobster, stump, and chanterelles), ginger, and other	Section 2.1 Section 3.0

	plants for tea were brought up during engagement meetings as culturally important and/or gathered by people for consumption and/or medicinal purposes. Starting in Year 1, Zoetica proposes to map vegetation in a biodiversity value-specific study area, including plant species of importance to community members. Additional information on vegetation of importance will be sought through workshops, and dialogue, and feedback will be sought prior to undertaking surveys.	
Ecology of land and habitat for wildlife and fish	Ecology of the land was mentioned as a specific concern as well as habitat for biodiversity values. Zoetica proposes to focus on mapping important habitat and vegetation and on identifying important wildlife habitat within biodiversity value-specific terrestrial and aquatic study areas. Further years of study will focus on more targeted studies of habitat specific to various biodiversity values.	Section 2.1 Section 2.2 Section 2.4 Section 2.6
Water supply and ecological features providing important services for life requirements of culturally important species, human use and consumption, and culturally harvested plants.	Ensuring the protection of water supply, and ecological features that provide habitat for various wildlife and fish as well as where culturally important plants are harvested were brought up in community feedback as important to consider during the design of baseline programs. In Tier 1 studies, Zoetica proposes studies for other biodiversity values that will feed into the ecosystem function and services information, along with desk-based studies. Hydrological studies will be conducted as part of the EMBP, and important water features and known/mapped aquifers will be identified within the biodiversity baseline program. Future studies are proposed that focus on the assessment of ecosystem function and services using the TESSA toolkit. Michel Lake, which falls outside of the current RSA_{AQU}, was identified as an important water source for the Township of Ignace. If human growth within Ignace as a result of the APM Project is predicted to impact the lake, it can be considered in future studies.	Section 2.1 Section 2.4 Section 3.0
Moose and deer	Monitoring of moose and deer populations and their overall health were noted as important study design considerations during community engagement meetings. In Tier 1 studies starting in Year 1, Zoetica proposes to focus on field verification of ecosite data and desk-based identification of candidate Significant Wildlife Habitat (SWH) for both species, and seasonal habitat suitability modelling within a biodiversity value-specific study area for moose. Additional Tier 2 population-level studies may be designed based on results and needs identified from Tier 1.	Section 2.1 Section 2.2 Section 2.6 Section 3.0
Black bear, wolf, fox, and other carnivore species	Black bear has been noted as a hunted species by several community members. In addition, other carnivores such as wolves and foxes have been noted to increase and influence populations of other species that they take as prey. In Tier 1 studies, Zoetica proposes to determine the presence, distribution and abundance of suitable habitat and SWH for black bear through ecosystem mapping, habitat suitability mapping, and desk-based identification of SWH within	Section 2.1 Section 2.2 Section 3.0

	biodiversity value-specific study areas. SWH for additional carnivores (i.e., den sites) will be noted if identified. Future years of study may focus on general community surveys for carnivores and on select, regionally important carnivore populations if warranted (e.g., if a SAR carnivore is detected during community surveys, and important/suitable habitat for that species is found within the AOI). Lynx was brought up in dialogue as an important local species; this species is best captured through studies of impacts of the project to snowshoe hare (see below), as lynx population sizes fluctuate very closely with the well-documented 8 to 11-year snowshoe hare cycle and are limited by the availability of this prey species.	
Snowshoe hare, red squirrel, and other small terrestrial mammals	Snowshoe hare and red squirrel were noted as country foods, and snowshoe hare act as the main and limiting prey species for lynx and are an important prey item for other carnivores. In Tier 1 studies starting in Year 1, Zoetica proposes to focus on determining the presence, distribution, and abundance of suitable habitat for snowshoe hare and northern flying squirrel through ecosystem mapping within biodiversity value-specific study areas. Snowshoe hare are included due to their keystone role as a primary prey species for many carnivores in the boreal forest. Northern flying squirrel are included due to their role as keystone species that disseminate the spores of ectomycorrhizal fungi that associate with roots of pine trees and helps them obtain water and nutrients, and which are also important prey species for a variety of vertebrate predators. Future years may focus on population-level studies of local snowshoe hare populations and potentially other small terrestrial mammals and/or key supporting habitat features (e.g., squirrel middens, mast trees) for those species of cultural and/or conservation importance.	Section 2.1 Section 2.2 Section 3.0
Beaver, muskrat, and other semi-aquatic mammals	Beaver dams have been brought up as a concern for the protection of local resources. Also, it was mentioned that at least one person in the community eats beaver and muskrat meat. In Tier 1 studies starting in Year 1, Zoetica proposes to focus on determining 1) the presence of semi-aquatic mammal species through eDNA studies, and 2) the presence, distribution, and abundance of candidate SWH for semi-aquatic mammals (i.e., den sites for mink, otter). Future years of study may focus on determining the numbers and locations of beavers in a biodiversity value-specific study area and their role in sustaining ecosystem function and services, and possibly additional semi-aquatic mammal species, where warranted.	Section 2.1 Section 2.2 Section 2.4 Section 2.6 Section 3.0
Ducks, geese, and upland game birds like grouse, raptors (e.g., owl)	During engagement, community members mentioned that several bird species were hunted. In Tier 1 studies starting in Year 1, Zoetica proposes to focus on determining the presence, distribution, and abundance of birds, identify candidate SWH features, and suitable habitat for eastern whip-poor-will (a SAR known to be present in the avian (bird) RSA; RSA_{AVI}) within a biodiversity value-specific study area. Future years of study may focus on ground-truthing candidate SWH and conducting surveys for seasonal presence/not detected of Upland Breeding Birds, Upland Game Birds, Waterbirds, Shorebirds, and Raptors.	Section 2.1 Section 2.2 Section 3.0

Garter snakes, tree frogs, turtles, and other herpetofauna	During community workshops it was mentioned that garter snakes are abundant and should be considered for analysis (Appendix B.2, CanNorth 2020). In addition, studies for frogs and turtles were mentioned for consideration in the baseline program (Appendix B.1, CanNorth 2020). Tier 1 studies starting in Year 1 will focus on determining the presence, distribution, and abundance of habitat for herpetofauna including the identification of candidate SWH in the biodiversity value-specific study area. Future studies may focus on ground-truthing candidate SWH and conducting presence/not detected surveys for herpetofauna, with the potential for population surveys for species of importance that are detected and could be impacted by the APM Project.	Section 2.1 Section 2.2 Section 2.6 Section 3.0
Earthworms, bees, earwigs, wood ticks, spruce budworm, grasshoppers, and other terrestrial invertebrates	Concerns related to wood ticks, increases or decreases of several insects, and invasive species were brought up as concerns during community workshops (Appendix B.1 and B.2, CanNorth 2020). Further engagement conducted in May 2020 identified the main concern related to wood ticks as being a human health issue while acknowledging that there has been an increase in wood ticks with an increase in deer populations in the area. Thus, for the BIS, wood ticks will be considered as a current stressor on ungulate health, but focused studies on wood tick will not be conducted. In Tier 1 starting in Year 1, Zoetica proposes to conduct studies focusing on 1) determining the presence of candidate SWH for monarch butterflies, and 2) recording incidental observations of target species during ecosystem mapping. Future studies may focus on 1) general community surveys and eDNA metabarcoding studies for terrestrial invertebrates, and 2) targeted surveys for at-risk or rare species if species or habitat are observed in Tier 1 studies.	Section 2.1 Section 2.2 Section 3.0
Walleye, lake trout, pike, sucker, perch, baitfish	Overfishing was raised as a concern during workshops conducted to gather community feedback (Appendix B.2, CanNorth 2020). Community input included good information on fish presence in lakes and identified fishing activity in the area surrounding Ignace (CanNorth 2020). Fish was identified as an important food source for local Indigenous communities (Appendix B.1 and B.2, CanNorth 2020). Additional engagement conducted in April and May 2020 identified several popular fishing areas where fishing could potentially increase in the future. Further, baitfish were identified as an important biodiversity value for recreational and commercial fishing, and participants mentioned that there may be bait blocks in the general area. Zoetica proposes that Tier 1 studies starting in Year 1, focus on determining the presence, distribution, and abundance of aquatic habitat types for fish in the biodiversity value-specific local study area (LSA) as well as the potential presence of various fish species (species composition) in various habitats within the LSA using eDNA analysis. Future studies may focus on determining fish community composition and demographics of fish populations and their habitat.	Section 2.4 Section 2.6 Section 3.0
Aquatic food web (e.g., benthic	Understanding the importance of food chains was brought up during workshops with community members (Appendix B.1, CanNorth	Section 2.6 Section 3.0

invertebrates and other primary and secondary producers)	2020). In Tier 1 studies starting in Year 1, Zoetica proposes a focus on determining the species composition (e.g., species presence) of aquatic primary and secondary producers in various waterbody types within the LSA_{AQU} through eDNA methodologies. Future studies may focus on additional community measures such as diversity indices which over time can, itself, be used as a proxy for determining project impacts on biodiversity), relative abundance of species, and measures of fish growth and health.	

1.4.1 Future Planned Community Engagement for Biodiversity Impact Studies

Engagement with the communities surrounding the Revell Batholith Area has already begun (see Section 1.4 and **Table 1-1**, Section 1.5.1, and Section 1.5.2) and feedback has been interwoven into the early planning phase of the BIS. As noted, engagement will continue as an ongoing process throughout the BIS. Annual results of the biodiversity baseline reports and annual updates to the biodiversity IA will be presented to stakeholders and rights-holders in the area, the information from which may reveal concerns or opportunities for additional feedback from these groups. Such two-way information exchange will allow for the regular and structured refinement of the BPD Report. Feedback from communities will be sought during these refinement stages and will provide continued transparency of the BIS Program, and to maintain accountability of the program to local communities, rights-holders, scientific experts, the regulator and other federal and provincial agencies, and other interested parties. Ongoing engagement will ensure that community values and concerns, as they relate to biodiversity values, are accounted for in the development of the BIS Program.

1.4.2 Future Stakeholder/Rights-holder Involvement

Opportunities for Indigenous and community involvement in the collection of baseline data will be sought, identified, and interwoven, wherever possible, into the biodiversity baseline program. Any opportunities for stakeholder and rights-holder involvement in baseline work will be documented and updated in the present living BPD Report. Community involvement may include, but is not limited to, the following:

- Designing and leading ceremony and Spiritual components of the BIS Program (focus on ceremony and Spirit)
- Providing cultural training or cultural protocols to field staff who will be involved in the baseline data collection
- Providing guidance or local field knowledge including accessibility to sites, field logistics, and areas of importance
- Working with field biologists to collect data in the field (where studies require trained biologists and consultants to lead the work)
- Pairing Indigenous youth and Elders with field biologists to encourage knowledge transfer and interweaving of traditional knowledge and western science
- Being trained to collect baseline data independently of biologists, wherever possible (e.g., wildlife camera data collection)

1.5 Previous Biodiversity and Related Baseline Work for APM Project

The biodiversity baseline program planned by Zoetica seeks to build on environmental data available in the Revell Batholith Area, wherever possible. These datasets include past work done and information gathered for the APM Project by the NWMO with support from contractors who are experts in their field, Big Unobstructed Databases, and government sources. Previous work conducted on a more localized scale than available in Big Unobstructed Databases is outlined in Sections 1.5.1 to 1.5.5 below, the proposed EMBP studies (some of which will be conducted in collaboration with the BIS) are outlined in Section 1.5.6, and identification of gaps in data availability and data quality or extent for use in the BIS Program is presented in Section 1.5.7.

1.5.1 Phase 1: Desktop Studies and Engagement

The NWMO, supported by contractors who are experts in their field, worked with the Ignace Community Liaison Committee and other Ignace community members to assemble information about the environmental, social, economic, and cultural conditions of the community, as well as objectives, issues and concerns. This information helped to provide a starting point for discussion with the community to explore the potential effects of the project on the community and the opportunities to achieve community objectives through the project. This work set the stage for subsequent deeper engagement and research on environment.

Phase 1 desktop studies and engagement were completed with the goal of gaining an understanding of the different potential APM Project areas, including the Revell Batholith Area, its surrounding environment, and the connections of people to the area. Assessments were conducted to determine whether environmental surroundings were sufficient for hosting a DGR and supporting infrastructure, and how to best cooperate with local communities throughout assessment and implementation of the entire APM Project and beyond.

Phase 1 desktop studies and engagement provided a foundation of information on land use, protected areas, heritage sites, topography, geological characteristics, sediment quality, terrain, groundwater quality, watershed boundaries, recreational and commercial fisheries, air quality, meteorology, and species of concern in the area, along with incidental reports on species present and pre-existing environmental conditions. During Phase 1 studies, scientific and technical studies investigated the geological suitability of the area for hosting a DGR. Data were compiled from existing data sources, including the Ontario Ministry of Natural Resources and Forestry (MNRF) and the Natural Heritage Information Centre (NHIC). Additional field data were gathered by Tulloch Engineering (Tulloch Engineering 2018a) on Ecological Land Classification (ELC), Significant Wildlife Habitat (SWH) features, stream reach classifications, and potential presence of SAR to produce environmental sensitivity maps.

1.5.2 Phase 2: Environmental Field Studies and Engagement

Phase 2 field studies and engagement further captured the suitability of potential repository areas for a DGR, and sought to reflect the input and interests of local stakeholders and rights-holders (Tulloch Engineering 2018b, 2018a, 2019a, 2019b). Field studies and further engagement activities were initiated in 2016 in potentially suitable sites, including the Revell Batholith Area. The environmental studies conducted within the Revell Batholith Area during this phase were focused on a limited spatial area that included three borehole sites and four potential access roads. Data were collected using general reconnaissance, trail cameras, song meters, night acoustic surveys, and select ground-truthing of terrestrial vegetation mapping data. Desk-based reviews (Tulloch Engineering 2018b) identified candidate SWH. Ground-based surveys rendered the identification of no candidate SWH within a subset of these candidate SWH identifications within the 2018 Study Area (Tulloch Engineering 2018a). Non-significant moose aquatic feeding areas (MAFAs; Classes 1 and 2) were identified along an un-named tributary to

Mennin Lake that parallels Trapline Road. Surface water, sediment, and soil were sampled as well. During these Phase 2 environmental field studies, potentially occurring SAR were determined (based on range maps and habitat conditions), and some presence/not detected studies for SAR were conducted within small areas (e.g., eastern whip-poor-will song recorded associated with boreholes). Phase 2 studies also allowed for the opportunistic identification of local flora, rare vegetation, amphibians, migratory birds, fish, and mammals, and the collection and analyses of environmental quality parameters. Engagement and discussion activities were carried out to better understand APM Project benefits, recognize areas where cooperation was possible and where concerns exist, and where mitigation may be required for potential negative effects of the APM Project.

Engagement sessions were conducted in 2018 and 2019 with stakeholder and rights-holder groups to solicit feedback regarding what is important to local communities and stakeholders in terms of the environment, what existing impacts are perceived, and what values are important for baseline monitoring. A summary of stakeholder and rights-holder concerns that were raised are presented in Appendix B.1 and B.2 of Canada North Environmental Services' ('CanNorth') EMBP Design Report (CanNorth 2020); those with particular relevance to the development of the BIS Program are summarized in Section 1.4 and **Table 1-1** of the BPPA Report.

1.5.3 Terrestrial Ecosystem Mapping

A preliminary natural features map was created by compiling external data sources during previous Phase 2 studies (Tulloch Engineering 2018b), which included ecosite classifications, rare vegetation communities, MAFAs, NHIC element occurrences, and sustainable forest licensee forestry data. Data were sourced from Land Information Ontario (LIO), Natural Resources Canada, Dryden District of the MNRF, NHIC, Ontario Forest Resource Inventory (FRI), and forestry information, and information was cross-referenced to create initial maps for ground-truthing. Select areas were then assessed in the field against the preliminary data gathered and identified knowledge gaps were investigated. The scope was further narrowed to three borehole sites and proposed access road routes where sensitivity mapping and environmental characterization were conducted (Tulloch Engineering 2019a). The scale of these data compilations and mapping represents a small fraction of what is proposed for the scope of the BIS Program.

1.5.4 Aquatic Habitat Mapping

A desktop assessment was performed in 2016 in several study areas surrounding Ignace, including the Revell Batholith Area, to categorize streams according to the types of fish habitat they are likely to support (Tulloch Engineering 2018b, 2018a). Information for aquatic habitat mapping was acquired from LIO, ecosite information from the MNRF, and topographic information from GeoGratis. Streams were classified into eight categories including five wetland type "W" categories including: marsh (Wm), fen (Wf), bog (Wb), and swamp (Ws), as well as unclassified wetlands (Wu), where wetland type was unknown. Strahler stream order (Strahler 1957) was used for streams that did not pass through wetlands with headwater streams classified as Strahler orders 1 (H1) and 2 (H2). Higher order streams were classified as "O", or "U" if Strahler order was unknown. Waterbodies were not classified; however, where information was available, these waterbodies were denoted by thermal regime (cold, cool, and warm) from data acquired from the LIO database.

Field studies were conducted to ground-truth mapped aquatic habitat data (Tulloch Engineering 2018b). During field studies, biologists measured the following field habitat metrics: aquatic habitat type; water chemistry (temperature, dissolved oxygen, conductivity, pH); substrate (stream bottom) composition; stream channel morphology; habitat suitability for use by fish; vegetation types along the stream edge; presence of groundwater seeps; and confirmation of reach breaks identified during desktop mapping. Field observations were compared to desktop mapping of stream reach classifications and wetland evaluations to determine confidence in mapping. Results of field verification generally agreed with desktop mapping and the ecological importance of observed differences was determined to be minimal. The reclassifications were primarily due to the inability to differentiate between similar wetland types from aerial imagery, natural progression (changes) of wetland types over time, seasonal changes in water flow, and changes in habitat due to beaver activity. Some of these classified streams can be utilized in the BIS Program; however, stream classification for the proposed BIS will require classification over a much wider area.

1.5.5 Additional Wildlife and Fisheries Studies

Focused field studies for fish and wildlife were conducted in key areas within the AOI surrounding the borehole locations, the affiliated roads, and a buffer zone surrounding them (Tulloch Engineering 2018a, 2019b). Fish and wildlife data were collected through general reconnaissance, ELC studies, fisheries assessments, trail camera deployment, song meter and acoustic surveys, rare plant surveys, and recorded incidental observations. Field efforts focused on detecting SAR (species of conservation concern identified federally by COSEWIC and provincially by COSSARO), presence of migratory birds, and fish and fish habitat information. Surveys were conducted in several areas including Basket Lake, Indian Lake West, and Indian Lake East, as well as in some locations within the local and regional study areas identified for the BIS (see Section 1.8). Useful data on biodiversity values were identified through fish community surveys, MAFA assessments, habitat assessments for protected species, and incidental observations made during these studies.

1.5.6 Environmental Media Baseline Program Design

The APM Project EMBP has recently been designed by CanNorth to characterize the environmental media baseline conditions prior to commencement of the APM Project (CanNorth 2019a, 2019b, 2020). Environmental components that will be studied in the EMBP include:

- Tissue samples
- Hydrology
- Surface water parameters
- Air quality, noise, and light
- Shallow groundwater
- Soil quality

These environmental components (excluding tissue samples) collectively represent the abiotic environment on which living organisms depend. Any changes to the abiotic environment can have an impact on organisms that depend on environmental conditions to be maintained within a certain range of variation around their current state. Many potential impacts on biodiversity values selected for inclusion in the baseline study will occur through the alteration of the abiotic environment. For example, altering shallow groundwater levels could potentially reduce water levels within aquatic environments and alter vegetation, fish, and wildlife communities. While the abiotic environment has an impact on the biotic environment, the inverse is also true. For example, removal of vegetation can alter soil properties and increase the risk of slope failure on steep slopes, impacting habitat for other organisms and ecosystem function and services.

The inherent feedback between the biotic and abiotic environment will require collaboration between the BIS baseline program and the EMBP to ensure data are collected in an efficient manner that benefits both programs. Early communications (which have already begun through semi-monthly meetings) ensure all collected data can be efficiently utilized by both programs (e.g., benthic invertebrate and fish collection), as well as find potential efficiencies to reduce duplication of effort (e.g., for the proposed eDNA program).

1.5.7 Data Gaps

While previous field data and related programs provide a starting point for determining baseline study components that are likely to be important for the BIS Program, data collected to date have been collected with different scopes and objectives. Many past field studies were conducted within small, discrete spatial boundaries, such as within and directly surrounding borehole locations, rather than study areas of relevance for biodiversity studies. Larger scale studies are needed to first support community decision-making on willingness, and then an IA, if the community is willing to proceed to this stage. Therefore, data gaps exist that need to be filled via desk-based and field-based surveys within the greater area of relevance for the BIS Program (see Section 1.8). Big Unobstructed Databases, as well as government data sources, will continue to be explored by Zoetica to fill data gaps (see Table D-1 in Appendix D of the BPPA Report). However, it appears that many of the Big Unobstructed Databases contain data collected at spatial scales that are too coarse and/or using non-systematic methods, which limit their uses for filling gaps. Government data (see Table D-2 in Appendix D of the BPPA Report; Zoetica 2020) include useful forest cover information from the MNRF that can be used as a starting point to begin planning surveys for the BIS Program; and data from the NHIC may include previous observations of SAR or species of importance to local stakeholders/rights-holders within or near proposed study areas, which can enable known species in the area to be considered in baseline design planning. However, government data appear to be patchy in coverage and at a coarser spatial scale than needed for the BIS Program (see Section 2.1.2.3.1).

1.6 Biodiversity Values

Good practices for developing biodiversity studies include carefully defining the scope, i.e., the biodiversity values that will be included in the baseline study and potentially carried through the IA process as VCs. A well-thought-out baseline program will ensure due diligence can be demonstrated, will prevent wasting resources by collecting unnecessary information, will enable positive outcomes, and will reduce the risks to the APM Project cost, schedule, and/or performance. Ultimately, the BIS will need to meet the requirements to be laid out in the TISG for the APM Project, which will be written by the IAAC in discussion with the CNSC. Additional concerns of rights-holders and stakeholders may necessitate supplemental studies be undertaken by the NWMO to facilitate public confidence in the project.

Scoping of biodiversity values to include in baseline studies is one of the earliest steps of the BIS, and is detailed in Zoetica's BPPA Report, Section 3.1 (Zoetica 2020), where the inclusion of various biodiversity components is rationalized. Biodiversity values selected through early scoping practices include those identified through community engagement, and through consideration of regulatory requirements (e.g., listed species, protected areas, habitat features that must be avoided). Biodiversity values may also include species that could serve as indicator species for changes to ecosystem and ecosystem function, where appropriate. Biodiversity values may also include species that may become listed under the Ontario *Endangered Species Act* or the federal *Species at Risk Act* (*SARA*), or those that may undergo a range shift into the APM Project area due to climate change during the managed life of the project. The biodiversity values recommended for inclusion in the BIS are presented within Zoetica's BPPA Report (Zoetica 2020) and summarized in **Table 1-2** within the current report.

Table 1-2. Biodiversity values recommended for inclusion in the Biodiversity Impact Studies.

Terrestrial	**Aquatic and Semi-Aquatic**	**Ecosystem Function and Services**
• Terrestrial Vegetation • Ungulates • Carnivores • Small Terrestrial Mammals • Bats • Birds: upland breeding birds, raptors, game birds • Herpetofauna: reptiles • Terrestrial Invertebrates	• Wetland and Aquatic Vegetation • Semi-Aquatic Mammals • Birds: waterbirds, shorebirds • Herpetofauna: amphibians, reptiles • Fish and Fish Habitat • Primary and Secondary Aquatic Producers • Semi-Aquatic Invertebrates	• Provisioning Services (e.g., food, medicine, fresh water, materials) • Regulating Services (e.g., forests, wetlands, pollinators) • Supporting Services (e.g., fish and wildlife habitat, genetic diversity)

1.7 Potential Project Interactions

A preliminary project component and biodiversity interaction matrix was included in Zoetica's BPPA Report, and modified below as **Table 1-3**. This matrix was based on the proposed biodiversity values to include in the BIS and available information (with assumptions) about APM Project components, to date. Potential cumulative effects were also included in the BPPA Report, and details can be viewed in the BPPA Report, Sections 3.2.1.3 and 3.2.2.3 (Zoetica 2020).

Table 1-3. Preliminary APM Project component and biodiversity interaction matrix based on proposed biodiversity values to include in the APM Project BIS (to be refined during the VC scoping process) and available information (with assumptions) about APM Project components to date. A third dimension can be added to this scoping table that identifies indirect project impacts transmitted through other intermediary disciplines (e.g., physical sciences, traditional and local land use).

Project Component / **Biodiversity Value**	**Lighting**	**Road Traffic**	**Linear Infrastructure**	**Vegetation Clearing**	**Communication Towers**	**Population & Settlement Pattern Changes[1]**	**Facilities & Activities that potentially affect:**			
							Noise & Vibration[2]	**Air Emissions & Dust[2]**	**Water Quality[2]**	**Water Quantity[2]**
Vegetation		x	x	x		x		x		x
Ungulates	x	x	x	x		x	x	x		
Carnivores		x	x	x		x	x	x		
Small Terrestrial Mammals		x	x	x		x	x	x		
Semi-Aquatic Mammals		x	x (near water)	x		x	x	x	x	x
Bats	x	x	x	x	x		x	x	x	
Birds	x	x	x	x	x		x	x	x	x
Herpetofauna	x	x	x	x			x	x	x	x
Terrestrial & Semi-Aquatic Invertebrates	x	x	x	x				x	x	x
Fish and Fish Habitat	x		x (water crossings)	x		x	x	x	x	x
Primary & Secondary Aquatic Producers			x (water crossings)					x	x	x
Ecosystem Function and Services[3]			x	x		x		x	x	x

Notes:
1 Additional pressures, such as increases in development pressures related to in-migration of APM Project workforce, may impact several activities listed and will be captured in the IA in collaboration with the social and economic impact studies.
2 Project components and activities that potentially affect the physical environment will be determined by the EMBP (e.g., whether runoff from the excavated rock storage will affect water quality). Changes to the physical environment can in turn interact with biodiversity, which will be captured in the BIS Program.
3 Cultural ecosystem function and services, such as those associated with spirit, enjoyment, and visual beauty of the landscape, are not addressed in the BIS but will be part of the APM Project's health and social impact assessment.

1.8 Study Areas

Study areas need to be established early in the development of baseline studies to first support community decision-making, then to support an IA (Gullison *et al.* 2015), if the community proceeds to this stage. Identifying the spatial scale(s) for which to study biodiversity values is critical for ensuring that adequate information is collected to support the IA without the collection of erroneous information (Ross *et al.* 2006). Good practice suggests that study areas should encompass the extent of anticipated APM Project activities and impacts, and a consideration of the distribution of biodiversity values across the landscape (Gullison *et al.* 2015). Study areas should also be large enough to capture any potential cumulative effects that may occur in the region within the ranges of VCs present (IFC 2013). Zoetica began the process of defining a study area by mapping the AOI as defined by the NWMO, which represents the area within which the APM Project footprint area will be placed. The AOI was designed to include the area necessary to maintain design flexibility into and beyond the IA stage. Local and/or Regional Study Areas (LSA and RSA, respectively) for each biodiversity value were defined in Zoetica's BPPA Report, Section 5.2 (Zoetica 2020). Some of these maps are included again for the relevant baseline studies to be undertaken in the initial Tier 1 studies described in this BPD Report.

1.9 Statistical Considerations for Sampling Design

1.9.1 Survey and Sample Location Selections

Sections 3.2 and 5.2 of the BPPA Report describe the potential project-related and cumulative effects that were considered when planning baseline field work. These effects, in turn, were considered when selecting survey sites and defining the spatial extent of survey effort focusing on each biodiversity value. Control sites in areas beyond the anticipated spatial extent of potential project-related effects will also be selected for each biodiversity value, as appropriate, to support a Before-After-Control-Impact (BACI) study design, as described in the BPPA Report, Section 3.2.3 (Zoetica 2020). The use of proper control sites will enable the disentanglement of environmental changes unrelated to the APM Project (e.g., natural sources of regional variation such as weather or climate change) from project-related impacts.

In developing baseline data collection maps for the BIS, considerations were made for locating data collection sites, such that there is proportional representation within and around areas that are currently impacted, or relatively pristine. It is important that background information gathered, and data collection sites selected support the understanding of a dynamic system that has changed through the past and will continue to change into the future. The current baseline conditions represent the state of the current environment, which is the amalgamation of natural and anthropogenic changes, cycles, and processes that have occurred and changed from time immemorial until the present, and which will continue to change into the future. Therefore, it is important to collect data in both relatively disturbed (e.g., by roads, forestry roads, forest fires, forestry practices) and relatively pristine ecosystems (e.g., areas not in forestry rotation, areas not impacted by roads, relatively inaccessible areas) in proportion to their availability in each study area, which better allows for predictions about changes when those proportions begin to change, and to consider various scenarios. The consideration of currently impacted and non-impacted sites, and how both will be captured in the baseline study design, along with how the impacts of future projects will be considered, are discussed Section 7.0, Table 7-2 in the BPPA Report (Zoetica 2020).

Biodiversity baseline field programs are optimized by determining survey locations in advance, based on a solid foundation of ecosystem maps. Zoetica does not recommend arriving on site and deciding study locations fully *in media res*, as biases will inevitably occur. Although more logistically difficult, care should be taken not to bias the selection of study sites (e.g., based on access alone). Zoetica generally supports using a stratified random approach to allocate sampling effort (Gullison *et al.* 2015) using the results from ecosystem mapping done in Tier 1 data collection (described in Section 2.1). Stratified random selection of sampling locations and control sites, including replacement sites that can be visited should a random site not be accessible (e.g., black bear present), can be realized using a Generalized Random Tessellation Stratified (GRTS) (Stevens and Olsen 1999, 2004), which can be performed using the 'spsurvey' package in R (R Core Team 2016). The GRTS study design is further described in Zoetica's BPPA Report, Section 4.3.1 (Zoetica 2020).

Decisions about model selection and the use of data following data collection will likely need to be refined over time, in discussion with modeling statisticians (e.g., Dr. Carl Schwarz, Professor Emeritus of Actuarial Sciences, Simon Fraser University), and alongside a growing exploration of available data, and data that can be collected during baseline surveys (with considerations of sample sizes, data normality, equality of variance, and other factors that determine the types of statistics that are valid). However, using a proper GRTS study design provides promise that biodiversity data can be analyzed using Species Distribution Models (SDM); Stacked Species Distribution Models (SSDM), Joint Species Distribution Models (JSDM), and Ordination-based Models (ORD), which are all available to accomplish the task of linking species to environmental covariates. Data collected at the Atikokan meteorological station (associated with the Township of Ignace) between 1971-2000 are also summarized in Golder Associates (2013), which included an analysis of monthly daily averages for mean, minimum, maximum, extreme maximum and extreme minimum temperatures; monthly average rainfall or snowfall, including extreme daily rainfall and snowfall amounts; and average seasonal wind speeds and direction. Golder Associates recently completed a study for the NWMO to assess climate change impacts on the probable maximum precipitation (PMP) and intensity-duration-frequency (IDF) precipitation amounts for the Ignace study area (Schardong *et al.* 2020); this report summarizes the analyses of current and future (2050s and 2080s) climate on PMP and IDF estimates and provides a qualitative climate assessment beyond 2100.

1.9.2 Power Analyses

Data collected in Tier 1 should ideally be sufficiently powerful to demonstrate whether or not an effect has occurred, with a reasonable level of certainty. Statistically valid baseline data collection will be defined as achieving a theoretical/aspirational benchmark of a "good" statistical power of 0.8-0.9 (Jones *et al.* 2003), assuming that the goal is to detect a small to medium (d(0.2)-d(0.5)) effect size change due to the APM Project (Cohen 1990, Sawilowsky 2009) over various time frames of relevance (e.g., the program should be able to detect a large effect size (major impact) over a short time frame (e.g., 1-2 years) and more subtle and incremental, smaller impacts (medium to small effect sizes) over longer periods of time (e.g., 3-10 years)), and that baseline data will be used in BACI or gradient BACI designs (Smith 2002). In some cases, such as where species are in very low abundance, it may not be feasible to collect a sufficiently high sample size to achieve this goal; however, other considerations will be made to select study organisms for the purposes of statistical analyses to reduce the probability of this issue. If data cannot be generated to achieve this power within the project timeline, a more conservative threshold (e.g., higher alpha value) for detecting statistical change can be adopted, such that early adaptive management can be employed in response to a potential adverse effect.

Statistical methods for field survey design (*A Priori* Power Analyses), testing sampling effort (*In Media Res* Analyses), sampling intensity (*Post Hoc* Analyses), and statistical goals are reviewed in the BPPA Report, Section 4.3.2 (Zoetica 2020). The use of the general approaches outlined in the BPPA Report will ensure that the baseline program is neither under- nor over-sampled and proceeds in a scientifically valid and efficient way. More detailed decisions on statistical tests and models to use for baseline data analyses will be determined at a later date, as many tests require an initial examination of the structure of the data before optimal decisions can be made.

1.10 Data Management

1.10.1 Data Management and Transfer from Field Data Collection Contractor

The field data collection contractor will be expected to create their own Project Quality Plan (PQP) to meet the needs and standards of the NWMO. Data entry and management in the field should follow these steps:

1. Transcribe information recorded on paper field data forms into an electronic spreadsheet or database as soon as possible, ideally on a daily basis. This person must input their initials into the "Entered by" field of both the hard copy and the spreadsheet. If data are entered on digital forms (see below) then only verification steps need to be completed.
2. A second person should verify (double-check) data entry against the original data form. This person must input their initials into the "QA/QC by" field of both the hard copy and the spreadsheet. Any discrepancies or ambiguities should be verified with survey team members.
3. All photographs taken for the site (including habitat and data form backup) should be organized into a folder labelled by the unique site code. All sites completed each day should be organized into a folder labelled by the survey date. If digital forms are filled (see below), then photographs and other pertinent information for the unique site can be appended directly to the digital form. Back-ups can be filed in folders for each unique site on a hard drive.
4. Photographs and spreadsheets should be backed up and stored securely on a hard drive or uploaded to a server/database approved by the NWMO daily or as soon as practicable.
5. At the end of the field campaign, GPS waypoints and tracks, modified or annotated Avenza Maps, and any other documentation should also be backed up and stored securely on a hard drive or uploaded to a server/database approved by the NWMO, prior to the official data transfer(s) to the NWMO.

The field data collection contractor will also be expected to submit their data to the NWMO directly; data transmittal from the field data collection contractor to the NWMO will include their datasets, metadata files, and a transmittal letter, examples of which will be provided by the NWMO through their instructional guidance form NWMO-INS-01390-0201. Currently, the NWMO uses a DAP data management program, and data will undergo a check by the NWMO on receipt. Data would then need to be requested by Zoetica (e.g., for use in analysis and reporting) from the NWMO, and the DAP-associated protocols for data transfer from the NWMO to Zoetica would be followed.

The NWMO is in the process of implementing a more automated environmental data management system (EDMS). When that system is in place, digitized data forms will be created by the NWMO based on templates of data collection forms supplied by Zoetica. Data that are filled out using digital forms will automatically be sent to the NWMO, and Zoetica will obtain automated emails noting when new, quality-checked data are available. Data will then be downloadable by Zoetica. Zoetica will not conduct an additional QA/QC check on data that have come from the field data collection contractor; it will be expected that data will have already undergone a rigorous QA/QC check and will be useable on delivery. However, if any obvious errors are noted by Zoetica, they will be reported to the NWMO for feedback through their compliance management protocols.

To adhere to the proposed baseline reporting schedule, the field data collection contractor will be required to submit their final field data to the NWMO, following the NWMO data transfer protocols, within a maximum of two weeks of completing field work, such that the NWMO can process the data and enter it into their own data management system. If the dataset passes QA/QC checks, the NWMO will send the data to Zoetica within 8 days of receiving it. If the dataset does not meet quality criteria, the field data collection contractor will need to make revisions and resubmit to the NWMO. Once data are received from the NWMO, Zoetica will follow NWMO data management protocols and verify that the data received match what is documented on the *Data Clearance Form*. Once the data are verified, a signed version of the *Data Clearance Form* is stored on ZoeticaNet in the data clearance form category as a permanent record and backup, which the NWMO can access as needed.

1.10.1 Data Management and Transfer from Zoetica

For data, reports, and other deliverables generated by Zoetica (e.g., maps, reports, analyzed data), data management will follow Zoetica's internal data management procedures, which are detailed in the Biodiversity Impact Studies PQP. Briefly, prior to supplying data to the NWMO, all files will be uploaded to ZoeticaNet. New versions or iterations of documents are 'stacked' through ZoeticaNet as they are edited, such that each iterative change is preserved, in case a previous version needs to be restored or revisited. When files are uploaded to ZoeticaNet, the privacy for the file can be selected that will control who is able to see and download the file. Therefore, sensitive or confidential data can be stored on ZoeticaNet with restricted access such that we comply with the terms of data sharing agreements associated with various data sources. ZoeticaNet currently has hundreds of gigabytes of capacity and can be expanded as needed; we also possess a dedicated GIS desktop computer and several multi-terabyte external hard drives for backup storage, which are stored securely at the Zoetica office. All deliverables to the NWMO (e.g., report, maps, shapefiles) are uploaded to ZoeticaNet as a permanent record and backup that the NWMO can access as needed. Data transferred from Zoetica to the NWMO will follow NWMO protocols. If the DAP system is still in place, the data transfer will follow NWMO-INS-01390-0201, including datasets, metadata files, and a transmittal letter. NWMO will provide the DAP Metadata Editor to Zoetica to create metadata for all data deliverables, including any data acquired directly by Zoetica from a third party or open data source. Once the EDMS system is operational, data transfer from Zoetica to the NWMO will follow accompanying procedures to be developed and disseminated by the NWMO. The NWMO is currently exploring data management software for statistical code (e.g., GitHub), and Zoetica will submit their statistical code to the platform ultimately adopted and using associated data transfer protocols (to be developed).

All acquired data will be stored in two locations in its original form. First it is stored in the 'raw data' folder within the project-specific folder on the GIS desktop. It is then copied to the project-specific folder on the data storage designated hard drive. All external storage devices are stored in a locked area within the Zoetica office. If file size allows, a third copy can be saved to ZoeticaNet. In cases where file sizes are excessively large, such as what can be the case for orthoimagery and drone-generated visual files, additional external storage devices will be used to back up materials, and they will be stored in a locked area within the Zoetica office. Outputs from the data or edited versions are saved in separate folders to ensure original copies of all data are maintained. Any data that are considered sensitive (e.g., NHIC occurrence data) will be stored in separate 'sensitive raw data' folders so that data sensitivity is known when accessed. All products from sensitive data (e.g., shapefiles, Excel outputs, maps) that are uploaded to ZoeticaNet will have the necessary permissions in place so only authorized personnel can access them, and will have a clear label that it contains sensitive data and is not to be shared outside Zoetica, NWMO, or those with explicit permission to view.

All datasets that are acquired in anticipation of use in the BIS will have their source documented in the *Data Source Master List* which will be saved on the GIS desktop and a copy saved to ZoeticaNet. Data can be obtained from open sources online (e.g., Ontario GeoHub) or issued from an organization (e.g., MNRF). All data from open online sources will document the details of the download including the dataset name, source, data format, folder path name, date of download, most recent date the data were updated (if available), the source URL, and any applicable notes and limitations (e.g., open government license). All data issued from organizations will document the details of the dataset name, date the data were issued, most recent date the data were updated (if available), source organization, contact details for the organization personnel who issued the data (if applicable), folder path name, any use restrictions, data sensitivity or licensing information, and any applicable notes. Any data that are considered sensitive will have the line of information highlighted to ensure that sensitive data are obvious at a glance.

1.11 QA/QC

All baseline data collection will follow the appropriate Standard Operating Procedures (SOPs; see **Appendix A**) and QA/QC protocols provided, along with the internal PQP produced by the field data collection contractor to satisfy NWMO quality standard requirements. This section focuses on the general QA/QC procedures that will apply to the overall BIS baseline program. For Tier 1 studies, Zoetica anticipates that only eDNA studies will have method-specific as well as data-specific QA/QC protocols, which are described in Sections 2.6.3.4 and 2.6.3.6.

1.11.1 Quality Assurance (QA)

The QA procedures herein apply only to procedures undertaken by Zoetica prior to submission of data to the NWMO. Separate QA measures will be developed by the field data collection contractor as part of their PQP development prior to undertaking field work.

Quality assurance protocols are a set of activities for ensuring quality in processes; QA involves prevention of quality issues through planned and systematic activities, including documentation. For the BIS baseline studies, measures for QA include:

- Application of best practices, guidelines, and standards for studying biodiversity values, with consideration of community input, the regulatory environment, and data requirements for the APM Project IA.
- Baseline studies will be designed to collect sufficient sample sizes (e.g., including appropriate samples per unit area/habitat grouping, replicates, spatial and temporal coverage) to enable detection of potential future project effects.
- Production of Zoetica's BPPA Report (Zoetica 2020) and this BPD Report, which provides documentation of research and steps taken to arrive at endorsed best practices and preferred approaches. The BPPA Report was reviewed by the NWMO's APM Environmental Review Group

(the ERG), which is comprised of IA and biodiversity experts and includes Indigenous representation.
- Additional community engagement (see Section 1.4.1) to ensure that local stakeholder and rights-holder input and concerns are integrated into the baseline study design.
- Development of baseline study design and future analyses and reporting will be completed by qualified, experienced, and knowledgeable staff, with senior review by registered professional biologists (R.P. Bio. designation in British Columbia).
- Expert subcontractors or specialized services (e.g., statisticians, air photo interpretation) may be retained, as needed and with the approval of the NWMO, to ensure that study design and future analyses are completed to a high standard of quality.
- Verification processes for data inputs and outputs, including checklists and documentation requirements.
- Recommendations for field data collection contractor qualifications and experience to assist with the NWMO's procurement process.
- Provision of sufficiently detailed SOPs, data forms, field maps, and other instruction (e.g., training by Zoetica staff) to the field data collection contractor and local field assistants prior to deployment.
- Requirements for redundancy in key field navigation gear, critical information (e.g., SOPs, data forms), and collected data (i.e., hard copies and electronic backups) to prevent loss.
- Increased training and oversight (e.g., quality checks by team leads) at the beginning of the field program to ensure that protocols are understood and being followed, and that modifications or corrective actions can be made early on, if needed, to ensure that the field program is completed to a high standard of quality.
- Regular reporting/communication schedule between the field data collection contractor, Zoetica, CanNorth, and the NWMO to track progress and ensure that any logistical problems be addressed in a timely manner.
- Regular data transfer schedule (rather than a "data dump" at the end of the field season) to enable periodic quality checks and as an extra backup, and identification of opportunities for continuous learning.
- Inclusion of contingency sampling/survey sites in survey plans, to ensure that if access is prohibitive (extremely difficult to impossible access) justified and ordered replacement sites are available.

The contracted services (e.g., field data collection contractor, laboratory services) will have or will develop their own project-specific QA/QC protocols (i.e., PQP) for equipment calibration, verification, and preventative maintenance; data entry and management, including record keeping; specific laboratory procedures and analyses (e.g., replication, controls, acceptance thresholds, storage conditions); good practices for cleaning and safety procedures; and other relevant tasks in their regular workflow; as well as the competency of staff completing the work. It is also expected that sample data being handled by contracted services will meet the data quality standards of the NWMO prior to being delivered to Zoetica for analysis.

1.11.2 Quality Control (QC)

The QC procedures herein apply only to procedures undertaken by Zoetica prior to submission of data to the NWMO. Separate QA measures will be developed by the field data collection contractor as part of their PQP development prior to undertaking field work. Quality control refers to a set of activities for identifying errors and ensuring quality in deliverables; QC involves activities or techniques used to achieve and maintain the product quality, process, and service. For the APM Project BIS baseline studies, measures for QC include:

- Review of data and verification documents produced by the field data collection contractor.
- Verification of data completeness prior to conducting statistical/data analyses or developing mapping products (as part of study design as well as for the baseline report). It is expected that verification of data quality will be part of the QC protocols of the field data collection contractor.
- Documentation of all data assumptions, limitations, and manipulations (i.e., metadata), as well as any recommendations to improve upon uncertainties.
- Verification and version tracking of software used in analyses (e.g., GIS tools, statistical programs) as described in the *Project Quality Plan* developed for the BIS.
- Internal peer review of baseline results and reporting (including mapped data) by qualified and experienced professionals to ensure that summarized information is accurate and that data interpretation is sound, scientifically valid, and defensible.
- Presentation of all raw data, calculations, and statistical steps as appendices in the baseline report to ensure transparency and allow for reproducibility of results.
- Inclusion of any statistical script used (e.g., R-script) in analyses within baseline report appendices.
- Document control and revision history tracking tables for reporting deliverables; project management through ZoeticaNet system.
- Regular communication within Zoetica and between Zoetica, subcontractors, field data collection contractor, the NWMO, and other technical programs, to discuss any quality issues identified and to propose solutions.
- Monthly summaries of work will continue to be provided to the NWMO for review throughout the baseline program, including discussions of any non-conformities affecting quality and corrective actions taken.
- Review of Year 1 of the BIS baseline program to assess the progress of filling data gaps and meeting data objectives, and to find opportunities for quality improvement and inform study design changes, if needed, for the next year.

2.0 TIER 1 STUDIES TO SUPPORT ALL BIODIVERSITY VALUES

This section presents the plans and details for each Tier 1 study planned for the BIS. Each study is designed to collect key information which will be required to plan or select Tier 2 studies. See Section 1.2 for details on the tiered approach. All Tier 1 studies will begin with desk-based work as part of pre-field work planning. The desk-based work will be completed by Zoetica. This desk-based work will include the collection, analysis, and mapping of available data. All field-based work will be completed by the field data collection contractor. This field-based work will include the collection of data according to the SOPs in **Appendix A**, and then digitizing and quality checking the data. After going through the NWMO's data management system (see Section 1.10.1), these data will then be provided to Zoetica for further analyses and interpretation, and ultimately incorporated into the biodiversity baseline reports and Impact Assessment (IA). **Table 2-1** provides a summary of the Tier 1 field programs, the approximate timeframe to complete them, and the skills that are required for the personnel that will conduct the data collection. Studies for the Tier 1 program are planned to commence beginning in the summer of Year 1. It is expected that with the exception of eDNA studies, which is proposed to include multi-seasonal sampling, the other Tier 1 studies can be completed within a single field campaign/season in Year 1. However, after Year 1, field data will be analyzed and used to corroborate desk-based mapping, where applicable, and any gaps identified (i.e., if confidence in mapping is deemed to be too low, or additional areas of ground truthing are required), additional field data collection of Tier 1 studies may be planned for future years to fill any remaining gaps. Results of Tier 1 studies will also be used to plan Tier 2 studies in future years.

Table 2-1. Outline of timeframes and required skills for the Tier 1 biodiversity field programs commencing in Year 1. Years herein pertain to a twelve-month time period commencing when field work starts (commencing in mid-June 2021).

Program	Timeframe	Frequency/Timing	Skills required for field-contractor personnel
Terrestrial Ecosystem Mapping	Year 1: June – August	• Generally conducted in July or August when vegetation is evident; advanced to mid-June in case of wildfires later in the summer • Subsequent years of field work must be conducted during the same window • Year 1 studies will focus on ground-truthing desk-based data within the aquatic LSA • Future studies may expand to ground-truthing in the vegetation RSA	• Vegetation specialists capable of identifying majority of vegetation species in the region and classifying ecosites • Soils specialists capable of describing soil profiles and classifying ecosites • Field assistants with knowledge of the region and its flora and fauna
Habitat Suitability Modelling & Candidate SWH Identification	Year 1: June – August	• Similar rationale as TEM; to be conducted at the same plots • But consider optimal timing for specific biodiversity values; e.g., MAFAs should be assessed from mid-June to end of July	• Wildlife biologists capable of assessing wildlife habitat suitability in the region • Familiarity with assessing Significant Wildlife Habitat
Aquatic Habitat Mapping	Year 1: July – September	• During summer low flow periods (May to September and adjusted to local conditions) when visibility and access are best, and vegetation is evident • Year 1 studies will focus on the aquatic LSA, and additional comparable control sites in the aquatic RSA • Spring visits in future years can detect non-permanent water bodies	• Fisheries biologist capable of assessing fish habitat and fish habitat suitability in Ontario • Familiarity with wetland classification (e.g., bog, fen, marsh, swamp) in accordance with definitions outlined in the *Ontario Wetland Evaluation System – Northern Manual* (MNRF 2014a) • Knowledgeable in aquatic vegetation species identification
eDNA Studies	Year 1-Year 3: Seasonal	• Summer, fall, and spring campaigns in Year 1 will be coordinated with surface water component of the EMBP • Winter sampling may occur in in future years only if other seasonal results indicate presence of species of interest in AOI or data gaps exist • eDNA studies will continue in subsequent years of baseline data collection • Study design may be refined in future years (study area, seasonal windows, sample sizes, and/or frequency)	• Experienced field biologists with knowledge of local wildlife and fish biology and ecology • Familiarity with wetland classification (Ontario Wetland Evaluation System) and stream reach identification • An understanding of best practices in eDNA sample collection, e.g., requirements for strict decontamination protocols and detailed record keeping • Required qualifications and experience should be coordinated with the needs of the surface water component of the EMBP; eDNA sample collection includes water quality measurements

2.1 Terrestrial Ecosystem Mapping

2.1.1 Overview

To understand and characterize the environment surrounding the APM Project, Terrestrial Ecosystem Mapping (TEM) will detail the various ecosystems present in the Revell Batholith Area. An ecosystem is a community of plants, animals, and other organisms and their interactions with their abiotic (physical) environment. Ecological classifications will be defined by topography, landscape gradients and patterns, terrain, vegetation, and soils.

2.1.1.1 Data Objectives

Completing TEM for the Revell Batholith Area will provide the required detail about the various types of ecosystems present. It will enable the identification of associations between the presence and abundance of terrestrial species detected in baseline studies with habitat features. Further, TEM will provide suitable habitat groupings for planning stratified random baseline surveys for biodiversity values, such as the design to be used for eDNA collection (see Section 2.6). Since ecosystems are complex communities of organisms interacting together, stratifying the landscape into ecosystem types will allow for an understanding of the co-varying organism clusters that are present across ecosystems.

2.1.1.2 End Use

The results of TEM will be utilized as input into various biodiversity programs for the BIS. TEM data will form a key base layer for habitat suitability modelling (see Section 2.2). TEM habitat groupings will be used to plan randomized, stratified study locations for use in collecting data via a GRTS design for Tier 2 studies of various biodiversity values. Finally, TEM is used to describe and assess the habitat that is available within the LSA and the greater RSA[6] (see **Figure 2-1**), and to determine the area (ha) of various habitats that will be lost or indirectly impacted due to the APM Project. TEM from the larger regional area will also assist in determining the local rarity of lost or impacted habitat.

2.1.1.1 Best Practice Guidance

The BPPA Report (Zoetica 2020) details the rationale for the decision of the selected best practices. The best practices that will be used while planning and conducting the TEM will depend on which stage of the TEM study is being undertaken. The various best practices that will be used within the TEM studies are detailed in **Table 2-2**.

Table 2-2. Summary of best practices and when they will be applied during Terrestrial Ecosystem Mapping.

Best Practice	**When Best Practice is Used**
Ontario's Ecosite Guidelines: Ecosites of Ontario (ELC Working Group 2009) Boreal Ecosite Factsheets (OMNR 2014) Field Guide to the Substrates of Ontario (OMNR 2015)	Conducting air photo interpretation to classify a polygon into ecosites; when at the site to confirm or reclassify a site; when completing the Site and Soil Description Form
Standard for Terrestrial Ecosystem Mapping (RIC 1998)	Determining survey effort; general project planning
Field Manual for Describing Terrestrial Ecosystems 2nd Edition (BC MFR and BC MOE 2010)	Determining field methods; developing field forms and protocols

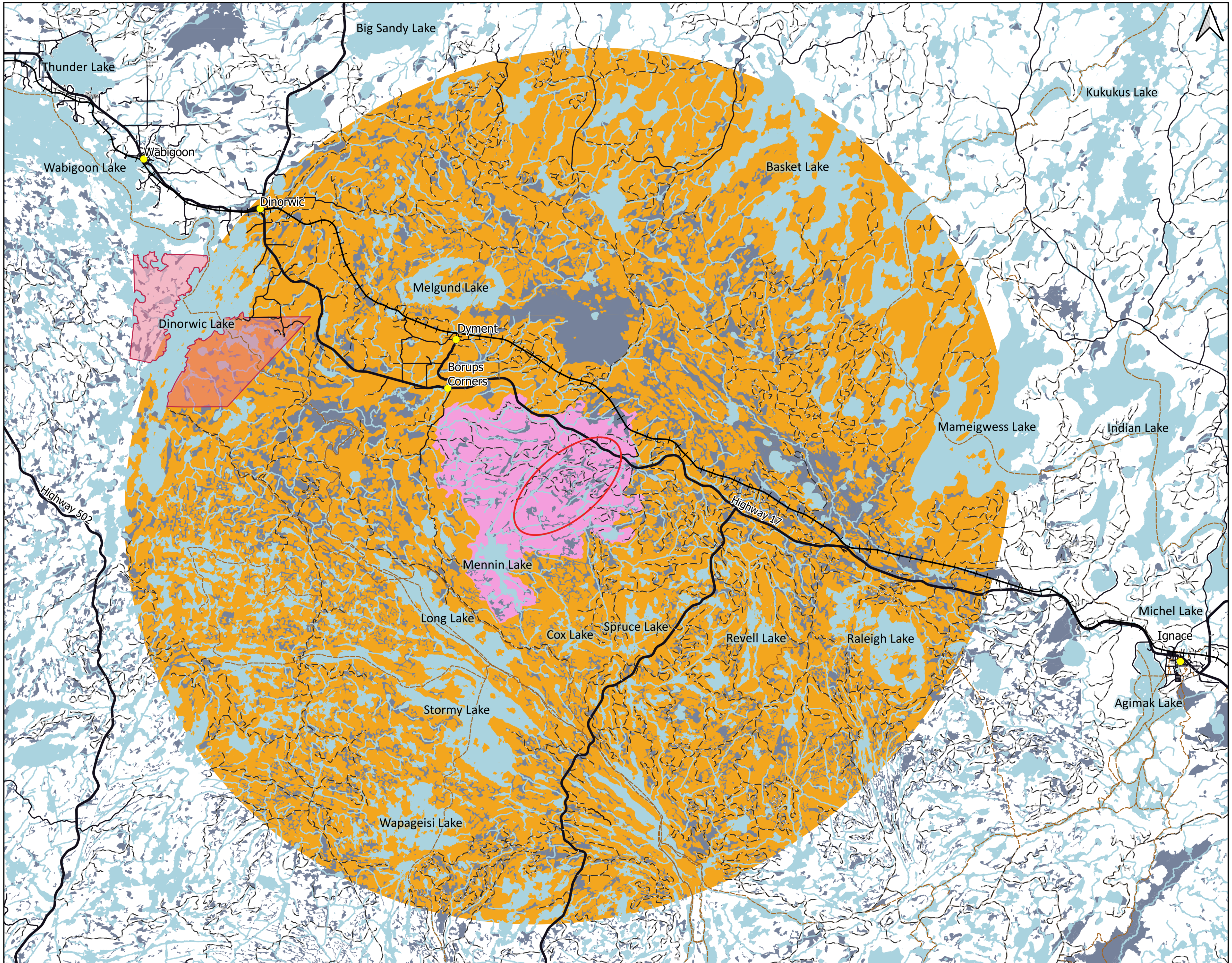
[6] We note that the RSA will not be mapped in Year 1; mapping will first be focused on the AOI and LSA and then progress outward for mapping habitat for species with representative habitat within the RSA.

2.1.2 Desk-based Program

Before any TEM field work can begin, a collation of desk-based data will be used to create a preliminary map of terrestrial ecosystems. The desk-based maps produced will act as a first draft, which will be validated and refined through field assessments (see Section 2.1.3). Validation will determine how accurate the desk-based map is, and refinement will increase the accuracy of the map by filling data gaps and fixing errors.

2.1.2.1 Study Area

As the TEM data (desk-based and ground-truthed) will inform the habitat suitability of other biodiversity values (e.g., moose) and will be used to stratify survey locations for other Tier 1 and 2 field studies, the study area for TEM must be large enough to provide regional context to all other biodiversity value study areas. The TEM study areas will ultimately cover the largest area that will be used to study vegetation in Tier 2 (see Section 3.0), and TEM data will provide an initial characterization of the vegetation of the Revell Batholith Area. The TEM study will be conducted within two scales of study areas: 1. A local study area, defined as the aquatic LSA (LSA_{AQU}), which covers the area required to plan other studies (e.g., eDNA and aquatic habitat mapping); and 2. a regional study area, defined as RSA_{VEG}, for vegetation (see **Figure 2-1**; see Section 3.2.3 in the BPPA Report (Zoetica 2020) for the general considerations and information for constructing biodiversity value-specific study areas). The RSA_{VEG} is the outermost boundary of all terrestrial RSAs for the biodiversity values included in the BIS, when overlain on one another, ensuring that accurate vegetation data are available for planning studies for and assessing impacts to biodiversity values that are dependent on the habitats that vegetation provides. Mapping efforts will first focus on the LSA_{AQU} in Year 1 and may be expanded outward into the RSA_{VEG} in future years. As the Revell Batholith Area represents one of two remaining sites that are being considered for the APM Project, this expansion approach provides partial assurance that the decision to map a very large area, which is a time consuming and costly endeavour, will occur in step with decisions to narrow down the selection of a final site.



NWMO Biodiversity Impact Studies

Terrestrial Ecosystem Mapping Study Areas (LSA_{AQU} and RSA_{VEG})

Figure 2-1

- Regional Study Area (RSA_{VEG})
- Local Study Area (LSA_{AQU})
- Area of Interest (AOI)
- Wetland
- Lake
- Watercourse
- Highway or Arterial Road
- Local Road
- Resource/Recreation Road
- Trail
- Railroad
- Community
- Wabigoon Lake No. 27

1:250,000

0 5 10 km

ZOETICA

Inset Basemap © OpenStreetMap contributors

Data received from:
Ontario Geohub - Indian Reserve (MNRF), OHN Waterbody (MNRF), OHN Watercourse (MNRF), ORWN Railway (MNRF), MNRF Road Segments (MNRF), Wetlands (MNRF) NWMO - AOI, Trail Segments (MNRF)

Project CRS: NAD83 / UTM zone 15N

Author: DM	Verified by: CC
April 21, 2021	Map ID: NWMO_BIS_019d

2.1.2.2 Data Sets

The preliminary data source for ecosystem information is the Enhanced Forest Resource Inventory (eFRI) developed by the MNRF. The eFRI dataset divides the landscape into polygons and classifies them according to the ELC system. The ELC system classifies Ontario into ecosystem types at various levels of detail and scale. The hierarchy of the ELC system is shown in **Figure 2-2**; the polygons in the eFRI dataset have been classified at the ecosite level. This dataset will be used to provide an understanding of ecosystems expected in the area and for preliminary planning.

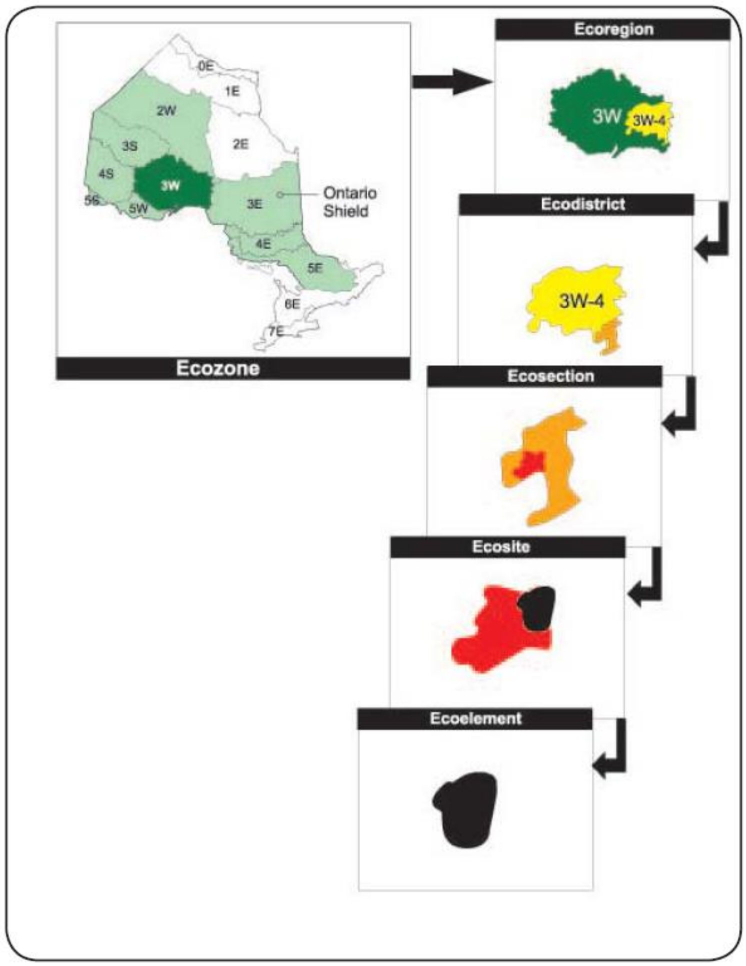


Figure 2-2. An example of the levels in the Ontario Ecological Classification hierarchy. Reproduced from *The Ecosystems of Ontario, Part 1: Ecozones and Ecoregions* (Crins *et al.* 2009).

Through the desk-based work described in Section 2.1.2.3.1, a more refined version of the eFRI dataset has been developed. This work used aerial imagery previously collected by the NWMO to create a more detailed and updated ecosite dataset (which includes wetlands). Other data will be used with the refined ecosite data to provide more ecosystem information. This will include watercourse and waterbody data from the Ontario Hydro Network (available from Ontario GeoHub); observations and occurrence data (available from NHIC) will be used to identify potential habitat use and locations of rare plants; and all data collected from previous NWMO field programs for the variety of information they have already collected, which include some already ground-truthed ecosites.

2.1.2.3 Methods

2.1.2.3.1 Desk-based Ecosite Refinement

After collation of the datasets in Section 2.1.2.2, the next task involves developing a more detailed and accurate ecosite dataset, which will better suit the needs of the BIS. The new ecosite dataset has been created by retyping the area using more recent imagery collected by the NWMO in 2017. The ecosite classification was refined with a smaller minimum polygon size. The original minimum polygon size used by the MNRF to classify the eFRI dataset was 8 ha. For the BIS, a smaller minimum polygon size will be required, as some important vegetation communities smaller than 8 ha may have been missed and would be under-represented. According to RIC (1998), polygons within the LSA_{AQU} should be refined to a land area of a minimum size of 0.5 ha at a 1:10,000 scale. Within the RSA_{VEG}, polygons should be refined to a minimum size of 2.0 ha at a 1:20,000 scale. This desk-based task was completed in 2020, by Sumac Geomatics, a sub-contractor to Zoetica, as they are skilled air-photo interpreters who have extensive experience delineating ecosite polygons in the Revell Batholith Area. To date, Sumac Geomatics has completed ecosite refinement within the LSA_{AQU}, and may extend the analysis to the RSA_{VEG}, if required. The desk-based exercise will result in a more accurate ecosite dataset, which will be referred to as the 'refined ecosite data' in the following sections. The refined ecosite data will be used by the field data collection contractor when ground-truthing.

2.1.2.3.2 Pre-Field Work Planning

Using the refined ecosite data to create field sampling plans will be completed by Zoetica, as sample locations and effort information will be required to plan the field-based activities presented in Section 2.1.3. Zoetica will perform GRTS on the refined ecosite data to stratify and randomize the locations of the plots, as well as the survey type for each plot (i.e., full, ground, or visual plots). The ratios for the proportion of each survey type recommended by RIC (1998) are presented in **Table 2-3**. The results of the GRTS survey design will be provided to the field data collection contractor.

During Year 1 of the field program, the focus will be on verifying the refined ecosite data within the LSA_{AQU}. As the LSA_{AQU} delineates the area expected to be potentially affected by the farthest-reaching project effects (i.e., dust, noise, and water withdrawal), verification of the LSA_{AQU} should be done at survey level 2 at a ratio of 3:17:80 (**Table 2-3**) for full/ground/visual plots, respectively (RIC 1998). Details on the differences between full, ground, and visual plots can be found in Section 2.1.3.4. To meet the level 2 survey intensity, 55% of each ecosite type in the LSA_{AQU} and TEM field work locations have been selected by Zoetica by performing GRTS on the refined ecosite data (see **Appendix A**). During the first field season, ground-truthing of the mapped ecosite data is planned to commence in Year 1 in mid-June to ground-truth as many plots as possible prior to the wildfire season in case of field work shutdowns. Sites not verified during Year 1 will be prioritized in subsequent years. Once a project footprint has been developed and finalized, all polygons within the project footprint that were not surveyed will be selected for surveying to ensure all habitat expected to be lost is properly classified.

In future field seasons, and if the Revell siting location is selected for continued investigation for the APM Project, the RSA_{VEG} may be surveyed at a survey level 4 at a ratio of 5:20:75 (**Table 2-3**) for full/ground/visual plots, respectively (RIC 1998). The selection of study sites in the RSA_{VEG} will be completed once the first field season is complete, and results of initial Tier 1 data are analyzed as the information collected in the field will be used to improve the desk-based ecosite mapping in the RSA_{VEG}.

Table 2-3. Survey intensity levels for Terrestrial Ecosystem Mapping. From RIC (1998). Survey intensity level 2 will be used in the LSA_{AQU}, and survey intensity level 4 will be used in the RSA_{VEG}.

Survey Intensity Level	Percentage of Polygon Inspections	Ratio of Full Plots: Ground Insp.: Visual Checks	Suggested Scales (K=1,000)	Range of Study Area (ha)
1*	76 – 100%	2 : 15 : 83	1:5 K to 1:10 K	20 – 500
2	51 – 75%	3 : 17 : 80	1:10 K to 1:20 K	100 – 10,000
3	26 – 50%	5 : 20 : 75	1:10 K to 1:20 K	5,000 – 50,000
4	15 – 25%	5 : 20 : 75	1:20 K to 1:50 K	10,000 – 500,000
5	5 – 14%	5 : 20 : 75	1:20 K to 1:50 K	10,000 – 1,000,000
R (reconnaissance)	0 – 4%	0 : 25 : 75	1:20 K to 1:50 K	50,000 – 1,000,000+
Notes: *Intensity Level 1 will be conducted once the site has been selected and the APM Project footprint has been finalized.				

2.1.3 Field Program

2.1.3.1 Survey Timing

The survey window to conduct TEM field work is dependent on the timing to identify the most species of vegetation. TEM field work is generally conducted in July or August when vegetation is the most visible; however, considerations of local seasonal conditions need to be made when determining the survey window (RIC 1998). The field data collection contractor will determine the ideal survey windows; this may include input from local botanists and Indigenous Knowledge holders. For Year 1, the TEM field work is planned to commence in mid-June to allow for the completion of as many planned survey plots as possible prior to a potential field shut-down due to wildfire risk in the area. All subsequent years of field work must be conducted during the same timing window to ensure seasonal consistency.

Field studies can be performed in moderate weather conditions that pose no safety concerns; however, rainy conditions could make walking between sites more difficult and reduce survey efficiency. If a helicopter is used for pick-up and drop-off, or ferrying between sites, then weather conditions must be suitable for safe flight and landing. Some helicopter landing sites may only be suitable for helicopter landing under dry conditions, which could result in the inaccessibility of some survey sites.

2.1.3.2 Survey Crew

Field survey crews for TEM will be paired with survey crews for habitat suitability modelling (Section 2.2). Ideally, each survey team will consist of one experienced ecosystem biologist (terrestrial vegetation specialist), one experienced soil specialist, one wildlife biologist with experience in habitat suitability modelling, and one local field assistant (e.g., from Indigenous communities) with general knowledge of flora and fauna (if community interest and availability allow). However, if the ecosystem biologist is also experienced in conducting soil assessments, both tasks could be completed by one biologist if they meet the requirements outlined below; however, this choice may lead to the ability to get fewer plot assessments done per day due to the longer time period required for the one individual to complete their tasks. To reduce the time required by this one individual, should this option be favoured, it would help to include a field assistant trained to dig soil pits while the biologist conducts the required vegetation surveys. The required experience, roles and responsibilities of the vegetation specialist, soil specialist and local field assistant are detailed below, and the roles and responsibilities of the wildlife biologist can be found in Section 2.2.3.2.

The local field assistant will aid in the navigation of the crew between sites, complete the Site Description Form upon arrival, and document the study location with photographs. The local field assistant will provide their local knowledge and expertise to the other field staff as needed. The local field assistant can also assist other field staff in setting up or executing their survey if required (e.g., digging soil pit, marking off vegetation plot, recording data).

The vegetation specialist should have extensive field experience in the region and will be expected to be able to identify most vegetation species that could be encountered during the survey. Any plants that could not be identified during the survey can be identified with a field guide or photographed, described, and sampled for later identification; however, this should be minimized for survey efficiency. Knowledge of rare plants will not be required; however, it is considered an asset for incidental observations and increasing survey efficiency.

The vegetation specialist will be required, with assistance from the local field assistant, to mark the plot boundary or plot centre (depending on plot type detailed in Section 2.1.3.4). They will then complete the Vegetation Form, Tree Attributes for Wildlife Form, and Coarse Woody Debris (CWD) Form and also ensure the Site Description Form is completed. Zoetica will develop a list of plant species of interest with input shared by stakeholders, rights-holders, Indigenous Knowledge keepers, and local botanists. Based on their experience in the area, the field data collection contractor's vegetation specialists may also provide recommendations of species that should be included on the list of species of interest. The list of important vegetation will include potentially present but rare plants, culturally significant plants, and any weeds, introduced, or invasive plants that have potential to occur in the region; this list will be provided to the field data collection contractor. It is expected that the field data collection contractor will know how to identify these species before beginning the survey and incidental observations of the species will be recorded.

The soil specialist should have extensive field experience describing the soils in the region. The soil specialist will be expected to have the experience and skills necessary to classify soils according to the *Field Guide to the Substrates of Ontario* (OMNR 2015)*;* however, experience using this guide would be considered an asset and is not mandatory. The soil specialist will be required, with assistance from the local field assistant, to dig a soil pit or mark out their visual inspection plot (depending on plot type detailed in Section 2.1.3.4). They will then complete the Site and Soil Description Form. Once the field forms are completed, but before leaving the site, the vegetation and soil field staff will need to discuss what ecosite classification they will assign to the plot.

While the field protocol necessitates walking between sites and documenting observations, the use of a helicopter can increase field efficiency by dropping the field crew off at a starting location and picking them up from their ending location. A helicopter will likely be required to gain access to some areas with limited ground access. This benefit can be cost-effective if the TEM occurs concurrently with other studies that will require the helicopter to access difficult areas. Coordination with other concurrent field studies, those conducted as part of the BIS and other disciplines, will be required to share the use of the helicopter to limit waiting time (e.g., staggering start and end time). The helicopter pilot will require experience and expertise in landing in similar difficult terrain.

2.1.3.3 Equipment and Materials

Gear checklists are provided in the SOPs in **Appendix A** for the gear needed by each field specialist. Standard data collection gear will include hard copies of field forms, SOPs, a list of survey location coordinates and field maps printed on waterproof paper, pencils, waterproof notebook, clipboard, binoculars, and camera. Navigational gear will include a GPS unit, tablet or smartphone with georeferenced digital field map of survey locations and routes between survey locations, and a compass. In case the tablet or smartphone stops working in the field, the list of survey location coordinates can be used along with the hard copy field map and GPS to find the survey locations and continue the survey. The field data collection contractor will ultimately be responsible for preparing their own health, safety, and environment plan for acceptance by the NWMO.

As discussed, helicopter services are likely needed to enable cost-effective and efficient coverage of the study area. Ideally, the aircraft will be able to accommodate the TEM and habitat suitability modelling survey crews; however, staggering crew pick-up and drop-off may be needed and will be determined when additional details about logistics are available. Alternatively, if helicopter services are not used – for example, if the NWMO determines that ground travel to the pre-determined sampling locations is feasible – then other modes of transportation will be required from home base to the study sites. In this case, a truck and/or ATVs will likely be required.

2.1.3.4 Field Protocol

Survey plots visited on the ground will be assessed using full, ground or visual methods at a ratio of 3:17:80, respectively (see Section 2.1.2.3.2). Which method to employ at each survey location will be pre-determined by Zoetica during the pre-field work planning. All field methods are detailed in the SOP in **Appendix A** and are based on the methods in *Field Manual for Describing Terrestrial Ecosystems 2nd Edition* (BC MFR and BC MOE 2010).

For vegetation surveys, a full plot involves recording all observed vegetation within a 400 m^2 plot; completing two transects within the plot to record coarse woody debris; and recording all trees within the plot and noting attributes for wildlife. When completing a ground plot vegetation survey, only the dominant and indicator plant species are recorded. For a visual plot, no vegetation information is recorded, and only the ecosite code is confirmed.

For soil descriptions, site topography details are recorded along with a general soil profile from a soil pit. When completing a ground plot survey, the site topography details are all recorded, but the details for the soil profile are reduced. For a visual plot, no site topography or soil information is recorded, and only the ecosite code is confirmed.

For the field protocol for the wildlife habitat descriptions, see Section 2.2.3.4.

2.1.3.5 Data Collection and Recording

The data forms to be used in the field will be adapted from those in the *Field Manual for Describing Terrestrial Ecosystems 2nd Edition* (BC MFR and BC MOE 2010). There are six total Ecosystem Field Forms that the field data collection contractor will need to complete; however, not all forms are completed for every survey. All Ecosystem Field Forms need to be completed by the field staff member assigned to each form (see Section 2.1.3.2 for crew member responsibilities). The forms that are completed for each survey type (full, ground, or visual) are summarized in **Table 2-4** and detailed in the SOP found in **Appendix A**.

When completing a full plot, all forms are thoroughly filled out to provide maximum detail. During a ground plot, not all forms are completed, and the level of detail required is reduced for the forms that need to be completed. When completing a visual plot, no site, soil, or vegetation descriptions are required to be recorded; only the basic site information is required to confirm the ecosite code and detail the rationale for the change from the pre-determined ecosite. The Wildlife Habitat Assessment Form is completed for all survey types.

Table 2-4. Summary of Ecosystem Field Forms and the type of survey for which they are completed.

Form Name	Survey Type		
	Full	Ground	Visual
Site and Soil Description Form	X	X*	X*
Vegetation Survey Form	X	X	
Tree Attribute for Wildlife Survey Form	X		
Coarse Woody Debris	X		
Wildlife Habitat Assessment Form	X	X	X
Significant Wildlife Habitat Form	X	X	X
Notes: * When completing the Site Description Form, only the required spaces are completed			

2.2 Habitat Suitability Modelling

2.2.1 Overview

Habitat suitability maps can be created from ecosystem maps (see Section 2.1) and can be used as a habitat surrogate approach for protecting other biodiversity values that may not be directly assessed (e.g., due to species rarity and seasonal mobility). Habitat suitability maps can also be used for determining the quality of habitats that provide the requirements needed by various species at different times of the year and life history requisites, and for measuring the APM Project impacts on these habitats. The latter consideration is valuable for calculating/predicting direct and indirect habitat loss and to evaluate options for achieving “no net loss” of biodiversity (Gullison *et al.* 2015).

2.2.1.1 Data Objectives

The objectives of the habitat suitability modelling are to 1) assign wildlife habitat suitability ratings to various ecosite classifications based on their relative importance to wildlife populations, and 2) assist in the selection of survey locations for more detailed Tier 2 studies. Results of the habitat suitability modelling conducted at select polygons in the refined ecosite dataset can be applied to areas where ground-truthing has not been conducted.

2.2.1.2 End Use

Mapping of available low- to high-quality habitat, based on currently understood species-habitat associations for various life requisites and signs of use by various biodiversity values, can be used to rank habitats spatially, over large areas. Mapped areas may include extrapolations of species-habitat relationships to areas where ground-truthing or surveys were not directly conducted. Habitat suitability maps can help evaluate the availability, spatial arrangement, uniqueness (compared to a regional context), and quality of habitat that could be directly or indirectly affected by a project. Habitat suitability maps can be fed into project design decisions (e.g., siting of infrastructure), and can help identify key locations for more detailed and targeted biodiversity surveys to be conducted as part of Tier 2 activities. Ultimately, habitat suitability ratings and mapping products can assist in the prediction of habitat loss and alteration, and can help to direct appropriate mitigation strategies early in the design of the APM Project.

2.2.1.3 Best Practice Guidance

In Ontario, there are no provincial standard protocols or guidelines for biodiversity habitat suitability modelling aside from tools developed for forest management. The general approach to habitat suitability modelling in Ontario involves comparing species habitat descriptions to eFRI data, ELC data (e.g., ecosites), other remotely sensed land cover data (e.g., Provincial Land Cover 2000, derived from Landsat-7), and/or field-based assessments. However, wildlife habitat assessments using remotely sensed data alone may be insufficient, as important habitat characteristics such as subcanopy and understory features are not visible to photo interpreters (Boan *et al.* 2013).

To develop more accurate and precise habitat suitability maps, field-based surveys are required to verify potentially suitable areas identified through desktop studies. Since protocols for more detailed habitat suitability models are lacking in Ontario, we recommend following the *British Columbia Wildlife Habitat Rating Standards* (RISC 1999), which detail the requirements for wildlife habitat assessment data collection as well as the development of wildlife habitat suitability maps. These Resources Information Standards Committee (RISC) standards define the habitat rating criteria for different map scales, along with the standardized level of detail needed while describing life requisites and seasonal habitat use to develop species-habitat criteria and preliminary habitat ratings. The refined ecosite dataset, developed through the desk-based ecosite refinement outlined in Section 2.1.2.3.1, must then be ground-truthed through field surveys, typically in coordination with other discipline teams that are assessing other terrestrial ecosystem components (e.g., vegetation, soils). A detailed, standardized form is used for recording data during wildlife habitat assessments (BC MFR and BC MOE 2010). Finally, the RISC standards provide guidelines for developing a final ratings table incorporating the additional field-based data on species-habitat relationships, which can then be used to develop habitat suitability models and maps for the BIS Program.

2.2.2 Desk-based Program

The desk-based program will be conducted by Zoetica scientists and will support the field components to be conducted by the field data collection contractor.

2.2.2.1 Study Area

Study areas for habitat suitability modelling will differ among biodiversity values selected. For field data collection, study areas for habitat suitability modelling will be the same as those described in Section 2.1.2.1, as the wildlife crew will be paired with the field crew conducting ground-truthing for verification of TEM. These areas were defined by using the largest areas for any of the biodiversity values (see rationale in Section 2.1.2.1).

For the creation of seasonal biodiversity value-specific habitat suitability maps for use in the development of future baseline studies (e.g., Tier 2 studies), as well as for use in impact studies, study areas will be clipped to those proposed for relevant biodiversity values selected for Tier 2 studies.

2.2.2.2 Data Sets

The datasets used for the selection of sampling areas to conduct habitat suitability modelling are the same as those derived for the TEM field program and are outlined in Section 2.1.2.2. Zoetica will create habitat suitability maps for calculating habitat measurements for baseline and impact studies purposes after updating the initial ecosystem mapping with results obtained during the vegetation surveys conducted as part of the TEM field program by the field data collection contractor (Section 2.1.3).

2.2.2.3 Methods

2.2.2.3.1 Rating Criteria

A habitat rating is a value assigned to a habitat based on its potential to support a particular species for a season and life requisite (e.g., breeding, shelter) compared to the best habitat in the province that is used for that species for the same season and life requisite. In Ontario, there are no provincial benchmarks for seasonal habitats for which all other habitats for that species are rated against. While habitat features associated with SWH are described for some species, the level of detail may not be sufficient to relate habitat ratings to specific life histories for each species (i.e., SWH is generally more seasonal and area specific); further, information in the habitat descriptions may not be at a fine enough scale to rate habitat within each polygon in the refined ecosite dataset (SWH is not rated for quality but either identified as not present, candidate SWH based on habitat description, or confirmed SWH typically based on species presence and abundance). While candidate SWH will be documented when identified during field activities (see Section 2.3), the establishment of benchmarks against which other seasonal/life requisite habitats will be rated will require development through additional literature reviews of local and regional habitat use and seasonal abundance and density data for the biodiversity values.

Habitat suitability ratings are ultimately designed to reflect the value of a habitat (i.e., its relative potential use by animals of a particular species for certain life history activities) rather than actual numbers of animals using the habitat; hence habitat suitability maps tend to be a more conservative and point out all potentially available habitat for each biodiversity value, regardless of whether it is currently occupied by that species (e.g., if the landscape is far below the carrying capacity for a species). In addition, Indigenous knowledge holders and local experts that are well-versed in species habitat requirements in northwestern Ontario will have a good idea of "ideal" habitat conditions for each wildlife value. For habitat suitability modelling for the biodiversity impact studies, Zoetica proposes to use the *Significant Wildlife Habitat Technical Guide* and the SWH Criteria Schedules available for the nearest ecoregion to the APM Project (i.e., 3W) as a starting point to identify "ideal" habitat features for certain seasons and life history requisites; however, additional literature research and input from Indigenous knowledge holders, and local and regional experts will be required to establish "ideal" habitat for all species, seasons, and life histories of interest for mapping. This process will ensure that the habitat within the study area of relevance to the species or group being considered is rated consistently with habitat models currently in use within the province, but that the additional information builds out habitat maps to provide more detail than the SWH Criteria Schedules.

For the rating of habitat for most species, Zoetica proposes to use the 4-class rating scheme that rates habitat suitability as high (H), moderate (M), low (L), and nil (N) for defined seasons and habitat uses, wherever reasonable to do so (Table 2-5). The 4-class rating system is suggested for species for which there is an intermediate knowledge level of habitat preferences. In the case where more detailed knowledge of seasonal habitat preference is available for the species (e.g., black bear and ungulates), a 6-class system will be attempted (RISC 1999). However, if not enough is known about seasonal habitat preferences of a wildlife species, the 4-class system will be used. A four class system results in fewer inconsistencies among field crew when ranking habitat and avoids conveying false precision where that precision is difficult to define (e.g., differentiating between "High" and "Moderately High" rated habitat). In some cases, research and input may reveal the need to use a 4-class system, where knowledge about species habitat preferences is more limited.

Table 2-5. Habitat suitability rating schemes for three levels of knowledge about a species' use of habitat. From RISC (1999)

% of Regional Best*	**Substantial Knowledge of Habitat Use (6-class)**		**Intermediate Knowledge of Habitat Use (4-class)**		**Limited Knowledge of Habitat Use (2-class)**	
	Rating	Code	Rating	Code	Rating	Code
100 – 76%	High	1	High	H	Habitat Useable	U
75 – 51%	Moderately High	2	Moderate	M		
50 – 26%	Moderate	3				
25 – 6%	Low	4	Low	L		
5 – 1%	Very Low	5			Likely No Value	X
0%	Nil	6	Nil	N		

Notes:
* "Regional Best" is the regional benchmark habitat for species against which all other habitats for that species are rated. For the biodiversity impact studies, Regional Best will be based on the Ontario SWH Criteria Schedule for Ecoregion 3W (OMNRF 2017) for particular seasons/life history requisites for some species where data are available, or will be developed from research and literature for other seasons/life requisites where data are not available.

The use of habitat by a species is closely related to the season or time of year, and specific activity or life requisite (e.g., breeding) that they will be using the habitat for. Thus, habitat ratings for species are typically conducted for a specified season and life requisite. Seasons may be defined at several different levels of detail (**Table 2-6**): 1-season (all combined), 2-season (Winter and Growing), 4-season (Winter, Spring, Summer, and Fall), and 6-season (Early Winter, Late Winter, Early Spring, Late Spring, Summer, and Fall). Decisions on the level of detail are specific to the species studied. Within any type of rating class, not all seasons in a year require being rated.

Table 2-6. Four levels for describing seasons of habitat use. From RISC (1999). Often, specific dates will be used to define each of the seasons listed in column 3, based on species-specific life history patterns and when unique seasonal habitat use patterns are observed.

Level	Code	Description*	Application
1-season	A	All seasons	• When habitat use between seasons cannot be differentiated (small map scales and/or species with low mobility)
2-season	W	Winter	• When seasonal habitat use can only be roughly differentiated • Small map scales
	G	Growing (spring, summer, fall)	
4-season	W	Winter	• When four distinct seasons of habitat use can be differentiated (medium to large map scales) • Species for which there is an intermediate or substantial knowledge level • When species occur in the province only part of the year (migratory species – only 3 of the 4 seasons rated)
	P	Spring	
	S	Summer	
	F	Fall	
6-season	WE	Early Winter	• When distinguishing detailed seasons for black bear and ungulates (for most of these species, only 4 or 5 of the 6 seasons will be rated; e.g., food habitat for bears may be rated for Early Spring, Late Spring, Summer, and Fall)
	WL	Late Winter	
	PE	Early Spring	
	PL	Late Spring	
	S	Summer	
	F	Fall	
Notes: * Winter, as an entire season, can be used for either a 2-season or a 4-season rating but is differentiated into early and late seasons using a 6-season rating scheme. Similarly, Spring is differentiated into early- and late- seasons using the 6-season rating scheme.			

Life requisites are special habitat requirements that are needed to sustain and perpetuate the species and may include food/cover and specific life requisites (e.g., reproduction, migration, hibernation) for a given species. Similar to seasons, life requisites may be defined at several different levels of detail (**Table 2-7**): Habitat can be rated generally as “Living” for food/cover life requisites (food, security, thermal, and security/thermal), or for specific life requisites (courtship, hibernating, migrating, reproducing, and staging).

Table 2-7. Life requisites used in suitability ratings: definitions and codes. From RISC (1999).

Life Requisite	Code	Definition
Food/Cover		
Food	FD	• Habitat used for consuming food items, including searching for and consuming food simultaneously (such as done by grazers, browsers, flying insectivores, and ducks)
Security	SH	• Habitat used for protection or hiding from predators
Security/Thermal	ST	• Habitat used for security and/or thermal values (this category used when differentiation between thermal and security values is difficult or impossible
Thermal	TH	• Habitat used for protection from heat, cold, precipitation, or wind
Specific		
Courtship/Mating	CO	• Habitat used for courting, pair-bonding or mating (when separate from reproducing habitat)
Hibernating	HI	• Habitat used for hibernating

Living	LI	• Habitat used for general living activities and includes other life requisites such as FD, ST, CO, HI, MS, RB, RE, or SG
Migrating (seasonally)	MS	• Habitat used for regular, annual travel (e.g., habitat used by deer for spring and fall migrations)
Reproducing (birthing)	RB	• Habitat used specifically for giving birth to live young (mammals); may or may not include courtship/mating, depending on the animal species
Reproducing (eggs)	RE	• Habitat used for building a nest, laying eggs, incubation, hatching, and feeding non-mobile young (amphibians, birds, and reptiles); may or may not include courtship/mating, depending on the animal species
Staging	SG	• Habitat used for staging during spring and fall migrations

Habitat suitability ratings based on the combination of seasons and life requisites, and the level to which they are applied depend on: 1) the particular requirements of each species, 2) scale of the map, and 3) objectives of the project. The minimum required life requisite is "Living" except for birds that breed in the area when "Reproducing" must also be rated. For most species, the minimum requirement for seasonal ratings is two seasons. Often, the seasons selected for rankings are those that may limit the population size via seasonal reductions in the carrying capacity of the landscape. **Table 2-8** provides an example of the minimum requirements for habitat suitability modelling for selected species as described in the RISC standards (RISC 1999).

Table 2-8. Minimum requirements for rating habitat use (life requisites and seasons) and the rating scheme to use for some commonly rated vertebrate species at two map scales. From RISC (1999).

Map Scale:	**1:50,000**		**1:20,000**	
	Rating Scheme	Habitat Use	Rating Scheme	Habitat Use
Mammals				
Ungulates	6-class	Living-Winter Living-Growing	6-class	Living-Winter Living-Growing
Bears	6-class	Living-Growing	6-class	Living-Growing
Mustelids: Marten, Fisher, Wolverine, Badger	4-class	Living-Winter Living-Growing	4-class	Living-Winter Living-Growing
Birds				
Residents	4-class	Living-All	4-class	Living-All
Breeding Visitants	4-class	Living-Growing	4-class	Living-Growing Reproducing
Amphibians and Reptiles				
Pond-dwelling amphibians	4-class	Living-All	4-class	Living-All
All other amphibians; Reptiles: Turtles & Lizards	2-class	Living-All	4-class	Living-All
Reptiles: Snakes	2-class	Living-All	4-class	Living-Growing Hibernating

2.2.2.3.2 Procedures for Developing Wildlife Habitat Ratings

In this section, the process for applying the habitat criteria to polygons in the refined ecosite dataset is described through the development of species accounts and ratings tables as part of the work required to support the baseline reporting. This information will be developed by Zoetica starting in Year 1 as part of the desk-based work for the Tier 1 baseline program and will be provided to the field data collection contractor before field verification.

2.2.2.3.2.1 Level of Survey Intensity

Survey intensity and sampling are typically used to conceptualize the inventory scale. The *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998) provides guidance on the survey intensity and field plot inspection density for various map scales. For the baseline studies, the survey intensity will be tied to the field survey intensity for TEM outlined in Section 2.1.2.3.2, as the field crews will be composed of surveyors for ground-truthing the refined ecosite dataset and wildlife personnel for the identification and rating of wildlife habitat. Field verification will begin during the first field season within the LSA_{AQU} and may be expanded in future years within the RSA_{VEG} (see Section 2.1.2.3 for rationale). The LSA_{AQU} delineates the area expected to be potentially affected by the farthest-reaching project effects (i.e., dust, noise, water withdrawal). Based on the size of the study areas for the baseline program, and guidelines presented in RISC (1999), field verification within the LSA_{AQU} (12,657 ha) will be conducted at a survey level of 2 and a ratio of 3:17:80 (see **Table 2-3**) for full/ground/visual plots, respectively (RIC 1998). Details on the differences between full, ground, and visual plots can be found in Section 2.1.3.4. Zoetica will perform GRTS to stratify and randomize the type of plots to be conducted at each location, to meet the required ratio; this information will be provided to the field data collection contractor. All survey sites for the LSA_{AQU} will be determined at this stage; however, not all sites might be visited in the first field season due to limitations of the number of sites able to be visited each day and the length of the survey window. Any survey sites not visited during the Year 1 field season will be prioritized in subsequent field seasons. Once a project footprint has been developed and finalized, any refined ecosite dataset polygons within the project footprint not surveyed, will then be selected for surveying (level 1 intensity – 100% of plots) to ensure all habitat that will be lost will be properly classified by habitat value for the selected biodiversity values.

In future years, the RSA_{VEG} (227,681 ha) may be surveyed, if required, at a survey level of 4 and a ratio of 5:20:75 (**Table 2-3**) for full/ground/visual plots, respectively (RIC 1998). The selection of study sites will be completed once the first field season is complete as the information collected in the field will be used to improve the ecosite mapping in the RSA.

2.2.2.3.2.2 Wildlife Species Selection

Careful consideration was given to the selection of wildlife species (biodiversity values) for habitat suitability modelling. Species are normally chosen to represent those that have economic or social value or that are at-risk. In general, ungulates and bears should always be included on the list of species as they are wide-ranging, require large tracts of seasonally different habitats, and represent species of economic, social, and ecological importance. Not all species are well suited for habitat suitability inventory. For example, habitat suitability modelling may not be the best inventory methodology for species where habitat requirements and distributions are not well understood. In addition, some species may have habitat needs that do not correlate well with polygons in the refined ecosite dataset (e.g., peregrine falcon breeding sites). Predatory species (e.g., lynx, wolf) may also be difficult to map when primary prey (e.g., snowshoe hare, moose) are not considered. Prey species are typically more abundant and provide more detectable signs.

General considerations in the selection of species for habitat inventory outlined in RISC (1999) include:

- Ungulates and bears

- Species that use a variety of habitats over their annual range
- Species where there is a good understanding of the relationship between life requisites and habitat attributes
- Species whose habitat requirements correlate well with the polygons in the refined ecosite dataset
- Species where there is a reasonable likelihood of observing the animals or detecting evidence of use in the field
- Prey species – when predator species is considered of importance for the project
- A list of no more than approximately six to 10 species (as the time to rate more within the field will be too time-consuming and hold up the TEM team)
- Species for which there is very little known about their distribution and habitat requirements should be excluded
- Wide-ranging, opportunistic carnivores that do not relate well to ecosystem map attributes should be excluded

For the baseline studies, a selection of species was considered for Tier 1 habitat suitability assessment that covers a variety of habitat types. Many of the species selected cover the habitat attributes required for other species not included in the list, including potential species at risk. The species proposed for habitat suitability modelling according to RISC (1999) standards are presented in **Table 2-9**.

Table 2-9. Proposed terrestrial wildlife species for habitat suitability modelling following RISC (1999) standards.[1]

Proxy/Surrogate Species for Suitability Maps	**Habitat Considerations Relevant to Other Species (protection of high-quality proxy species habitat leads to protection of the following)**	**Surrogate Species Beneficiaries**
Moose	• Wetlands (MAFAs) • Matrix of different forest ages • Riparian shrub habitat • Early seral stage habitat (forage) • Late seral stage coniferous forest habitat with a high canopy cover (for snow interception in late winter) • Mineral licks (SWH) • Seeps and springs (SWH) • Cervid movement corridors (SWH) – riparian areas, woodlots, areas of physical geography (ravines or ridges)	<u>Early successional stage forest (moose forage habitat)</u> White-tailed deer Black bear A wide variety of upland breeding birds reliant on early successional forest, including: Red-eyed vireo Alder flycatcher Common yellowthroat Winter wren Ruffed grouse Spruce grouse <u>Mature coniferous forest (late winter moose habitat)</u> American marten Fisher Northern flying squirrel A variety of late seral stage bird species, including: Winter wren Blackburnian warbler Brown creeper

		Spruce grouse Pileated woodpecker <u>Wetlands (and riparian areas)</u> Beaver Muskrat Waterfowl A variety of amphibians and reptiles with aquatic life history phases (e.g., frogs, salamanders, turtles) <u>Mineral licks</u> White-tailed deer Porcupine <u>Seeps and springs</u> Spotted salamander Blue-spotted salamander Ruffed grouse Spruce grouse Black bear <u>Cervid movement corridors</u> White-tailed deer Smaller mammal species
Black bear	• Early green-up locations • Area high in berry productivity (more open areas, edges) • Large tracts of forest interspersed with early successional vegetation • Forest with dense understorey and variety of tree and shrub species (nut-bearing and fruiting) • Secure den sites for winter hibernation and rearing of young (e.g., hollow trees); mammal denning sites are SWH	<u>Denning carnivores</u> Cougar **(END)** Gray fox **(THR)**[2] Wolverine **(THR)**[3] Gray wolf Red fox Coyote Canada lynx Bobcat
Snowshoe hare	• Early successional forest with dense understorey, interspersed with old forest with many gaps • Dense conifer stands in winter (thermal cover and protection from predators) • More open habitats with abundance herbaceous cover in summer (forage)	<u>Primary predators of snowshoe hare</u> Canada lynx American marten
Northern flying squirrel	• Mature and old stands of conifer or mixedwood forest with high structural diversity, abundant snags, and tall trees • Mature coniferous trees, live and dead cavity trees for maternal dens and shelter	<u>Late successional stage forest</u> American marten Fisher Winter wren Blackburnian warbler Brown creeper

	• Shrub layer that provides shelter for ground foraging	Spruce grouse Pileated woodpecker
Eastern whip-poor-will **(THR)**[2]	• Dry, open, deciduous woodlands of small to medium trees • Oak or beech with lots of clearings and shaded leaf-litter • Wooded edges, forest clearings with little herbaceous growth • >100 ha forests; may require 500-1,000 ha to maintain population • Shrubland or successional fields that are not being actively farmed (SWH)	Shrub/early successional bird breeding habitat Yellow-bellied cuckoo Northern hawk owl Philadelphia vireo House wren Northern mockingbird Brown thrasher Clay-coloured sparrow Black-billed cuckoo Tennessee warbler Palm warbler Connecticut warbler Wilson's warbler Lincoln's sparrow Ruffed grouse Eastern kingbird American woodcock

Notes:
1. THR = Threatened, END = Endangered as listed under the Species at Risk in Ontario (SARO).
2. Eastern whip-poor-will and gray fox are also listed as Threatened on Schedule 1 of the federal *Species at Risk Act* (*SARA*).
3. Wolverine is also listed as Special Concern on Schedule 1 of *SARA*.

In addition, all SWH will be recorded when encountered, including for those species selected for habitat suitability modelling, as applicable (e.g., moose MAFAs; see Section 2.3.2.4.1). Additional species of interest (e.g., SAR, species of importance to stakeholders/rights-holders) are more suited for direct study than employing a habitat suitability modelling approach. For example, eDNA sampling in multiple seasons may help to identify important amphibian breeding habitats (considered SWH) and aquatic overwintering habitats (see **Table 2-15** in Section 2.6.3.1), as well as habitats for cryptic waterbirds and other difficult-to-detect species. For amphibian species that inhabit both woodland and wetland habitats at different times of the year, eDNA metabarcoding results indicating these species' presence could trigger further studies to identify potential amphibian movement corridors (also considered SWH).

The reader is reminded that the current BPD Report focuses on the Tier 1 field studies, and that results of data collected in Tier 1 along with ongoing engagement will inform future tiers, which will result in the release of additional baseline design report SOPs, and updates to the current, living document. Detailed baseline designs proposed for Tier 2 and 3 studies will likely include aerial surveys to locate raptor stick nests, point counts and/or automated song meters to identify important shorebird and waterfowl migratory stopover areas. Habitat suitability modelling for additional species, including SAR, may also be conducted in future years of study if detection of required habitat and/or species through field observation and eDNA studies indicates the potential use of the applicable study area and the project could result in potential effects. Changes in understanding of how far-reaching potential project effects could extend may also trigger the mapping for additional species.

Future studies will be identified and refined based on the consideration of information collected during Tier 1, and through ongoing engagement needed to address concerns of local communities, rights-holders, scientific experts, the regulator and other federal and provincial agencies, and other interested parties.

2.2.2.3.2.3 Preliminary Species-Habitat Criteria and Maps

Before field sampling occurs, preliminary species-habitat criteria will be developed and mapped by Zoetica. Two main components of the preliminary species-habitat criteria for wildlife habitat suitability modelling include:

1. **The Species Account**: Provides general background on the biology of selected species. Habitat requirements for each life requisite and associated season are identified.
2. **The Habitat Rating**: Relates the habitat requirements described for each species in the species account to relevant ecosystem attributes. All assumptions used for assigning ratings are described and a preliminary ratings table will be developed by Zoetica. The preliminary habitat ratings present the hypothesis of the relationship between species and habitat attributes in the APM Project area. Field verification is conducted alongside TEM ground-truthing by the field data collection contractor.

As part of the baseline program, Zoetica will develop desk-based preliminary habitat criteria for each of the selected species. The preliminary habitat criteria are refined at several stages during the baseline program. During Tier 1 studies, where sufficient wildlife sign is observed, refinement of the ratings criteria may be possible. Suitability ratings would then be updated for each unique polygon in the refined ecosite dataset (Section 2.1.2.3.1). Criteria and maps may also be refined as more data are gathered on species occurrence and relative abundance during Tier 2 studies.

Collation of Existing Data

The development of preliminary habitat criteria and maps include the collation of existing data and includes the following data sources:

- **Existing Species Models**: While no known habitat suitability maps exist for the relevant biodiversity value-specific local and regional study areas, a criteria list for SWH has been developed for Ecoregion 3W (for particular species, some of which are at risk), which outlines what constitutes an SWH. These SWH criteria will be applied to find and investigate candidate SWH within the various study areas around the APM Project (see Section 2.3).[7] Criteria developed for species-specific SWH will be assessed for applicability of use in the development of preliminary species-habitat models.
- **Ecosystem Mapping**: The RISC standard for wildlife habitat ratings (RISC 1999) requires broad-scale ecosystem mapping (1:250,000). The eFRI dataset, which contains polygons classified into ecosites, could be used since it is available for the entire RSA_{VEG} and exceeds the scale requirement detailed in the RIC standard. However, a refined ecosite dataset is being produced through the desk-based work outlined in Section 2.1.2.3.1; this refined dataset will have a smaller minimum polygon size than the eFRI dataset and will greatly exceed the requirement in RISC standard for wildlife habitat ratings (RISC 1999). Using the refined ecosite dataset will allow for more accurate habitat assessments due to more homogeneous polygons and ecosite information that is based

[7] The APM Project is located within Ecoregion 4S; however, a SWH Criteria Schedule has not yet been developed by the MNRF for this ecoregion. Given the proximity of Ignace to Ecoregion 3W, the MNRF has confirmed that it is likely more appropriate to adopt the draft 3W schedule.

on much more recent imagery than the eFRI dataset. The refined ecosite dataset will be created in stages beginning with the LSA_{AQU} and moving out into the RSA_{VEG} gradually; the coarser eFRI dataset will be used where the desk-based refinement has not yet been completed. The refined ecosite dataset will be ground-truthed along with completing wildlife habitat suitability ratings. Preliminary habitat suitability maps may be created from the refined ecosite dataset if sufficient time allows before ground-truthing.

- **Provincial Benchmarks**: No known Ontario provincial benchmarks exist for species; however, a criteria list for SWH has been developed for Ecoregion 3W (for particular species, some of which are at risk), which can be applied to the habitat within the various study areas around the APM Project[7] to help determine certain key habitats for select species.
- **Literature Review**: A literature review using references supplied by species experts, governmental reports, online searches including the Web of Science is critical in the development of species-habitat criteria, and assists in updating the most recent relevant information on local species and habitat requirements.
- **Interweaving Indigenous Knowledge**: Indigenous Knowledge provided by Indigenous communities, Elders, and knowledge holders can provide valuable information for building local species-habitat criteria and maps.
- **Interviewing Species Experts**: Knowledge provided by species and habitat experts (western science) can provide valuable information for building local species-habitat criteria and maps.

Development of Species Accounts

A species account is a description of the life history, biology, and habitat requirements of a given species, and for habitat suitability modelling, it refers to the life requisites and habitat requirements relevant to the project area. Information obtained during the review of the literature and from interweaving IK and information from species experts can provide the basis of information used to develop the species account. The focus of the species account should be on what habitat requirements are relevant to the boreal forest conditions similar to those found in Northwestern Ontario and include as much detail as possible when relating life requisites to habitat requirements and ecosystem attributes. The information included in **Table 2-10** will be included in a species account, where available (adapted from RISC 1999):

Table 2-10. Information to be included in a species account. Adapted from RISC (1999).

Information Type	Description of Details
Name	• Include the scientific and common name of the species, as well as the standard species codes (Cannings and Harcombe 1990).
Status	• As listed by the Ontario *Endangered Species Act* and federal *Species at Risk Act*, as well as any COSEWIC designations.
Distribution	• Include provincial range and detail whether the species, as it occurs in the project area, is at the periphery or at the centre of its range.
Study Area (e.g., AOI, LSA, RSA) & Map Scale	• Identify the ecoregions, ecodistricts, and ecosites for the study area. • Identify the map scale for which the species-habitat criteria are being developed.
Ecology & Habitat Requirements	• Include a brief description of the species' life history and ecology as it relates to the use of habitats in the project area. • Describe the general seasonal habitat requirements of the species.

Habitat Use (Life Requisites and Seasons)	• Identify the season level (e.g., 1-, 2-, or 4-season) and the combination of life requisites and seasons that will be rated for the project.
	• Note: food and cover life requisites are generally required throughout the year and the season must always be identified explicitly in the ratings table. Most other life requisites (e.g., reproduction, hibernation, migration) are confined to specific times of the year and are specific to each species – the season for these specific life requisites must be identified in the Species Account.
	• Identify months of habitat use for each life requisite and the season for which it is rated:
	  o For resident species, all months of the year may be accounted for and rated.
	  o For migratory species, only months for which it occurs in the province are rated.
	  o For those migratory species in which some individuals or populations regularly overwinter, all months of the year should be accounted for and rated.

Habitat Use & Ecosystem Attributes	• For each life requisite-season combination to be rated, describe the specific ecological attributes (e.g., ecosite classification, important plant species, canopy closure, age structure, slope, aspect, terrain characteristics) which provide the required life requisites. • Ensure these attributes are identified in the ecosystem database to be created and maintained by Zoetica.

Development of Preliminary Habitat Ratings

After developing species accounts to describe the species' life history and habitat requirements, the next step is to relate how that information will be used to develop the preliminary habitat suitability ratings. The guidelines for rating the species' habitat are outlined in **Table 2-11**.

Table 2-11. Criteria and description of information used to develop preliminary habitat suitability ratings. Adapted from RISC (1999).

Criteria	Description

Rating Scheme	• Three habitat suitability rating schemes are outlined in RISC (1999):
	  o 6-class rating scheme – for detailed knowledge of species' habitat use. Note: Zoetica endorses the use of 4-class rating scheme where it is too difficult to differentiate between the rating classes as it is less prone to inconsistencies in rating across survey crew and plots and is suitable for this project
	  o 4-class rating scheme – for intermediate knowledge of species' habitat use
	  o 2-class rating scheme – for limited knowledge of species' habitat use
	• Note: The level of detail sets the parameters for developing both the preliminary and final ratings tables.

Provincial Benchmark	• Identifies the highest suitability habitat for the species in the region, against which all other habitats for that species are rated. • No formal provincial benchmarks exist for habitat suitability modelling in Ontario; however, species-specific SWH will be used as a starting point for ideal habitat features supporting species in certain seasons and for certain life history requisites, but this information will need to be supplemented with habitat evidence gathered from literature and local and regional studies and knowledge to develop relationships between species life histories and important habitat requirements to identify benchmarks for rating all habitat against.
Ratings Assumptions	• Provide a descriptive account of the ratings assumptions, including:

	o The effects of ecosystem attributes (e.g., slope, aspect, structural stage) on the ratings; o The highest potential rating for each habitat attribute and/or ecosite classification expected in the project area; and, o The minimum and maximum ranges of expected ratings for each habitat attribute and/or ecosite classification. • Assumptions should always accompany the preliminary ratings table and should reference the information source wherever possible.
Preliminary Ratings Table	• Provide suitability ratings (by season and life requisite) for all structural stages, for features such as: o Landscape position (slope, aspect, crest, special habitats) o Moisture regimes (floodplain, dry average, moist, deep/shallow soil, rock outcrop) o ecosite classification o Special features (e.g., lakes, cliffs, wetlands) o Structural stages may be grouped (e.g., shrub/herb, young forest, mature/old forest)
Ratings Adjustments Considerations	• Create a list of habitat attributes that may not be included in the ratings table but may be important for the species. o Size and proximity effects, or attributes that may be used to adjust ratings table to produce a more accurate habitat map. For example, if literature demonstrates that a species avoids habitat within 1 km of roads, habitat ratings for that species can be downrated when a habitat unit is within 1 km of a road. o Listing expected adjustments at this stage provide further direction for field sampling and verification.

2.2.2.3.2.4 Final Species-Habitat Maps

Draft/preliminary species habitat maps will be developed after creating a rating scale and relating it to ecosites. Final species-habitat maps will be developed following field verification in Year 1. The species-habitat maps may be revised again after conducting Tier 2 studies, which will capture more detailed information on species presence and composition within the relevant species study areas. The final species-habitat maps will differ from the preliminary species-habitat criteria and maps in that they include the final ratings tables as developed from the additional data collected during field sampling and the field-verified refined ecosite data. The final species-habitat maps will be accompanied by:

1. The revised species account
2. Revised ratings assumptions
3. The final ratings table developed from:
    - Project species list
    - Standard ratings schemes required for each species
    - Standard life requisites and seasons required for each species
    - Preliminary ratings tables that have been revised from field sampling in future years
    - Field data as summarized in baseline reporting
    - Ecosite modifications and subdivisions based on field-based TEM results

The final species-habitat ratings maps are typically assigned a reliability qualifier that reflects the level of information available for a species' life requisite, as well as the understanding of the species-habitat relationships, and applicability to ecosystem mapping. The qualifier indicates the accuracy and reliability of the species-habitat ratings and resultant maps. General criteria for assigning a reliability qualifier to species-habitat ratings and habitat maps include (adapted from RISC 1999):

- Low Reliability: Available information used in the habitat ratings is based on studies in other provinces or countries with some or little local information on species-habitat relationships. No verification has been done.
- Moderate Reliability: Available information used in the habitat ratings is based mainly on studies, reports and expertise on the species-habitat relationships gained within Ontario. Some information from ecosystems in the study area, but mostly extrapolated from similar ecosystems. No verification or limited verification has been done.
- High Reliability: Available species-habitat relationship information used in the habitat ratings is based mainly on detailed studies, reports and expertise gained within Ontario and pertaining directly to the ecosystems in the study area. Ratings have been verified. Verification includes testing the ratings against actual data (e.g., nest records, element occurrence records) or by ground-truthing and sampling.

2.2.3 Field Program

The field program will be undertaken by the field data collection contractor, using rating criteria and desk-based habitat suitability criteria developed by Zoetica and outlined in Section 2.2.2.

2.2.3.1 Survey Timing

The timing of field surveys will be coordinated with the timing of TEM field efforts (Section 2.1.3.1) in mid-June to August when vegetation is the most visible and easily identified. A wildlife biologist will be part of the field team and responsible for conducting the wildlife habitat suitability assessments alongside the vegetation specialists who will be ground-truthing the mapped TEM. During the Year 1 field season, the focus will be on verifying habitat suitability within the LSA_{AQU} (see Section 2.1.2.1 for the rationale for using the LSA_{AQU}). In future years, the RSA_{VEG} (see Section 2.1.2.1 for the rationale for using the RSA_{VEG}) may be surveyed if warranted. The selection of survey locations will be undertaken once the first field season is complete as the information collected in the field will be used to improve the ecosite mapping in the RSA_{VEG} (see Section 2.1.2.3.2).

2.2.3.2 Survey Crew

The field survey contractor for habitat suitability modelling will be paired with survey crews for TEM (Section 2.1.3). Ideally, each combined survey team will consist of one experienced ecosystem biologist (terrestrial vegetation specialist), one experienced soil specialist, one wildlife biologist with experience in habitat suitability modelling, IK holder with expertise pertinent to habitat suitability and use, and one local field assistant (e.g., from Indigenous communities) with general knowledge of wildlife and habitat use (if community interest and availability allow). The roles and responsibilities of the vegetation and soil crew and local field assistants are detailed in Section 2.1.3.2.

For habitat suitability modelling and identification of SWH (see Section 2.3), the wildlife biologist will be responsible for the field identification of potential wildlife habitat (including candidate SWH), and its suitability for seasonal habitat use by identified biodiversity values, including the value of the plot-type for each species on a seasonal basis. The wildlife biologist will also be responsible for recording habitat data on all relevant forms (see SOPs and forms in **Appendix A**). Minimum qualifications for wildlife personnel on a wildlife habitat mapping project include an understanding and experience in wildlife habitat analysis with a preference of knowledge of *BC Wildlife Habitat Rating Standards* (RISC 1999) and knowledge of the habitat needs of wildlife in northwestern Ontario, how those needs relate to ecosite classifications and how ecosite classifications change over time, and an understanding of and experience in identifying and evaluating SWH (OMNR 2000). Additional crew members are responsible for notifying the wildlife biologist in the case where wildlife sign is observed. Knowledgeable field assistants may also assist in applying local knowledge of wildlife seasonal habitat use, where applicable.

Field work will likely require contracted helicopter services. The pilot is not expected to be directly involved in habitat suitability modelling studies but will be relied on to find appropriate landing spots for the survey team. The helicopter may also be required to move field crews from location to location multiple times per day.

2.2.3.3 Equipment and Materials

Standard field gear and data collection materials (e.g., binoculars, camera, notebook, pencil, clipboard) should be carried to record incidental observations of wildlife and wildlife sign (e.g., tracks, scratch marks, bedding sites, signs of feeding, kill sites, animal trails, nests, dens, burrows, and scat), information about site access, or other pertinent notes.

Helicopter services are likely needed to enable cost-effective and efficient coverage of the study area for habitat suitability modelling studies. Ideally, the aircraft will be able to accommodate the TEM and habitat suitability modelling survey crews; however, staggering of crew pick-up and drop-off may be needed and will be determined when additional details about logistics are available. Alternatively, if helicopter services are not used – for example, if it is determined by the NWMO that ground travel to the pre-determined sampling locations is feasible – then other modes of transportation will be required from home base to the study sites. In this case, a truck and/or ATVs will likely be required.

Field work for habitat suitability modelling studies will require general navigational equipment to travel from the helicopter landing spot or road-based access point to the pre-determined sampling site, including GPS unit (also used to record geographic coordinates of important features, and plot locations), compass, and tablet or smartphone with georeferenced digital maps as well as hard copy field maps as a backup. The field data collection contractor will be required to develop a comprehensive health, safety and environmental management plan that is accepted by the NWMO before the initiation of any field activities.

2.2.3.4 Field Protocol

The habitat suitability field protocol will be conducted in coordination with the TEM field methods (Section 2.1.3). Detailed SOPs are provided in **Appendix A**. The species accounts and preliminary ratings tables will be provided by Zoetica before field activities and should be used as references in the field. As data are collected, the preliminary ratings tables and ratings assumptions should be updated and revised if required. Additional sampling may be required to ensure important habitat for selected species is represented.

The field activities for the assessment of habitat suitability are conducted for both full plots and ground plots as outlined in Section 2.1.3.4. Habitat suitability assessments are completed separately for each species based on the habitat requirements for each species for various seasons and life requisites that have been pre-determined by Zoetica as important for rating.

2.2.3.5 Data Collection and Recording

A summary of field methods is outlined in Section 2.1.3.4 and detailed SOPs are provided in **Appendix A** and include field forms and instructions for filling in forms.

Completing the Ecosystem Field Forms

The Wildlife Habitat Assessment Form is part of a suite of Ecosystem Field Forms used to collect ecological mapping data. It is not a stand-alone form but must be used in conjunction with the Site and Soils Description Form and Vegetation Forms for full plots. The Wildlife Habitat Assessment Form is designed to collect information at a detailed level to develop final habitat suitability ratings for each species and requisite/season.

For each species, habitat is assessed in two ways:

1. The plot type
2. The plot-in-context

Plot type refers to the combination of site, soil, and vegetation characteristics that describe the plot. Two sampling plots may have the same plot type if they share these characteristics. The plot type assessment is tied to the ecosystem field forms that have the ecosite classifications on which the final ratings table is based. Thus, food/cover ratings developed for the plot type guide developing the final ratings for the study area.

However, in the context of the surrounding habitats and features, plots may have different values to a wildlife species. The plot-in-context assessment provides a record of the habitat features occurring in the study area that have a synergistic effect on the wildlife values and helps in the formulation of rules about the spatial arrangement required for habitat use.

For all plots, all information on the Wildlife Habitat Assessment form must be completed with the exception that wildlife tree and coarse woody debris sections must be completed only for species that require these attributes.

2.3 Identification of Candidate Significant Wildlife Habitat

2.3.1 Overview

Significant Wildlife Habitat will be recorded when encountered for all applicable species. For some species of interest that are wide-ranging and use different habitats seasonally, detailed habitat suitability models will also be produced (see Section 2.2). SWH is defined in the Ontario Provincial Policy Statement (PPS) (MMAH 2020) under the *Planning Act* as:

- *Wildlife habitat* – areas where plants, animals and other organisms live, and find adequate amounts of food, water, shelter and space needed to sustain their populations. Specific wildlife habitats of concern may include areas where species concentrate at a vulnerable point in their annual life cycle; and areas which are important to migratory and non-migratory species.
- *Significant* – in regard to wildlife habitat, ecologically important in terms of features, functions, representation or amount, and contributing to the quality and diversity of an identifiable geographic area or natural heritage system.

The MNRF has developed the *Significant Wildlife Habitat Technical Guide* (OMNR 2000) and Significant Wildlife Habitat Criteria Schedules for select ecoregions to assist ecologists, biologists, environmental planners, and others involved in planning and development processes in the identification, evaluation, and ranking (i.e., prioritization) of SWH. Although there are currently no SWH criteria schedules for Ecoregion 4S, where the AOI and surrounding study areas are located, draft SWH criteria schedules are available for the adjacent Ecoregion 3W to the east (OMNRF 2017). The SWH technical guide and criteria schedules describe the criteria required for the identification of candidate SWH and confirmed SWH. Candidate SWH refers to habitat that meets the criteria outlined in the SWH criteria schedule for the specific ecoregion, as determined through desk-based work and/or field verification. Confirmed SWH refers to candidate SWH that has been field verified and confirmed to contain the biota and defining criteria contained within the SWH criteria schedule for that ecoregion.

2.3.1.1 Data Objectives

The objectives of the identification of SWH are 1) to identify potentially important habitats within the biodiversity value-specific study areas, and 2) to assist in the selection of survey locations for more detailed Tier 2 studies.

2.3.1.2 End Use

Applying the MNRF approach of identifying SWH will capture potentially occurring significant habitat in various seasons for both at-risk and not-at-risk wildlife species (OMNRF 2017); the identification of important breeding, migration/stopover, and wintering habitats will be crucial for the APM Project's biodiversity IA, and may also contribute to research and recovery efforts for SAR. Maps of potentially suitable habitats can then be used to direct targeted field reconnaissance surveys to confirm habitat quality for target species/species groups. In addition, if additional habitat suitability modelling (see Section 2.2) is needed to improve the understanding of the availability and quality of habitat on the landscape for certain species, mapped SWH can be used as a starting point. Mapping SWH can also help evaluate the availability, spatial arrangement, uniqueness (compared to a regional context), and quality of habitat that could be directly or indirectly affected by the APM Project.

2.3.1.3 Best Practice Guidance

The general approach for identification of candidate SWH in Ontario involves first comparing species' habitat descriptions to land cover data (e.g., ecosites). Appendix G in the *Significant Wildlife Habitat Technical Guide* presents habitat matrices for all native vertebrate (amphibians, reptiles, birds, mammals) and vascular plant species in Ontario (OMNR 2000). The matrices include habitat/behaviour descriptions and general habitat features associated with each species, such as wetlands, open water, riparian areas, grasslands, parklands/suburban areas, thickets and second growth, old growth and mature stands, forest edges, downed woody debris, seeps, and cliffs, talus slopes, and ravines. Dialogue with IK holders and knowledgeable stakeholders, including regional MNRF staff; Sustainable Forest License (SFL) holders; local naturalists, landowners, or hunters/trappers; municipalities; and ECCC, can also help to identify areas for ground-truthing.

2.3.2 Desk-based Program

The desk-based program will be conducted by Zoetica scientists and will support the field components to be conducted by the field data collection contractor.

2.3.2.1 Study Area

As the identification of most types of SWH will be collected in the field at the same time as the verification of TEM (see Section 2.1.2.1), survey efforts will first focus on the LSA_{AQU} starting in Year 1 and may be expanded outward into the RSA_{VEG} in future years – see rationale for TEM study area in Section 2.1.2.1. However, since the timing of TEM surveys is in the summer (mid-June to August), and some SWH should be identified during other seasons (e.g., waterfowl and shorebird migratory staging/stopover areas), Tier 2 seasonally-specific surveys for various biodiversity value-specific SWH may be conducted within TEM plots that occur within the biodiversity value-specific study areas. These additional spring, fall, and/or winter surveys for SWH can be completed in future years; the field data collection contractor should review the types of SWH that potentially occur in the study areas (OMNRF 2017; also available in the SOP and forms in **Appendix A**) and coordinate field work accordingly.

2.3.2.2 Datasets

The datasets used for the selection of sampling areas to conduct candidate SWH identification are the same as those derived for the TEM field program and are outlined in Section 2.1.2.2. The refined ecosite data will be used to identify candidate SWH for field work planning and to analyze the results of the field studies. Once the refined ecosite dataset has been updated with the results from TEM field work (see Section 2.1.3), it can also be used for calculating habitat measurements for baseline and impact studies.

2.3.2.3 Methods

In this section, the process for mapping candidate SWH and the selection of survey plots and planned survey intensity is described. This information will be developed by Zoetica as part of the desk-based program and will be provided to the field data collection contractor prior to field surveys. Field methods for the identification of candidate SWH are described in Section 2.3.3.

2.3.2.4 Level of Survey Intensity

Details about survey intensity are the same as those presented in Habitat Suitability Modelling, Section 2.2.2.3.2.1. For the purposes of field verification, candidate SWH identification will be conducted at all plot types (full/ground/visual).

2.3.2.4.1 Significant Wildlife Habitat Types

Some ecosite classifications can be considered as SWH, which may be protected by the Ontario PPS issued under the *Planning Act* (1990). Rare vegetation communities considered SWH in Ecoregion 3W include:

- Cliff and Cliff Rim
- Talus Slope
- Rock Barren
- Rare Treed Type: Red and White Pine
- Rare Treed Type: Elm
- Rare Treed Type: Red and Sugar Maple
- Rare Treed Type: Mountain Ash (Lake Superior Coastline)
- Sand Dunes (Including Freshwater Coastal Dunes)
- Rare Arctic-Alpine Plant Communities (Including Great Lakes)
- Diverse and Sensitive Orchid Communities
- Provincially Rare Vegetation Communities
- Regionally Rare Plant Species

- Rare Treed Type: Black Ash (Ecodistrict 3W-1)

When determining if an area is SWH, the ecosite classifications are usually given as the basic habitat requirement, along with more specific requirements which will differentiate them from the generic ecosites. SWH has been described for a number of wildlife species or species groups (biodiversity values) in Ecoregion 3W (OMNRF 2017), including:

1. Seasonal Concentration Areas
    a. Waterfowl Stopover and Staging Area (Terrestrial)
    b. Waterfowl Stopover and Staging Area (Aquatic)
    c. Shorebird Migratory Stopover Area
    d. Colonially-Nesting Bird Breeding Habitat (Bank and Cliff)
    e. Colonially-Nesting Bird Breeding Habitat (Tree/Shrubs)
    f. Colonially-Nesting Bird Breeding Habitat (Ground)
    g. Eagle and Osprey Concentration Area
    h. Sharp-tailed Grouse Lek
    i. Bat Hibernaculum
    j. Bat Maternity Colony
    k. Amphibian Breeding Habitat
    l. Turtle Wintering Area
    m. Snake Hibernaculum
2. Specialized Habitat for Wildlife
    a. Waterfowl Nesting Area
    b. Wild Rice Stand
    c. Milkweed Patch
    d. Bald Eagle and Osprey Nesting Habitat
    e. Woodland Raptor Nesting Habitat
    f. Turtle Nesting Area
    g. Aquatic Feeding Habitat
    h. Seeps and Springs
    i. Mineral Lick
    j. Mammal Denning Site
    k. Marsh Bird Breeding Habitat
    l. Open Country Bird Breeding Habitat
3. Habitat for Species of Conservation Concern (Not including Endangered or Threatened Species)
    a. Special Concern and Rare (S1, S2 and S3) Plant and Animal Species
4. Animal Movement Corridors
    a. Cervid Movement Corridor
    b. Amphibian Movement Corridor

Any SWH that has already been identified or is encountered in the field will be documented and mapped. Examples of SAR of relevance to the Revell Batholith Area that have SWH defined in OMNRF (2017) are presented in **Table 2-12**, along with a list of other species that would benefit from the protection of the habitat. Note that all candidate SWH (not just those listed below) identified through desk-based or field-based studies will be documented and mapped as part of Tier 1 and/or Tier 2 studies for various biodiversity values.

Table 2-12. Examples of relevant species at risk for mapping of Significant Wildlife Habitat and other species that will benefit from the protection of that habitat (beneficiary species). Note: the table includes descriptions of SWH from the SWH Criteria Schedules for Ecoregion 3W (OMNRF 2017) for selected species of conservation concern, but does not explicitly include habitats of other Endangered or Threatened Species, which are protected under the Ontario *Endangered Species Act*. Conservation statuses may have been updated since the publication of the SWH Criteria Schedules for Ecoregion 3W (OMNRF 2017) and are reflected in this table.

Example Species of Interest	**Habitat Considerations that are also Significant Wildlife Habitat**	**Other Beneficiary Species**
Little brown myotis **(END)** Northern long-eared myotis **(END)**	• Suitable caves and mine shafts that are used as hibernacula (SWH) • Mature deciduous or mixed forest stands with >10/ha large-diameter wildlife trees (maternity colony; SWH)	Big brown bat Silver-haired bat
Snapping turtle **(SC)**	• Suitable sand gravel beaches adjacent to undisturbed shallow weedy areas of marshes, lakes, and rivers; located in an open and sunny area, e.g., south-facing slopes that are used by turtles for nesting areas (SWH) • Permanent waterbodies, large wetlands, and bogs and fens with water deep enough not to freeze and/or have soft mud substrates for burrowing (turtle wintering area; SWH)	Western painted turtle
Short-eared owl **(SC)**	• Grasslands, open areas or meadows that are grassy or bushy • Also nests in bogs, fens, and marshes • Large grasslands, fields, meadows that are not being actively farmed and serves as open country bird breeding habitat used for ground-nesting (SWH)	Bobolink **(THR)** Eastern bluebird Vesper sparrow LeConte's sparrow Savannah sparrow Horned lark Northern harrier American kestrel
Yellow rail **(SC)**	• Large, freshwater or brackish grass and sedge marshes with dense vegetation • Wetlands with shallow water and emergent aquatic vegetation used readily by marsh birds for breeding habitat (SWH)	Black tern **(SC)**[1] American bittern Sora Red-necked grebe Northern shoveler Ring-necked duck American coot Pied-billed grebe Marsh wren Sedge wren Common loon Sandhill crane Solitary sandpiper Trumpeter Swan Green-winged teal Spotted sandpiper
Bank swallow **(THR)**	• Sand, clay or gravel riverbanks or steep riverbank cliffs • Lakeshore bluffs of easily crumbled sand or gravel • Gravel pits, road-cuts, grasslands, or cultivated fields that are close to the water	Cliff swallow Northern rough-winged swallow

	• Areas with exposed soil banks, undisturbed or naturally eroding that is not a licensed/permitted aggregate area (colonially-nesting bird breeding habitat – bank and cliff; SWH)	
Horned grebe **(SC)**	• Ponds, marshes, lakes, bays, coastal inlets, and watercourses used during migration (waterfowl stopover and staging area (aquatic; SWH) • Includes reservoirs managed as a large wetland or pond/lake • Abundant food supply (aquatic invertebrates and vegetation in shallow water, especially wild rice)	A great variety of geese, ducks, swans, and other waterbirds (OMNRF 2017)[2]
Notes: Abbreviations: END = Endangered; THR = Threatened; SC = Special Concern. Provincial (SARO) and federal statuses (Schedule 1 of *SARA*, COSEWIC assessments) are the same for the species unless otherwise noted. 1. Black tern is listed as SC under SARO but is not listed under *SARA* and was last assessed as Not at Risk by COSEWIC**.** 2. Waterfowl stopover and staging area applies to cackling goose, Canada goose, greater white-fronted goose, snow goose; trumpeter swan); wood duck, gadwall, American black duck, American wigeon, mallard, blue-winged teal, northern shoveler, northern pintail, green-winged teal, canvasback, redhead, ring-necked duck, lesser scaup, greater scaup, long-tailed duck, bufflehead, common goldeneye, common merganser, hooded merganser, red-breasted merganser, ruddy duck; red-necked grebe, sandhill crane, and common loon.		

2.3.2.4.2 Ecosystem Mapping

Before field sampling occurs, desk-based terrestrial ecosystem mapping will be completed by Zoetica (see Section 2.1). In all cases, surveys for SWH will be paired with the locations identified for TEM field verification based on a GRTS design. When final infrastructure is known, intensive surveys for TEM (see Section 2.1), habitat suitability modelling (where relevant, see Section 2.2) and SWH will be conducted in all polygons that overlap infrastructure placement. TEM field surveys are generally conducted in the summer in a randomized selection of habitat plots (see Section 2.1.2.3.2). However, specific ecosite requirements and seasonal requirements may exist for several SWH outlined in the *SWH Criteria Schedules for Ecoregion 3W* (OMNRF 2017). During the preparation of desk-based candidate SWH maps, SWH criteria outlined for Ecoregion 3W will be reviewed for SWH where specific ecosite requirements and seasonal requirements exist. In these cases, mapping layers will be sought by Zoetica to further direct the selection of sampling locations (points) for targeted Tier 2 SWH surveys. For example, open areas with sheet water during spring (mid-March to June) in Ecoregion 3W may be SWH for migrating waterfowl (OMNRF 2017). Thus, surveys for Waterfowl Stopover and Staging Areas should be conducted only in ecosites where open areas occur and have the potential to be flooded, and during the timing the flooding is expected.

2.3.3 Field Program

The field program will be undertaken by the field data collection contractor, using the ecosystem mapping and point selection information developed by Zoetica and outlined in Section 2.3.2.

2.3.3.1 Survey Timing

Tier 1 SWH field surveys will be coordinated with the timing of TEM field efforts (Section 2.1.3.1) in mid-June to August when vegetation is the most visible and easily identified. A wildlife biologist will be part of the field team and responsible for conducting the identification of SWH alongside the vegetation and soil specialists who will be ground-truthing the mapped TEM. The summer surveys will be conducted in parallel with the verification of TEM (see Section 2.1.3.1) and will focus on field-based identification of candidate SWH breeding habitats, permanent features (e.g., mineral licks), MAFAs, and other candidate SWH that are able to be identified through vegetation communities and characteristics. However, some types of SWH may only be identifiable in non-summer seasons (e.g., stopover and staging areas, wintering areas and hibernacula). Additional seasonal surveys of candidate SWH will be proposed as part of Tier 2 studies, within targeted areas corresponding to biodiversity value-specific study areas. The potential presence of SWH can also be investigated through discussions with local stakeholders, rights-holders, and other study teams that are on the ground in other seasons (e.g., geoscience). Tier 2 studies can then be designed to help field-verify candidate SWH and confirm SWH through targeted biodiversity value-specific surveys.

The SWH Criteria Schedule for Ecoregion 3W (OMNRF 2017) will be reviewed and survey timing and plots identified prior to the commencement of field surveys. During the Year 1 field season, the focus will be on identifying candidate SWH within the LSA_{AQU} (see Section 2.1.2.1 for the rationale for using the LSA_{AQU}). In future years, the RSA_{VEG} (see Section 2.1.2.1 for the rationale for using the RSA_{VEG}) may be surveyed if warranted. The selection of survey locations in the RSA_{VEG} will be undertaken once the first field season is complete as the information collected in the field will be used to improve the ecosite mapping in the RSA_{VEG} (see Section 2.1.2.3.2).

2.3.3.2 Survey Crew

The field data collection crew for candidate SWH identification will be the same crew that completes the ground-truthing for habitat suitability modelling. See Habitat Suitability Modelling, Section 2.2.3.2, for details about the survey crew, their roles and responsibilities, and minimum qualifications for wildlife personnel.

2.3.3.3 Equipment and Materials

See Habitat Suitability Modelling, Section 2.2.3.3, for details about standard field gear and data collection materials, navigational equipment, and transportation considerations.

2.3.3.4 Field Protocol

During the summer, the protocol for collecting SWH information will be conducted in coordination with the TEM field methods (Section 2.1.3). Detailed SOPs are provided in **Appendix A**. Ecosystem mapping and site locations will be provided by Zoetica before field activities and should be used as references in the field. The field activities for the identification of SWH are conducted for all plots (full plots, ground plots, and visual plots) as outlined in Section 2.1.3.4.

2.3.3.5 Data Collection and Recording

A summary of field methods is outlined in Section 2.1.3.4 and detailed SOPs are provided in **Appendix A** and include field forms and instructions for filling in forms.

The SWH Survey Form and associated instructions are based on the *Significant Wildlife Habitat Criteria Schedules for Ecoregion 3W* (OMNRF 2017). As described in the Criteria Schedule, different types of SWH are more likely to be present within certain ecosites. Ecosite information can, therefore, help to refine the types of SWH that should be assessed in more detail, while other types of SWH can quickly be screened out. However, since SWH may not exclusively occur in the listed ecosites, the habitat criteria associated with each type of SWH should be reviewed at the survey plot to confirm the likelihood of candidate SWH being present.

As discussed in Section 2.2.3.1, some SWH constitute non-summer seasonal habitats. In these cases, the surveyor should indicate "Unknown" in the Habitat Criteria field of the SWH Survey Form and provide rationale in the adjacent space on the form explaining that the survey timing was suboptimal for candidate SWH identification. However, any wildlife or wildlife sign observed, especially for species of interest (e.g., SAR, species of importance to local stakeholders/rights-holders) should also be recorded. These plots can then be revisited during the appropriate season during Tier 2 surveys to confirm the presence of SWH and/or species of interest.

2.4 Aquatic Habitat Mapping

2.4.1 Overview

Fish and fish habitat are valued by recreational and commercial land users, Indigenous communities, and the general public for social, recreational, commercial, domestic, and spiritual reasons. A popular activity in the region is fishing, highlighting the importance of fish and fish habitat, and the important link between these biodiversity values, ecosystem function and services, and socio-economic impact considerations. Fish habitat is protected by the *Fisheries Act* (R.S.C. 1985, c. F-14; updated in 2019) and includes any watercourse, waterbody, or wetland that provides functions for life history stages of fish. Fish species that are listed under the federal *Species at Risk Act* (S.C. 2002, c. 29) or the Ontario *Endangered Species Act* (S.O. 2007, c. 6) may be afforded even greater protections for habitat.

To understand and characterize the aquatic environment surrounding the AOI, aquatic habitat mapping will detail the various ecosystems present in the Revell Batholith Area. Results of these studies will help to support the requirements of the *Impact Assessment Act* and provide the basis for designing additional biodiversity value-specific studies to understand biodiversity in the AOI, and "*to assess the potential adverse and positive environmental, health, social and economic effects and impacts arising from the designated project activities"* as per the TISG Template (IAAC 2020b).

2.4.1.1 Data Objectives

The primary data objectives of the aquatic habitat mapping for the BIS are to:

1. Characterize the presence and distribution of fish habitat within the aquatic Local Study Area (LSA_{AQU}) and select control sites within the aquatic Regional Study Area (RSA_{AQU}) under baseline conditions (see Section 2.4.2.1 for study area delineations).
2. Detect any important fish areas including any habitat potentially used for spawning, rearing, overwintering, and migration in the LSA_{AQU} (Note: additional Tier 2 fish community studies and Tier 3 studies may be required to confirm specialized habitat).
3. Assess the potential for SAR habitat within the LSA_{AQU}.
4. Evaluate the distribution of habitats within the LSA_{AQU} and select control sites within the RSA_{AQU} to identify suitable sampling sites for Tier 2 fish community characterization studies.
5. Provide the required baseline data for the development of a potential monitoring program(s) to address the environmental, regulatory, and stakeholder/rights-holder concerns relevant to the APM Project.

Aquatic habitat mapping will cover the LSA_{AQU} to collect information on the watercourses that may be directly or indirectly (i.e., downstream) influenced by the APM Project and will include the identification of different types of aquatic habitat (e.g., wetland, pond, lake, headwater tributary, stream, river). Additional aquatic habitat mapping may be conducted in select areas within the RSA_{AQU} to establish biologically-relevant control sites. Aquatic habitat mapping forms the foundation on which to build intensive inventories where identification of fish-bearing streams, fish species distribution and physical habitat data are required. Aquatic habitat mapping also provides the ability to identify stream reaches where site-specific detailed inventories are required to determine the presence of fish, species present, and potentially important specialized habitats (e.g., spawning, rearing, overwintering, and migratory habitats).

2.4.1.2 End Use

Aquatic habitat mapping will assist in the selection of suitable locations for future fish and detailed fish habitat baseline (Tier 2) studies. Aquatic habitat mapping can also be used to identify the location of critical and sensitive aquatic and riparian habitats. The products derived from the desk-based and field aquatic habitat mapping (RIC 2001a, Stanfield 2017) will yield watershed-based mapping (1:20,000) showing known fish species presence and predicted distribution, lake characteristics (e.g., surface area, depth), stream reach boundaries and characteristics (e.g., stream width, fish habitat gradient), channel classification, and location and characteristics of obstructions. Aquatic habitat mapping, as outlined in Stanfield (2017) and RIC (2001a), can be used to help determine habitat suitability for assessing the potential of watercourses/waterbodies to support fish populations as well as identifying the location of critical and sensitive aquatic and riparian habitats. Aquatic habitat mapping will be used to help derive the initial selection of best management practices for further studies and to focus decisions regarding additional information requirements (e.g., locations of fish community composition studies). In addition to fish habitat, aquatic habitat mapping will identify stream reaches where suitable riffle habitat exists for future benthic invertebrate collections conducted as part of the EMBP (CanNorth 2020).

2.4.1.3 Best Practice Guidance

Methods outlined in the Ontario Stream Assessment Protocol (OSAP) (Stanfield 2017) and the Ontario Ministry of Transportation's (MTO) *Environmental Guide for Fish and Fish Habitat* (MTO 2009), and supplemented with the *Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures* (RIC 2001a), will be used for desk-based watershed mapping and field verification methods. The RIC standards are designed to assess desk-based aquatic habitat mapping at a more detailed scale (1:20,000) relative to methods described by MTO (1:50,000) and are generally more comprehensive as they are directed at full inventory methods and not focused on highway and transportation projects as described in MTO (2009).

The mapping portion of the *Reconnaissance Fish and Fish Habitat Inventory* (RIC 2001a) is intended to provide information on potential fish distributions and stream reach and related biophysical data for interpretation of habitat sensitivity and suitability for fish production. The approach includes a desk-based mapping application, similar to that conducted during preliminary environmental studies for the APM Project (see Section 1.5.4), as well as field survey to supplement mapping by verifying connectivity between waterbodies and identifying potential ephemeral streams and waterbodies, pooled areas, and to collect more detailed habitat characteristics at a selection of reaches.

2.4.2 Desk-based Program

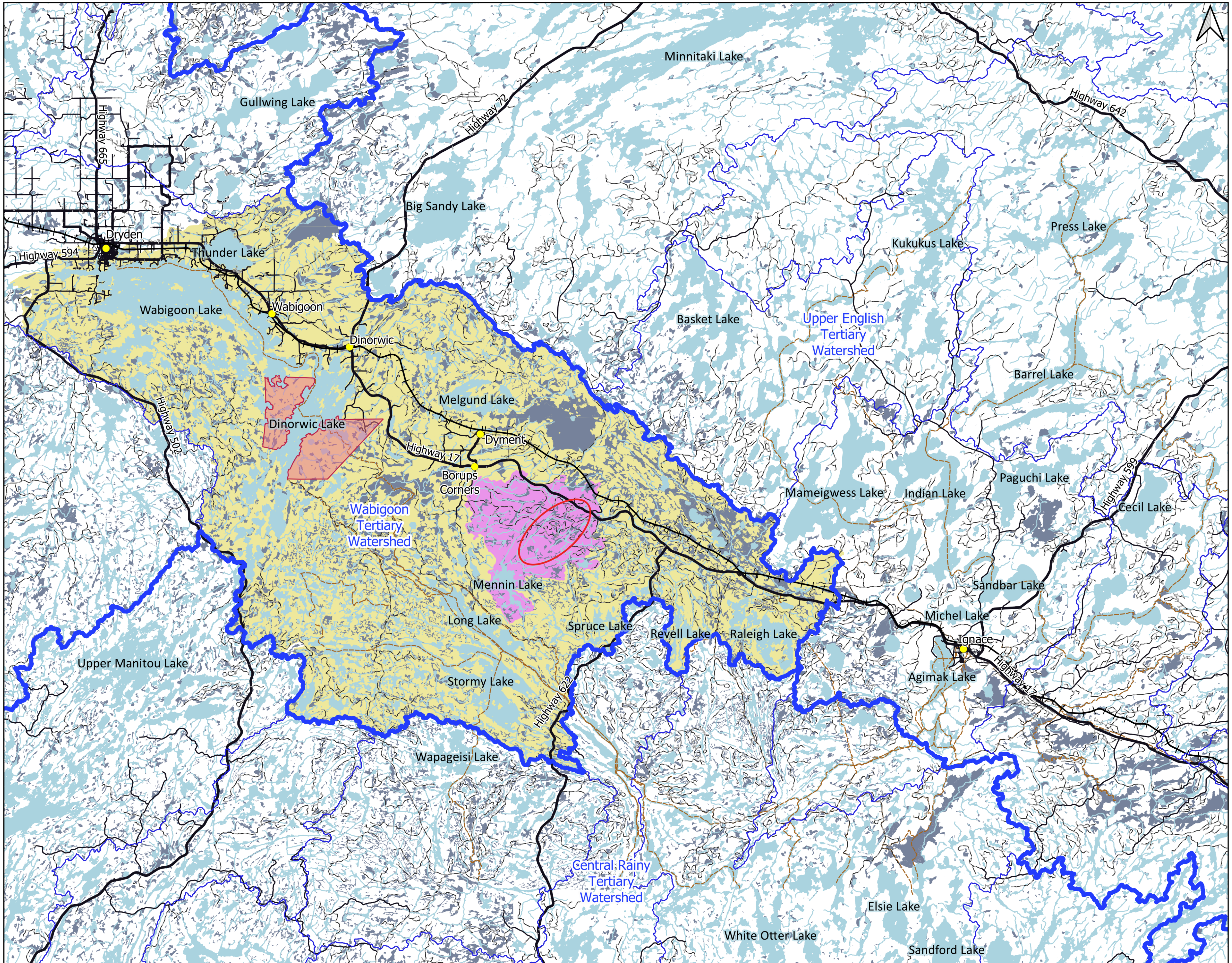
The *Reconnaissance Fish and Fish Habitat Inventory* (RIC 2001a) includes a pre-field preparation and planning component whereby information from maps and air photos is collected to build an initial aquatic habitat map classifying watercourses and waterbodies, including stream reaches, lakes, ponds, and wetlands. The Ontario habitat methods (OSAP and MTO highway protocol) do not include similarly detailed pre-field preparation instructions. This section outlines the methods and approaches that Zoetica will follow for the preparation of interim maps for planning and field survey purposes. The desk-based program will be conducted by Zoetica before the implementation of the field survey conducted by the field data collection contractor commencing in spring/summer of Year 1.

2.4.2.1 Study Area

Aquatic habitat mapping for the collection of fish habitat information will be conducted at two scales: within the local study area, defined as the LSA_{AQU}, and within select areas of the regional study area, defined as the RSA_{AQU} (**Figure 2-3**) to capture appropriate control sites. The area for the collection of fish habitat information is typically much larger than the immediate project footprint area and considers aquatic connectivity, water flow direction, and linkages that extend well beyond the boundary of the APM Project footprint. In determining the appropriate study areas, guidance outlined in the MTO's *Environmental Guide for Fish and Fish Habitat* (MTO 2009) was followed and includes the following considerations:

- The study area must encompass all waterbodies that potentially support fish and fish habitat that could potentially be affected by the APM Project.
- Aquatic ecosystems are continuous and inter-connected systems and fish and habitat variables (e.g., sediment, bedload, nutrients, food, cover) move throughout and along the fluvial continuum. Therefore, the study area should be large enough so that the background information encompasses inter-connected waterbodies and adjacent portions or reaches of waterbodies.
- Knowledge about fish or habitat conditions in adjacent areas can be used to interpret or identify potential for specific fisheries or habitat conditions in the immediate project area.
- Impacts in the immediate project area can be transferred to adjacent areas, potentially affecting fish and habitat in those areas.
- Flexibility for the APM Project is maintained, particularly in planning and siting surface infrastructure, road alignments (and other linear corridors), and associated waterbody crossings.
- Information from the broader area provides context to assess relative representation and the importance of a particular type of habitat.

The LSA_{AQU} includes the watercourses and waterbodies with the potential of being impacted by the APM Project. The LSA_{AQU} is defined by the waterbodies contained within a 1 km buffer around the AOI plus Mennin Lake and the Mennin River drainage, as it is assumed that Mennin Lake could be used as a source for water withdrawal as well as potential discharge (CanNorth 2020). The waterbodies contained within the AOI for the APM Project generally flow to the southwest and contribute flow to Mennin Lake (CanNorth 2019a). The northwest area of the AOI crosses the drainage basin boundary between the Revell River and the Mennin River basins, both of which eventually flow into Wabigoon Lake via the Wabigoon River. The Revell and Mennin Rivers provide the largest flows in the area and are likely to be used as sources for water withdrawal and assimilating effluent discharges for the APM Project (CanNorth 2019a), and effects to water chemistry or hydrology within the AOI could potentially influence downstream areas. Thus, the LSA_{AQU} also includes the watershed drainage for the Revell River north of the AOI to the confluence with the Wabigoon River and includes the Wabigoon River to its confluence with the Mennin River. Areas within these drainages that are upstream of the potential for effects from the APM Project were eliminated from the boundary of the LSA_{AQU}.



NWMO Biodiversity Impact Studies

Aquatic Habitat Mapping and eDNA Study Areas (LSA_{AQU} and RSA_{AQU})

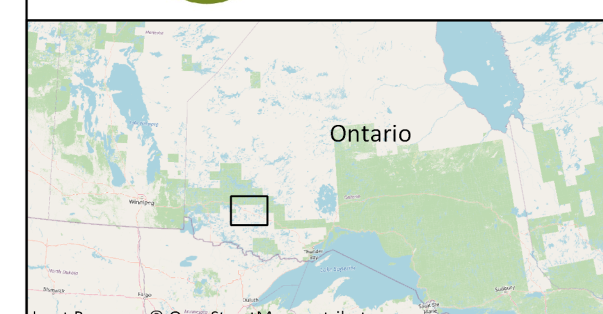
Figure 2-3

- Regional Study Area (RSA_{AQU})
- Local Study Area (LSA_{AQU})
- Area of Interest (AOI)
- Wetland
- Lake
- Watercourse
- Quaternary Watershed
- Tertiary Watershed
- Highway or Arterial Road
- Local Road
- Resource/Recreation Road
- Trail
- Railroad
- Community
- Wabigoon Lake No. 27

1:375,000

0 5 10 km

ZOETICA



Inset Basemap © OpenStreetMap contributors

Data received from:
Ontario Geohub - Indian Reserve (MNRF), OHN Waterbody (MNRF), OHN Watercourse (MNRF), ORWN Railway (MNRF), MNRF Road Segments (MNRF), Watershed Tertiary (MNRF), Watershed Quaternary (MNRF), Wetlands (MNRF)
NWMO - AOI, Trail Segments (MNRF)

Project CRS: NAD83 / UTM zone 15N

Author: DM	Verified by: CC
April 21, 2021	Map ID: NWMO_BIS_014b

The RSA_{AQU} covers a much larger area, which includes a larger boundary surrounding the LSA_{AQU}, outside of the direct influence of the APM Project but within the Wabigoon watershed (**Figure 2-3**). The RSA_{AQU} is designed to be large enough to provide a regional context of habitat in the Revell Batholith Area, provide an area within which suitable control sites can be selected, and to account for the potential need for the consideration of the movements of wide-ranging species, such as lake sturgeon (if found in the area using eDNA. Lake sturgeon is a SAR that can move up to 400 km in Ontario; Rusak and Mosindy 1997, Golder Associates Ltd. 2011). It is possible, though unlikely, that Lake Sturgeon could interact with the LSA_{AQU} at certain times of the year or during periods of its life cycle (e.g., spawning), if present in the larger Wabigoon watershed. The RSA_{AQU} also accounts for the area needed to accommodate the study of cumulative effects on fish and fish habitat.

The RSA_{AQU} is defined by the southern portion of the Wabigoon tertiary watershed boundary clipped to the northwest side of Wabigoon Lake. As human population size increases in the area due to the APM Project and other potential projects, fishing pressure in lakes in the surrounding area may be impacted. Within the RSA_{AQU}, four lakes (Wabigoon, Dinorwic, Melgund, and Raleigh) have been identified as popular recreation areas that may experience fishing pressure with an increased human population. Additional lakes outside of the RSA_{AQU} (e.g., Basket, Kukukus, Mameigwess, Indian, Barrel, Paguchi, and Cecil) have been identified as popular areas for fishing and may also be important to consider if human population growth resulting from the APM Project is expected to lead to more fishing and use in those areas. Other lakes identified as important for additional ecosystem services (e.g., as a water source) have been included for potential study. The RSA_{AQU} includes the watershed boundaries or the sub-basins of the tributaries to and including Revell Lake and its outflow, as these may provide suitable control sites for Mennin Lake and its drainage (CanNorth 2020). The size of the RSA_{AQU} may be refined as more is learned about the potential for downstream effects due to the APM Project.

2.4.2.2 Data Sets

The first steps described in the *Reconnaissance Fish and Fish Habitat Inventory* (RIC 2001a) are the desk-based project planning phases, which will be conducted by Zoetica. **Figure 2-4** demonstrates the steps in the data review and desk-based project baseline program, adapted from RIC (2001a).

The first step in the development of an aquatic habitat mapping inventory is the review of all existing fish and fish habitat information. The most relevant information on fish and fish habitat in Ontario is data collected by the MNRF. Additional sources of information will be reviewed based on, but not limited to, references outlined in the *Environmental Guide for Fish and Fish Habitat, Section 3: Background Data Collection* (MTO 2009).

Base Map (1:20,000 Stream Network): The 1:20,000 base map and drainage that will be used for the project needs to be identified. Zoetica proposes that the Ontario Hydro Network (1:20,000) watercourse mapping (from Ontario GeoHub) be used.

Watercourse/Waterbody Referencing: All streams on the 1:20,000 base map need to be identified using a unique watercourse/waterbody identifier, which is used on all data forms (see Aquatic Habitat Mapping SOP in **Appendix A**). The following watercourse/waterbody information will be used to reference all waterbodies in the aquatic study areas (adapted from RIC 2001a):

- *Watercourse/Waterbody Identifier*: This will include an alpha-numeric string of characters that uniquely identifies a watercourse/waterbody within a watershed and link streams and waterbodies based on their relationship to one another.
- *Gazette Name*: Official name of the waterbody as listed in the Gazetteer of Canada for Ontario. Use ‘unnamed’ if the waterbody is not gazetted.
- *Alias*: Locally used name for the waterbody and can be obtained from MNRF archives or local sources.
- *Stream Code* and *Site Codes:* The Ontario-based *Flowing Waters Information System* (FWIS) will be used to determine Stream Codes and site codes if and where they have been assigned already in the study areas. If no stream codes have been identified, Zoetica will provide a new stream code in the reach tables provided in **Appendix A**. The stream code is used to link with the FWIS database but does not described how streams are interconnected. Stream codes are based off the common name of the stream.
- *Geo-referencing*: The Universal Transverse Mercator (UTM) coordinate is used to identify the location of a lake, pond, stream, or wetland, and/or survey site. UTMs are recorded as three sets of numbers: zone – easting – northing, separated by periods, and can be obtained from the 1:20,000 map or Global Positioning System (GPS).
  - For stream reaches, use UTM of upstream reach break.
  - For survey sites in stream reaches, record UTM coordinates of the downstream end of the site.
  - For waterbodies (lakes, ponds, wetlands), the UTM normally refers to the location of the inlet stream on the waterbody. If more than one inlet exists, the main inlet is used, and in cases where no inlet exists, the UTM of the geographic centre of the waterbody is used.
  - For survey sites in waterbodies, UTM coordinates are recorded from the approximate centre of the site.
  - For features with a linear extent, UTM is for the downstream end.
- *Numeric Identifiers*: Each mapped feature e.g., reach breaks, survey sites) must be location referenced. This will be done by recording the UTM of the feature, or by assigning a unique numeric identifier (NID) to the feature. This can be recorded as a waypoint number using a GPS unit.
  - Record the NID for a mapped feature on the interim map.
  - All data forms (e.g., reach tables, survey forms; see Aquatic Habitat Mapping SOP in **Appendix A**) include the NID field.

Desk-based aquatic habitat mapping will be conducted using available aerial imagery and the desk-based refined ecosite dataset (see Section 2.1.2.3.1), as the classification data for wetlands based on the ELC system (ELC Working Group 2009) will be one of the datasets used to delineate reaches.

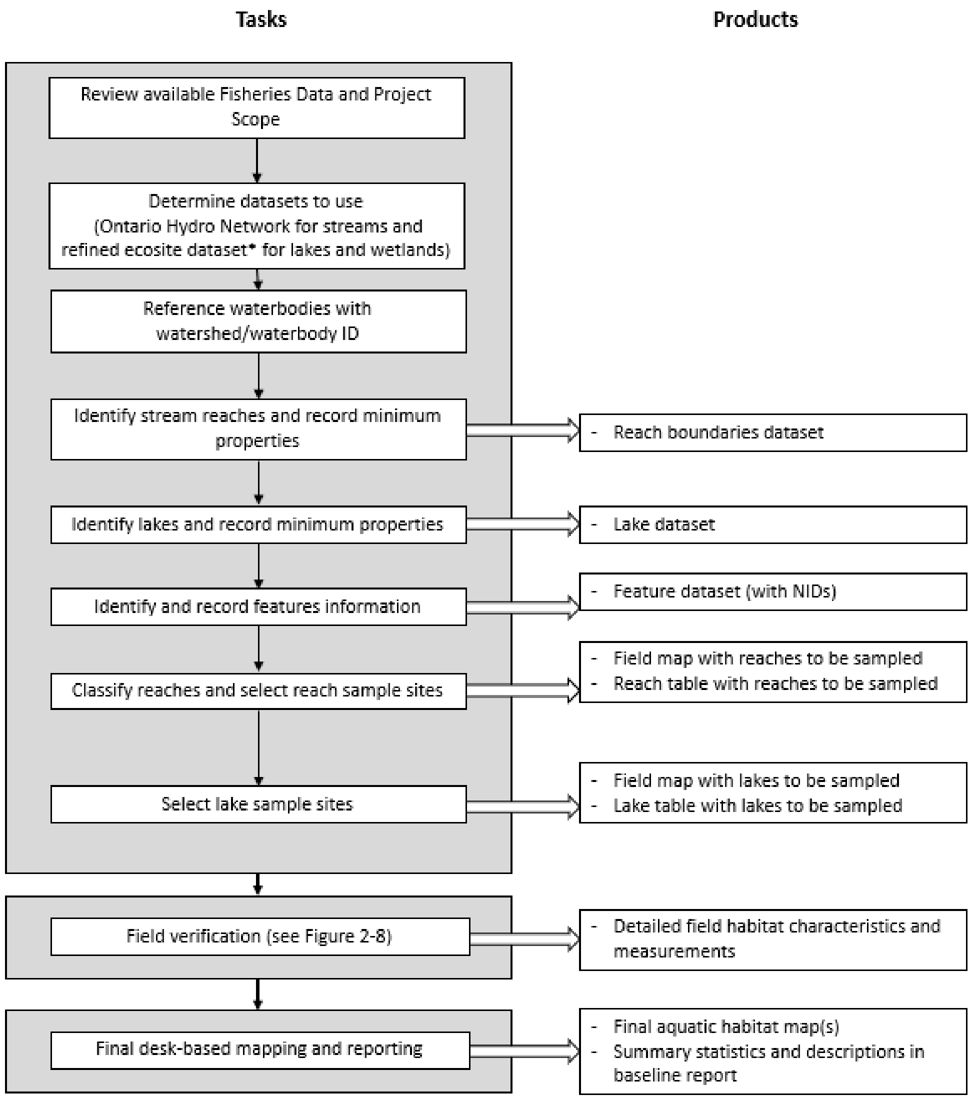


Figure 2-4. Flowchart of the tasks and products in the desk-based aquatic habitat mapping phase of the APM Project. Adapted from RIC (2001a).

2.4.2.3 Methods

All relevant features and information collated during the desk-based review phase conducted by Zoetica include:

- Previous fish sampling and distribution information including sampling sites, known upstream and downstream distribution limits
- Waterfalls that may act as obstructions to fish movement
- Chutes or cascades that may potentially act as obstructions
- Culverts and other stream crossings that potentially alienate fish habitats
- Major beaver dams
- Logjams and sediment wedges
- Landslides or major erosional events that affect the channel
- Evidence of subsurface flow

- Enhancement activities
- Other information that may affect the survey objectives and plan

After the data review phase, interim maps will be prepared by Zoetica following standards outlined in the *Standards for Fish and Fish Habitat Maps* (RIC 2001b) with the adaptations described in this protocol. These interim maps are to be used throughout the field survey by the field data collection contractor and will include:

- Watercourse/waterbody codes for all waterbodies with information (streams, lakes, and connected wetlands)
- Features from data review, referenced with NID

2.4.2.3.1 Classification and Survey Design

All waterbodies and watercourses in the LSA_{AQU} will be classified and mapped using maps and air photo analysis. The steps in classification and survey design are presented in **Figure 2-4**. Additional waterbodies and watercourses in the RSA_{AQU} may also be classified, for areas that will be selected as control sites. It is not necessary to survey all waterbodies and watercourses in the LSA_{AQU}, as the classification of water features in the LSA_{AQU} allows for the extrapolation of information collected in the field to reaches that were not surveyed. However, due to greater probability of project effects acting on aquatic habitats nearer to the potential project, a higher proportion of aquatic habitat will be surveyed within the AOI, with a lower proportion further away.

The *Reconnaissance Fish and Fish Habitat Inventory* (RIC 2001a) provides a framework to classify stream reaches, lakes, and wetlands, to allow for the implementation of a design to survey within these various waterbody types based on a stratified approach. Reach channel types and habitat characteristics within each class are assumed to be consistent. Field survey locations within these reaches and habitat types will be selected after desk-based waterbody classification and before field data collection beginning in summer of Year 1 using a statistical randomized design (e.g., GRTS; see Section 1.9.1). Additional sites will be added to help characterize potential fish species presence and distribution limits in reaches containing barriers (e.g., above and below falls) and areas where potential impacts require being assessed at specific locations (e.g., near proposed project infrastructure).

The 1:20,000 base maps are used for planning purposes and data collection and provide the base to display data. Aerial imagery at a scale of 1:20,000 will be used to classify watercourses/waterbodies and delineate reaches, while the wetland classification from the desk-based refined ecosite dataset (see Section 2.1.2.3.1) will be used to classify wetlands. These data sets will be combined with overland trail and roads to determine access and plan field logistics. A helicopter reconnaissance survey will need to be conducted by Zoetica and potentially CanNorth to assess the accuracy of reach delineation, to determine locations of habitat that cannot be identified using desk-based maps and imagery interpretation (e.g., transitions from riffle/run to pool habitat), and to inform changes to survey design (e.g., potential reselection of survey sites). Refinements to field maps will be made soon after return such that the field data collection contractor can be provided with more accurate maps for habitat data collection at each selected survey reach. Immediately before habitat data collection, the field data collection contractor should also conduct field checks to plan field access and choose representative survey locations within reaches. Ideally, in Year 1, this field check could be paired with field training and conducted at the same time as the reconnaissance trip to verify maps. Seasonal changes in flow (e.g., ephemeral habitats), and recent potential barriers to fish passage (e.g., new beaver lodges) not previously identified, should also be noted.

2.4.2.3.1.1 Watercourse/Waterbody Identification

During initial desk-based mapping conducted by Zoetica, all water features within the LSA_{AQU} will be identified as streams, lakes/ponds, or wetlands. Waterbody identification is required for the basis of the development of stream reach and waterbody reach tables. Each waterbody (lakes, ponds, and connected wetlands (see Glossary and Abbreviations)) will be considered as a separate reach for survey designation.

Waterbodies less than 2 m deep are considered wetlands and may not be distinguishable from lakes using air photos alone. Thus, all shallow open water wetlands are considered part of waterbody surveys unless there are distinct ‘channels’ flowing through them, in which case they are considered as part of the stream surveys.

2.4.2.3.1.2 Stream Reach Identification

Stream reach identification through desk-based mapping is required for the selection of field survey sites. Stream reaches are relatively homogenous lengths of a stream composed of repeating structural characteristics and fish habitat types (e.g., riffle, run).

Stream reaches should be defined by a minimum length of 100 m (0.5 cm on a 1:20,000 scale map or air photo). Stream reaches are delineated using all available sources including, at minimum, the most recent air photos and maps at a scale no smaller than 1:20,000. **Table 2-13** identifies the physical factors used to determine reaches based on their uniformity and reach boundaries are defined by changes to these attributes. Obstructions or potential barriers to fish passage are considered reach boundaries if they meet the following:

- Are less than 100 m or 10 times the bankfull width in length (if longer, they are defined as reaches); and,
- Are consistent with changes in physical criteria listed in **Table 2-13** (e.g., falls with characteristics that are different from both upstream or downstream reaches). Reach breaks mark the boundary between adjoining reaches.

Table 2-13. Stream reach identification classifiers.

Reach determinations (uniformity)	**Reach boundaries defined by:**
Channel pattern	Changes in the stream channel (e.g., changes from a single channel to braided or multiple channels, or tributary confluences)
Channel confinement	Changes in confinement pattern (e.g., a change from a wide floodplain to a confined canyon)
Gradient	Changes in gradient
Stream size	Stream order (using Strahler stream order; Strahler 1957)
Stream habitat attributes	For stream channels that run through wetlands, changes in wetland type or change in the size of the wetland surrounding the stream
Streambed and bank material	Changes in streambed and bank materials (e.g., a change from erodible to non-erodible materials)

Each reach on a stream is assigned a unique number, in an upstream-ascending order, with the first reach situated closest to the mouth of the stream. If reaches need to be broken into smaller reaches based on field observations (e.g., a feature is not identifiable on air photo), numbers are assigned following decimals (e.g., 1, 2, 2.1, 2.2, 2.3, 3, …), limiting the number of changed reach identifiers. Details on reach numbering can be found in *Standards for Fish and Fish Habitat Maps* (RIC 2001b) and **Figure 2-5**.

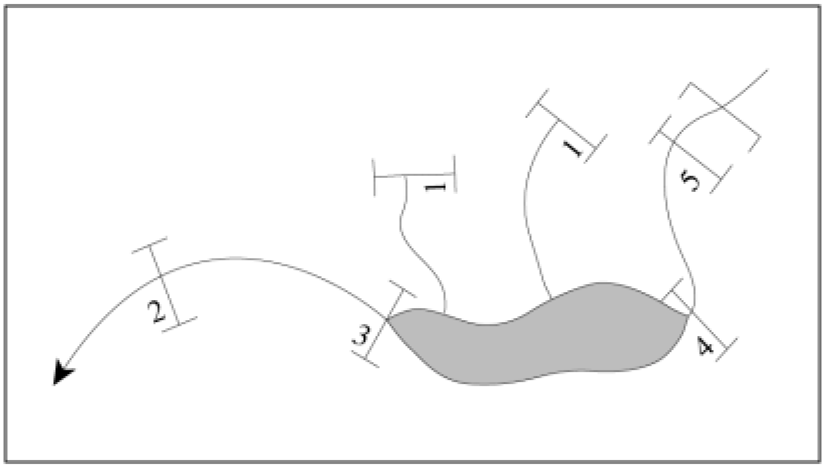


Figure 2-5. Reach numbering system. Bars represent reach breaks. Each tributary resets at a reach number of 1. From RIC (2001b).

A preliminary stream reach table including all stream reaches in the LSA_{AQU}, as well as reaches for control sites within the RSA_{AQU} (e.g., reaches along the Revell and Mennin Rivers upstream of the AOI and LSA_{AQU}) will be derived by Zoetica to record general physical data for each reach using desk-based information derived from aerial photography and refined ecosite mapping (see Section 2.1.2.3.1). For pre-field planning purposes, the information in the stream reach table will be used to determine the subset of stream reaches to be surveyed.

The following preliminary information will be gathered in the stream reach table:

a. Station ID
b. Watercourse ID (a unique ID generated for each watercourse in the LSA_{AQU})
c. Reach number (determined through mapping)
d. Watercourse name (gazetted name and/or alias)
e. Length
f. Wetland(s) and type
g. Pattern
h. Confinement
i. Segment (section of river between tributaries used for priority selection)
j. Study Area
k. Priority (assigned by desk-based stratified random reach selection)
l. NID (a unique number for identification of reach breaks)
m. UTM of upstream and downstream reach breaks (easting, northing)

Referencing information (a to g) is consistent with that used on aquatic habitat mapping forms (see Aquatic Habitat Mapping SOP in **Appendix A**). The reference number (NID) is a user-defined number to aid in the identification of the reaches for surveying. The determination of stream order will include all identified channels as shown in **Figure 2-6**. Pattern and confinement will be determined from maps and air photos. All connected wetlands will be identified in the stream reach table. Wetland type will be filled in based on descriptors in Section 2.4.2.3.1.3. Only shallow open water wetlands with distinct 'channels' flowing through them are considered as part of the stream surveys; those without 'channels' are considered as part of the waterbody surveys and recorded in the waterbody reach table (Section 2.4.2.3.1.3).

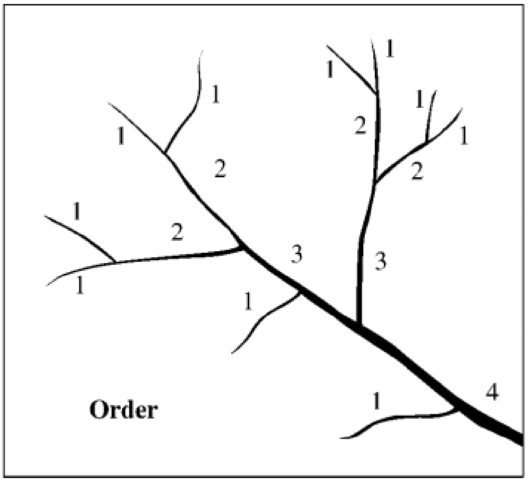


Figure 2-6. A visual graphic of the determination of stream order using Strahler Order (Strahler 1957). Adapted from RIC (2001a).

Determining Stream Reach Survey Locations

Zoetica suggests surveying 100% of the stream reaches within areas potentially impacted directly by the APM Project (within the AOI, and including the Mennin and Revell Rivers), approximately 30% of stream reaches within the LSA_{AQU}, and 5 to 15% of stream reaches within select areas used as control sites in the RSA_{AQU}. Year 1 of the Aquatic Habitat Mapping studies for the BIS will focus on the AOI and LSA_{AQU}. In addition, reference areas upstream of the AOI and Mennin Lake and within the RSA_{AQU} will be selected for study. Zoetica's approach is to follow a stratified random, BACI design. Streams will be stratified based on stream order and type of wetland surrounding them. Within the AOI, the goal is to survey all watercourses that may be directly impacted by the APM Project, and where information could help inform project design and facility locations. However, it will not be feasible to survey all watercourse segments in the AOI in a single field season – according to reach delineation completed in the LSA_{AQU} based on Ontario Hydro Network spatial data, there are 107 stream reaches fully or more than 50% contained within the AOI. Therefore, Zoetica proposes to focus on reaches in second-order or higher streams (n=45) in the AOI in the first campaign of the aquatic habitat mapping studies. Additional aquatic habitat mapping may be conducted in first order streams in future years of study once more is learned about the final location of the APM Project and species occurrence within the AOI through eDNA studies (see Section 2.6). In addition, Zoetica proposes that aquatic habitat mapping be conducted in other parts of the LSA_{AQU} downstream of the AOI, including on the Mennin and Revell Rivers, and in sections of the Wabigoon River between the Mennin and Revell Rivers. Further, habitat survey sites in select areas of the Mennin and Revell Rivers upstream of the AOI are proposed to act as potential control locations.

Once the final reaches for field surveying have been selected by Zoetica, a stream reach table including only those reaches to be surveyed, and a map to direct survey locations will be provided by Zoetica to the field data collection contractor (see Aquatic Habitat Mapping SOP in **Appendix A**). Digital shape files will be transferred to the field data collection contractor following NWMO's data transfer procedure so that the field data collection contractor can construct field maps of a desirable scale.

2.4.2.3.1.3 Lake, Pond, and Wetland Identification

A lake is an open waterbody with a maximum depth greater than 2 m and with less than 25% of its surface area covered with wetland vegetation. Open waterbodies that do not fit these criteria are considered wetlands. Wetlands are classified into the following four classes/types based on the Ontario Wetland Ecosystem Classification System for Northern Ontario (from MNRF 2014a) including marsh, swamp, fen, and bog (see Glossary and Abbreviations).

All reaches, including lakes, ponds, and wetlands, will be numbered by Zoetica during desk-based mapping. Lakes, ponds, and wetlands are considered reaches for the survey and are assigned a unique number in sequential, upstream-ascending order, consistent with the stream reach numbering system.

A preliminary waterbody reach table will be created by Zoetica to record all lake, pond, and wetland reaches in the LSA_{AQU} and select control sites within the RSA_{AQU}, and general physical data will be recorded for each reach using desk-based information derived from aerial photography and refined ecosite mapping (see Section 2.1.2.3.1). The following information will be gathered in the preliminary waterbody reach table:

a. Station ID
b. Polygon ID (a unique ID generated for each lake, pond, or wetland in the LSA_{AQU})
c. Sample order (assigned by desk-based stratified random reach selection)
d. Waterbody type (lake, pond, or wetland type)
e. Panel (whether the survey is a Census, PanelOne, or OverSample)
f. Survey point UTM (easting, northing)
g. Waterbody name (gazetted name and/or alias)
h. Tertiary watershed name
i. Lake reach number (determined through mapping)
j. Number of inlets
k. Number of outlets
l. NID (a unique number for identification of lake inlets and outlets)
m. Inlet and outlet UTM coordinates (easting, northing)
n. Priority (order of priority the sites should be surveyed)

The preliminary waterbody reach table is used to facilitate the selection of waterbodies to be surveyed in a watershed. For pre-field planning purposes, the information in the waterbody reach table is used to determine the subset of waterbody reaches to be surveyed.

<u>Determining Waterbody Survey Locations</u>

During Year 1 of aquatic habitat mapping, Zoetica proposes to focus on waterbodies that exist in the AOI and $LSA_{AQU,}$ as well as select waterbodies in the RSA_{AQU} that may serve as control sites. Waterbodies will be stratified based on size (i.e., ponds ≤ 1 ha; lakes >1 ha) and wetland type (i.e., marsh, swamp, bog, fen). Zoetica proposes that the selection of waterbodies follows a stratified random BACI design (i.e., GRTS) to select potential habitat survey sites in the LSA_{AQU} and that sites selected for aquatic habitat surveying are the same as those selected for eDNA sampling (see Section 2.6.2.3).

The AOI consists of a large number of wetlands and ponds. The goal of the baseline program is to survey all waterbodies and wetlands that may be directly impacted by the APM Project within the AOI. However, as the final project location has not yet been determined, and it will not be feasible to survey all waterbodies in the AOI in a single field season (see Section 2.4.2.3.1.2), the survey design during the first field campaign will consist of reduced effort over the entire AOI. Additional surveying can be undertaken once more information about the APM Project is known (including location, components, activities, and the extent of potential impacts) and based on results from the initial eDNA studies (see Section 2.6).

Several lakes including Mennin Lake (outside of the AOI but within the LSA_{AQU}) will also be hand-selected for aquatic habitat surveying as it is proposed to be used for water withdrawal and discharge for the APM Project. In addition, a selection of lakes in the RSA_{AQU} (including Revell Lake, Cox Lake, and Spruce Lake) will be hand-selected for survey to act as potential control sites for Mennin Lake. More than one control site will be used to ensure that control sites remain if others are impacted by activities such as forestry, forest fires, or development in the area over time).

A waterbody reach table is provided in the Aquatic Habitat Mapping SOP in **Appendix A**. Digital shape files will be transferred to the field data collection contractor following NWMO's data transfer procedure so that the field data collection contractor can construct field maps of a desirable scale.

2.4.3 Field Program

This section describes the requirements for field verification of aquatic habitat mapping and fish habitat assessments that will be conducted by the field data collection contractor. Field methods are focused on checking the accuracy of the reach delineations derived via desk-based mapping products (outlined in Section 2.4.2.3.1) and include detailing habitat characteristics that cannot be sufficiently addressed using aerial imagery alone. Field methods in Tier 1 are also aimed at collecting fish habitat information that can inform fish habitat suitability for species presence and distribution during various life history stages, to inform additional future sampling requirements for fish presence and community surveys to be conducted in future assessments (i.e., Tier 2 studies), to identify where more detailed fish and fish habitat assessments will likely be required (e.g., SAR habitat, the habitat that will be lost due to the APM Project), and to identify potential areas suitable for offsetting should a future assessment illustrate a need.

2.4.3.1 Survey Timing

The standard survey period for aquatic habitat mapping in the field is during the summer low flow periods (May – September; MTO 2009) to characterize stream habitat information. However, timing should be adjusted based on local conditions to coincide with when low flow periods typically occur, or when they are occurring during the year the work is conducted (understanding that there is some inter-annual variability based on weather). Conducting surveys during summer low flow periods ensures optimum visibility into the water and that seasonal aquatic and riparian vegetation is present (MTO 2009). Measurements of temperature regimes during low flow periods can be used to confirm or determine the potential use of waterbodies and watercourses by cold water species (MTO 2009). Surveying during low flow periods can also effectively determine flow permanence, baseflow conditions, and connectivity of refuge habitats (MTO 2009). Field visits conducted in the spring can also assist in mapping non-permanent waterbodies and should be conducted where ephemeral streams and waterbodies are suspected, and where non-permanent waterbodies could act to connect other permanent waterbodies for part of the season. Survey timing should be conducted during weather conditions suitable to allow for good visibility through the water column. Limnological surveying (conducted by the EMBP) should be carried out as near to mid-day as possible.

Helicopter services will likely be required to cover the entire study area efficiently. It should be acknowledged that weather days may delay the field data collection schedule if general flight conditions are not satisfied (e.g., heavy fog or precipitation reducing visibility).

2.4.3.2 Survey Crew

Each survey team may consist of two experienced fisheries biologists familiar with fish habitat identification and survey methods in Ontario, including limnology and water chemistry measurements, bathymetry, and general knowledge of aquatic plant identification; and one local field assistant (e.g., from Indigenous communities, if community interest and availability allow). Alternatively, one fisheries biologist familiar with limnology, water chemistry, and bathymetry; one vegetation specialist with expertise in identification of aquatic vegetation; and one local field assistant can comprise each field crew team. At each site, the field crew lead (fisheries biologist on the team with the most experience) will be responsible for directing the field activities. The field lead must be familiar with all requirements of field collection outlined in Section 2.4.3.4, including the identification of wetland types as per the *Ontario Wetland Evaluation System: Northern Manual* (MNRF 2014a), and knowledgeable in contingency planning where selected sites are inaccessible, or issues in data collection arise. One fisheries biologist will be responsible for recording data on field forms and mapping habitat (see Aquatic Habitat Mapping SOP in **Appendix A**), and one fisheries biologist or vegetation specialist and a field assistant will be responsible for conducting waterbody measurements. Since bathymetry and water chemistry will be recorded as part of the EMBP (CanNorth 2020), field crews for the fish habitat program may be the same as those identified for the EMBP. Alternatively, if bathymetry crews are not fisheries biologists, bathymetry and limnology measurements may be conducted separately from fish habitat measurements using two separate crews.

This field work will likely require contracted helicopter services. The pilot is not expected to be directly involved in fish habitat (watercourse/waterbody mapping) studies but will be relied upon to find appropriate landing spots when transporting the survey team and equipment from location to location.

2.4.3.3 Equipment and Materials

Equipment and materials required for bathymetry, limnology and water chemistry are described in the EMBP (CanNorth 2020). Additional equipment required for aquatic habitat surveys are listed in the Aquatic Habitat Mapping SOP in **Appendix A**. Helicopter services are likely needed to enable cost-effective and efficient coverage of the LSA_{AQU} and select control sites in the RSA_{AQU} for aquatic habitat mapping studies. Ideally, the aircraft will be able to accommodate the aquatic habitat mapping survey crews; however, staggering of crew pick-up and drop-off may be needed and will be determined when additional details about logistics are available. Helicopters may also be required to move equipment (boats or field equipment) to survey locations. Alternatively, if helicopter services are not used – for example, if it is determined by the NWMO that ground travel to the pre-determined survey locations is feasible – then other modes of transportation will be required from home base to the study sites. In this case, a truck and/or ATVs will likely be required.

2.4.3.4 Field Protocol

The field protocol for aquatic habitat mapping surveys is divided into field survey methods for watercourses (including wetlands with distinct 'channels' flowing through them) and field inventory methods for waterbodies such as lakes, ponds, and wetlands (all except for those with distinct 'channels' flowing through them). However, the general process for field survey is the same and is outlined in **Figure 2-7**.

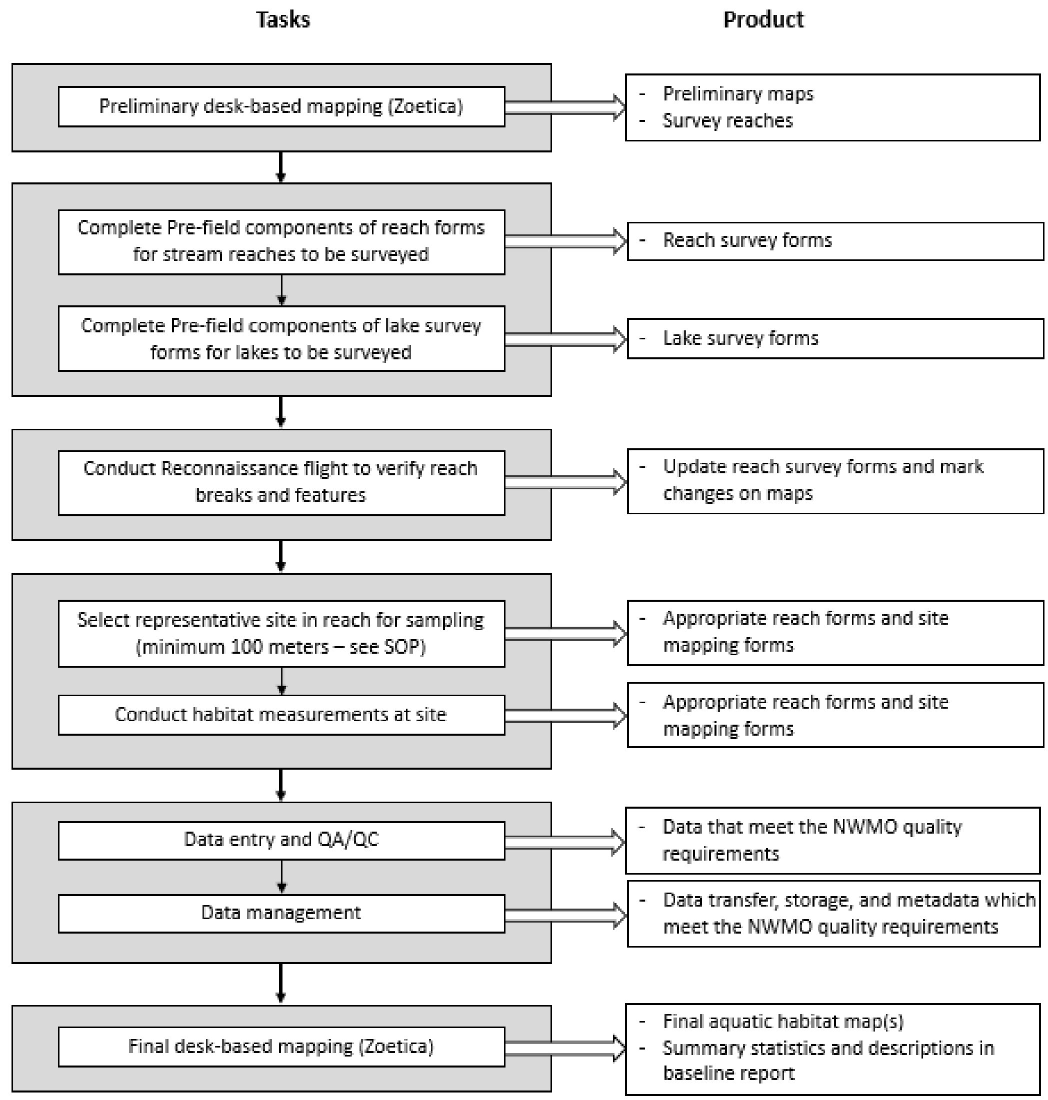


Figure 2-7. Flowchart of the tasks and products in the field-based aquatic habitat mapping.

2.4.3.4.1 Watercourse (Stream) Surveys

To maximize the efficiency of time in the field, a standardized field plan must be followed. Biophysical information will be collected at the lowest stream flows (typically between May and September). To minimize disturbance to fish and water quality, water sampling should be conducted before physical survey.

The field component of the watercourse (stream) surveys includes the following:

1. Site description and identification of sampling sites and site delineation
2. Site features description (including the surrounding land use)
3. Description of water conditions

4. Watercourse morphology characterization
5. Channel measurements
6. Cover and habitat inventory
7. Features identification (e.g., migratory obstructions)
8. Wildlife observations (recorded in comments section)
9. Photography
10. Mapping reach information on the Aquatic Habitat Mapping Form (see Aquatic Habitat Mapping SOP in **Appendix A**)

For wetland reaches, the minimum information required is location (site referencing), cover estimates, water characteristics (temperature, pH, conductivity, turbidity), photos, and cover and habitat inventory. Details including data collection procedures and recording are summarized in Section 2.4.3.5.1 and SOPs, field forms, and instructions on filling forms detailed in **Appendix A**.

2.4.3.4.2 Waterbody (Lake/Pond/Wetland) Surveys

The field component of the waterbody (lake/pond/wetland) surveys includes the following:

1. Site description and identification of sampling sites and site delineation
2. Site features description (including the surrounding land use)
3. Description of water conditions
4. Waterbody morphology characterization
5. Waterbody major inlet and outlet survey (to be conducted following watercourse survey protocol)
6. Characterization of water quality and limnology (to be coordinated with the EMBP; CanNorth 2020)
7. Bathymetric characterization (to be coordinated with the EMBP; CanNorth 2020)
8. Bank and shoreline cover and habitat characterization
9. In-water cover and habitat characterization
10. Wildlife observations (recorded in comments section)
11. Photography
12. Mapping reach information on the Aquatic Habitat Mapping Form (see Aquatic Habitat Mapping SOP in **Appendix A**)

2.4.3.4.2.1 Field Survey Organization for Waterbodies

The following is an example of a sequence of field activities for the waterbody surveys adapted from RIC (2001a) (Note: fish sampling will occur as part of Tier 2 activities planned for future years):

1. Conduct a preliminary sounding track (an E-line) along the main axis of the waterbody (to be coordinated with the EMBP; CanNorth 2020). This will assist in the planning of transects for bathymetric mapping, in locating the best site for the limnological station, and in the placement of fish sampling gear during future Tier 2 studies.
2. Conduct a shoreline cruise to record various descriptions (e.g., lakeshore features, surrounding terrain, bank and shoreline vegetation and aquatic plant distribution).
3. Complete the bathymetric sounding transects; establish, mark and record the survey benchmark (to be coordinated with the EMBP; CanNorth 2020).
4. Conduct the assessment/description of associated inlet and outlet streams (to be conducted as part of the watercourse surveys).

5. Complete the limnological survey. Temperature and oxygen profiles should be done before any water samples or Secchi disk measurements are taken in order not to disturb the water column (to be coordinated with the EMBP; CanNorth 2020). Limnological surveys should be carried out as near to mid-day as possible.
6. Throughout the survey, take photographs.
7. Review data forms and complete any other data collection required.

Bathymetric, water quality, and limnological survey procedures are described in the EMBP (CanNorth 2020). Data collection procedures for the above activities are discussed in Section 2.4.3.5.2, and in the Aquatic Habitat Mapping SOP (**Appendix A**), which includes field forms and instructions on filling forms.

2.4.3.5 Data Collection and Recording

This section describes the field data collection and recording procedures required for the aquatic habitat mapping studies. The Aquatic Habitat Mapping SOP, including field forms and instructions for filling out forms, is attached in **Appendix A**.

2.4.3.5.1 Watercourse (Stream) Surveys

Stream reach identification and referencing information collected during the desk-based program (Section 2.4.2.3.1.2) for the pre-field planning phase of aquatic habitat mapping are provided in the Watercourse (Stream) Survey Reach Table and Map (see Aquatic Habitat Mapping SOP in **Appendix A**) and carried through to the field stream and watercourse data forms. Stream reach survey field data are collected on the Site Identifier Form, the Site Features Form, the Watercourse (Stream) Survey Form and the Aquatic Habitat Mapping Form (see Aquatic Habitat Mapping SOP; **Appendix A**). Detailed guidelines for filling out the field forms are included in the Watercourse Reference Guide: Stream Reaches in the Aquatic Habitat Mapping SOP (in **Appendix A**). All forms are to be filled out as completely as possible for each reach selected for field assessment. Each reach must be mapped separately on an Aquatic Habitat Mapping Form (included in the Aquatic Habitat Mapping SOP in **Appendix A**) and information from each reach is compiled to complete the collection record from for the station.

Any sections of the form that do not pertain to the location should be crossed out or marked with an "N/A" to indicate that the information was omitted on purpose and not forgotten.

Site Identifier Form (included in Aquatic Habitat Mapping SOP in **Appendix A**): used to fill out site identifier information including access information, site description, and site marking.

Site Features Form (included in Aquatic Habitat Mapping SOP in **Appendix A**): used to fill out surrounding landscape information and potential stressors to the watercourse.

Watercourse (Stream) Survey Form (included in Aquatic Habitat Mapping SOP in **Appendix A**): adapted from MTO (2009) and designed to capture data collected in the pre-field (desk-based) and field phases of the watercourse (stream) aquatic habitat mapping survey. Some data types collected during the pre-field mapping are verified in the field.

Aquatic Habitat Mapping Form (included in Aquatic Habitat Mapping SOP in **Appendix A**): used to record field observations during the watercourse survey. Record locations of photograph locations and direction, shoreline features, and significant stream side and aquatic plant communities on these maps. Substrate classes should be mapped and the transition of any changes to substrate composition denoted. Any connected wetlands should be marked on the map. Conditions of the banks showing erosional and depositional areas should be marked.

2.4.3.5.2 Waterbody (Lake/Pond/Wetland) Surveys

Waterbody identification and referencing information collected during the desk-based program (Section 2.4.2.3.1.3) for the pre-field planning phase of the aquatic habitat mapping are carried through to the field data forms. Waterbody (lake/pond/wetland) field data are collected on the Site Identifier Form, the Site Features Form, the Waterbody (Lake/Pond/Wetland) Survey Form and the Aquatic Habitat Mapping Form (see Aquatic Habitat Mapping SOP in **Appendix A**). Information on inlet and outlet streams (if surveyed) is collected on the Watercourse (Stream) Survey Form (included in Aquatic Habitat Mapping SOP in **Appendix A**).

Site Identifier Form (included in Aquatic Habitat Mapping SOP in **Appendix A**): used to fill out site identifier information including access information, site description, and site marking.

Site Features Form (included in Aquatic Habitat Mapping SOP in **Appendix A**): used to fill out surrounding landscape information and potential stressors to the waterbody.

Waterbody (Lake/Pond/Wetland) Survey Form (included in Aquatic Habitat Mapping SOP in **Appendix A**): adapted from MTO (2009) and designed to capture data collected in the pre-field (desk-based) and field phases of the waterbody surveys. Some data types collected during the pre-field mapping are verified in the field. Refer to **Appendix A** or data collection and recording instructions.

Aquatic Habitat Mapping Form (included in Aquatic Habitat Mapping SOP in **Appendix A**): used to record field observations during the waterbody surveys. Record locations of the limnological station, photograph locations and direction, inlets/outlets, shoreline features, and significant aquatic plant communities on these maps. Details of bathymetric surveys (transect locations and direction, spot depth measurements) should be recorded on the Aquatic Habitat Mapping Form.

2.5 Drone Pilot Program

2.5.1 Overview

A drone pilot program is recommended to investigate the usefulness and viability of this rapidly improving technology that has promise for collecting imagery data. Utilization of drones could potentially reduce the amount of field effort required to verify mapping products and identify important ecological features now and into the future. The use of drones in biodiversity data collection is relatively new and is largely in an exploratory and experimental phase of research; the use of drones for data collection has not been thoroughly tested and compared to traditional methods. Solely relying on drones to collect data without comparison to conventional methods could introduce risks due to unknown accuracy and reliability. For this reason, Zoetica is proposing the use of drones as a pilot program could be implemented in future years to verify habitat mapping data and for the identification of specific habitat features and wildlife congregation areas, but not as an independent form of data collection.

2.5.1.1 Program Objectives

The drone pilot program is proposed to run alongside more traditional field-based methods within the terrestrial and aquatic LSAs. Drone surveys have the capability of producing meaningful spatial data that are accurate, reproducible, and comparable across time and other studies. The primary data objectives of the drone pilot program studies for the BIS are to act as supplementary data sources to evaluate the viability of the technology and methods for:

1. Testing the effectiveness and logistical potential (against more traditional methods) for the use of drones in the terrestrial and aquatic LSAs for objectives 2-6 that follow.
2. Vegetation and landscape feature inventory maps covering the LSA_{TER} and LSA_{AQU} to a high resolution.
3. Aquatic habitat mapping, including updates of barriers to fish and other features that change with time and affect hydrology.
4. Production of high-resolution imagery that will enable the counting of trees to estimate density, the identification of raptor stick nests in trees, and identification of features such as beaver dams and lodges.
5. Detection of vegetation disease and green-up using multispectral cameras where reflectance can be linked to vegetation health.
6. Detection of the presence of large mammals or congregations of birds via the use of imagery and infrared camera technology.

2.5.1.2 End Use

As best practices for drone use in ecological studies become better established and field-tested/verified, drone studies could become a valuable component of the BIS, which could be carried through the monitoring phase. The use of drone surveys would support the NWMO's goal of integrating new and emerging technologies and providing opportunities for local people to meaningfully participate in the baseline program. Data imaging gathered can be utilized for multiple biodiversity values:

High-Resolution Imagery: Aerial imagery collected by drones will be available at a higher spatial resolution than the imagery that is available from satellites. Drones can be easily deployed to collect high-resolution aerial imagery and can accurately follow a pre-programmed path for frequent monitoring. Detailed imagery will enable Zoetica to estimate tree inventories and tree density, as well as calculate overall landscape cover and composition using the i-Tree software suite. The i-Tree software suite also includes tools that can estimate ecosystem function and services such as carbon sequestration, air quality, and hydrology characteristics that will change due to vegetation removal. Detailed images may also assist in mapping watercourses, lakes, wetlands, barriers to fish movement, ecosite classifications, landforms, and human-caused disturbances (e.g., roads, railways, logging). Updated data can then be used for habitat suitability modelling (see Section 2.2). Drone-collected imagery could also be used to survey for or opportunistically identify wildlife or wildlife features such as raptor nests, beaver dams, waterbird congregations (Hodgson *et al.* 2018) and large mammals.

Multispectral Imagery: Multispectral sensors can capture data within specific wavelengths utilizing multiple bands (i.e., each wavelength range falls within each band). The wavelengths of light that will be collected will likely include blue, green, red, and near-infrared. Gathering data across the light spectrum into multiple bands provides more information and allows for more advanced processing techniques than traditional aerial photography (e.g., supervised or unsupervised land cover classifications, vegetation mapping). Areas mapped using multispectral imagery will be explored for patterns of phenology (green-up), species identification and distribution, and existing vegetation health and diseases. These values can be confirmed during field work to provide insight into the utility of the technology for monitoring vegetation health, including changes in existing stressors such as spruce budworm or glyphosate spraying.

Infrared Imagery: Infrared imagery can very efficiently detect warm-bodied animals and could be used in targeted wildlife surveys. Depending on a combination of factors such as the target's radiation and emissivity, the temperature of the background behind the target, the resolution of the instrument sensor, and height from the ground, imagery is capable of detecting animals as small as mice (Bushaw *et al.* 2019). While this technology is capable of detecting such small warm-bodied animals, its use in the BIS will be focused on larger animals like ungulates and carnivores for the baseline data collection as these are more reliable targets for surveys.

2.5.1.3 Best Practice Guidance

Best practices for drone ecological surveys do not yet exist; therefore, Zoetica will be compiling methods in collaboration with the contracted drone operator based on requirements, existing methods, technological limitations, and aspects recognized by Zoetica as important for ecological studies. Generally, best practices for drone usage includes following manufacturer directions, piloting best practices (e.g., always fly with a full battery, conduct mechanical checks before flight, employ trained assistants for health and safety grounds), and proper pre-trip planning. These general best practices can reduce the likelihood of drone crashes; however, there can be undetectable mechanical issues or unexpected environmental issues that cannot be avoided. Post-flight, all activity details should be logged. The potential for the impacts on wildlife and sensitive species need to be considered when applying drone technology to ecological surveys. Drone noise and visual impacts could affect bird species, leading to altered behaviour and flight initiation. For example, raptors (e.g., bald eagles, hawks, osprey) have been observed to attack drones. If flying in areas where bird interactions are identified as a potential threat to both wildlife and property, drone pilots must be accompanied by a biologist acting as a spotter to observe the behaviour of the birds. In comparison to traditional methods of aerial wildlife surveys that are predominately done by helicopter, drone technology introduces a much safer and cost-effective alternative to both pilots and surveyors.

Assmann *et al.* (2019) has reviewed drone practices used for vegetation monitoring, providing guidance on initial steps and aspects to consider, which can be generalized to other drone surveys. Their proposed workflow for scientific data collection using multispectral drone sensors includes the following 10 steps, after developing specific research questions and scientific objectives:

1. Identification of spatial and temporal scales (grain and extent)
2. Flight planning
3. Ground control points and radiometric in-flight targets
4. a) Metadata collection and pre-flight survey, and b) radiometric calibration imagery
5. Flight and data acquisition
6. Initial processing
7. Georeferencing
8. Radiometric calibration
9. Final processing
10. Geolocation and radiometric quality control

Steps 1 through 4 reflect pre-flight considerations both off and on site, Step 5 is the flight and data collection, Steps 6 through 10 are post-flight processing, control considerations, and output. This workflow will result in scientific data outputs (reflectance maps/vegetation index maps) used to answer the research questions and objectives. Data will then be analyzed and stored. Standardized best practices and workflow will help reduce key errors associated with solar angle, weather conditions, geolocation, and radiometric calibration, allowing multispectral sensors to generate meaningful, reproducible, and comparable spatial data (Assmann *et al.* 2019).

2.5.2 Desk-based Program

2.5.2.1 Study Area

The goal for the drone pilot program is to initially gather imagery data for the entire LSA_{TER} and LSA_{AQU} (see **Figure 2-1** in Section 2.1.2.1 and **Figure 2-3** in Section 2.4.2.1), followed by an assessment of success and viability to expand to biodiversity value-specific RSAs (study areas were defined in Zoetica's BPPA Report, Section 5.2).

2.5.2.2 Data Sets

In 2017, the NWMO collected aerial imagery using a fixed-wing aircraft within the Revell Batholith Area, which covers the AOI and the surrounding area. The data collected by the drone pilot program will supplement the existing imagery by allowing repeated measures to look at change in vegetation cover, vegetation health, and aquatic habitat cover over time; increasing the resolution for calculations of things like tree cover and raptor nests; and by increasing the spectral resolution by capturing a wider range of wavelengths over multiple bands.

2.5.2.3 Methods

Methods for specific biodiversity value surveys cannot be detailed at this time as they will be a Tier 2 activity that requires information from Tier 1 surveys. The selection of study methods will depend on the target biodiversity value(s) and survey goals, as well as the drone and cameras that are commercially available. It is likely that some of the methods for achieving program objectives of the drone pilot program (see Section 2.5.1.1), beyond the higher level methodological guidance listed as Best Practice in Section 2.5.1.3, may need to be developed by the drone company as they will be more familiar with flight protocols that work best for their drones.

2.5.3 Field Program

2.5.3.1 Survey Timing

The seasonal timing of field work will depend on which objective (see Section 2.5.1.1) the drone program will be assisting in. All drone efforts will rely on the vegetation cover, snow cover, and potential seasonal presence and distribution of biodiversity values. Drone survey timing will be informed by Tier 1 studies (TEM, Section 2.1; Aquatic Habitat Mapping, Section 2.4) and Tier 2 studies focusing on specific biodiversity values (Section 3.0), especially for vegetation, ungulates, semi-aquatic mammals, and birds. Depending on the technical specifications of the drone, there will need to be considerations of constraints and limitations due to ambient weather, wind, and temperature.

2.5.3.2 Survey Crew

The success of the drone pilot program will depend on skilled drone pilots with previous experience working and flying in remote locations with the sensors required in the targeted survey. Legal requirements for the survey crew include:

- All pilots must carry a valid Transport Canada issued drone pilot certificate
- All drones must be marked and registered
- The rules in the *Canadian Aviation Regulations* must be followed

If these qualifications are met, there is potential for community involvement in the drone pilot program. Local companies can supply drones and operators to conduct the surveys. There may also be opportunities for local field assistants (e.g., from Indigenous communities) to help drone operators by providing their knowledge of the area.

2.5.3.3 Equipment and Materials

The capacity for drones to achieve the potential applications will depend greatly on the drone specifications (e.g., quality of sensors available to the drone operators, and quality, speed, and battery life of the drone itself). Great diversity in drones exists, and each type has certain advantages and disadvantages for research. Rotary-wing drones display advantages in terms of their ease of use, their ability to hover at specific locations and altitudes, and their ability to take off and land vertically (i.e., no runway is required). Fixed-wing drones have a simpler design and are less prone to mechanical failures; they also have increased aerodynamics, which allows for greater travel distances. Ultimately, the equipment used will need to have the proven ability to function in the expected ambient weather, use batteries or fuel to cover long distances, contain an auto-pilot system that can be programmed for repeatability, signal proximity from pilot and location, and cameras with the necessary resolution and quality (e.g., camera sensor size, lens characteristics, multispectral imaging systems, GPS unit). The success of the field work will also depend on the experience of the drone contracting company ultimately hired, including their training, knowledge and experience with relevant post-field work imagery processing and analyses. Demonstration of state-of-the-art equipment and highly skilled operating and processing personnel will greatly decrease the risk of such a program failing to produce useful results.

2.5.3.4 Field Protocol

No established protocols exist to date, and field protocols will largely be established to meet field goals via the contracted drone operators. As the drone program is a pilot program, Zoetica intends for the contracted drone company to compile best practices and methods, including optimal drone specifications, before initiating field work.

2.5.3.5 Data Collection and Recording

Drone surveys can produce large amounts of data, which can result in challenges for handling and storage. Recorded drone data will be digital, varying in format based on instruments utilized. The drone contractor will be responsible for the storage of pre-processed imagery, conducting post-survey image processing, and for evaluating the imagery for detections of key features identified by Zoetica in Section 2.5.1.1.

2.6 Environmental DNA (eDNA) Studies

2.6.1 Overview

Environmental DNA (eDNA) refers to extra-organismal genetic material that has been expelled into the environment, such as skin, feces, gametes, hair, and other cells. Instead of collecting samples directly from the organism, eDNA can be collected from the surrounding environment, such as water or soil, to assess habitat occupancy. Compared to traditional surveys, eDNA methods are non-invasive, highly sensitive and accurate, generally more cost-effective for taxa that are otherwise difficult to detect, have a low risk of pathogen transfer between sites, and typically do not require permits. Furthermore, eDNA metabarcoding uses high-throughput sequencing to enable the rapid detection of multiple species at the same time, and both samples and data can be archived for retroactive analysis in the future.

At the present time, there are some limitations for species detection using eDNA as a result of uncertainties in data interpretation, often due to an incomplete understanding of the ecology of eDNA and errors or issues in laboratory processes (e.g., PCR, sequencing, bioinformatics) (Cristescu and Hebert 2018, Zinger *et al.* 2019). For example, eDNA methods cannot necessarily tell us the abundance, density, or biomass of species; the duration, frequency, or temporal proximity of habitat use; or the precise physical location of a species. It is important to acknowledge the challenges of inferring species presence across time and space, or species presence versus viable population and confounding sources of eDNA (e.g., the feces from a predatory organism passing through the area) (Goldberg *et al.* 2016). Despite these limitations, eDNA metabarcoding is an exciting and promising new tool for biodiversity baseline data collection and monitoring studies. This technique is a powerful first-pass methodology to detect species (e.g., cryptic species that would require more effort for an initial detection using traditional methods), which can then be used for planning Tier 2 studies focusing on key population and community data collection methods that can provide more detail on abundance and relative abundance values.

2.6.1.1 Data Objectives

The primary data objectives of the eDNA metabarcoding studies for the BIS are to:

1. Provide community-level species composition data that can indicate areas that have more or fewer species and that contribute relatively more or less to the overall genetic diversity of the AOI and LSA_{AQU}.
2. Locate cryptic species that are difficult to detect using traditional methods, some of which may be species-at-risk and/or important to stakeholders and rights-holders.
3. Characterize the presence and distribution of biodiversity values within the AOI and LSA_{AQU} under current conditions that may inform subsequent, more targeted studies that include measures of population abundance and relative abundance.
4. Locate suitable sampling stations appropriate for repeated sampling.
5. Provide baseline data for the development of species richness monitoring program(s) to address environmental, regulatory, and stakeholder/rights-holder concerns regarding potential losses of species and genetic diversity, to support the biodiversity impact assessment.

The purpose of collecting community-level species composition data (Objective 1) is to determine whether changes to the presence and distribution of a species (including loss) are due to the project. These baseline data can show that the species was not present to begin with, or that a range shift (natural or perhaps climate change-induced) is occurring regardless of the project. The consideration of genetic diversity is recommended as part of best practice guidelines for biodiversity-inclusive IAs (Secretariat of the Convention on Biological Diversity and Netherlands Commission for Environmental Assessment 2006) and is an important component of the Canadian Biodiversity Strategy in response to the Convention on Biological Diversity (Biodiversity Convention Office 1995). Preserving genetic diversity can help ensure the adaptation potential (i.e., natural selection) and long-term survival of a species or population, in light of natural or project-related changes to the environment.

For eDNA sampling from freshwater ecosystems (e.g., waterbodies, watercourses, wetlands), the data objectives within the AOI are primarily driven by the potential APM Project footprint and associated infrastructure that could directly impact these habitats and the biodiversity values that depend on them to fulfill their life history requisites, such as fish, herpetofauna, and SAR.

Data objectives within the LSA_{AQU} are primarily driven by potential project interactions and localized cumulative effects on aquatic and semi-aquatic biodiversity values. The LSA_{AQU} encompasses the watercourses and waterbodies that could potentially be impacted by the APM Project, including the watershed drainages for the Mennin, Revell, and Wabigoon rivers downstream from the APM Project. Potential project-related and cumulative impacts on surface water quality and hydrology, such as accidental discharge of contaminated wastewater and increased water use/withdrawal, could result in direct and indirect habitat loss, mortality, and impacts to movement for aquatic and semi-aquatic biodiversity values.

To meet the data objectives, the sampling design for aquatic eDNA metabarcoding studies considered: spatial and temporal requirements, based on currently available recommended guidelines and subject matter expert advice for eDNA methods; areas of importance to local stakeholders/rights-holders; and, statistical validity and scientific rigour with respect to future analyses for informing the biodiversity IA (see Section 1.9). Aquatic eDNA studies for the BIS will be conducted in coordination with the EMBP's surface water program (CanNorth 2020).

2.6.1.2 End Use

Conducting eDNA metabarcoding studies from aquatic ecosystems will be a valuable component of the BIS. Use of eDNA metabarcoding would support the NWMO's goal of integrating new and emerging technologies, and as sampling methods are relatively simple, the opportunity for local community involvement during baseline data collection and subsequent monitoring studies is high.

eDNA metabarcoding analyses will provide community-level (species composition; i.e., number of species) data for a suite of biodiversity values in an area of northwestern Ontario that is relatively understudied. Detection of candidate biodiversity VCs, including at-risk and rare species, species of importance to local stakeholders and rights-holders, and selected indicator species (see BPPA Report) will help inform future baseline work using either traditional methods (e.g., population surveys to obtain abundance or relative abundance data) or targeted eDNA methods within the AOI, LSA_{AQU}, and RSA_{AQU}. The detection and tracking of aquatic invasive species through eDNA metabarcoding or targeted qPCR assays can also be useful in understanding pressures on aquatic systems over time. Hernandez *et al.* (2020) has developed and validated 60 targeted eDNA qPCR assays to monitor invasive, threatened, and exploited freshwater vertebrates (fishes, amphibians, reptiles) and invertebrates (mollusks, crustaceans) in Québec. Assays for species that potentially occur in the Revell Batholith Area can be considered during Tier 2 studies.

In addition, eDNA metabarcoding analyses can be employed throughout the duration of the BIS to collect robust baseline data on species composition and species associations throughout the study area for informing the biodiversity IA. These data can be used to help assess the range of natural variation in species composition and species associations (clusters) such that APM Project-specific significance thresholds and monitoring benchmarks for potential reductions in species or changes in species associations can be identified in conjunction with local stakeholders/rights-holders and regulatory agencies. By establishing baseline variability, eDNA metabarcoding can also be incorporated into a long-term monitoring program for the APM Project to help evaluate the accuracy of impact predictions that are uncertain or potentially significant, to inform whether mitigation is working, and to facilitate adaptive management to improve mitigation, where needed, to protect and conserve biodiversity.

Zoetica notes that it will be inadequate to simply predict impacts in terms of a reduction in species numbers; the abundance of species could decline by half due to theoretical impacts while the number of species detected through eDNA may remain unchanged. Thus, it is important to collect species composition data, but then use those data to direct targeted population level and community surveys that produce relative or absolute abundance estimates, where possible. These more focused studies can then employ BACI designs to assess project impacts on biodiversity.

2.6.1.3 Best Practice Guidance

The use of eDNA metabarcoding for assessing biodiversity is an emerging technology that has recently been applied to biodiversity monitoring studies around the world (reviewed in Ruppert *et al.* 2019). DNA barcoding is becoming recognized as an important tool for biodiversity baseline data collection (Gullison *et al.* 2015) and ecological assessment (Hering *et al.* 2018). Compared to traditional/conventional survey methods, eDNA methods are non-invasive; have low risk of pathogen transfer between sites (e.g., amphibian chytrid fungus); are highly sensitive and accurate; generally more cost-effective for species that are cryptic, secretive, or occur in low densities (e.g., SAR); and have little to no permitting requirements. Furthermore, eDNA metabarcoding along with next-generation sequencing can enable the rapid screening for multiple species (which can be measured in water and soil) simultaneously and retroactive analysis of previously collected data.

Some research has shown that eDNA metabarcoding performs equal to, or better than, traditional capture-based surveys for species detection, relative abundance estimates, or characterization of ecological fish communities (Civade *et al.* 2016, Hänfling *et al.* 2016, Li *et al.* 2019) and/or herpetofauna (Lacoursière-Roussel *et al.* 2016, Valentini *et al.* 2016, Lopes *et al.* 2017). In addition, terrestrial animals frequently travel to and from water sources and eDNA metabarcoding methods have been developed to identify mammals (Ushio *et al.* 2017, Harper *et al.* 2019b) and birds from water samples (Ushio *et al.* 2018). The use of eDNA metabarcoding has also been used for detection of rare and/or invasive aquatic species in the Great Lakes and tributaries (Klymus *et al.* 2017, Balasingham *et al.* 2018, Mychek-Londer *et al.* 2020).

Since eDNA survey methods are relatively new and continue to be optimized (especially eDNA metabarcoding), there are currently no formally accepted, standard methods; however, cohesive international guidelines are emerging, such as the *Environmental DNA Sampling and Experiment Manual Version 2.1* produced by the eDNA Methods Standardization Committee (The eDNA Society 2019). Within Canada, efforts are also being made through collaboration among academic researchers, government regulators, and industry experts to develop standards and guidelines for eDNA sample collection, analysis, and interpretation (Loeza-Quintana *et al.* 2020). For example, *Environmental DNA Protocol for Freshwater Aquatic Ecosystems Version 2.2* has been submitted to the BC Ministry of Environment for consideration as a new RISC Inventory Standard (Hobbs *et al.* 2017). Critical considerations for study design and results inference, and for incorporating appropriate QA/QC protocols and controls, have been published as recommended guidelines (Goldberg *et al.* 2016). A recent paper presents recommendations for sampling protocols in lentic and lotic systems, including sample volumes and spatial intervals (Bedwell and Goldberg 2020).

The Canadian Standards Association (CSA Group) recently published a Standards Research report on eDNA standardization needs for fish and wildlife population assessments and monitoring, including minimum reporting requirements to allow for replication (Helbing and Hobbs 2019; see also Nicholson *et al.* 2020). Dickie *et al.* (2018) emphasize the need for eDNA-based studies of biodiversity to include robust field sampling design and methods (e.g., minimizing subjectivity) and to document and publish critical methodological information; the authors also provide good practice recommendations and encourage the development of standard, fully documented protocols. There are also recommendations specific to the eDNA metabarcoding workflow, including appropriate selection of primers (Mychek-Londer *et al.* 2020) and the advantage of using multiple markers (Morey *et al.* 2020), and increasing the transparency of bioinformatic data processing (Deiner *et al.* 2017, Zinger *et al.* 2019).

Best practices and guidelines will continue to be informed by ongoing research aimed at overcoming uncertainties in data interpretation. These uncertainties can occur due to differences in eDNA persistence and fate within various environments (e.g., Shogren *et al.* 2017, Harrison *et al.* 2019), accounting for potential biases introduced by the laboratory processes used to sequence DNA (e.g., Kelly *et al.* 2019), and differences in habitat-specific sampling needs (e.g., Harper *et al.* 2019a). However, it is important to recognize that uncertainties in eDNA metabarcoding continue to exist, and misuses of the technology may be detrimental for biodiversity science and conservation (Cristescu and Hebert 2018). It is crucial that sources of uncertainty – most notably, the rates of false positives and false negatives – be understood, identified, and addressed. Table 1 in Cristescu and Hebert (2018) summarizes the problems associated with species detection using eDNA and presents possible solutions, which include optimization, calibration, and validation of eDNA field and laboratory methods; and comparison of results derived from eDNA methods with traditional assessments of community composition. The BIS aims to address these uncertainties through a rigorous study design that includes statistically valid survey site selection based on data objectives and anticipated analyses; field and laboratory quality controls and comprehensive data recording; repeated sampling between seasons and years; and an ongoing collaboration with eDNA metabarcoding experts (Dr. Hanner's Laboratory) who will assist with study design, training of local field staff, and laboratory eDNA analyses.

2.6.2 Desk-based Program

2.6.2.1 Study Area

Freshwater eDNA studies are generally targeting aquatic and semi-aquatic biodiversity values, such as fish and amphibians. However, one of the major advantages of high-throughput metabarcoding analysis is that all of the detectable eDNA within a sample will be analyzed. Therefore, in addition to supporting baseline data collection for fish, amphibians, and primary and secondary aquatic producers (note: data for benthic invertebrates and zooplankton will also be analyzed as part of the EMBP; CanNorth 2020), metabarcoding analyses can also detect the eDNA of other biodiversity values that have been in the area. Such additional values include turtles (e.g., snapping turtle, a SAR potentially occurring in the area), semi-aquatic snake species, birds (e.g., waterfowl and wading birds), mammals (e.g., semi-aquatic mammals such as beaver and mink, as well as moose and black bear), semi-aquatic and aquatic invertebrates (e.g., the invasive rusty crayfish), and even aquatic vegetation. Aquatic eDNA studies in Year 1 are proposed to be focused within the AOI and the LSA_{AQU} (see **Figure 2-3**) as these areas are expected to be directly and indirectly impacted by the APM Project based on surface water flow and connections. However, it is important to note that knowledge of groundwater connections is needed to fully understand the areas of potential project impacts. Studies of groundwater flow and connection to surface water hydrology will be undertaken by the NWMO Geosciences group (CanNorth 2020); Zoetica will use these results to refine eDNA sampling locations in future years of the biodiversity baseline program, which may also include additional sampling and control sites within the RSA_{AQU}.

2.6.2.2 Data Sets

Design of aquatic eDNA studies will require analysis of existing geospatial data for water features in the AOI and LSA_{AQU}. Currently available data from Government of Ontario databases include watercourse and waterbody datasets from the Ontario Hydro Network, the Wetlands dataset from Ontario GeoHub, the eFRI dataset from MNRF. Although the MNRF recently updated their eFRI dataset in 2020, it used imagery from 2008-2011 and ecosites are coarsely defined, with a minimum polygon size of 8 ha. Zoetica's analysis of the Wetlands dataset from Ontario GeoHub indicated several large plots overlapping the AOI and LSA_{AQU} where the wetland type is labelled as 'Unknown'.

As the preferred alternative, new satellite imagery was acquired recently and ELC analysis by Sumac Geomatics for the BIS was completed for the terrestrial and aquatic LSAs in June 2020. Zoetica recommends that study designs for eDNA and other biodiversity baseline program components (e.g., TEM, Aquatic Habitat Mapping) be developed using these updated ELC data for multiple reasons: 1) they will be the most up to date and accurate data available for the study area (with a minimum polygon size of 0.5 ha, these data are more refined than eFRI), 2) use of a common dataset for all applicable components of the BIS will promote consistency and ease of understanding, and 3) ecosite-based wetland classification is more detailed than the broader categories used in the Wetlands dataset (ELC Working Group 2009). Although wetland classification for the BIS baseline studies is recommended to follow that of the *Ontario Wetland Evaluation System: Northern Manual* (OWES; MNRF 2014a), having more detailed data is always valuable in case further analyses are warranted and/or desired. For the purposes of BIS study designs, wetland ecosites (i.e., Ecosites B126-156, B222-224) identified in the updated ELC dataset will be combined into the four wetland types classified in the OWES: marsh, swamp, bog, fen (see Glossary and Abbreviations).

The Ontario MNRF and NHIC track important wildlife and fish habitat data that may be useful for informing eDNA sampling locations, especially for collecting field positive samples. Samples collected within areas known to host certain species should render positive identifications of those species. If there are failures to detect known species from these positive test sites, these failures will indicate failures in the protocols being used and can be used to help identify and mitigate against false negative results (i.e., it provides a QC check that protocols are working properly; see Section 2.6.3.4). Significant Wildlife Habitat most relevant for the focus of the eDNA studies includes Amphibian Breeding Habitat, Amphibian Movement Corridor, and Turtle Wintering Area (OMNRF 2017); and important fish habitat data documented in Ontario GeoHub including:

- Spawning Area – an area where a species of fish habitually spawns
- Nursery Area, Fish – an area where a fish species raises its newborn, if that area is different from the Spawning Area
- Feeding Area, Fish – an area where a fish species habitually feeds
- Staging Area, Fish – an area where a fish species rests during migration
- Travel Corridor, Fish – a route used by a fish species for migration; usually parts of streams or rivers, but could include pathways that connect wetlands to lakes or rivers, or pathways within or between lake basins that fish use seasonally as a migration route to carry out a component of their life cycle.

Life history requisites and habitat requirements for aquatic and semi-aquatic species of interest (e.g., see Section 2.6.3.1), as well as the information listed in the SWH Criteria Schedule for Ecoregion 3W for identifying candidate SWH, will also assist in site selection for sampling. Criteria schedules indicate ELC Ecosites and habitats within which the SWH is more likely to be found. For example, Amphibian Breeding

Habitat may occur in swamps and thickets, vernal/seasonal pools, riparian areas and a variety of wetland interiors and margins within Ecosites B109-156 and B223-224 (OMNRF 2017).

2.6.2.3 Methods

As discussed in Data Objectives (Section 2.6.1.1) and Study Area (Section 2.6.2.1), Year 1 of the eDNA studies for biodiversity will focus on the AOI and LSA_{AQU}. To coordinate the BIS with the EMBP, Zoetica reviewed CanNorth's (2020) study design. Field data collection contractors that are collecting surface water for the EMBP are planning on collecting eDNA samples from Mennin Lake (n=2), Mennin River (n=1), and Revell River (n=1). Quarterly surface water sampling is proposed in AOI Ponds (n=7), Reference Ponds (n=3), Mennin Lake (n=3), Mennin River (n=3), North Inflow to Mennin Lake (n=1), Wabigoon River (n=3), Revell River (n=1), and Reference Lake (n=2) within the EMBP's LSA_{SW}. The EMBP also calls for the field data collection contractor to collect water samples from 10 locations in the RSA, but sampling lakes are to be determined following further engagement workshops with local communities (CanNorth 2019b, 2020). As shown in Figure 6.1 of CanNorth's *Environmental Media Baseline Program Design (Final Report)*, almost all ponds within the AOI are already planned for surface water sampling, which will allow for coordination with the BIS eDNA program. However, Zoetica also proposes to expand eDNA sampling within the AOI to include streams and wetlands and to cover more area and water features within the LSA_{AQU}, using a stratified random study design.

Zoetica's approach for eDNA study design is to first categorize water features into the following six habitat groupings that are thought to be likely to host different species assemblages:

- Watercourses: rivers/streams
- Waterbodies: lakes/ponds ≤1 ha, lakes/ponds >1 ha
- Wetlands: marsh, swamp, peatlands (bogs and fens)

Bogs and fens will be grouped together as a single habitat grouping (peatlands) with respect to sample allocation. Bogs and fens tend to be drier and nutrient-poor compared to marshes and swamps; as such, less biodiversity, especially aquatic and semi-aquatic species, is expected in these peatlands.

The next step in Zoetica's approach is a stratified random, BACI sampling design. Within the AOI, the goal is to survey all waterbodies, watercourses, and wetlands that may be directly impacted by the APM Project. However, as the final project location has not yet been determined, the sampling design during the first field campaign will consist of reduced effort over the entire AOI, along with paired sampling in the LSA_{AQU}. Additional surveying can be undertaken once more information about the APM Project is known (including location, components, activities, and the extent of potential impacts) and based on results from the initial eDNA studies. It will not be feasible to sample all watercourse segments or wetland polygons in the AOI in a single field season – according to the Ontario Hydro Network spatial data and the refined ecosite dataset, there are 55 watercourse segments and 125 wetlands fully or more than 50% contained in the AOI, respectively.

Therefore, Zoetica proposes to focus on second-order or higher stream segments that are greater than 200 m in length (requirement to collect sample replicates; see Section 2.6.3.4) and do not coincide with lake/pond polygons, and approximately 50% of wetlands, in the AOI in the first year of the eDNA studies (**Table 2-14**). If species of interest (e.g., SAR or species of importance to stakeholders/rights-holders) are found in these streams and it is important to get more precise locations, then further sampling can be performed on the corresponding first-order streams during subsequent field campaigns. Zoetica's analysis of the refined ecosite dataset also found 17 lakes/ponds in the AOI, all of which will be sampled. Thus, initial eDNA studies will consist of sampling at a total of 96 sites in the AOI (**Table 2-14**). To maximize statistical power, approximately equal sampling effort will be employed within the AOI and outside of the AOI, for a total of 193 sampling locations in the AOI and LSA_{AQU}.

Table 2-14. Habitat groupings to be sampled in Year 1 of eDNA studies as selected using GRTS.

Habitat Grouping	**AOI**	**LSA_{AQU}**	*Total*
Lakes/Ponds ≤ 1 ha	6	11	17
Lakes/Ponds > 1 ha	11	6	17
Rivers/Streams	19	20	39
Wetlands – Marsh	2	8	10
Wetlands – Peatlands	17	13	30
Wetlands – Swamp	41	39	80
Total	96	97	193

A stratified random study design (i.e., GRTS) was used to select potential sampling sites in the LSA_{AQU}. For *post hoc* statistical analyses, Zoetica will attempt to create paired samples within and outside the AOI based on similar site characteristics, such as water quality and depth, vegetation cover, emergent aquatic vegetation, and other features, which would be assessed during Aquatic Habitat Mapping (see Section 2.4.3). Paired sampling would allow for more robust comparisons when using distance from the project as a covariate. However, existing datasets show that the representation of wetlands in the eDNA study areas is not the same; for example, there are 10 marshes within the AOI, whereas 37 marshes are present within the LSA_{AQU}. Zoetica recommends sampling multiple sites of each habitat grouping to capture the natural variability. To maintain equal sample sizes in total between the AOI and LSA_{AQU}, fewer sites in a common wetland type (e.g., fen or swamp) will be sampled in favour of rarer wetland types (e.g., marsh). *Post hoc* statistical analyses will also consider stream flow direction because potential impacts may be expected to be greater downstream from the AOI than upstream. However, Zoetica notes that groundwater connections will also need to be considered (study of groundwater flow direction will be undertaken by the NWMO Geosciences group; CanNorth 2020).

After each season of field work and/or when the eDNA metabarcoding laboratory results are available, Zoetica will conduct a review of the survey effort within the LSA_{AQU} versus species data acquired. Zoetica will create a species accumulation curve to determine whether enough sampling was completed to detect all species in the area (i.e., when no new species would be expected to be found even if more sites are added). If it is determined that the slope of the curve is still increasing, then the study design will be amended to increase the sample size. Conversely, if it is determined that the slope reached zero well before the end of the campaign, then the sample size could potentially be reduced, such as the removal of sites that resulted in negative species detections. Due to the time and resources needed to complete laboratory work and bioinformatic analyses for the high number of eDNA samples planned, it is unlikely that adjustments to the field program can be made for the next seasonal campaign. At minimum, adjustments will be made on an annual basis.

2.6.3 Field Program

2.6.3.1 Survey Timing

Although eDNA methods for biodiversity are not as limited to a particular survey window in the manner dictated for more traditional methods (that rely on live-capture or visual or audio observations), there are still optimal sampling times and conditions that should be employed for eDNA studies. It is best to collect samples during a time when biodiversity values are more likely to be present, which means that multiple, repeated seasonal samples may need to be collected from each target site to optimize the chances of detecting all or most of the species using each site. Some considerations of various species groups in this regard are presented below.

AMPHIBIANS: Many amphibian species will migrate to ponds and wetlands in the spring to breed, eggs will hatch after a few days or a few weeks, larval amphibians will require a few months to complete transformation (metamorphosis), and then young adults will either stay in the pond, migrate to nearby ponds, or migrate into woodland habitats in the late summer/fall (see **Table 2-15**). Freeze-intolerant amphibians typically overwinter by settling underwater in the deep areas of ponds that do not fully freeze, or by burrowing underground beneath the frost line. Freeze-tolerant species may instead overwinter above ground and beneath leaf litter. Some species aggregate in overwintering areas and tend to have high site fidelity. The overwintering locations of amphibians are generally not well understood; therefore, eDNA sampling in the winter may identify important overwintering areas and may be critical for developing mitigation measures for herpetofauna. The need for winter sampling will depend on the eDNA results from other seasons and the likelihood that the APM Project will impact amphibian winter habitat.

FISH: Fish species also undergo seasonal movements to and from suitable spawning areas. For example, northern pike (*Esox lucius*) and walleye (*Sander vitreus*) both spawn in the spring shortly after lake ice melts. While northern pike spawn in shallow (<30 cm) areas at the mouths of inflow streams or in marshes or sheltered bays with aquatic vegetation, walleye prefer to spawn over rocky areas of lakes or rivers with fast-moving water (Scott and Crossman 1973). In contrast to pike and walleye, coldwater species such as cisco (*Coregonus* spp.) inhabit deep (>8 m) areas of lakes during the summer months and spawn during the fall instead. These species move inshore to spawn in shallow water over a variety of substrates. Both adult and juvenile fish are particularly vulnerable when they form dense aggregations in these high-quality areas during the spawning period. Furthermore, since sample collection will likely occur at or just under the surface, coldwater species are more likely to be detected during the spawning period when fish are/have been present in shallower waters. Ontario has developed restricted activity windows to protect fish during spawning migrations and other critical life history stages (**Table 2-16**). The spawning seasons for other fish species of interest (e.g., at-risk, culturally important) in the Revell Batholith Area are presented in **Table 2-17**; there are species that spawn in the spring, summer, and fall.

OTHER SPECIES (E.G., TURTLES, BIRDS, MAMMALS): Seasonal sampling designed for amphibians and fish would also cover important life history periods for many species in the area. Optimizing sampling for these biodiversity values should also coincide with habitat occupancy (and increased probability of eDNA capture) by various other aquatic organisms, turtles, birds, and mammals. In addition, for species with less well documented seasonal use schedules in the area, eDNA sampling and metabarcoding analyses may reveal seasons of use by species that would otherwise not be known.

Assuming that the APM Project will have year-round construction and operation activity schedules, characterization of species presence and community assemblages in different seasons will be important for the biodiversity IA and for developing appropriate spatial (e.g., avoidance) and temporal mitigation measures. Seasonal aquatic eDNA sampling at waterbodies and wetlands, in coordination with the surface water component of the EMBP, may capture eDNA of herpetofauna and fish (along with other biodiversity present) at the following stages of their life cycles:

- Spring (early-mid May) – earlier-breeding amphibians, snapping turtles, spring spawning fish
- Summer (early-mid July) – late-breeding and early-transforming amphibians, snapping turtles, spring/summer spawning fish and developing eggs, larvae, fry
- Fall (mid-late September) – late-transforming and migrating amphibians, snapping turtles, fall spawning fish
- Winter (December to March) – overwintering herpetofauna; fall spawning fish, eggs, larvae, fry. *Note: winter sampling will only be conducted if species of interest are present in the AOI in the summer or fall, and that would be expected to overwinter within certain habitat types in the AOI.*

Greater sampling effort can be undertaken during periods when the concentration of eDNA is expected to be higher, such as during the breeding season. As shown in **Table 2-15**, **Table 2-16**, and **Table 2-17**, breeding/spawning activities for many amphibian and fish species of interest are expected to occur in the spring, summer, and fall. Therefore, for Year 1 of the eDNA studies, Zoetica recommends focusing sampling efforts during these three seasons to maximize the likelihood of capturing eDNA from a greater variety of species that may use aquatic habitats within the AOI and LSA_{AQU} for breeding as well as post-breeding (dispersal and migration) activities. For Year 1, Zoetica also proposes to focus on capturing eDNA from aquatic and semi-aquatic vertebrates (vs. invertebrates) as fish and fish habitat have been identified as highly important to stakeholders and rights-holders (see Section 1.4), and initial screening of waterbodies and wetlands for fish, amphibians, and turtles will greatly help to focus Tier 2 studies for these biodiversity values. Focusing on vertebrates for eDNA analyses will be achieved through optimized laboratory primer selection (see Section 2.6.3.6).

Since pond-breeding amphibians relevant to the study area are not expected to undergo long-distance migrations (typically <1.0 km; Semlitsch and Bodie 2003, Semlitsch 2008), sampling throughout the LSA_{AQU} should capture amphibians that would also be overwintering within this study area. The need for winter sampling can be re-assessed after receiving the results of these initial studies and more refined information on the APM Project footprint, which will assist with making more accurate predictions as to whether the APM Project has the potential to impact overwintering sites.

Survey conditions will also influence timing; it is recommended that sample collection be avoided during or immediately after heavy rains, as the resulting high-flow conditions are more likely to dilute or transport eDNA away from the source, or inhibit laboratory analyses by increasing suspended particulates, both of which may lead to false negative results (Hobbs *et al.* 2017). Conversely, these conditions may also stir up sediments that have trapped historic eDNA, leading to false positive results about current species presence (Turner *et al.* 2015). There are a number of other environmental factors that can affect eDNA persistence and degradation; as such, it will be important that the eDNA sampling program be well coordinated with the EMBP surface water sampling program to record water chemistry parameters and other site characteristics during sample collection, to enable appropriate data interpretation and transparent reporting (see Section 2.6.3.5).

Table 2-15. Breeding, hatching, transformation dates for at-risk and potential indicator herpetofauna species (for forest and/or wetland health, denoted by a *) that potentially occur in the Revell Batholith Area (MNRF 2014b, Government of Canada 2019, Ontario Nature 2020). Timing windows based on information available from northwestern Ontario (Runesson 2014) are indicated in **bold**. As appropriate, Indigenous Knowledge should be interwoven to better inform the life history summaries; local information should be gathered from the regional MNRF office and/or local stakeholders and rights-holders, if possible.

Species	Breeding Habitat	Breeding	Hatching	Transformation	Fall Movement and Winter Habitat
Eastern (red-spotted) newt*	Permanent ponds, usually with dense submergent vegetation, usually within or a short distance from forests. May also occur in swamps, roadside ditches, slow-flowing streams.	April to June	20-35 days; **late summer**	2-3 months; **efts take 1-4 years to become aquatic adults**	After transformation. **Aquatic adult newts active in ponds all year; efts and terrestrial adults overwinter under logs.**
Blue-spotted salamander*	Wide variety of forest cover (deciduous, mixed, coniferous upland and lowland). Also breeds in ponds, marshes, roadside ditches.	**Early spring breeders, can be found in ponds in early May**	3-4 weeks	**Late summer**	Adults leave shortly after breeding, young leave after transformation. **Overwinters beneath logs and rocks near the water's edge.**
Gray treefrog*	Wide variety of habitat including swamps, marshes, farm ponds, flooded farmland, floodplains. Temporary and permanent pools.	Mid-May until early July	5 days	40-60 days; transformation in late July or early August	Adults arboreal
Wood frog*	Ponds in swamps with many leaves on the bottom. May also breed in marshes and ponds a short distance from woodlands.	**Emerge right after thaw, begin breeding as soon as they reach ponds; breeding season lasts 2 weeks**	17-24 days	**1.5-2 months**	Adults usually remain in forest habitat. **Overwintering: hibernate under rocks or logs and partially freeze.**
Mink frog*	Edges of rivers, lakes, ponds, pools, puddles, ditches, streams, cold springs, open water with abundant lily pads. Prefers quiet bays and protected areas.	**Late May into August**	unknown	**3 months – 2 years**	**Overwintering: hibernate underwater in their home lake, pond, or river.**
Snapping turtle **(SC)**[1]	Permanent, semi-permanent fresh water, marshes, swamps or bogs, rivers and streams with muddy banks or bottoms. Often uses soft soil or clean dry sand on south-facing slopes for nest sites. May nest some distance from water.	**Egg laying season occurs in June**	**50-60 days**	n/a	**Females leave after egg-laying. Overwintering starts in October.** Often hibernate together in groups in mud under water. Home range size approx. 28 ha.
Mudpuppy[2]	Bottom of lakes, ponds, rivers, streams, and other large bodies of water. Hides among vegetation and beneath logs and rocks.	May or June	2 months	4-6 years	Entirely aquatic; variable movements within waterbodies

Notes:
1. Snapping turtle is listed as SC = Special Concern under both SARO and Schedule 1 of the federal *SARA*.
2. Mudpuppy is currently Not at Risk provincially and federally; however, an updated COSEWIC assessment is expected in April 2022.

Table 2-16. Restricted activity timing windows for the protection of spawning fish and developing eggs and fry for the Northwest Region of Ontario (DFO 2013). DFO has developed restricted activity timing windows for various fish species; however, for the APM Project, only fish species of importance to local stakeholders/rights-holders and those protected by regulations are shown in this table.

Spring Spawning Species	Spring Spawning Period
Walleye	April 1 – June 20
Northern pike	April 1 – June 15
Lake sturgeon, S-NR pop. (**THR, END**)[1]	May 1 – June 30
Other/Unknown spring spawning species	April 1 – June 15
Fall Spawning Species	**Fall Spawning Period**
Lake herring/Cisco	October 1 – May 31
Other/Unknown fall spawning species	September 1 – June 15

Notes:
Abbreviations: S-NR = Saskatchewan-Nelson River; THR = Threatened, END = Endangered
1. Lake sturgeon (S-NR pop.) is listed as Threatened under SARO and assessed as Endangered by COSEWIC. This species is currently under consideration for a status change for Schedule 1 of *SARA*.

Table 2-17. Reproduction information for fish species not explicitly considered by DFO in Northwestern Ontario for restricted activity timing windows (Table 2-16) but proposed as biodiversity values for inclusion in the baseline program due to their importance to local stakeholders/rights-holders, legal protections, and potential inclusion for tissue sampling as part of the EMBP (CanNorth 2020). Data from Eakins (2020).

Species	Spawning Season
White sucker	Spring (April – June)
Silver lamprey, S-NR pop. (**DD, SC**)[1]	Spring (May – June)
Longnose dace	Spring-summer (May – July)
Brassy minnow[2]	Spring-summer (May – July)
Silver chub, S-NR pop. (**NAR**)[3]	Summer (June – July)
Emerald shiner	Summer (June – August)
Shortjaw cisco (**THR**)[4]	Fall (October – December)

Notes:
Abbreviations: S-NR = Saskatchewan-Nelson River; NAR = Not at Risk, THR = Threatened, DD = Data Deficient
1. Silver lamprey (S-NR pop.) is currently listed as Data Deficient in Ontario and assessed as Special Concern by COSEWIC. This species is currently under consideration for a status change for Schedule 1 of *SARA*.
2. Brassy minnow is currently provincially and federally unlisted/unassessed; however, an updated COSEWIC assessment is expected in November 2021.
3. Silver chub as a species is listed as Threatened under SARO; populations are currently not distinguished in Ontario under Provincial conservation listings. However, fish in the RSA_{AQU} are from the Saskatchewan-Nelson River population, which is assessed Federally as Not at Risk by COSEWIC.
4. Shortjaw cisco is listed as Threatened under SARO; also assessed as Threatened by COSEWIC (but not officially listed under *SARA*).

Climatic conditions and seasonal water table fluctuations may also affect sampling in wetlands. For example, some wetlands may dry out in the summer, especially if there has been a prolonged drought. In these cases, it will not be possible to collect water samples for eDNA analyses. The presence of open/surface water during dry periods will likely need to be ascertained on the ground; assessment of ephemeral streams and waterbodies is a component of Aquatic Habitat Mapping (see Section 2.4.3).

In addition, it is likely that helicopter services will be required to cover the entire study area efficiently and to ensure that sites are not selected in a biased way (e.g., based on accessibility via roads and linear corridors). It should be acknowledged that weather days may delay the field schedule if general flight conditions are not satisfied (e.g., heavy fog or precipitation reducing visibility).

2.6.3.2 Survey Crew

Expertise and training in aquatic eDNA sample collection will be provided by Dr. Robert Hanner's research laboratory at the University of Guelph. After training, each survey team will consist of either two contracted field staff or NWMO staff, or one contracted field staff/NWMO staff and one local field assistant (e.g., from Indigenous communities, if community interest and availability allow, see Section 1.4.2). At each site, one person will handle the eDNA sampling equipment while the other will take environmental measurements (e.g., water quality) and be the record keeper. It is recommended that at least two survey teams be deployed simultaneously to cover the study areas as efficiently as possible to reduce the number and degree of potentially confounding environmental factors (see Section 2.6.3.1).

Zoetica will provide instruction on GRTS sampling (see Section 2.6.2.3), which involves sampling sites in a specific order and allows for site replacements (by assigning oversample points) if difficulties are encountered in the field. Although the waterbody, watercourse, or wetland to be sampled will be pre-determined (see Section 2.6.2.30), suitable microhabitats for sampling will need to be selected on the ground based on amphibian and fish habitat preferences (e.g., see Breeding Habitat column of **Table 2-15**), the professional/research experience and knowledge of the field data collection contractor, and local knowledge provided by the field assistant or stakeholders/rights-holders. For lotic systems, it is recommended that the sampling site consist of a single stream reach (i.e., a relatively homogenous length of stream; see Section 2.4.2.3.1.2). The survey team should verify that sample replicates will be collected within a discrete stream reach.

The required qualifications and experience for contracted field staff should be coordinated with the needs of the surface water component of the EMBP. the contracted field staff are required to be familiar with, at minimum:

- Local wildlife and fish biology and ecology – to make informed decisions about microhabitat selection, including knowledge of preferred substrates, cover materials, water depth and velocity, and other preferred in-stream, riparian, and upland habitat features (see **Table 2-15** for examples for selected herpetofauna).
- Wetland classification – while the updated ELC dataset will provide the most accurate wetland data (compared to the existing eFRI from MNRF and Wetlands dataset from Ontario GeoHub), wetland classification by air photo interpretation has inherent uncertainty and ground-truthing is recommended to verify the accuracy of wetland types and polygon boundaries (based on the OWES; MNRF 2014a).

Zoetica recommends that the Hanner Lab experts provide continued guidance throughout the eDNA campaigns wherein different environmental conditions and logistical challenges are expected to be encountered. The Hanner laboratory's experience will be invaluable for developing any small-scale, on-the-ground contingency plans or modifications needed to ensure that the sampling design remain valid, including the collection of all applicable information to provide transparency in data interpretation. This approach will also allow for training of new contracted field staff and/or local field assistants (if the crew is expected to change between seasons) or refresher training for previous survey crew members.

An understanding of best practices in eDNA sample collection with respect to the need for strict decontamination protocols and detailed record keeping prior to going into the field would be beneficial. The Hanner Lab technician will have relevant eDNA experience. It is expected that the Hanner Lab technician will train the field data collection contractor and local field assistant on eDNA sample collection, filtration, storage, and transport according to standard protocols for the Hanner laboratory and in such a way as to ensure that sample quality is maintained and preserved. It is also expected that the field data collection contractor and local field assistant will be sufficiently trained during Year 1 to enable them to complete subsequent years of baseline eDNA sample collection as well as for a potential future monitoring program. As such, all survey team members should directly participate in using the eDNA equipment and other instruments (see Section 2.6.3.3), recording information on data forms (see Section 2.6.3.5), and preparing samples for shipment to the laboratory.

The helicopter pilot is not expected to be directly involved in eDNA studies but will be relied upon to find appropriate landing spots for the survey team.

2.6.3.3 Equipment and Materials

The sampling crew will be using the OSMOS eDNA sampling kit (Halltech Aquatic Research Inc., Guelph, ON), a backpack sampler that completes water filtration on-site and includes a telescopic pole with tripod and locking clamp to allow for hands-free sampling from a distance, which helps to prevent contamination by reducing the need to enter a waterbody, watercourse, or wetland. The OSMOS system has digital flow, pressure, and temperature sensors with programmable settings to enable standardization of these sample collection parameters. This eDNA sampler can efficiently filter 1-2 L of water in a few minutes if water turbidity is low. If there is high turbidity (e.g., tannins, suspended particulate matter), filters with a larger pore size to help increase the flow rate may be installed; all changes to standard protocol will be documented (see Section 2.6.3.4). One OSMOS eDNA sampler will be available per survey team.

Environmental data will be collected at each eDNA sampling site. A water quality meter will be required to measure water temperature, pH, conductivity, and dissolved oxygen. A water flow meter should be used to measure stream flow (discharge or velocity). If it is feasible, water quality and flow instruments can be shared between the eDNA program and the surface water sampling program of the EMBP. Canopy cover is a proxy for UV radiation and should be measured using a densiometer, and air temperature should be measured using a thermometer. Weather information such as cloud cover and precipitation can be visually estimated.

Materials and consumables required for eDNA sampling include cellulose nitrate filters (or glass fibre filters, if cellulose nitrate filters cannot be acquired) with pore sizes ranging from 0.45-5 µm, disposable gloves, tweezers, storage containers, markers and labels, and field data forms printed on waterproof paper. Reagents required include bleach and liquid dish soap for decontamination, tap water and distilled water for rinsing equipment, and distilled water for the field negative (see Section 2.6.3.4). Submission of eDNA samples by the field data collection contractor to the University of Guelph Laboratory Services Division, Agriculture & Food Laboratory, should be accompanied by both hard copy and electronic data forms, and site photos. Standard field gear and data collection materials (e.g., binoculars, camera, notebook, pencil, clipboard) should be carried to record incidental observations, information about site access, or other pertinent notes.

Field work for eDNA studies will require general navigational equipment to travel from the helicopter landing spot to the pre-determined sampling area, including GPS units (also used to record the coordinates of sampling locations), compasses, and tablets or smartphones with georeferenced digital maps as well as hard copy field maps as a backup. A comprehensive list of equipment and materials needed for eDNA field studies is available in the eDNA field SOP in **Appendix A**.

As discussed, helicopter services are likely needed to enable cost-effective and efficient coverage of the study area for eDNA studies. Ideally, the aircraft will be able to accommodate the eDNA survey crews (at least 6 passengers); however, staggering of crew pick-up and drop-off may be needed and will be determined when additional planning details are available from the NWMO. Alternatively, if helicopter services are not used – for example, if it is determined by the NWMO that ground- or water-based travel to the selected water features is feasible or desirable due to safety reasons, taking into account that some bias in sampling locations would be introduced – then other modes of transportation will be required from home base to the study sites. However, it is Zoetica's opinion that use of biased sampling sites will threaten the scientific credibility of data collected and that all analyses and results will have to be framed with caveats around site selection and its potential influence on results. Thus, the field data collection contractor will be responsible for determining the best mode of transportation to the sampling locations selected by Zoetica; travel by ATV, on foot, or by boat may be preferable in some instances. In some cases where access is not possible, sites may need to be skipped and replaced using the GRTS replacement point protocol.

2.6.3.4 Field Protocol

The eDNA survey team will travel to each pre-selected water feature, and suitable microhabitats will be identified in the field by skilled wildlife and fisheries field personnel within the field crew that is contracted for sampling. The OSMOS eDNA sampler will be set up according to the manufacturer's instructions. As much as practical, survey crew should avoid entering the watercourse, waterbody, or wetland. The geographic coordinates of the sampling location, along with other site descriptors and sampling information, will be recorded on the field data form (see Section 2.6.3.5) and marked as a waypoint on the GPS unit. The physical location can also be marked with flagging tape to help relocate the sampling site during the next seasonal campaign and subsequent years of study.

For sampling from **lotic systems** (watercourses), stationary point sampling will be used. It is recommended to sample in headwater streams and tributaries (rather than the mainstem), stream margins, and the thalweg (main concentration of flow, normally the deepest part of the channel) (Hobbs *et al.* 2017, Stanfield 2017). Sampling will occur at or just under the water surface to avoid stirring up sediment. Two litres of water will be collected through the OSMOS system per filter. Three replicates will be collected at each site, spaced 100 m apart (Bedwell and Goldberg 2020), for a total of 6 L of water sampled. Always collect replicates from downstream to upstream to prevent contamination.

For sampling from **lentic systems** (waterbodies and wetlands), mobile sampling (wherein the surveyor will walk along the shoreline while running 2 L of water through the OSMOS system per filter) may increase the area surveyed. However, mobile sampling is logistically difficult in northwestern Ontario. Therefore, stationary point sampling is also proposed for lentic systems. Sampling will occur at or just under the water surface to avoid stirring up sediment. Three replicates will be collected at each site for a total of 6 L water sampled. It is recommended to sample as much of the spatial extent of the shoreline as possible (Hobbs *et al.* 2017); therefore, replicates can be collected at suitable microhabitats along the shoreline.

In addition, three types of QA/QC 'samples' will be collected: one duplicate sample will be collected at every other site to assess reproducibility, one field negative sample (distilled water) will be collected every three sites to help assess the false positive rate, and where possible, a field positive sample will be collected at a site where the species of interest is known to occur. The field positive will help to confirm that the field protocols are working, establish rates of false negatives, and corroborate traditional surveying techniques. In addition to these field controls, the Hanner laboratory will include three types of laboratory controls to ensure the quality and reliability of the resulting data (see Section 2.6.3.6).

eDNA sample collection, storage, and transport protocols will follow the standard operating procedures of the Hanner laboratory. For the biodiversity baseline program, Zoetica has developed a field SOP customized for the proposed eDNA studies – see **Appendix A**. After 2 L of water has passed through the OSMOS system, the filter will be carefully removed with clean tweezers and stored in a sample envelope in a Ziploc bag with silica bead desiccant packets. Preserved filters should be stored in the refrigerator (not frozen) until shipping to the Hanner laboratory for analysis. Although the shelf life of samples stored in this manner is thought to be 6-12 months (Hobbs *et al.* 2017), samples should be sent to the laboratory for DNA extraction as soon as possible.

Decontamination of sampling equipment and gear (e.g., reusable filter housing and pre-filter, extendable pole on the OSMOS system, rubber boots if it was necessary to enter the water feature) must be conducted <u>between</u> separate sites (i.e., different watercourse, waterbody, or wetland that is not hydrologically connected). This involves washing visible particulate matter from the equipment using soap, spraying/soaking the gear with a 10-50% bleach solution (the concentration depends on whether the equipment directly touches the sample), letting it sit for at least 1 minute, and then triple rinsing with water away from a watercourse or waterbody. Tap water may be used for boots and other gear; however, distilled water should be used to rinse the filter housing and pre-filter. Triple rinsing is essential to prevent the contamination of waterbodies with bleach, which can harm sensitive species such as amphibians. In addition to avoiding cross-contamination of eDNA samples, it is important to decontaminate field gear to avoid transferring pathogens such as chytrid fungus and ranaviruses to sensitive amphibians (CHHWG 2017).

Incidental observations of wildlife or wildlife sign, fish, and human use of the area will be recorded. Although the BIS eDNA studies do not include paired taxonomic analyses (as is being done for zooplankton and benthic invertebrates as part of the surface water component of the EMBP; CanNorth 2020), incidental wildlife observations can help corroborate the results of eDNA metabarcoding analyses if these species are detected.

2.6.3.5 Data Collection and Recording

Minimum recommended reporting for eDNA studies includes documentation at all stages of the process, including design, water collection, sample preservation, extraction process, and, in the case of metabarcoding analyses, high-throughput sequencing (Goldberg *et al.* 2016). The recommended reporting information relevant to the BIS field program includes:

<u>Water collection</u>

- Contamination precautions including negative controls
- Collection volume, container material, replicates, depth
- Site description (e.g., flow rate, area)

Sample preservation

- Method, temperature, duration
- Filter type (if applicable), filtering location (e.g., in field)

The inclusions of decontamination procedures, field negative samples, replicates/duplicates, collection of surface water (i.e., depth), and filter preservation/storage method were described in Section 2.6.3.4 above. Regarding container material and filtering location, this is more applicable to sampling approaches that use Nalgene collection bottles or Whirl-Pak bags and separate filtering equipment; the use of the OSMOS eDNA sampler will be documented for the BIS. Information about watercourse flow rate and waterbody/wetland area can be used within an occupancy modelling framework to estimate detection probability for eDNA studies (e.g., Goldberg *et al.* 2018). The area of waterbodies and wetlands can be calculated by Zoetica from available spatial data (see Section 2.6.2.2). Flow rate measurements, which includes estimating flow in smaller streams and larger rivers, will be conducted by the field data collection contractor using a water flow meter. The remaining recommended reporting guidelines are addressed below.

At each eDNA sampling site, the general site information, environmental conditions, and sampling conditions will be recorded on the data form (see eDNA Field SOP in **Appendix A** for more details about environmental data collection and data recording). Site photographs should also be taken as additional documentation of the habitat characteristics and incidental observations. A subset of sample identifiers (matching the data form) will be recorded on each eDNA sample storage envelope (see eDNA Field SOP in **Appendix A**).

The OSMOS system has digital flow, pressure, and temperature sensors that will be monitored, and adjustments may be made in the field if needed. For example, a pilot study using the Smith-Root eDNA backpack sampler found that peak filtration efficiency and eDNA capture occurred at a flow rate threshold of 1.0 L/min using 5 µm filters, and that high filtration pressures may reduce eDNA retention (Thomas *et al.* 2018). Thus, if flow rate is very low due to high levels of particulates, it would be better to switch to filters with increased pore size rather than turn up the pump pressure of the system. If any modifications are made to the initial (standard) parameters, however, these changes must be documented on the data form.

Documentation of sample/filter storage conditions (e.g., temperature, duration) is needed up to the point when samples are shipped to the laboratory for analysis. Once samples arrive at the University of Guelph, Hanner laboratory technicians will perform and document laboratory analyses according to their internal SOPs and QA/QC checks.

2.6.3.6 Laboratory Analyses

The Hanner laboratory has or will develop validated methods for DNA extraction, PCR amplification, library preparation, MiSeq sequencing, and bioinformatics analyses for detecting the biodiversity of the AOI and LSA_{AQU}. For Year 1 studies, two sets of markers/primer sets will be used to enhance capture of eDNA from aquatic and semi-aquatic vertebrate species, and one primer set will focus on aquatic invertebrate species but also has the potential to capture vertebrates. The Hanner laboratory's practices will consider the common critiques of eDNA metabarcoding and laboratory-based methods and will follow the most up-to-date best practices and guidelines available (Cristescu and Hebert 2018, Helbing and Hobbs 2019, Zinger *et al.* 2019) to ensure that data quality requirements of the NWMO are met.

Laboratory QA/QC controls will include technical PCR replicates, extraction blanks, and positive controls; one of each type will be included per sequencing run of approximately 96 samples.

The Hanner laboratory will present the eDNA metabarcoding results summarizing methods and results focused on species detected (and/or higher taxa as appropriate to taxonomic resolution of the marker gene and reference database used to infer analysis) in a summary report. In addition, because existing morphologically-based taxonomy can overlook cryptic species, a summary of "molecular operational taxonomic units" (MOTUs) will also be included to further facilitate site comparisons. Raw data will be appended (e.g., as an Excel spreadsheet) and archived. Data produced by the Hanner laboratory will need to meet the data delivery standards of the NWMO, including metadata, QA/QC, and transmittal requirements, at minimum (see Section 1.10).

There are some limitations to the BIS study design proposed above in comparison to the paired eDNA and taxonomic specimen collection planned for the EMBP, as CanNorth's parallel approach enables conventional Sanger sequence analyses to aid in building the barcode reference library (CanNorth 2020). Analyses for biodiversity, on the other hand, will be relying on existing sequences (e.g., in the Barcode of Life Database, GenBank and other marker-specific databases) unless tissue sample collection is also undertaken for the BIS. Zoetica presented options for building barcode reference sequence libraries for biodiversity in Table 5-1 of the BPPA Report. Zoetica's preferred approach is to start with available reference sequences and to reserve a small tissue sample from specimens already being collected for the EMBP. Additional input from stakeholders and rights-holders is needed prior to deciding on any invasive procedures. One of the major advantages of eDNA metabarcoding, however, is that all DNA present in the sample (that can be amplified with a given set of PCR primers) will be sequenced and all data can be stored indefinitely for re-analysis (e.g., against tissue samples that may be collected in future years of the baseline program).

2.7 Data Analysis and Reporting: Tier 1 Studies

This section outlines the data analysis and reporting that will be conducted for the Tier 1 studies. While statistical methods including GRTS analysis were used for the stratification of habitat data for survey site selection in the field program, the results of the Tier 1 studies are not data complex and do not require any statistical modelling for reporting purposes. Except for eDNA studies (detailed in Section 2.6) where seasonal and annual surveys may be conducted, most Tier 1 studies will involve only one survey site visit to collect data to map and verify habitat within the applicable study areas. For eDNA studies, probability of occupancy cannot be determined with only one season of field data.

Assuming field data collection contractors submit their data according to the timeline outlined in Section 1.10, the first iteration of a baseline report will be completed by the end of Year 1. This completion timeframe will allow for adequate time to integrate the Year 1 baseline results into the planning process for future years of data collection. The following sections provide an overview of the data analyses and reporting that will be conducted for each study conducted in Tier 1.

2.7.1 Terrestrial Ecosystem Mapping

The objective of the TEM Tier 1 studies is to improve the ecosite data currently available in the eFRI dataset into smaller and more accurate polygon units. Data collected will be used to plan stratified random study locations for use in collecting more species-specific data during Tier 2 studies.

Data collected as part of Tier 1 studies will be presented as summary statistics for each ecosite classification to determine the vegetation and soil characteristics that are common and potentially unique to the study areas. The field verified data collected at a subset of randomized polygons (by ecosite) selected for ground-truthing during Tier 1 studies will be used to extrapolate data to similarly classified polygons that have not been field verified. Summary statistics will include:

- The proportion of ecosites ground-truthed that agree with the desk-based refined ecosite dataset
- Areas (in hectares and percentage) comprised of each ecosite relative to all ecosites within the AOI and LSA_{AQU}
- Basic comparative statistics to assess the ecosite uniqueness within the AOI compared to the LSA_{AQU}, and once mapping the RSA_{VEG} is completed, compared to the RSA_{VEG}

Analyses of ecosite data will be presented as maps and summary tables showing the distribution and amounts of habitat within each study area level (i.e., AOI, LSA_{AQU}, and RSA_{VEG}). All desk-based maps will be updated to represent the ecosite classification changed during ground-truthing. The updated ecosite data will be used for the selection of Tier 2 study sites for various biodiversity values.

2.7.2 Habitat Suitability Modelling

The objectives of habitat suitability modelling include:

- Assigning wildlife suitability ratings to various polygons derived from TEM based on their relative importance to select wildlife
- Determining the suitable habitat in the AOI compared to the LSA_{AQU}, and once mapping the RSA_{VEG} is completed, comparing it to the RSA_{VEG}
- Assisting in the selection of survey locations for future Tier 2 baseline studies

Polygons in the refined ecosite dataset will be used to assign a preliminary wildlife-specific habitat suitability rating based on various life history requirements and seasonal requirements for that species. Preliminary mapping will be used in the field to ground-truth the ratings of the ecosites. Field data collected at a subset of randomized polygons as part of the Tier 1 TEM studies will also be ground-truthed for verification of wildlife habitat suitability ratings and results will be used to extrapolate data collected in these sampled plots to similarly classified polygons that have not been field verified. Summary statistics will include:

- The proportion of ecosites ground-truthed that agree with wildlife-specific habitat suitability ratings derived via desk-based methods
- Amount in hectares and percentage of each rating level (Nil, Low, Moderate, High) of each ecosite relative to the rating levels of all ecosites within the study areas (AOI, LSA, and once mapping is complete the RSA)
- Basic comparative statistics to assess the uniqueness of high-quality habitat within the AOI compared to the LSA_{AQU}

The report will include updated ratings criteria based on evidence from the field and will present updated habitat suitability maps for each species and life requisite/season assessed to show the distribution of high-quality habitat across the study areas. Updated species accounts will also be presented in the baseline report. The reports will include a discussion of the important habitat features for each life history stage chosen for each selected species.

2.7.3 Identification of Candidate Significant Wildlife Habitat

The objectives of candidate SWH identification include:

- Determining the presence and distribution of candidate SWH in the AOI compared to the LSA_{AQU}, and once mapping the RSA_{VEG} is completed, comparing it to the RSA_{VEG}
- Assisting in the selection of survey locations for Tier 2 baseline studies

Field data collected at a subset of randomized polygons as part of the Tier 1 TEM studies during the summer (corresponding to the breeding season for many wildlife species) will also be used to identify candidate SWH and potentially confirm rare vegetation communities relevant to Ecoregion 3W (also SWH). Basic comparative statistics to assess the presence and distribution of candidate SWH within the AOI compared to the LSA_{AQU} will be summarized in the baseline report. The report will include a discussion of any candidate SWH observed during Tier 1 field assessment and will provide rationale for survey site selection for Tier 2 field studies. Targeted Tier 2 surveys for SWH will also include ground-truthing candidate SWH during non-summer/non-breeding seasons.

2.7.4 Aquatic Habitat Mapping

The primary objectives of the aquatic habitat mapping for the BIS are to characterize the presence and distribution of fish habitat within the LSA_{AQU} and select control sites within the RSA_{AQU} under baseline conditions, highlight likely important fish areas, assess the potential for SAR habitat, and to evaluate the distribution of habitats within the LSA_{AQU} and select control sites in the RSA_{AQU} to choose suitable sampling sites for fish community characterization in future Tier 2 studies.

As part of the desk-based program, watercourses and waterbodies will be mapped and segregated into reaches, with a selection of those reaches ground-truthed during the field-based program. Data collected as part of Tier 1 studies will be presented as summary statistics for each reach classification to determine the available habitat within the aquatic study areas. The field verified data collected at a subset of randomized reaches ground-truthed during Tier 1 studies will be used to update waterbody habitat classifications (e.g., wetland classifications) and can be used to extrapolate data to reaches that have not been field verified. Summary statistics will include:

- The proportion of reaches ground-truthed that agree with desk-based aquatic habitat mapping
- The proportion of each reach type derived through desk-based aquatic habitat mapping relative to all reaches within the study areas (AOI, LSA_{AQU}, and in select areas of the RSA_{AQU})
- Basic comparative statistics to assess the uniqueness of aquatic habitat within the AOI compared to the LSA_{AQU} and select control sites in the RSA_{AQU}

Field truthing of watercourses and waterbodies will be used to update maps and will be presented in the baseline report to show the distribution of various aquatic habitat types within each study area (AOI, LSA_{AQU}, and RSA_{AQU}). The updated habitat data will be used to identify the potential use by various fish species and will be used for the selection of Tier 2 study sites. Results of aquatic habitat mapping within the study areas will assist in the assessment of potential species presence, the identification of critical and sensitive aquatic and riparian habitat, and gear type required for future Tier 2 community composition studies. The results of the eDNA program can be used in parallel with aquatic habitat mapping to identify species presence and in planning for future studies. Lake characteristics (bathymetry and limnology/water chemistry) will be presented within the EMBP baseline report and may be summarized in the BIS baseline report as it relates to fish habitat. In addition to fish habitat, aquatic habitat mapping will identify stream reaches where suitable riffle habitat exists for future benthic invertebrate collections conducted as part of the EMBP (CanNorth 2020).

2.7.5 Drone Pilot Program

The objective of the drone pilot program is to assess the capability of using drone technology to collect detailed data in a reproducible manner. Once the data collected from drones on a smaller spatial scale (e.g., LSA_{TER} and LSA_{AQU}) can be verified as equal or better than traditional methods, the program can be expanded to the larger regional areas.

The data collected as part of the drone pilot program will include imagery which is much more detailed than freely available satellite imagery. The different types of imagery collected will each serve different purposes and will include detailed imagery, multispectral imagery, and infrared imagery. The raw drone imagery will require some initial processing (e.g., mosaicking, orthorectification), which will be completed by the contracted drone company. Detailed image analysis can then be targeted towards mapping watercourses, lakes, wetlands, barriers to fish movement, and other hydrological features; and ecosite classifications and other vegetation information (e.g., vegetation health as determined by using multispectral analysis). Imagery analysis of tree counts and tree density will allow for the calculation of overall landscape tree cover and composition; this can be done using programs such as the i-Tree software suite, which allows for estimates of tree density as well as contributions and potential effects on ecosystem function and services such as carbon sequestration and air quality.

The report will include imagery maps based on various data types (high-quality imagery, multispectral imagery, and/or infrared imagery). Drone imagery can be integrated into terrestrial ecosystem maps and/or habitat suitability maps, or imagery of significant landscape structures like beaver dams and raptor nests can be directly presented in the baseline report as part of photographic documentation of the study area.

2.7.6 Environmental DNA (eDNA) Studies

The objective of the eDNA program in Year 1 is to provide community-level species composition (i.e., number of species) data across the AOI and LSA_{AQU}, giving indications as to which areas contribute more or less to the overall genetic diversity, and to detect species of interest (e.g., SAR) and cryptic species. These data will also provide the BIS with baseline information for the development of species and community baseline collection programs, many of which will seek to quantify abundance and relative abundance along with measures of diversity. Further, eDNA metabarcoding analyses can be employed throughout the duration of the BIS to collect robust baseline data on species composition and species associations throughout the LSA_{AQU} for informing the potential impacts of the project to genetic diversity (e.g., as would occur through the extirpation of species) for the biodiversity IA.

Data analysis can be used to help assess the range of natural variation in species composition and species associations (clusters) across habitat types and to set monitoring benchmarks (e.g., species expected within various habitats) that can detect reductions in species numbers or changes in losses in species over time. The resulting species composition data, which will then be reviewed alongside TEM and aquatic habitat mapping data and input from local stakeholders and rights-holders, will also be used to help refine the scope of biodiversity values for subsequent Tier 2 baseline data collection.

Data analysis will be conducted to determine the sources of uncertainty – most notably, the rates of false positives and false negatives, which must be understood, identified, and addressed. Besides creating a list of identified species within the area potentially affected by the APM Project, eDNA data collected within stratified random aquatic habitats will also enable cluster analyses to be completed by Zoetica. Cluster analyses can identify species clusters that tend to co-vary among habitat types; this will help to better understand species associations and communities, and the abiotic conditions that segregate them.

Reporting of eDNA data will be through species composition maps of the AOI and LSA_{AQU}, and statistical comparisons of species composition between study areas. Updated species presence accounts will also be presented in the baseline report. The reports will include a discussion of species composition and presence in relation to expectations found from habitat suitability modelling.

3.0 FUTURE TIER 2 AND 3 STUDIES

Tier 2 studies on community composition (which will provide measures of abundance and relative abundance of key fish and wildlife groups), population metrics, ecosystem function and services, and targeted biodiversity values will build on results from Tier 1 data collection. The data collected during Tier 1 field work will be used to update the desk-based TEM, habitat suitability modelling, candidate SWH mapping, and aquatic habitat mapping. The updated mapping product will allow for the generation of a defensible stratified random allocation of sampling/survey effort, completed using GRTS (see Section 1.9.1 for details on GRTS), for Tier 2 studies.

The Tier 2 protocols will be added to the BPD Report by Zoetica during future iterations of the report when Tier 2 field studies are required for the APM Project. Some Tier 2 survey protocols may be issued prior during the Year 2 update of the BPD Report to support the community decision making process. Greater efficiencies will be achieved in waiting to write Tier 2 study design protocols until after assessing initial habitat mapping data and possibly eDNA results (depending on how long lab analysis takes) in the terrestrial and aquatic LSAs; receiving additional feedback on proposed methods from the ERG, communities, and regulators; and after identifying additional government protocols and potential collaborations that could be realized for these studies. The SOPs for Tier 2 studies, and maps detailing how survey efforts should be distributed over space and among ecosystem habitat groupings (informed by Tier 1 terrestrial and aquatic habitat mapping) will be generated starting in the fall of Year 1 and will enable the construction of a defensible GRTS design and survey effort allocation for Tier 2 studies.

Baseline data from Tier 1 will also be used to inform whether the more “uncertain” Tier 2 study options should be triggered. Currently, Zoetica has presented in the BPPA Report (Zoetica 2020) many options for studies that may be triggered in Tiers 2 and 3, and not all will be required. Based on results of Tier 1 studies, some studies are likely to be no longer relevant. For example, if suitable habitat is not found for a species within an area that could be impacted by the APM Project (e.g., snapping turtles), and if eDNA results do not suggest presence, a study on such a species (or group, if relevant) may be removed from consideration.

While lists of species potentially present in the area have been developed to assist in determining biodiversity values to focus on, they will need to be refined by the Tier 1 studies to ensure that no species are missed or unnecessarily included. In some cases, it may be appropriate to focus on key species of importance like a SAR, while in other cases, a guild approach, or another habitat-species grouping can be used, if the project is predicted to functionally alter the ecosystem such that a guild or grouping (e.g., water-dependent birds) could be impacted, and where dynamics between species (inter- and intra-specific competition due to changes in relative abundance) could also play a role in impacts. A review of Tier 1 study results may also indicate a need for subsequent Tier 1 effort, which can be indicated in BPD Report updates.

Baseline methods for subsequent years of the program will be updated through ongoing reviews of best practices, standards, guidelines, and emerging technologies, and through learning from the first year(s) of baseline data collection. The Tier 2 studies, as directed by results from the Tier 1 studies, will focus primarily on a refined selection of biodiversity values relative to Tier 1 studies (see Zoetica's BPPA Report, Section 5.2; Zoetica 2020). The anticipated preferred methods to be used for Tier 2 studies are listed below:

- Vegetation:
    - Floristic inventory and intuitive meander to survey for rare plants, culturally significant plants, and weeds, introduced and invasive plants
- Ungulates:
    - Moose aerial inventory
- Carnivores:
    - Barbed wire hair traps with DNA analysis, paired with remote camera traps
    - Snow track surveys
- Small Terrestrial Mammals:
    - Snowshoe hare tracking program
    - Snow track surveys
- Semi-Aquatic Mammals:
    - Beaver lodge and/or food cache counts
    - Snow track surveys
- Bats:
    - Visual and/or acoustic monitoring for hibernacula (*if needed*)
    - Surveys to identify candidate maternity colony/roost sites
    - Exit surveys at candidate roost trees (*if needed*)
    - Stationary point acoustic surveys (automated bat detectors)
- Birds:
    - Helicopter nest surveys (raptors)
    - Point count surveys (upland breeding birds, game birds)
    - Call playback surveys (cryptic waterbirds, nocturnal raptors)
    - Lek surveys (sharp-tailed grouse; *if needed*)
    - Observation stations (waterbirds) – spring staging, breeding, fall staging
    - Nightjar acoustic surveys (SAR: eastern whip-poor-will, common nighthawk)
    - Ground sign and nest surveys (raptors) and transect surveys (open habitat raptors)
    - Autonomous song meters (upland breeding birds including SAR, owls)
- Herpetofauna
    - Ground visual encounter surveys (amphibians and reptiles)
    - Aquatic visual encounter survey and egg mass surveys (amphibians), supplemented with aquatic traps (amphibians) and drift fences (amphibians and reptiles) if needed
    - Song meters and auditory surveys (amphibians)

- Fish and Fish Habitat
  - Fish community surveys
- Primary and Secondary Aquatic Producers
  - Taxonomic surveys (to be completed as a collaboration between the BIS and EMBP)

Eventually, Tier 1 and 2 data collection efforts are expected to result in a select number of focused questions, which can be addressed using focused Tier 3 protocols. Some Tier 3 studies have been identified as possibilities in Zoetica's BPPA Report, Section 5.2 (Zoetica 2020), but they will have to be solidified and modified based on data from Tiers 1 and 2. The focus of Tier 3 studies will be answering specific and relevant questions that arise from undertaking Tier 1 and Tier 2 studies and will typically focus on target taxa.

4.0 REFERENCES

Assmann, J. J., J. T. Kerby, A. M. Cunliffe, and I. H. Myers-Smith. 2019. Vegetation monitoring using multispectral sensors — best practices and lessons learned from high latitudes. Journal of Unmanned Vehicle Systems 7:54–75.

Balasingham, K. D., R. P. Walter, N. E. Mandrak, and D. D. Heath. 2018. Environmental DNA detection of rare and invasive fish species in two Great Lakes tributaries. Molecular Ecology 27:112–127.

BBOP. 2012. Standard on Biodiversity Offsets. Business and Biodiversity Offsets Programme (BBOP), Washington, D.C.

BC MFR, and BC MOE. 2010. Field Manual for Describing Terrestrial Ecosystems. Land Management Handbook. 2nd edition. B.C. Ministry of Forests and Range and B.C. Ministry of Environment.

Bedwell, M. E., and C. S. Goldberg. 2020. Spatial and temporal patterns of environmental DNA detection to inform sampling protocols in lentic and lotic systems. Ecology and Evolution 10:1602–1612.

Biodiversity Convention Office. 1995. Canadian Biodiversity Strategy: Canada's Response to the Convention on Biological Diversity. Minister of Supply and Services Canada.

Boan, J. J., B. E. McLaren, and J. R. Malcolm. 2013. Predicting non-inventoried forest elements using forest inventory data: The case of winter forage for woodland caribou. Écoscience 20:101–111.

Bushaw, J., K. Ringelman, and F. Rohwer. 2019. Applications of Unmanned Aerial Vehicles to Survey Mesocarnivores. Drones 3:28.

Cannings, R. A., and A. P. Harcombe, editors. 1990. The Vertebrates of British Columbia, scientific and English names. Royal B.C. Mus. Heritage Rec. 20, Wildl. Rep. No. R24. Min. Municipal Affairs, Recreation and Culture and Min. Environ., Victoria, BC.

CanNorth. 2019a. Environmental Media Baseline Program – Preliminary Sample Design Feasibility Assessment. Nuclear Waste Management Organization, Adaptive Phased Management Project – Northwestern Ontario Region. Prepared by Canada North Environmental Services for the Nuclear Waste Management Organization.

CanNorth. 2019b. Technical Memorandum: Environmental Media Baseline Program - Supporting Details for Final Design. Nuclear Waste Management Organization, Adaptive Phased Management Project – Northwestern Ontario Region. Prepared by Canada North Environmental Services for the Nuclear Waste Management Organization.

CanNorth. 2020. Environmental Media Baseline Program Design - Final Report. Nuclear Waste Management Organization, Adaptive Phased Management Project – Northwestern Ontario Region. Prepared by Canada North Environmental Services for the Nuclear Waste Management Organization.

CHHWG. 2017. Decontamination Protocol for Field Work with Amphibians and Reptiles in Canada. Canadian Herpetofauna Health Working Group.

Civade, R., T. Dejean, A. Valentini, N. Roset, J. C. Raymond, A. Bonin, P. Taberlet, and D. Pont. 2016. Spatial Representativeness of Environmental DNA Metabarcoding Signal for Fish Biodiversity Assessment in a Natural Freshwater System. PLoS ONE 11:1–19.

Cohen, J. 1990. Things I have learned (so far). American Psychologist 45:1304–1312.

Crins, W. J., P. A. Gray, P. W. C. Uhlig, and M. C. Wester. 2009. The Ecosystems of Ontario, Part 1: Ecozones and Ecoregions. Technical Report SIB TER IM. Ontario Ministry of Natural Resources, Inventory, Monitoring and Assessment, Peterborough, Ontario.

Cristescu, M. E., and P. D. N. Hebert. 2018. Uses and Misuses of Environmental DNA in Biodiversity Science and Conservation. Annual Review of Ecology, Evolution, and Systematics 49:209–230.

CSBI. 2015. A cross-sector guide for implementing the Mitigation Hierarchy. Prepared by The Biodiversity Consultancy for the Cross Sector Biodiversity Initiative. Lead authors: Ekstrom, J., Bennun, L., and Mitchell, R., Cambridge, UK.

Deiner, K., H. M. Bik, E. Mächler, M. Seymour, A. Lacoursière-Roussel, F. Altermatt, S. Creer, I. Bista, D. M. Lodge, N. de Vere, M. E. Pfrender, and L. Bernatchez. 2017. Environmental DNA metabarcoding: Transforming how we survey animal and plant communities. Molecular Ecology 26:5872–5895.

DFO. 2013. Ontario Restricted Activity Timing Windows for the Protection of Fish and Fish Habitat. Fisheries and Oceans Canada. https://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/on-eng.html.

Dickie, I. A., S. Boyer, H. L. Buckley, R. P. Duncan, P. P. Gardner, I. D. Hogg, R. J. Holdaway, G. Lear, A. Makiola, S. E. Morales, J. R. Powell, and L. Weaver. 2018. Towards robust and repeatable sampling methods in eDNA-based studies. Molecular Ecology Resources 18:940–952.

Eakins, R. J. 2020. Ontario Freshwater Fishes Life History Database, Version 5.02 [Online database]. http://www.ontariofishes.ca.

ELC Working Group. 2009. Ecosites of Ontario - Operational Draft. Ecological Land Classification Working Group, Ministry of Natural Resources.

ENDM. 2019. Abandoned Mines. Ministry of Energy, Northern Developments and Mines. https://www.mndm.gov.on.ca/en/mines-and-minerals/applications/ogsearth/abandoned-mines.

Gélinas, J., D. Horswill, R. Northey, and R. Pelletier. 2017. Building Common Ground, A New Vision for Impact Assessment in Canada: The Final Report of the Expert Panel for the Review of Environmental Assessment Processes. Canadian Environmental Assessment Agency.

Goldberg, C. S., K. M. Strickler, and A. K. Fremier. 2018. Degradation and dispersion limit environmental DNA detection of rare amphibians in wetlands: Increasing efficacy of sampling designs. Science of the Total Environment 633:695–703.

Goldberg, C. S., C. R. Turner, K. Deiner, K. E. Klymus, P. F. Thomsen, M. A. Murphy, S. F. Spear, A. McKee,

S. J. Oyler-McCance, R. S. Cornman, M. B. Laramie, A. R. Mahon, R. F. Lance, D. S. Pilliod, K. M. Strickler, L. P. Waits, A. K. Fremier, T. Takahara, J. E. Herder, and P. Taberlet. 2016. Critical considerations for the application of environmental DNA methods to detect aquatic species. Methods in Ecology and Evolution 7:1299–1307.

Golder Associates. 2011. Recovery Strategy for Lake Sturgeon (Acipenser fulvescens) – Northwestern Ontario, Great Lakes-Upper St. Lawrence River and Southern Hudson Bay-James Bay populations in Ontario. Ontario Recovery Strategy Series. Ontario Ministry of Natural Resources, Peterborough, Ontario.

Golder Associates. 2013. Environment Report – Township of Ignace, Ontario. Phase 1 Desktop Assessment. Prepared for the Nuclear Waste Management Organization.

Government of Canada. 2019. Snapping Turtle (Chelydra serpentina) - Species Summary. https://species-registry.canada.ca/index-en.html#/species/1033-710.

Gullison, T., J. Hardner, S. Anstee, and M. Meyer. 2015. Good Practices for the Collection of Biodiversity Baseline Data. Prepared for the Multilateral Financing Institutions Biodiversity Working Group & Cross Sector Biodiversity Initiative.

Hänfling, B., L. L. Handley, D. S. Read, C. Hahn, J. Li, P. Nichols, R. C. Blackman, A. Oliver, and I. J. Winfield. 2016. Environmental DNA metabarcoding of lake fish communities reflects long-term data from established survey methods. Molecular Ecology 25:3101–3119.

Harper, L. R., A. S. Buxton, H. C. Rees, K. Bruce, R. Brys, D. Halfmaerten, D. S. Read, H. V. Watson, C. D. Sayer, E. P. Jones, V. Priestley, E. Mächler, C. Múrria, S. Garcés-Pastor, C. Medupin, K. Burgess, G. Benson, N. Boonham, R. A. Griffiths, L. Lawson Handley, and B. Hänfling. 2019a. Prospects and challenges of environmental DNA (eDNA) monitoring in freshwater ponds. Hydrobiologia 826:25–41.

Harper, L. R., L. Lawson Handley, A. I. Carpenter, M. Ghazali, C. Di Muri, C. J. Macgregor, T. W. Logan, A. Law, T. Breithaupt, D. S. Read, A. D. McDevitt, and B. Hänfling. 2019b. Environmental DNA (eDNA) metabarcoding of pond water as a tool to survey conservation and management priority mammals. Biological Conservation 238:108225.

Harrison, J. B., J. M. Sunday, and S. M. Rogers. 2019. Predicting the fate of eDNA in the environment and implications for studying biodiversity. Proceedings of the Royal Society B: Biological Sciences 286:20191409.

Helbing, C. C., and J. Hobbs. 2019. Environmental DNA Standardization Needs for Fish and Wildlife Population Assessments and Monitoring. Standards Research. Canadian Standards Association (CSA Group).

Hering, D., A. Borja, J. I. Jones, D. Pont, P. Boets, A. Bouchez, K. Bruce, S. Drakare, B. Hänfling, M. Kahlert, F. Leese, K. Meissner, P. Mergen, Y. Reyjol, P. Segurado, A. Vogler, and M. Kelly. 2018. Implementation options for DNA-based identification into ecological status assessment under the European Water Framework Directive. Water Research 138:192–205.

Hernandez, C., B. Bougas, A. Perreault-Payette, A. Simard, G. Côté, and L. Bernatchez. 2020. 60 specific eDNA qPCR assays to detect invasive, threatened, and exploited freshwater vertebrates and invertebrates in Eastern Canada. Environmental DNA 2:373–386.

Hobbs, J., C. S. Goldberg, C. C. Helbing, and N. Veldhoen. 2017. Environmental DNA Protocol for

Freshwater Aquatic Ecosystems, Version 2.2. Prepared for BC Ministry of Environment, Ecosystems Branch.

Hodgson, J. C., R. Mott, S. M. Baylis, T. T. Pham, S. Wotherspoon, A. D. Kilpatrick, R. Raja Segaran, I. Reid, A. Terauds, and L. P. Koh. 2018. Drones count wildlife more accurately and precisely than humans. Methods in Ecology and Evolution 9:1160–1167.

IAAC. 2020a. Glossary of Terms For The Impact Assessment Of Designated Projects Under The Impact Assessment Act. Impact Assessment Agency of Canada.

IAAC. 2020b. Tailored Impact Statement Guidelines Template for Designated Projects Subject to the Impact Assessment Act and the Nuclear Safety and Control Act. Impact Assessment Agency of Canada. https://www.canada.ca/en/impact-assessment-agency/services/policy-guidance/practitioners-guide-impact-assessment-act/tailored-impact-statement-guidelines-projects-impact-assessment-nuclear-safety-act.html#_Toc16256536.

IFC. 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. International Finance Corporation.

IFC. 2013. Good Practice Handbook - Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets. International Finance Corporation, Washington, D.C.

Jones, S. R., S. Carley, and M. Harrison. 2003. An introduction to power and sample size estimation. Emergency Medicine Journal 20:453–458.

Kelly, R. P., A. O. Shelton, and R. Gallego. 2019. Understanding PCR Processes to Draw Meaningful Conclusions from Environmental DNA Studies. Scientific Reports 9:1–14.

Klymus, K. E., N. T. Marshall, and C. A. Stepien. 2017. Environmental DNA (eDNA) metabarcoding assays to detect invasive invertebrate species in the Great Lakes. PLoS ONE 12:1–24.

Lacoursière-Roussel, A., Y. Dubois, E. Normandeau, and L. Bernatchez. 2016. Improving herpetological surveys in eastern North America using the environmental DNA method. Genome 59:991–1007.

Li, J., T. W. Hatton-Ellis, L. J. Lawson Handley, H. S. Kimbell, M. Benucci, G. Peirson, and B. Hänfling. 2019. Ground-truthing of a fish-based environmental DNA metabarcoding method for assessing the quality of lakes. Journal of Applied Ecology 56:1232–1244.

Loeza-Quintana, T., C. L. Abbott, D. D. Heath, L. Bernatchez, and R. H. Hanner. 2020. Pathway to Increase Standards and Competency of eDNA Surveys (PISCeS)—Advancing collaboration and standardization efforts in the field of eDNA. Environmental DNA 2:255–260.

Lopes, C. M., T. Sasso, A. Valentini, T. Dejean, M. Martins, K. R. Zamudio, and C. F. B. Haddad. 2017. eDNA metabarcoding: a promising method for anuran surveys in highly diverse tropical forests. Molecular Ecology Resources 17:904–914.

MMAH. 2020. Provincial Policy Statement, 2020.

MNRF. 2014a. Ontario Wetland Evaluation System: Northern Manual. 1st edition. Ministry of Natural Resources and Forestry.

MNRF. 2014b. Significant Wildlife Habitat Mitigation Support Tool. Ontario Ministry of Natural Resources and Forestry.

Morey, K. C., T. J. Bartley, and R. H. Hanner. 2020. Validating environmental DNA metabarcoding for marine fishes in diverse ecosystems using a public aquarium. Environmental DNA 2:330–342.

MTO. 2009. Environmental Guide for Fish and Fish Habitat. Environmental Standards and Practices. Provincial and Environmental Planning Office, Ministry of Transportation.

Mychek-Londer, J. G., K. D. Balasingham, and D. D. Heath. 2020. Using environmental DNA metabarcoding to map invasive and native invertebrates in two Great Lakes tributaries. Environmental DNA 2:283–297.

Nicholson, A., D. McIsaac, C. MacDonald, P. Gec, B. E. Mason, W. Rein, J. Wrobel, M. Boer, Y. Milián-García, and R. H. Hanner. 2020. An analysis of metadata reporting in freshwater environmental DNA research calls for the development of best practice guidelines. Environmental DNA 2:343–349.

Noronha, J. 2016. Deep Geological Repository Conceptual Design Report Crystalline / Sedimentary Rock Environment. Nuclear Waste Management Organization.

NWMO. 2013. Summary Findings and Decisions: Creighton, Saskatchewan; Ear Falls, Ontario; English River First Nation, Saskatchewan; Hornepayne, Ontario; Ignace, Ontario; Pinehouse, Saskatchewan; Schreiber, Ontario; Wawa, Ontario. Phase 1 Preliminary Assessments. Nuclear Waste Management Organization.

NWMO. 2016. Indigenous Knowledge Policy. Nuclear Waste Management Organization, Toronto, Ontario.

OMNR. 2000. Significant Wildlife Habitat Technical Guide. Ontario Ministry of Natural Resources, Fish and Wildlife Branch, Wildlife Section and Science Development and Transfer Branch, Southcentral Sciences Section, Peterborough, Ontario.

OMNR. 2014. Boreal Ecosite Factsheets. Peter Uhlig, Ontario Ministry of Natural Resources.

OMNR. 2015. Field Guide to the Substrates of Ontario. Ontario Ministry of Natural Resources.

OMNRF. 2017. Significant Wildlife Habitat Criteria Schedules for Ecoregion 3W. Ontario Ministry of Natural Resources and Forestry, Northwest Region Resources Section.

Ontario Nature. 2020. Ontario Reptile and Amphibian Atlas - Field Guide. https://ontarionature.org/programs/citizen-science/reptile-amphibian-atlas/species/.

R Core Team. 2016. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

RIC. 1998. Standard for Terrestrial Ecosystem Mapping in British Columbia. Prepared by Ecosystem Working Group, Terrestrial Ecosystems Task Force, Resources Inventory Committee.

RIC. 2001a. Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures. Prepared by BC Fisheries, Information Services Branch for the Resources Inventory Committee.

RIC. 2001b. Standards for Fish and Fish Habitat Maps. Prepared by B.C. Fisheries, Information Services Branch for the Resources Inventory Committee.

RISC. 1999. British Columbia Wildlife Habitat Rating Standards. Prepared by Ministry of Environment, Lands and Parks, Resources Inventory Branch for the Terrestrial Ecosystems Task Force, Resources Inventory Committee.

Ross, W. A., A. Morrison-Saunders, and R. Marshall. 2006. Common sense in environmental impact assessment: it is not as common as it should be. Impact Assessment and Project Appraisal 24:3–22.

Runesson, U. T. 2014. Northwestern Ontario Forest - Virtual Zoo: Common Reptile and Amphibian Species. Faculty of Natural Resources Management, Lakehead University, Thunder Bay, Ontario. http://www.borealforest.org/reptiles.htm.

Ruppert, K. M., R. J. Kline, and M. S. Rahman. 2019. Past, present, and future perspectives of environmental DNA (eDNA) metabarcoding: A systematic review in methods, monitoring, and applications of global eDNA. Global Ecology and Conservation 17:e00547.

Rusak, J. A., and T. Mosindy. 1997. Seasonal movements of lake sturgeon in Lake of the Woods and the Rainy River, Ontario. Canadian Journal of Zoology 75:383–395.

Sawilowsky, S. S. 2009. New Effect Size Rules of Thumb. Journal of Modern Applied Statistical Methods 8:597–599.

Schardong, A., J. Kelly, and S. Capstick. 2020. Climate Change Impacts on Precipitation for a Deep Geological Repository (Ignace Study Area). Prepared by Golder Associates Ltd. for the Nuclear Waste Management Organization.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada, Minister of Supply and Services, Ottawa, Ontario.

Secretariat of the Convention on Biological Diversity, and Netherlands Commission for Environmental Assessment. 2006. Biodiversity in Impact Assessment, Background Document to CBD Decision VIII/28: Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment. CBD Technical Series No. 26. Montreal, Quebec.

Semlitsch, R. D. 2008. Differentiating Migration and Dispersal Processes for Pond-Breeding Amphibians. Journal of Wildlife Management 72:260–267.

Semlitsch, R. D., and J. R. Bodie. 2003. Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibians and Reptiles. Conservation Biology 17:1219–1228.

SENES Consultants. 2013. Township of Ignace, Ontario. Phase 1 Preliminary Community Well-Being Assessment. Prepared for the Nuclear Waste Management Organization.

Shogren, A. J., J. L. Tank, E. Andruszkiewicz, B. Olds, A. R. Mahon, C. L. Jerde, and D. Bolster. 2017. Controls on eDNA movement in streams: Transport, Retention, and Resuspension. Scientific Reports 7:1–11.

Smith, E. P. 2002. BACI Design. (A. H. El-Shaarawi and W. W. Piegorsch, Eds.) Encyclopedia of Environmetrics. John Wiley and Sons, Ltd., Chichester, UK.

Stanfield, L. W. 2017. Ontario Stream Assessment Protocol, Version 10.0. (L. Stanfield, Ed.). Government of Ontario.

Statistics Canada. 2017. Ignace, TP [Census subdivision], Ontario and Kenora, District [Census division], Ontario (table). Ottawa, Ontario. https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E.

Stevens, D. L., and A. R. Olsen. 1999. Spatially Restricted Surveys over Time for Aquatic Resources. Journal of Agricultural, Biological, and Environmental Statistics 4:415–428.

Stevens, D. L., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the

American Statistical Association 99:262–278.

Strahler, A. N. 1957. Quantitative analysis of watershed geomorphology. Eos, Transactions American Geophysical Union 38:913–920.

Tengö, M., E. S. Brondizio, T. Elmqvist, P. Malmer, and M. Spierenburg. 2014. Connecting diverse knowledge systems for enhanced ecosystem governance: The multiple evidence base approach. Ambio 43:579–591.

The eDNA Society. 2019. Environmental DNA Sampling and Experiment Manual Version 2.1. eDNA Methods Standardization Committee, Otsu, Japan.

Thomas, A. C., J. Howard, P. L. Nguyen, T. A. Seimon, and C. S. Goldberg. 2018. ANDe™: A fully integrated environmental DNA sampling system. Methods in Ecology and Evolution 9:1379–1385.

Tulloch Engineering. 2018a. Technical Memorandum 1, Ignace, ON. Adaptive Phased Management - Phase 2 Environmental Work. Prepared for the Nuclear Waste Management Organization.

Tulloch Engineering. 2018b. Summary Report. Phase 2: Preliminary Environmental Studies, Township of Ignace and Area, Ontario. Prepared for the Nuclear Waste Management Organization.

Tulloch Engineering. 2019a. Memorandum of 2018 Environmental Field Investigation Methods and Results. Phase 2: Preliminary Environmental Studies, Township of Ignace and Area, Ontario. Prepared for the Nuclear Waste Management Organization.

Tulloch Engineering. 2019b. 2018 Surface Water, Sediment and Soil Quality Monitoring Report - DRAFT. Phase 2: Preliminary Environmental Studies, Township of Ignace and Area, Ontario. Prepared for the Nuclear Waste Management Organization.

Turner, C. R., K. L. Uy, and R. C. Everhart. 2015. Fish environmental DNA is more concentrated in aquatic sediments than surface water. Biological Conservation 183:93–102.

Ushio, M., H. Fukuda, T. Inoue, K. Makoto, O. Kishida, K. Sato, K. Murata, M. Nikaido, T. Sado, Y. Sato, M. Takeshita, W. Iwasaki, H. Yamanaka, M. Kondoh, and M. Miya. 2017. Environmental DNA enables detection of terrestrial mammals from forest pond water. Molecular Ecology Resources 17:e63–e75.

Ushio, M., K. Murata, T. Sado, I. Nishiumi, M. Takeshita, W. Iwasaki, and M. Miya. 2018. Demonstration of the potential of environmental DNA as a tool for the detection of avian species. Scientific Reports 8:1–10.

Valentini, A., P. Taberlet, C. Miaud, R. Civade, J. Herder, P. F. Thomsen, E. Bellemain, A. Besnard, E. Coissac, F. Boyer, C. Gaboriaud, P. Jean, N. Poulet, N. Roset, G. H. Copp, P. Geniez, D. Pont, C. Argillier, J. M. Baudoin, T. Peroux, A. J. Crivelli, A. Olivier, M. Acqueberge, M. Le Brun, P. R. Møller, E. Willerslev, and T. Dejean. 2016. Next-generation monitoring of aquatic biodiversity using environmental DNA metabarcoding. Molecular Ecology 25:929–942.

Zinger, L., A. Bonin, I. G. Alsos, M. Bálint, H. Bik, F. Boyer, A. A. Chariton, S. Creer, E. Coissac, B. E. Deagle, M. De Barba, I. A. Dickie, A. J. Dumbrell, G. F. Ficetola, N. Fierer, L. Fumagalli, M. T. P. Gilbert, S. Jarman, A. Jumpponen, H. Kauserud, L. Orlando, J. Pansu, J. Pawlowski, L. Tedersoo, P. F. Thomsen, E. Willerslev, and P. Taberlet. 2019. DNA metabarcoding—Need for robust experimental designs to draw sound ecological conclusions. Molecular Ecology 28:1857–1862.

Zoetica. 2020. Biodiversity Impact Studies – Northwestern Ontario Region: Best Practices and Preferred

Approach. Prepared by Zoetica Environmental Consulting Services for the Nuclear Waste Management Organization.

APPENDIX A – STANDARD OPERATING PROCEDURES

Standard Operating Procedures (SOPs), field data forms, work instructions (WIs), checklists, and other instructional documents needed for the BIS baseline field studies are presented in this appendix and distributed to the field data collection contractor. SOPs for Tier 1 studies include:

- Terrestrial Ecosystem Mapping, Habitat Suitability Modelling, and Identification of Significant Wildlife Habitat SOP
- Aquatic Habitat Mapping SOP
- Aquatic Environmental DNA Field Sampling SOP
- Incidental Wildlife and Plant Observations WI – *all BIS field staff should document pertinent incidental observations.*

SOP (Rev.4)

File Name: NWMO_BIS_2020_TEM HSM SWH SOP_IG (R004)

THE NWMO BIODIVERSITY IMPACT STUDIES: STANDARD OPERATING PROCEDURES FOR TERRESTRIAL ECOSYSTEM MAPPING, HABITAT SUITABILITY MODELLING, AND IDENTIFICATION OF SIGNIFICANT WILDLIFE HABITAT – NORTHWESTERN ONTARIO SITE

July 26, 2021

PREPARED BY Zoetica Environmental Consulting Services

SUBMITTED TO Melissa Mayhew
Nuclear Waste Management Organization
22 St. Clair Avenue East
Fourth Floor, Toronto, ON
M4T 2S3, Canada

OFFICE 102-22351 St Anne Ave, Maple Ridge, BC, V2X 2E7
PHONE 604 467 1111
WEBSITE www.zoeticaenvironmental.com

Revision History

Project Title: NWMO Biodiversity Impact Studies

Document Title: SOP for TEM, Habitat Suitability Modelling, and SWH Identification - Northwestern Ontario Site

Document File Name: NWMO_BIS_2020_TEM HSM SWH SOP_IG (R004)

Rev. #	Issue Date	Description	Prepared By	Reviewed By	Approved By
R000	14-Aug-2020	BIS Year 1 final submission to NWMO	D. MacKinnon	A. Buckman	H. Bears
R001	18-Dec-2020	Revised submission for Rev.1 of NW Ontario BPD Report: - Edited for list and map of field sampling locations (App B, C) - Minor copyedits, formatting (throughout)	D. MacKinnon	H. Bears	H. Bears
R002	21-Apr-2021	Revised submission for Rev.2 of NW Ontario BPD Report: - Clarified percent cover estimates to the nearest 10% (3.2.1, 3.2.2, 3.4.1) - Explained standard 7-letter alpha code system for species codes; clarified when species level ID is needed (3.4.1) - Minor copyedits, formatting (throughout)	C. Chui	D. MacKinnon	H. Bears
R003	24-Jun-2021	Revised Tables to include/exclude information and incorporate feedback received by field contractor. Clarifications added to text.	D. MacKinnon	A. Buckman & H. Bears	A. Buckman
R004	22-Jul-2021	Revised Site and Soil form to include requested fields, changed GRTS number to Station ID, removed plot number/crew id and added time/change date format for new unique identifier, added HSM cheat sheet appendix (App E), add requirements for mandatory notes in section 4.4.1, changed percent cover from 10% to 5%.	D. MacKinnon	C. Chui	H. Bears

Table of Contents

List of Figures

List of Tables

GLOSSARY OF TERMS

BAF	Basal Area Factor
CWD	Coarse Woody Debris
DBH	Diameter at Breast Height
ELC	Ecological Land Classification
GPS	Global Positioning System
GRTS	Generalized Random Tessellation Stratified
NWMO	Nuclear Waste Management Organization
OS	OverSample
P1	PanelOne
QA	Quality Assurance
QC	Quality Control
SOP	Standard Operating Procedure
TEM	Terrestrial Ecosystem Mapping
UTM	Universal Transverse Mercator
Full, Ground and Visual Survey Types	Each survey type explains the level of detail which will be collected at each site. A Full Survey is the highest level of detail; all forms are completed. Ground Surveys have a moderate amount of detail; the Vegetation Form, Wildlife Assessments, and only the required fields of the Site and Soil Description Form need to be completed. A Visual Survey is the lowest level of detail; only the required fields of the Site and Soil Description Form need to be completed.
PanelOne and OverSample points	PanelOne (P1) points are pre-selected points in a Generalized Random Tessellation Stratified study design. If a P1 site is found to be inaccessible after reasonable effort, then the surveyor can visit/consider the next OverSample (OS) point as a replacement.

1.0 INTRODUCTION

1.1 Purpose and Principle

The purpose of this Standard Operating Procedure (SOP) is to guide field data collection contractors in the collection of baseline data to facilitate site selection and impact assessment for the NWMO's Adaptive Phased Management (APM) Project.

There are currently insufficient data available for mapping the landscape to the level of detail or spatial resolution needed to support other studies and habitat suitability modelling products. The current SOP focuses on collecting baseline data for defining ecosystems, ecosystem attributes, and habitats that could host various species of interest in the area. The completion of Terrestrial Ecosystem Mapping (TEM) and Habitat Suitability Modelling for the project will act as a foundation of information that will be used in planning and focusing on future studies. The methods described in this Standard Operating Procedure (SOP) are based on the general methodology in *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998) and the detailed field methods in *Field Manual for Describing Terrestrial Ecosystems 2nd Edition* (BC MFR and BC MOE 2010). All figures and tables are from *Field Manual for Describing Terrestrial Ecosystems 2nd Edition* (BC MFR and BC MOE 2010) unless otherwise indicated.

1.2 General Precautions

Suggestions and precautions noted herein should not be interpreted as prescriptive or exhaustive. The field data collection contractor is responsible for their own field safety protocols, which includes the planning of field safety gear.

The area in which the fieldwork is to be completed is remote, and hazards may arise while in the field. The field data collection contractors should be experienced in the region, or a similar remote area, and should ensure that adequate safety protocols are developed for field crews. It is the responsibility of the field data collection contractor to develop safety protocols and to ensure field crews are properly trained and skilled in the data collection methods being employed. The field data collection contractor is responsible for their own field safety protocols, which includes the planning of field safety gear (including redundancies).

Where certain survey points are inaccessible due to safety concerns, the field crew will be able to skip the point and move to the next available point without compromising the statistical validity of the survey, following the design within this program. If a helicopter is available, it can be used to access points that are inaccessible by ground, to access locations close enough to facilitate ground-based entry to points. Where helicopters are used, it is the responsibility of the field data collection contractor and contracted helicopter company to ensure that all helicopter related safety protocols are followed.

1.3 Quality Control

The field data collection contractor is expected to develop their own Quality Assurance (QA) and Quality Control (QC) protocols to ensure that field-based activities (e.g., data collection and data entry) meet the expectations of the NWMO. QA/QC protocols must include a method to back up all field data collected and to prevent the loss of data stored in one location or method (e.g., a lost field form).

2.0 SITE AND SOIL DESCRIPTION

2.1 Equipment and Materials

Field forms for printing can be found in Appendix A; all hard copies brought into the field should be printed on waterproof paper. Where possible, electronic equipment should also be waterproof. The field data collection contractor is responsible for their own field safety protocols, which includes the planning of field safety gear.

2.1.1 General Field Equipment

- Hard copies of field forms
- Hard copies of SOP
- Hard copies of survey location coordinates and field maps
- Hard copy of *Ecosites of Ontario* (ELC Working Group 2009)
- Pen/pencils
- Waterproof notebook
- Clipboard
- Binoculars
- Camera
- GPS unit
- Tablet or smartphone with georeferenced map
- Compass
- Large spool measuring tape
- Small measuring tape
- Rangefinder (optional)

2.1.2 Soil Description Specific Equipment

- Shovel
- Trowel
- Golf tees
- Soil pH testing kit
- Pruners
- Water bottle (for texturing)
- Grain size card
- Munsell colour charts
- Hand lens
- Hand-held weather meter
- Hard copy of *Field Guide to the Substrates of Ontario* (OMNR 2015)

2.2 Field Procedure

1. Each day, a route should be determined using the *List of Sites and Site Information* in Appendix B and *Map of Field Sampling Locations* in Appendix C. Each daily route plan should ensure any sites not visited the previous day due to time limitations are included in the next day's route. The field data collection contractor should note any required use of helicopters to assist access or speed up fieldwork.
2. When in the field, follow the day's route to navigate to the next site. Sites have been determined using a GRTS design to create stratified and randomized points. As part of this design method, some points are pre-selected as PanelOne (P1) for sampling or OverSample (OS). If a P1 site is determined after a reasonable effort to be inaccessible, an OS site can be used in place of the P1 site. If the OS site is also deemed inaccessible after reasonable effort, the next OS site can be visited/considered. The field data collection contractor should take care not to skip points too quickly and without effort in favour of randomized points that happen to occur next to easily accessible areas (roads, cleared forest); this may impose a site selection bias meant to be diminished via the use of pre-selected, random points. While points should be visited in order, wherever possible, logistical constraints due to difficulty accessing areas may render it necessary to deviate from the ordering from P1 points and OS points from time to time, (e.g., in a situation where there is only one way into a large, difficult to access area and points can be selected along

a hiking route). In such cases, the replacement of any P1 sites with an OS site should be noted in the notes section of the ***Site and Soil Description Form***.

3. Using the *List of Sites and Site Information* in Appendix B, check what type of survey is meant to be conducted at each point visited (**Full, Ground, or Visual**; this survey type is predetermined for the field data collection contractor by Zoetica).
4. Locate and mark plot boundaries (20m x 20m square) for Full plots or plot center for Ground plots (no marking required for visual plots).
5. Assemble required gear for survey type according to the gear lists in Section 3.1.

2.2.1 Full Site and Soil Description Procedure

1. Photograph the plot. It is a good idea to take 4 photos in each cardinal direction (begin looking north and turn clockwise), as well as one that shows canopy cover (up) per site. Photographs should also be taken of any notable features and the location the soil pit will be dug. Record the number of each photo in notes and photo number, along with a description of what the photo is showing.
2. Locate and excavate a soil pit to a depth of about 20 cm then auger to a total depth of 50 cm. Photograph pit profile.
3. On the ***Site and Soil Description Form***, enter the information in the header (date, time form was completed, all surveyors' names and roles, weather fields, page number).
4. Using the *List of Sites and Site Information* in Appendix B, record the information in the predetermined site information section (UTM zone, easting/lat., northing/long., Station ID, polygon number, ecosite code, and survey type)
5. Record latitude and longitude or UTM coordinates using field GPS. Record estimated location accuracy and elevation.
6. Determine the slope and aspect.
7. Traverse the entire plot systematically, observing the position of the plot relative to the surrounding landscape, microtopographic features, and the composition of surface substrates. Record the mesoslope position.
8. Assess the soils and determine humus form, soil drainage, rooting zone soil texture, and percent coarse fragments. Record the depth of the soil pit and rooting depth. Note presence and depth of Ah or Ae horizons, gleying, and seepage. Record the depth and type of root restricting layer, if any, and the depth of the surface organic horizon.
9. Confirm the ecosite code. Integrate site, soil and vegetation factors and keys in *Ecosites of Ontario* (ELC Working Group 2009) to determine ecosite code. On the ***Site and Soil Description Form,*** note the new ecosite code and rationale for change if the ecosite determined in the field is different from the predetermined ecosite.
10. Describe the key site features under notes and photo number. Draw a site diagram if important features can be effectively depicted.
11. Check to be sure that all required fields have been completed. If any fields require review or completion at a later date (e.g., confirmation of species identification), indicate this at the bottom of the form.

2.2.2 Ground Site and Soil Description Procedure

1. Photograph the plot. It is a good idea to take 4 photos in each cardinal direction (begin looking north and turn clockwise), as well as one that shows canopy cover (up) per site. Photographs should also be taken of any notable features and the location the soil pit will be dug. Record the

number of each photo in notes and photo number, along with a description of what the photo is showing.

2. Locate and excavate a soil pit to a depth of about 20 cm then auger to a total depth of 50 cm. Photograph pit profile.
3. On the ***Site and Soil Description Form***, enter the information in the header (date, time form was completed, all surveyors' names, weather fields, page number).
4. Using the *List of Sites and Site Information* in Appendix B, record the information in the predetermined site information section (UTM zone, easting/lat., northing/long., Station ID, polygon number, ecosite code, and survey type).
5. Record latitude and longitude or UTM coordinates using field GPS. Record estimated location accuracy and elevation.
6. Confirm the ecosite code. Integrate site, soil, and vegetation factors and keys in *Ecosites of Ontario* (ELC Working Group 2009) to determine ecosite code. On the ***Site and Soil Description Form,*** note the new ecosite code and rationale for change if the ecosite determined in the field is different from the predetermined ecosite.
7. Describe the key site features under notes and photo number. Draw a site diagram if important features can be effectively depicted.
8. Check the form to ensure all the required information has been collected. If any fields require review or completion at a later date (e.g., confirmation of species identification), indicate this at the bottom of the form.

2.2.3 Visual Site and Soil Description Procedure

1. Photograph the plot. It is a good idea to take 4 photos in each cardinal direction (begin looking north and turn clockwise), as well as one that shows canopy cover (up) per site. Photographs should also be taken of any notable features. Record the number of each photo in notes and photo number, along with a description of what the photo is showing.
2. On the ***Site and Soil Description Form***, enter the information in the header (date, time form was completed, all surveyors' names, weather fields, page number).
3. Using the *List of Sites and Site Information* in Appendix B, record the information in the predetermined site information section (UTM zone, easting/lat., northing/long., Station ID, polygon number, ecosite code, and survey type).
4. Record latitude and longitude or UTM coordinates using field GPS. Record estimated location accuracy and elevation.
5. On the ***Site and Soil Description Form***, record what ecosite code the plot is in. Use the keys in *Ecosites of Ontario* (ELC Working Group 2009) to identify the ecosite code. If different from the pre-typed ecosite, detail why it was changed.
6. Describe the key site features under notes and photo number. Draw a site diagram if important features can be effectively depicted.
7. Check the form to ensure all the required information has been collected. If any fields require review or completion at a later date (e.g., confirmation of species identification), indicate this at the bottom of the form.

2.3 Field Form

Site and Soil Description Form

Date (MM-DD-YYYY) 1	Time Completed (hh:mm) 2	All Surveyors 3	Weather Conditions: 4	Page 5 Of

Wind Direction: 6	Wind Speed (km/h): 7	Temperature (°C): 8	Rain last 24hr (mm): 9	Snow past 24hr (cm): 10

Predetermined Site Information

UTM Zone	Easting/Lat. 11	Northing/Long.	Station ID 12	Polygon Number 13	Ecosite 14	Survey Type Full ☐ Gr. ☐ Vis. ☐ 15

Information Determined at Site

UTM Zone	Easting/Lat. 16	Northing/Long.	GPS Accur. (m)	Elevation (m)	Ecosite 47	Rational for Ecosite Change 48

Site Description

Slope 17 %	Aspect 18 °	Surface Shape CCV ☐ CVX ☐ STR ☐ 19	Microtop Feature 20	Meso Slope Pos. Crest ☐ Upper ☐ Mid ☐ Lower ☐ Toe 21 Level ☐ Dep. ☐ Gully ☐	Floodplain? Y☐ 22 N☐	Drainage (1-7) 23

Site dist. ☐ n/a ☐ fire ☐ harvest ☐ site prep ☐ planted ☐ terrain ☐ biotic ☐ soil dist. ☐ other 24	Humus/ Organic Form ☐ Mull ☐ Moder ☐ Fibrimor ☐ Humimor ☐ Peatymor ☐ Anmoor 25	Seepage ☐n/a 26 cm

Humus Thickness 27 cm	Ah? ☐ Ae? ☐ 28 cm	Soil Pit Depth 29 cm	Estimated Rooting Depth 30 cm	R.Z. Coarse Frag 31 %	R.Z. Text. 32

TLFH 33 cm	TSOM 34 cm	Dep. Mot. 35 cm	Dep. Gley. 36 cm	Dep. Water T. 37 cm	Dep. Imp. Lay. 38 cm	Dep. Tex. Chg. 39 cm
Dep. Bedrock 40 cm	Dep. Of Data 41 cm	Texture B Hor. 42 cm	Texture C Hor. 43 cm	Effec. Texture 44 cm	Moisture Reg. 45	Substrate Series 46

Site Diagram 49

Notes and Photo Numbers:

50

Review needed: 51 Date entered into spreadsheet: 52 Entered by: QA/QC by:

2.4 Completing the Form

Field Label	Description and Instructions
1	Enter the **date** in MM-DD-YYYY format. (e.g., 02-01-2020 for February 1st, 2020).
2	Enter the **time** the form was completed in hh:mm (24 hr) format (e.g., 13:00 for 1pm). Note that if more than one form is used, the same time should be entered on all form to indicate when all forms were completed.
3	Enter all **surveyor(s)** first initial and last name, followed by their role.
4	Describe the **weather conditions**, including any precipitation. Examples include sunny, overcast, cloudy, light rain, fog.
5	Enter digit for the **page number**. Complete the total number of pages once the survey is complete in case multiple pages are used.
6	Record the general **wind direction** using cardinal/ordinal directions (e.g., N, NNE, NE, ENE), the word calm for no wind, or the word variable for frequently changing wind direction.
7	Record the **wind speed** in km/h.
8	Record the **temperature** in °C.
9	Record the **rainfall from the past 24 hours** in mm.
10	Record the **snowfall from the past 24 hours** in cm.
11	Copy the predetermined site coordinates from the *List of Sites and Site Information* in Appendix B. If using UTM coordinates, enter the **UTM zone, easting**, and **northing**.
12	Copy the **Station ID** from the *List of Sites and Site Information* in Appendix B.
13	Copy the **polygon number** from the *List of Sites and Site Information* in Appendix B.
14	Copy the **ecosite** code that was previously determined from the *List of Sites and Site Information* in Appendix B.
15	Check the box for the **survey type** being completed, either full, ground, or visual. This information will be on the *List of Sites and Site Information* in Appendix B.
16	Using a GPS unit, write the **coordinates** of the center of the plot, the **accuracy** of the GPS, and the **elevation**.
17	Record the percent **slope** gradient, measured with a clinometer or similar instrument.
18	Record the **aspect**, which is the orientation of the slope relative to true north, measured by compass, in degrees. Enter due north as 360°, and for level ground enter 0.
19	Note the general **surface shape** and mark the appropriate surface shape box. **CCV** **Concave** – surface profile is mainly “hollow” in one or several directions **CVX** **Convex** – surface profile is mainly “rounded” like the exterior of a sphere **STR** **Straight** – surface profile is linear, either flat or sloping in one direction
20	Record the type, size, and frequency of **microtopographic** features. **<u>Size and frequency of microtopographic features:</u>** **mc.** **micro** – low relief features (< 0.3 m high) with minimal effect on vegetation **sl.** **slightly** – prominent features (0.3–1m high) spaced > 7 m apart **md.** **moderately** – prominent features (0.3–1m high) spaced 3–7 m apart

st. **strongly** – prominent features (0.3–1m high) spaced 1–3 m apart
sv. **severely** – prominent features (0.3–1m high) spaced < 1 m apart
ex. **extremely** – very prominent features (> 1 m high) spaced > 3 m apart
ul. **ultra** – very prominent features (> 1 m high) spaced < 3 m apart

Types of microtopographic features:

cha **channelled** – incised water tracks or channels
dom **domed** – raised bogs
gul **gullied** – geomorphic ridge and ravine patterns
hmk **hummocked** – mounds composed of organic materials
lob **lobed** – solifluction lobes
mnd **mounded** – mounds composed of mineral materials
net **netted** – net vegetation patterns from freeze-thaw action in alpine or subarctic terrain
pol **polygonal** – polygonal patterns associated with permafrost
rib **ribbed** – wetland pattern with raised ridges perpendicular to the direction of water flow
dmo **smooth** – surface relatively flat
tus **tussocked** – associated with tussock-forming graminoids
und **undulating** – controlled by bedrock

21 Indicate the **mesoslope position** of the plot relative to the localized catchment area (see **Figure 2-1**).

Crest The generally convex uppermost portion of a hill; usually convex in all directions with no distinct aspect.
Upper Slope The generally convex upper portion of the slope immediately below the crest of a hill; has a specific aspect.
Middle Slope Area between the upper and lower slope; the surface profile is generally neither distinctly concave nor convex; it has a straight or somewhat sigmoid surface profile with a specific aspect.
Lower Slope The area toward the base of a slope; generally has a concave surface profile with a specific aspect.
Toe The area demarcated from the lower slope by an abrupt decrease in slope gradient; seepage is typically present.
Depression Any area concave in all directions; may be at the base of a mesoscale slope or in a generally level area.
Level Any level meso-scale area not immediately adjacent to a meso-scale slope; the surface profile is generally horizontal and straight with no significant aspect.
Gully An area in a double toe slope position where the receiving area is also sloped (perpendicular to the toe slopes).

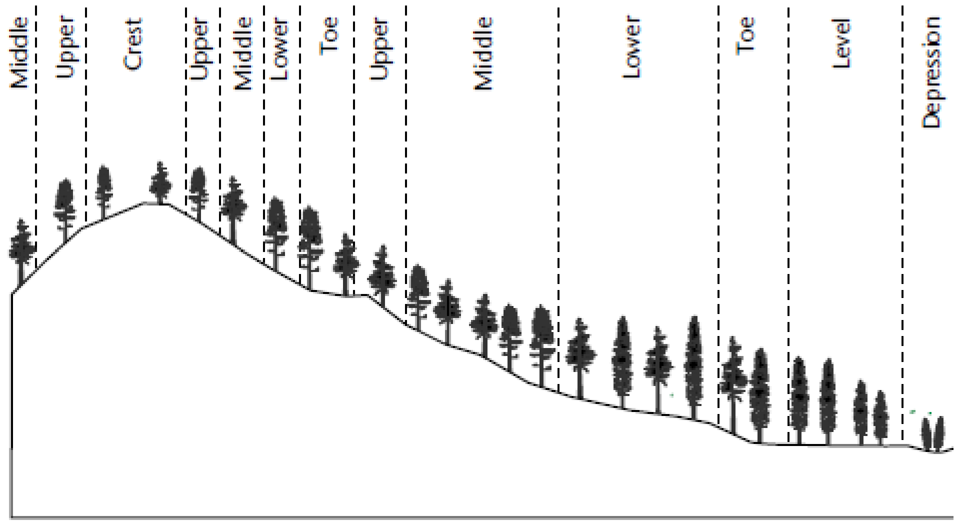


Figure 2-1. Mesoslope position.

22 Indicate whether the site is within a **floodplain** by checking the yes (Y) box or no (N) box.

23 **Drainage class** describes the speed and extent to which water is removed from a mineral soil in relation to additions. Enter the code according to the chart in **Figure 2-2** or the definitions in **Table 2-1.**

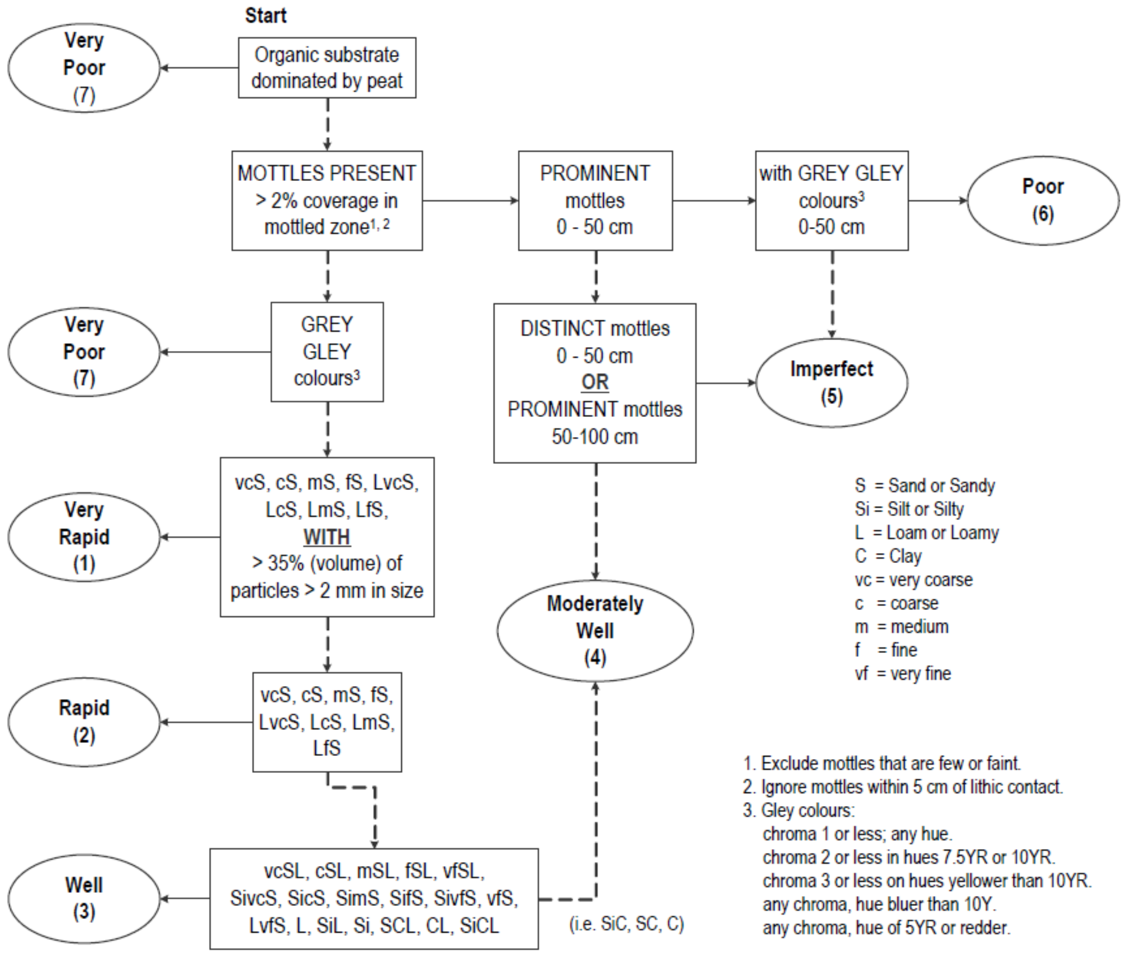


Figure 2-2. Drainage classes (OMNR 2015).

Table 2-1. Drainage classes and codes.

Code	Name	Description
1	**Very Rapid**	Water is removed from the soil very rapidly in relation to supply. Water source is precipitation and available water storage capacity following precipitation is essentially nil. Soils are typically fragmental or skeletal, shallow, or both.
2	**Rapid**	Water is removed from the soil rapidly in relation to supply. Excess water flows downward if the underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Water source is precipitation. Soils are generally coarse-textured.
3	**Well**	Water is removed from the soil readily, but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Water source is precipitation. On slopes, subsurface flow may occur for short durations, but additions are equalled by losses. Soils are generally intermediate in texture and lack restricting layers.

4	**Moderately Well**	Water is removed from the soil somewhat slowly in relation to supply because of imperviousness or lack of gradient. Precipitation is the dominant water source in medium- to fine-textured soils; precipitation and significant additions by subsurface flow are necessary in coarse-textured soils.
5	**Imperfect**	Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is the major source. If subsurface water or groundwater (or both) is the main source, the flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface or groundwater flow (or both) increases as available water storage capacity decreases. Soils generally have a wide range of texture, and some mottling is common.
6	**Poor**	Water is removed so slowly in relation to supply that the soil remains wet for much of the time that it is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface or groundwater flow (or both), in addition to precipitation, are the main water sources. A perched water table may be present. Soils are generally mottled and/or gleyed.
7	**Very Poor**	Water is removed from the soil so slowly that the water table remains at or near the surface for most of the time the soil is not frozen. Groundwater flow and subsurface flow are the major water sources. Precipitation is less important, except where there is a perched water table with precipitation exceeding evapotranspiration. Typically associated with wetlands. For organic wetlands, also evaluate the soil moisture subclass, and when entering on the form, separate from drainage by a slash. For example, v/ac.

24 Note any **site disturbance** events that have caused vegetation and soil characteristics to differ from those expected at climax for the site. Provide details in the **Notes** section.

25 Examine the **humus form profile** and tick the appropriate box according to **Figure 2-3**.

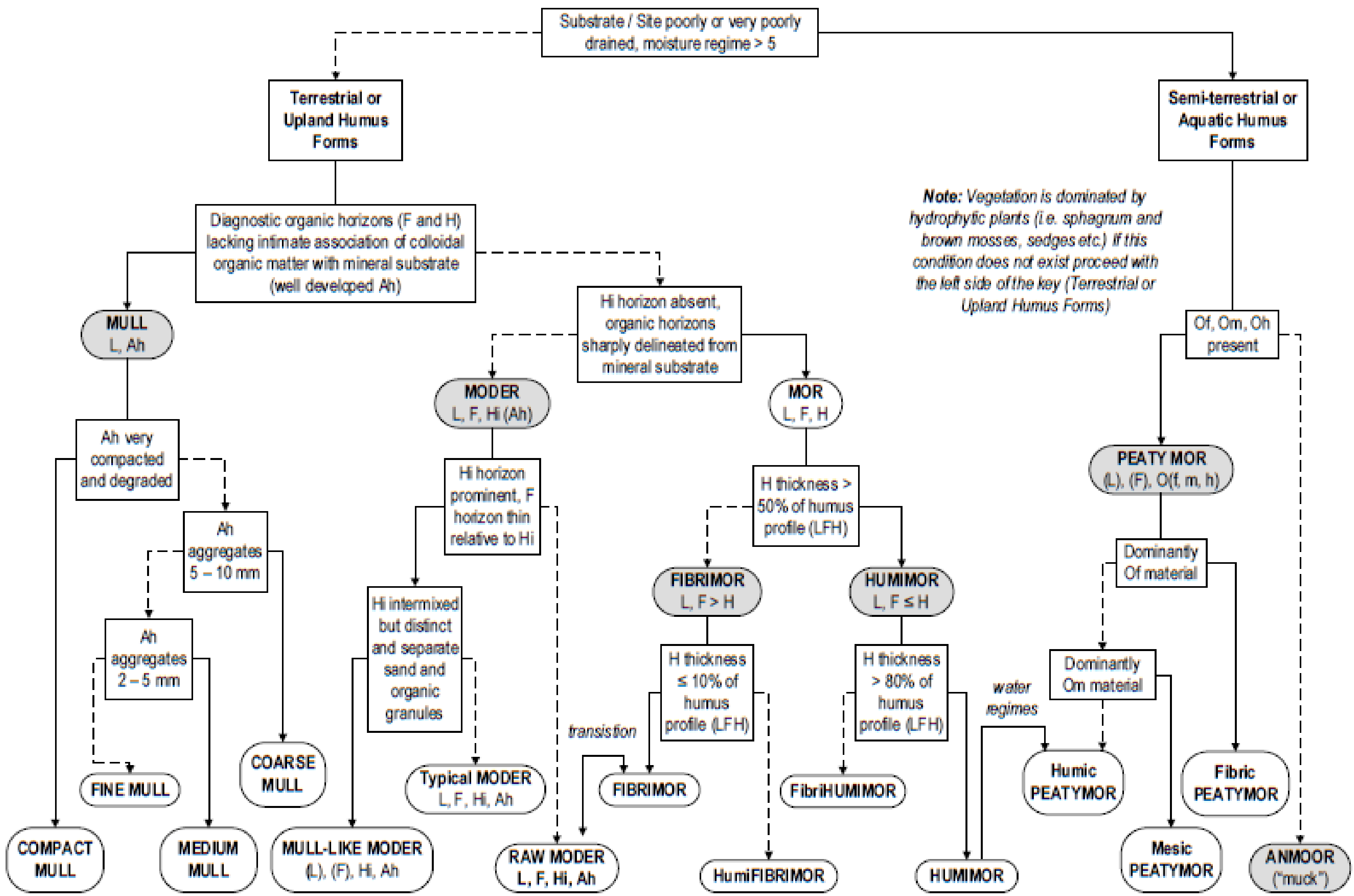


Figure 2-3. Key to humus form classification (OMNR 2015).

26 Record the depth (from the ground surface) of active **seepage** or water table. If no seepage is present, mark the n/a box.
27 Measure the **thickness of the surface organic horizon**, in centimetres, from the top of the ground surface to the top of the first mineral horizon.
28 If an **A horizon** is present, mark the appropriate type box and record the thickness of the horizon in centimetres.
29 Record the **depth of the soil pit.**
30 Record the **rooting zone depth.** It is measured from the ground surface to the point at which the majority of roots stop.
31 Estimate the **percent coarse fragment** (>2 mm diameter) volume in the rooting zone of the soil profile rounded to the nearest 10%.
32 After determining the rooting depth, estimate the **rooting zone texture** class as a weighted average of the mineral horizons within the rooting zone (**Figure 2-4**, **Table 2-2**). Where rooting is restricted to the organic horizons, use the organic material codes in **Table 2-2**. Rooting zone classes are greatly simplified and use only percent coarse fragments (> 2 mm) by volume, and texture class sizes by percent weight for sand (.05 to < 2 mm), silt (< .05 to .002 mm), and clay (< .002).

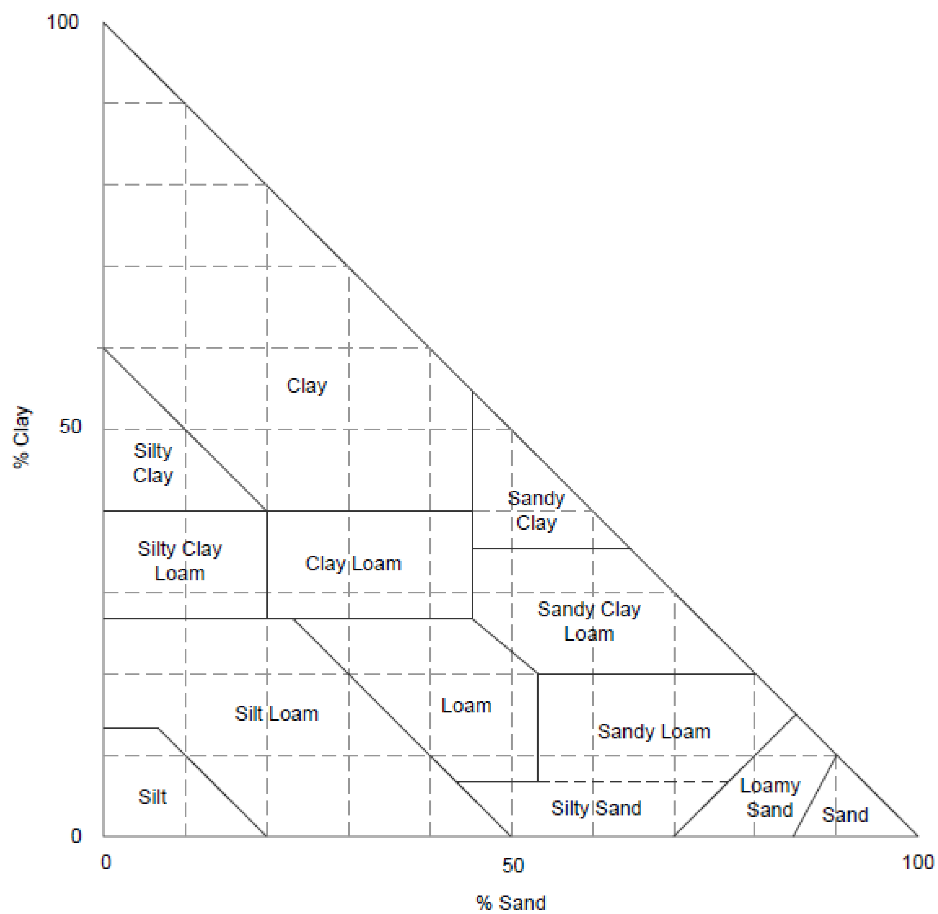


Figure 2-4. Rooting zone particle size classes (OMNR 2015).

Table 2-2. Rooting zone particle sizes classes.

Code	Class	Definitions	
Coarse fragments ≥ 70%			
F	Fragmental	Particles <2 mm of various textures	
Coarse fragments ≥ and less than 70%			
SS	Sandy-skeletal	Particles <2 mm sandy	
CLS	Coarse-loamy-skeletal	Particles <2 mm coarse-loamy	
FLS	Fine-loamy-skeletal	Particles <2 mm fine-loamy	
SIS	Silty-skeletal	Particles <2 mm fine-silty or coarse-silty	
CS	Clayey-skeletal	Particles <2 mm clayey	
Code	**Class**	**Code**	**Class**
Coarse fragments < 35%			
S	Sandy	Organic Material Codes	
CL	Coarse-loamy	**FI**	Fibric
FL	Fine-loamy	**ME**	Mesic
CSI	Coarse-silty	**HU**	Humic
FSI	Fine-silty	**WO**	Woody
FC	Fine-clayey		
VFC	Very-fine-clayey		

33 Record the **thickness of folic material (TLFH)** which is measured from the upper limit (living moss rule*) to the lower limit of folic material (interface with rock, or mineral materials).

34 Record the **thickness of surface organic layer (TSOM)** which is measured from top of LFH or O layer to first contact with mineral material, buried water layer, or bedrock.

35 Record the **depth to mottles** which is measured from the organic-mineral interface to the uppermost level of distinct or prominent mottles. Record "-99" if not encountered.

36 Record the **depth to gleying** which is measured from the organic-mineral interface to the uppermost level of gley. Record "-99" if not encountered.

37 Record the **depth to water table** which is measured from the surface (see living moss rule*) to the upper limit of observed water. Record "-99" if not encountered.

38 Record the **depth to impervious layer** which refers to a hardened mineral layer and does not include bedrock. Record "-99" if not encountered.

39 Record the **depth of major texture change**. Record "-99" if not encountered.

40 Record the **depth to bedrock** which is measured from the surface (see living moss rule*), to observed bedrock. Record "-99" if not encountered.

41 Record the **depth to which data** were collected.

42 Record the **texture of the B Horizon** as described in *Field Guide to the Substrates of* Ontario (OMNR 2015).

43 Record the **texture of the C Horizon** as described in *Field Guide to the Substrates of* Ontario (OMNR 2015).

44 Record the **effective texture** according to the key in *Field Guide to the Substrates of* Ontario (OMNR 2015).

45 Record the **moisture regime** according to the keys in *Field Guide to the Substrates of* Ontario (OMNR 2015).

46 Determine the **substrate series** using the keys found in *Field Guide to the Substrates of* Ontario (OMNR 2015).

47 Discuss with the vegetation specialist and decide on the **ecosite code** which best describes the site.

48 Describe the **rationale for ecosite change** by detailing what about the plot does not align with the previously assigned ecosite code and/or why the new ecosite code fits better. If more room is needed, use the notes section.

49 Provide a sketch of the site if there are any features of note.

50 Use the **notes and photo numbers** space to record important site or soil features not described elsewhere, or for explanatory notes keyed to other entries on the form. All photos taken for this form need the photo number recorded, and a brief description of what is shown in the photo. If more space is needed, use the back of the field sheet and indicate with a large and bold arrow that more information is recorded on the back of the form.

51 To indicate if some information on the form needs **review** before final submission (e.g., review species identification) write the word yes in this field. Indicate in the notes space which field(s) need to be reviewed as well as the date the review was completed.

52 Not to be completed in the field. Data should be entered into a spreadsheet as soon as possible, ideally completed daily. Once data are entered into the spreadsheet, fill in the date entered and who entered it. Data entry should be reviewed by a second person and any discrepancies discussed with the original surveyor. Enter the name of the QA/QC reviewer once completed.

* Living Moss Rule:
In all instances (universally applied) of measuring the upper limits of surface organic horizons, the living matter is excluded. The upper point of measure lies directly below the living portion. For mosses, the living portion of the plant is the green and obviously fresh portion of the stem immediately adjacent to the brown portion. This roughly equates to the photosynthesising portion of the plant. (OMNR 2015)

3.0 VEGETATION SURVEY

3.1 Equipment and Materials

Field forms for printing can be found in Appendix A; all hard copies brought into the field should be printed on waterproof paper. Where possible, electronic equipment should also be waterproof. The field data collection contractor is responsible for their own field safety protocols, which includes the planning of field safety gear.

3.1.1 General Field Equipment

- Hard copies of field forms
- Hard copies of SOP
- Hard copies of survey location coordinates and field maps
- Hard copy of *Ecosites of Ontario* (ELC Working Group 2009)
- Pen/pencils
- Waterproof notebook
- Clipboard
- Binoculars
- Camera
- GPS unit
- Tablet or smartphone with georeferenced map
- Compass
- Large spool measuring tape
- Small measuring tape
- Rangefinder (optional)

3.1.2 Vegetation Specific Equipment

- Plant identification guides
- Hand lens
- Diameter tape
- Releskop or prism set
- Tape
- Flagging tape
- Flagging stakes
- Hard copies of critical distance tables
- Calculator
- Callipers
- Densiometer (optional, as an aid for estimating canopy cover %)

3.2 Field Procedure

1. Each day, a route should be determined using the *List of Sites and Site Information* in Appendix B and *Map of Field Sampling Locations* in Appendix C. Each daily route plan should ensure any sites not visited the previous day due to time limitations are included in the next day's route. The field data collection contractor should note any required use of helicopters to assist access or speed up fieldwork.
2. When in the field, follow the day's route to navigate to the next site. Sites have been determined using a GRTS design to create stratified and randomized points. As part of this design method, points are pre-selected as PanelOne (P1) for sampling or OverSample (OS).
    - If a P1 site is determined to not be representative of the polygon (e.g., microclimate on top of a small hill or severely disturbed), the surveyors can move the point to another location within the polygon that is more representative. Ideally, the point will be moved the shortest distance possible from the original point. Record the rationale for moving the point in the notes section of the ***Site and Soil Description Form***.
    - If a P1 site is determined to not fit a 20m x 20m plot within the intended polygon while preserving a 20m buffer from other ecosite polygons, then the surveyors can consider completing a 10m x 40m plot. If there is still not enough space to place a 10m x 40m plot, then the surveyors can move the plot to another representative area within the polygon,

ideally moving it the shortest distance possible. If there is no location the plot will fit within the polygon, then it can be replaced with an OS site. Record the rationale for moving or replacing the point in the notes section of the ***Site and Soil Description Form***.

- If a P1 site is determined after a reasonable effort to be inaccessible, an OS site can be used in place of the P1 site. If the OS site is also deemed inaccessible after reasonable effort, the next OS site can be visited/considered. Record the rationale for replacing the point in the notes section of the ***Site and Soil Description Form***.

The field data collection contractor should take care not to skip points too quickly and without effort in favour of randomized points that happen to occur next to easily accessible areas (roads, cleared forest); this may impose a site selection bias meant to be diminished via the use of pre-selected, random points. While points should be visited in order wherever possible, logistical constraints due to difficulty accessing areas may render it necessary to deviate from the ordering from P1 points and OS points from time to time, such that points can be planned to be visited along hiking routes (e.g., in a situation where there is only one way into a large, difficult to access area). In such cases, the replacement of any P1 sites with an OS site should be noted in the notes section of the ***Site and Soil Description Form***.

3. Using the *List of Sites and Site Information* in Appendix B, determine survey type (Full, Ground, or Visual).
4. Locate and mark plot boundaries (20m x 20m square) for Full plots or plot center for Ground plots (no marking required for visual plots).
5. Assemble required gear for survey type according to the gear lists in Section 3.1.

3.2.1 Full Vegetation Survey Procedure

1. Photograph the plot. It is a good idea to take 4 photos in each cardinal direction (begin looking north and turn clockwise), as well as one that shows canopy cover (up) per site. Photographs should also be taken of any notable features. Record the number of each photo in notes and photo number, along with a description of what the photo is showing.
2. On the ***Vegetation Survey Form***, enter the information in the header (date, time form was completed, polygon number, vegetation surveyors' names, survey type, page number).
3. Enter the code for the structural stage.
4. Estimate the stand height to the nearest 5m.
5. Standing at one point in the plot, list all species observed in each layer.
6. Traverse the entire plot (or one quadrant at a time) in an increasing spiral or zigzag pattern, noting each new species. It is expected that the surveyor records a large majority of plant species within the plot using reasonable effort to record plants that are visible during traversing. The plant species list should include both major and minor species (i.e., <5% vegetative cover).
7. Collect unknown species, recording each by a temporary name and plot collection number on the form (e.g., moss 01, hairy grass 02, herb 03, etc.). Mark sample bags and pressing sheets with plot and collection numbers.
8. When the list seems complete, begin estimating percent cover. For each layer:
   - estimate total layer cover (to the nearest 5%, unless trace amounts exist, then record as <5%) and enter at top of the form;
   - estimate individual species covers (to the nearest 5%, unless trace amounts exist, then record as <5%) for the entire layer and sublayers, if present (i.e., first A, then A1, A2, A3);
   - add up species covers and compare to total species cover and total layer cover; reconcile any discrepancies, remembering that overlap can occur between species and layers.

9. Check that all required fields have been completed on the form. If any fields require review or completion at a later date (e.g., confirmation of species identification), indicate this at the bottom of the form.
10. On the ***Tree Attributes for Wildlife Survey Form***, enter the information in the header (date, time form was completed, polygon number, vegetation surveyors' names, BAF, Plot Size, Minimum DBH, page number).
11. For each sample tree, record the species and classify them as standing or fallen.
12. Determine dbh and percentage of bark remaining at breast height.
13. Record data required to calculate the length of each sample tree or estimate the length.
14. For each standing live tree, assign a crown class and determine the height to live crown.
15. For each sample tree, assess the appearance, crown condition, bark retention, wood condition, lichen loading, and wildlife use.
16. For each tree, count (or estimate if greater than 10) and record the number of cavities or crevices in each tree.
17. Check that all the required information has been collected and noted on the form. Strikethrough any fields that were not assessed. If any fields require review or completion at a later date (e.g., confirmation of species identification), indicate this at the bottom of the form.
18. On the ***Coarse Woody Debris Survey Form***, enter the information in the header (date, time form was completed, polygon number, vegetation surveyors' names, page number).
19. Establish the first coarse woody debris sampling line by following a random azimuth for that plot.
    - Measure out a 24-m line from the plot centre, correcting the slope distance to horizontal by using slope tables or trigonometry.
    - Anchor the tape at both ends of the line.
20. Establish the second sampling line at plus 90° from the first line by following the same procedures in (19) above.
21. Record the azimuth of each line.
22. Note the length of each line sampled out of the total. The full length of one or both lines may not be sampled because of unsafe conditions or heavy accumulations of CWD. Otherwise, they will be 24 out of 24 m.
23. Walk out along the first sampling line and select the pieces of CWD to be measured according to the sampling rules. Take care not to trample and crush the CWD as you walk along the line.

    As each piece that fits the definition of CWD is encountered, note the following:
    - tree species to the level that is reliable,
    - diameter,
    - decay class, based on the entire piece, by using the table of decay class indicators,
    - tilt angle of each piece, and
    - length of each piece.
24. Where CWD pieces are suspended above the sampling line it may be necessary to estimate certain attributes (diameter and/or length).
25. If odd-shaped pieces are encountered, use the rectangular method by record their diagonal length at intersection and width (ground to height of piece) (Marshall *et al.* 2000).
26. Repeat steps 23, 24, and 25 for the second transect line.

27. Check the form to ensure all the required information has been collected. If any fields require review or completion at a later date (e.g., confirmation of species identification), indicate this at the bottom of the form.
28. Confirm the ecosite code. Integrate site, soil and vegetation factors and keys in *Ecosites of Ontario* (ELC Working Group 2009) to determine ecosite code. On the ***Site and Soil Description Form,*** note the new ecosite code and rationale for change if the ecosite determined in the field is deferent to the predetermined ecosite.

3.2.2 Ground Vegetation Survey Procedure

1. Photograph the plot. It is a good idea to take 4 photos in each cardinal direction (begin looking north and turn clockwise), as well as one that shows canopy cover (up) per site. Photographs should also be taken of any notable features. Record the number of each photo in notes and photo number, along with a description of what the photo is showing.
2. On the ***Vegetation Survey Form***, enter the information in the header (date, time form was completed, polygon number, vegetation surveyors' names, weather, survey type, page number).
3. Record the dominant species, as well as any species specified in the *List of Plant Species for Ground Plots* in Appendix D, noting the layer. Evaluate the percent cover by species and total for each layer (to the nearest 5%, unless trace amounts exist, then record as <5%).
4. Determine the structural stage.
5. Measure or estimate average stand height and canopy composition.
6. Confirm the ecosite code. Integrate site, soil and vegetation factors and keys in *Ecosites of Ontario* (ELC Working Group 2009) to determine ecosite code. On the ***Site and Soil Description Form,*** note the new ecosite code and rationale for change if the ecosite determined in the field is deferent to the predetermined ecosite.
7. Check the form to ensure all the required information has been collected. If any fields require review or completion at a later date (e.g., confirmation of species identification), indicate this at the bottom of the form.

3.2.3 Visual Vegetation Survey Procedure

1. Photograph the plot. It is a good idea to take 4 photos in each cardinal direction (begin looking north and turn clockwise), as well as one that shows canopy cover (up) per site. Photographs should also be taken of any notable features. Record the number of each photo in notes and photo number, along with a description of what the photo is showing.
2. On the ***Site and Soil Description Form***, record what ecosite code the plot is in. Use the keys in *Ecosites of Ontario* (ELC Working Group 2009) to identify the ecosite code. If different from the pre-typed ecosite, detail why it was changed.
3. Check the form to ensure all the required information has been collected. If any fields require review or completion at a later date (e.g., confirmation of species identification), indicate this at the bottom of the form.

3.3 Field Forms

Date (MM-DD-YYYY)	Time Completed (hh:mm)	Polygon Num.	Surveyor(s)	Struc. Stage	Ave. Stand Height	Survey Type	Page	Of
1	2	3	4	5	6	Full ☐ Grd. ☐ 7	8	

COL.	TREES	A1	A2	A3	A	B1	B2	B
9	10					11		

COL.	SHRUBS	B1	B2	B
9	10		11	

COL.	HERB LAYER (C)	%
9	10	11

COL.	MOSS/LICHEN/SEEDLING (D)	%
9	10	11

COL.	ADDITIONAL SPECIES	Layer	%
9	10		11

Notes and Photo Numbers:

12

% Cover by Layer	TREE (A)	SHRUB (B)	HERB (C)	MOSS/LICHEN (D)
	13			

Review needed:	Date entered into spreadsheet:	Entered by:	QA/QC by:
14	15		

Vegetation Survey Form

Tree Attributes for Wildlife Survey Form

Date (MM-DD-YYYY)	Time Completed (hh:mm)	Polygon Number	Surveyor(s)	BAF (M^2/Ha)	Minimum DBH (cm)	Page	Of
1	2	3	4	5	6		7

Tree no.	Species	Stand/Fall	DBH (cm)	M or E	Rem. Bark (%)	Length				Estimated Length (m)	Cr. Class	Height to Live Crown	Wildlife Codes						Num Cavity or Crevice	Notes and Photo Numbers
						Top (%)	Bot. (%)	Bot. Pos. (m)	Slope Distance (m)				Appear	Crown	Bark	Wood	Lichen	Wildlife Use		19
01	8	9	10	11	12			13		14	15	16			17				18	
02																				
03																				
04																				
05																				
06																				
07																				
08																				
09																				
10																				
11																				
12																				
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				

Review needed: 20 Date entered into spreadsheet: 21 Entered by: QA/QC by:

Coarse Woody Debris Survey Form

Date (MM-DD-YYYY)	Time Completed (hh:mm)	Polygon Number	Surveyor(s)	Page	Of
1	2	3	4		5

Tree no.	Transect #1							Transect #2							Degree and Type of Piling (in plot boundaries)					
	Azimuth	6		(0-359)	Sampled	7	of 24m	Azimuth	6		(0-359)	Sampled	7	of 24m						
	Species	Diameter (cm)	Class	Tilt Angle	Length (m)	Height of end (cm)	Angle grnd.	Species	Diameter (cm)	Class	Tilt Angle	Length (m)	Height of end (cm)	Angle grnd.	Pile #	Size of pile (m) Length	Width	Height	Diam (cm)	Inter. space
01	8	9	10	11	12	13	14								1		15		16	17
02															2					
03															3					
04															4					
05															5					
06															6					
07															7					
08															8					
09															Notes and Photo Numbers					
10															18					
11																				
12																				
13																				
14																				
15																				
16																				
17																				
18																				

Review needed: 19 Date entered into spreadsheet: 20 Entered by: QA/QC by:

3.4 Completing the Form

3.4.1 Completing the Vegetation Survey Form

Field Label	Description and Instructions
1	Enter the **date** in MM-DD-YYYY format. (e.g., 02-01-2020 for February 1st, 2020).
2	Enter the **time** the form was completed in hh:mm (24 hr) format (e.g., 13:00 for 1pm). Note that if more than one form is used, the same time should be entered on all form to indicate when all forms were completed.
3	Enter the **polygon number** where the plot is taking place.
4	Enter vegetation **surveyor(s)** first initial and last name.
5	Record the **structural stage** using the following codes: **1 Sparse/cryptogam** - Either the initial stages of primary succession, or a very early stage of cohort establishment following a stand-destroying disturbance, or a cryptogam community maintained by environmental conditions (e.g., bedrock, boulder fields, talus); bryophytes or lichens can be dominant; time since disturbance is < 20 years for normal forest succession; sparse tree, shrub and herb cover: either sparsely vegetated overall (low cover of vascular plants and cryptogams, if present), or dominated by cryptogams. **1a Sparse** - less than 10% vegetation cover **1b Bryoid** - bryophyte-dominated **1c Lichen** - lichen-dominated **2 Herb** - Early successional stage or a herb community maintained by environmental conditions (e.g., very wet, warm & dry, or late snow site) or disturbance (e.g., flooding, intensive grazing, animal burrowing); generally dominated by herbs (forbs, graminoids, ferns), although herb cover can be low if sparsely vegetated overall as long as herbs characterize the vegetation; trees and shrubs are usually absent or sparse, however shrub cover and stature as compared to herb cover and stature determines whether the site is considered herbaceous; time since disturbance is < 20 years for normal forest succession; many non-forested communities are perpetually maintained in this stage. **2a Forb-dominated** - includes non-graminoid herbs and ferns **2b Graminoid-dominated** - includes grasses, sedges, reeds, and rushes **2c Aquatic** - floating or submerged plants dominate; (sedge communities growing in marshes with standing water are classed as 2b). **2d Dwarf shrub-dominated** - dominated by dwarf woody species **3 Shrub/Herb** - Early successional stage or a shrub community maintained by environmental conditions (e.g., wet soils, cold air accumulation) or disturbance (e.g., wildfire); tree cover sparse but tree seedlings and advance regeneration may be abundant; either dominated by shrubby vegetation, or if sparsely vegetated overall, shrub cover and stature characterizes the community as a shrubland. **3a Low Shrub** - dominated or characterized by shrubby vegetation < 2 m tall; time since disturbance < 20 years for normal forest succession; may be perpetuated indefinitely by environmental conditions (e.g., cold air basins) or disturbance. **3b Tall Shrub** - dominated or characterized by shrubby vegetation that is 2–10 m tall; time since disturbance < 40 years for normal forest succession; may be perpetuated indefinitely

4 Pole/Sapling - Trees > 10 m tall, typically densely stocked, and have overtopped shrub and herb layers; younger stands are vigorous (usually > 15–20 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure are not yet evident in the canopy
5 Young Forest - Self-thinning has become evident and the forest canopy has begun to differentiate into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the Pole/Sapling stage; begins as early as age 30 (e.g., broadleaf or vigorous conifer stands) and extends to 50–80 years, depending on tree species and ecological conditions; in forest stands at environmental extremes
6 Mature Forest - Trees established after the last stand-replacing disturbance have matured; a second cycle of shade-tolerant trees may have become established; shrub and herb understories become well developed as the canopy opens up
7 Old Forest - Stands of old age with complex structure; patchy shrub and herb understories are typical; regeneration is usually of shade-tolerant species with composition similar to the overstorey; long-lived seral species may be present in some ecosystem types or on edaphic sites.

6 Estimate the **average stand height** to the nearest 5m.

7 Check the box for **survey type** being completed, either full or ground.

8 Enter digit for the **page number**. Complete the total number of pages once the survey is complete in case multiple pages are used.

9 If samples are **collected**, write the number of samples.

10 Enter the **species name** for each observed species in the appropriate layer section. For difficult-to-key vegetation, such as mosses, lichens, *Carex* sedges, etc., identification to the species level is not needed **<u>except for at-risk, rare, and culturally-important species</u>**.

Use the "Additional Species" section to list species from the E layer (epiphytes), additional species from any other layer if there has been insufficient space elsewhere on the form, and for species growing on subdominant substrates. Use a second page if needed.

11 Estimate **percent cover** for each species (to the nearest 5%, unless in trace amounts, which will be recorded within a category of <5%). Trees and Shrub species covers must be estimated by both strata and layer (A1, A2, A3, A, B1, B2, B). If trees in A1 are veterans, record this under “Notes.” For each of the A and B layers, the total percent coverage for a species may be less than the sum of the covers for each of the sub-layers, due to crown overlap.

Vegetation Layers

All vegetation is assigned to one of the following layers. Criteria for A and B layers and sub-layers are depicted in **Figure 3-1**.

A. The *tree layer* includes all woody plants greater than 10 m tall. Three sub-layers are recognized:

A1 Dominant trees - includes the dominant (tallest) trees of the main canopy, which may be veterans of one or more fires (previously classed as A0), or the tallest trees of the same age class as the main canopy; usually a minor portion of the stand composition.

A2 Main tree canopy (codominant trees) - the main layer of tree cover, composed of trees whose crowns form the upper layer of foliage; typically the major portion of the stand composition.

A3 Sub-canopy trees - includes trees greater than 10 m high that do not reach the main canopy; may form a distinct secondary canopy; often a mixture of trees of various heights younger than those in the main canopy or may be suppressed trees of the same age; includes “intermediate” and “overtopped” trees.

B. The *shrub layer* includes all woody plants less than 10 m tall, except low (usually < 15 cm tall) woody or trailing plants which are considered part of the herb layer. Established tree regeneration more than two years of age and less than 10 m in height is considered part of the shrub layer. Two sublayers are recognized:

B1 Tall shrub layer - includes all woody plants 2–10 m tall, including shrubs and advance tree regeneration and trees in poorly growing stands where the canopy is less than 10 m high.

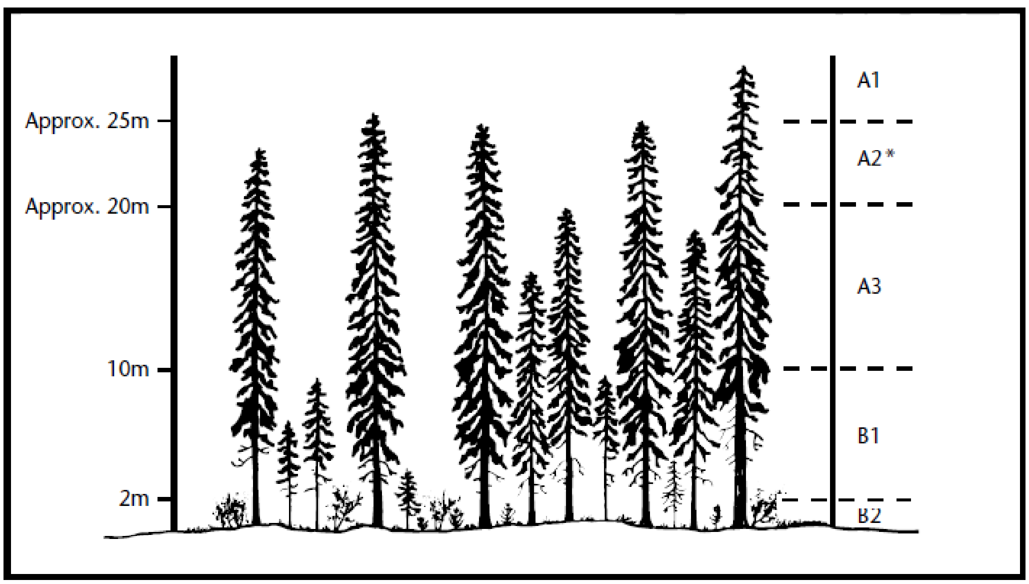
B2 Low shrub layer - includes all woody plants less than 2 m high, except low (< 15 cm) woody or trailing plants; includes shrubs and established tree regeneration more than two years old and dwarfed or immature specimens of species normally considered in the shrub category.

C. The *herb layer* includes all herbaceous species, regardless of height, and some low woody plants less than 15 cm tall.

D. The *moss, lichen, liverwort and seedling layer* includes all bryophytes, terrestrial lichens, and liverworts, and tree seedlings less than two years old that occur on mineral soil and humus.

Dr - *Mosses, lichens, liverworts* that occur on rock.

Dw - *Mosses, lichens, liverworts* that occur on wood.



* *A2 layer will be shorter than indicated in low growing stands*

Figure 3-1. Stratification of forest stands, shrubs, and trees.

E. The *epiphyte layer* includes all species which grow on other living plants. Enter epiphytes in the additional species block.

12 Use **notes and photo number** space to record important features not described elsewhere, or for explanatory notes keyed to other entries on the vegetation form. All photos taken for this form need the photo number recorded, and a brief description of what is shown in the photo. If more space is needed, use the back of the field sheet and indicate with a large and bold arrow that more information is recorded on the back of the form.

13 After all species have been listed, enter the **total percent** cover by layer (to the nearest 5%, unless trace amounts exist, then record as <5%). Note that because of overlaps the sum of the percent cover values for all species within each layer may be greater than the total layer coverage.

14 To indicate if some information on the form needs **review** before final submission (e.g., review species identification) write the word yes in this field. Indicate in the notes space which field(s) need to be reviewed as well as the date the review was completed.

15 Not to be completed in the field. Data should be entered into a spreadsheet as soon as possible, ideally completed daily. Once data are entered into the spreadsheet, fill in the date entered and who entered it. Data entry should be reviewed by a second person and any discrepancies discussed with the original surveyor. Enter the name of the QA/QC reviewer once completed.

3.4.2 Completing the Tree Attributes for Wildlife Survey Form

Field Label **Description and Instructions**

1 Enter the **date** in MM-DD-YYYY format. (e.g., 02-01-2020 for February 1st, 2020).

2 Enter the **time** the form was completed in hh:mm (24 hr) format (e.g., 13:00 for 1pm). Note that if more than one form is used, the same time should be entered on all form to indicate when all forms were completed.

3 Enter the **polygon number** where the plot is taking place.

4 Enter vegetation **surveyor(s)** first initial and last name.

5 Enter the standard metric (m^2/ha) **Basal Area Factor (BAF)** prism used.

6 Enter the **minimum diameter (dbh)** being used.

7 Enter digit for the **page number**. Complete the total number of pages once the survey is complete in case multiple pages are used.

8 Enter the appropriate **species code**. Species codes can be found in Chapter 5 – Life Forms in *Ecosites of Ontario* (ELC Working Group 2009); if uncertain of the correct code or a code has not been assigned, write the entire scientific name.

9 Classify the tree as **standing (S) or fallen (F)** using the following criteria:

S Standing Trees or portions of trees with the root attached and self-supporting (i.e., the tree would remain standing if all supporting materials were removed).
F Fallen Trees or portions of trees with the root attached and not self-supporting, greater than 1.3 m in length.

10 Measure the **diameter at breast height (dbh)**, i.e., 1.3 m, of all live, dead, standing, and fallen trees.

- On slopes, breast height is measured from the high side of the tree.
- Measure diameter to the nearest 0.1 cm.
- Hold the diameter tape tight, making no allowance for missing bark.
- If it is not possible to measure dbh accurately because of an obstruction or unsafe conditions, enter an estimate.

11 Record if dbh was **estimated or measured**. If it was necessary to estimate dbh, enter E; otherwise, enter M.

12 Record, to the nearest percent, the percentage of **bark remaining** at breast height. Use the diameter tape to measure the total circumference and the portion of the circumference with bark remaining. The ratio of the two numbers multiplied by 100 equals the percent remaining bark. For example, if a tree with a 60 cm circumference has bark remaining on 16 cm, the percent remaining is 16 ÷ 60 × 100 = 27%. If the field surveyor does not have a calculator in the field, then record both numbers as a fraction and complete the math once a calculator can be used.

13 Determine the total **length** of all trees greater than 1.3 m high by collecting all the information required to complete the fields on the form. Measure length from the ground surface on the high side of the stem, along the stem, to the top.

- If the tree is broken, record the length of the stem to the point of breakage.
- On fallen trees, measure from the root collar to the top of the last attached portion of the stem.
- Length may be estimated if it is not possible to measure accurately because of obstructions, unsafe conditions.

Slope to top of tree (Top):
Enter the percent slope to the top of the tree; the sign must be shown (usually '+'). The maximum acceptable reading is 99%. If a reading greater than 99 is obtained, move further from the tree, or upslope.

Slope to DBH or bottom of tree (Bot):
Enter the percent reading to dbh, or the base of the tree, or to the lowest visible point; the sign must be shown ('+' or '-'). The maximum allowed reading is 99%.

Bottom position (Bot pos):
Enter, to the nearest 0.1 m, the height at which the Bot % reading was taken.

Slope distance (SD):
Enter the distance, to nearest 0.1 m, from the observer's eye to the centre of the tree trunk at Bot pos.

The above information will be used to calculate the length of each tree. The equation used is: Height = Bot pos + (Top - Bot)/100 × (SD× cos(arctan(abs(Bot/100)))).

14 If the information to calculate tree length cannot be collected, then an **estimate of length** can be entered.

15 Assign a **crown class** designation to all standing live trees as follows:

D **Dominant Trees** with crown extending above the general level of the layer; somewhat taller than the codominant trees, and have well-developed crowns, which may be somewhat crowded on the sides.

C **Codominant Trees** with crowns forming the general level of the crown canopy; the crown is generally smaller than those of the dominant trees and usually more crowded on the sides.

I **Intermediate Trees** with crowns below, but extending into the general level of the crown canopy; crowns usually small and quite crowded on the sides.

S **Suppressed Trees** with crowns entirely below the general level of the crown canopy.

16 For each live tree, measure **height to live crown** (effective portion of the live crown for growth) in metres. This is normally the height on the stem at which live branches occupy about three-quarters of the stem circumference. Enter negative one (-1) for trees with no "effective" crown (e.g., only a few green branches).

17 Each tree sampled is classified according to the following criteria and the appropriate wildlife code is entered on the field form.

Appearance (Appear):
For each tree, enter a code (1–9) which corresponds to the illustration in **Figure 3-2** that best represents the appearance of the tree, using the shape of the tree stem as the dominant characteristic.

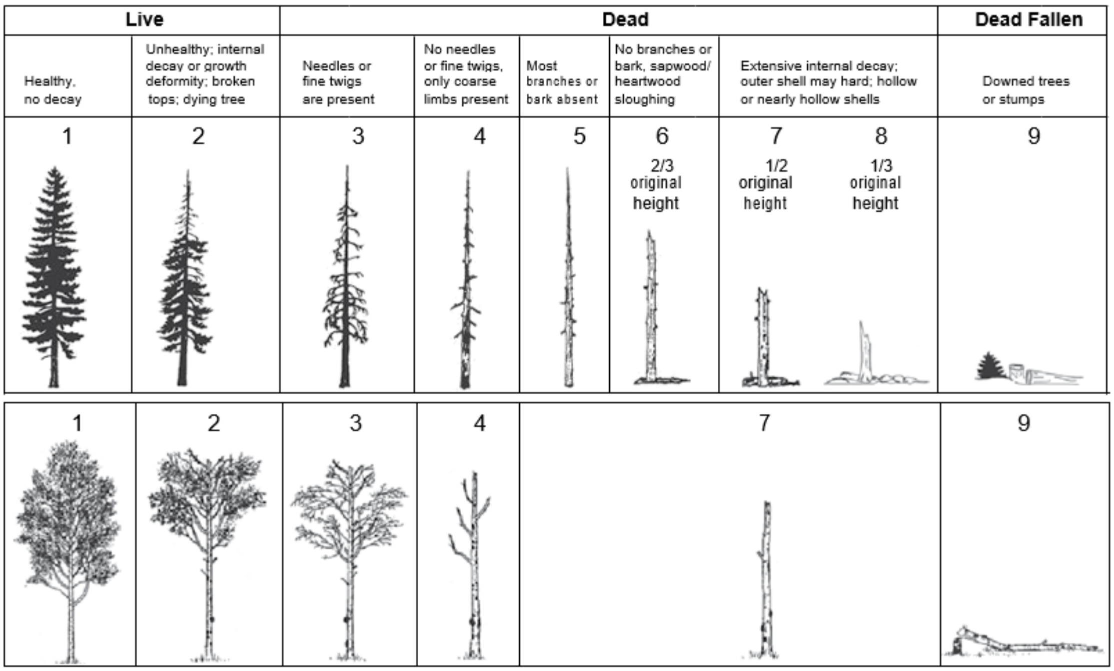


Figure 3-2. Visual appearance codes for wildlife trees.

Crown condition (Crown):
Using one of the classes in **Table 3-1**, rate the condition of the crown in relation to a normal live crown. Note: lower crown loss due to self-pruning is not counted as foliage or branch loss.

Table 3-1. Crown condition codes.

Code	Description
1	All foliage, twigs, and branches present
2	Some or all foliage lost; possibly some twigs lost; all branches usually present; possible broken top
3	No foliage present; up to 50% of twigs lost; most branches present; possible broken top
4	No foliage or twigs present; up to 50% of branches lost; top usually broken
5	Most branches have gone; some sound branch stubs remain; top broken
6	No branches present; some sound and rotting branch stubs, top broken

Bark retention (Bark):
Indicate the proportion of bark remaining on each tree, using the codes in **Table 3-2**.

Table 3-2. Bark retention codes.

Code	Description
1	All bark present
2	Bark lost on damaged areas only (< 5% lost)
3	Most bark present; bare patches; some bark may be loose (5–25% lost)
4	Bare sections; firm and loose bark remains (26–50% lost)
5	Most bark is gone; firm and loose bark remains (51–75% lost)
6	Trace of bark remains (76–99% lost)
7	No bark (100% lost)

Wood condition (Wood):
Classify the texture (soundness) of the wood for each tree, using the codes in **Table 3-3**.

Table 3-3. Wood condition codes.

Code	Description
1	No decay
2	Probable limited internal decay and/or deformities
3	Wood essentially hard; limited decay
4	Wood mostly hard, but decay spreading; softwood present
5	Balance of hard and softwood; spongy sections
6	More soft and spongy wood than hardwood
7	No more hardwood; all soft or spongy; powdery sections
8	Hollow shell; outer wood mostly hard or firm

Lichen loading (Lichen):
Assess all standing live or dead trees for lichen loading on branches that are within 4.5 m of the ground or root collar. Assign a rating (0–5) based on the approximate number of 5g clumps in **Table 3-4**. A value of 0 indicates no lichens, whether it is a live tree with branches and foliage or a dead tree. If a tree has lichens but none are below the 4.5 m mark, rate as zero.

Table 3-4. Lichen loading classes.

Class	Quantity of Lichen (5g clumps)
0	0
1	1
2	2-10
3	11-50
4	51-125
5	>125

Wildlife use:
If wildlife are observed using sample trees or if there is evidence of use, record a code for the type of use (activity) in the first column and the user in the second column (e.g., a feeding bird [FB], nesting amphibian [NA], denning mammal [DM]). If only the activity can be determined, leave the second column blank. If no evidence of wildlife use is observed, indicate with dashes (--).

Activity Code:

C Cavity nest

May be difficult to detect, but locations are somewhat predictable, and in season, the begging calls of nestlings are easy to detect; test a tree with a cavity nest by carefully striking it to determine if the nest is occupied; if possible, note species in the Comments section using the specific species code.

- Many woodpeckers prefer nesting in live hardwoods, often underneath branches.
- Nuthatches and chickadees nest in broken-off standing dead trees, or in broken branch holes, often directly below the breakage point where stem rots have entered the tree and softened the heartwood.
- Cavity nesters have perfectly round or oval nest holes.
- The Pileated Woodpecker and the Northern Flicker have oval nest holes.
- Downy Woodpeckers, Chickadees, and Nuthatches have small round nest holes.
- Brown Creepers have hammock nests under the loose bark.
- Some ducks, owls, and squirrels nest in abandoned woodpecker holes.

O Open nest

Nests of eagles, hawks, owls, and herons are usually situated in the upper part or crown of live and dead trees; raptors and herons build large platform-style stick nests.

D Denning/resting

May be used by bears, squirrels, bats, marten, fisher, weasels, skunks, and raccoons.

- Bears often hibernate in the hollow trunks of large standing trees.
- Entrances to tree dens can be basal or arboreal.

F Feeding

Some examples of indicators are:

- Pileated Woodpeckers excavate large rectangular feeding holes.
- Yellow-bellied Sapsuckers drill horizontal patterns of sap wells.
- Three-toed and Black-backed Woodpeckers scale off bark to feed on insects.
- Porcupines gnaw on large sections of bark (diagonal tooth marks are often apparent).
- Rabbits, hares, and squirrels feed on the base of young trees (squarish “windows” or girdling at the base).
- Squirrels cache cones or leave basal accumulations of cone bracts.

T Travel

Some animals may leave signs of travel like tracks. This travel sign includes both daily travel and migration routes that may appear more well worn.

M Mark tree

Trees used mostly for communication of territorial boundaries and during courtship; examples of indicators include claw marks by black bears and antler rubbing by deer.

P Perching/roosting

Some examples of indicators are:

- Perch trees of aerial foraging and hawking birds are typically tall, with prominent dead branches which provide a good view of the surrounding area; such perches are especially common near riparian edges.
- Plucking spots where raptors feed can be identified by “whitewash” (white streaks of excrement) and remains of prey in the vicinity.
- Roost trees are often in sheltered locations with natural or excavated cavities; roosting sites include cavities, hollows, beneath bark, and in foliage.

S **Squirrel cache**

User Code:

M **Mammal**
B **Bird**
R **Reptile**
A **Amphibian**

If a wildlife species using a sample tree can be positively identified, record the species code on the ***Wildlife Habitat Assessment Form*** or record it in the Notes section of the ***Site and Soil Description Form***.

18 Estimate and record the number of **cavities or crevices**. Enter 0 if none found.

19 Note any additional features and the photo number for each tree in the **notes and photo numbers** section. All photos taken for this form need the photo number recorded, and a brief description of what is shown in the photo. If more space is needed, use the back of the field sheet and indicate with a large and bold arrow that more information is recorded on the back of the form.

20 To indicate if some information on the form needs **review** before final submission (e.g., review species identification) write the word yes in this field. Indicate in the notes space which field(s) need to be reviewed as well as the date the review was completed.

21 Not to be completed in the field. Data should be entered into a spreadsheet as soon as possible, ideally completed daily. Once data are entered into the spreadsheet, fill in the date entered and who entered it. Data entry should be reviewed by a second person and any discrepancies discussed with the original surveyor. Enter the name of the QA/QC reviewer once completed.

3.4.3 Completing the Coarse Woody Debris Survey Form

Field Label	Description and Instructions
1	Enter the **date** in MM-DD-YYYY format. (e.g., 02-01-2020 for February 1st, 2020).
2	Enter the **time** the form was completed in hh:mm (24 hr) format (e.g., 13:00 for 1pm). Note that if more than one form is used, the same time should be entered on all form to indicate when all forms were completed.

3 Enter the **polygon number** where the plot is taking place.

4 Enter vegetation **surveyor(s)** first initial and last name.

5 Enter digit for the **page number**. Complete the total number of pages once the survey is complete in case multiple pages are used.

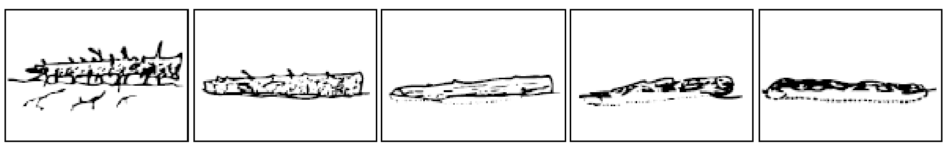
6 Record the first **azimuth** (randomly selected) for Transect No. 1, and the second at plus 90° to Transect No. 2.

7 Record the distance that was actually sampled (**Sampled ___ of 24 m**) out of the total distance, in the spaces provided.

8 Record **species** code for each piece. Species codes can be found in Chapter 5 – Life Forms in *Ecosites of Ontario* (ELC Working Group 2009); if uncertain of the correct code or a code has not been assigned, write the entire scientific name. If the species can not be determined put “X” for unknown, “Xh” for unknown hardwood, or “Xc” for unknown conifer.

9 Record the **diameter** of the piece perpendicular to the bole at the point where the sampling line is considered to intersect the central axis of the piece. Wrap a diameter tape around the bole, when possible, or use the reverse side of the tape to estimate the diameter. Callipers may also be used and are often easier when coarse woody debris is in several layers. Measure diameter to the closest 0.5 cm. If the CWD is hollow, estimate the diameter equivalent required to approximate the volume of the remaining wood.

10 Assign a **decay class** (1 to 5) based on the majority condition of the entire piece. The five classes used to describe the condition of coarse woody debris are based primarily upon wood texture, and secondarily on other characteristics. See **Figure 3-3** for descriptions of classes.



	Class 1	Class 2	Class 3	Class 4	Class 5
Wood Texture	Hard	Sap rot (but still hard, thumbnail penetrates)	Advanced decay (spongy/large peices)	Extensive decay (crumbly-mushy)	Small pieces, soft portions
Portion on Ground	Elevated on support points	Elevated but sagging slightly	Sagging or broken	Fully settled on ground	Partly sunken
Branches	Hard branches with twigs	Soft branches	Branches/stubs absent	Absent	Absent
Bark	Firm	Loose	Trace	Absent	Absent
Wood Appearance	Fresh/recent	Colour fading	Fading colour	Light or brown	Reddish brown
Wood strength	Supports person	May not support person	Breaks easily. Pieces snap	Collapses with weight. Pieces do not snap	Feels firm like ground
Invading Roots	None	None	In sapwood	In heartwood	In heartwood

Figure 3-3. Decay classes for coarse woody debris.

11 Record the **tilt angle** of the individual log away from the horizontal, regardless of the slope of the ground. A clinometer is placed on the surface of the piece at the point of the intercept measurement and the angle from the horizontal (in degrees) is recorded (see **Figure 3-4**).

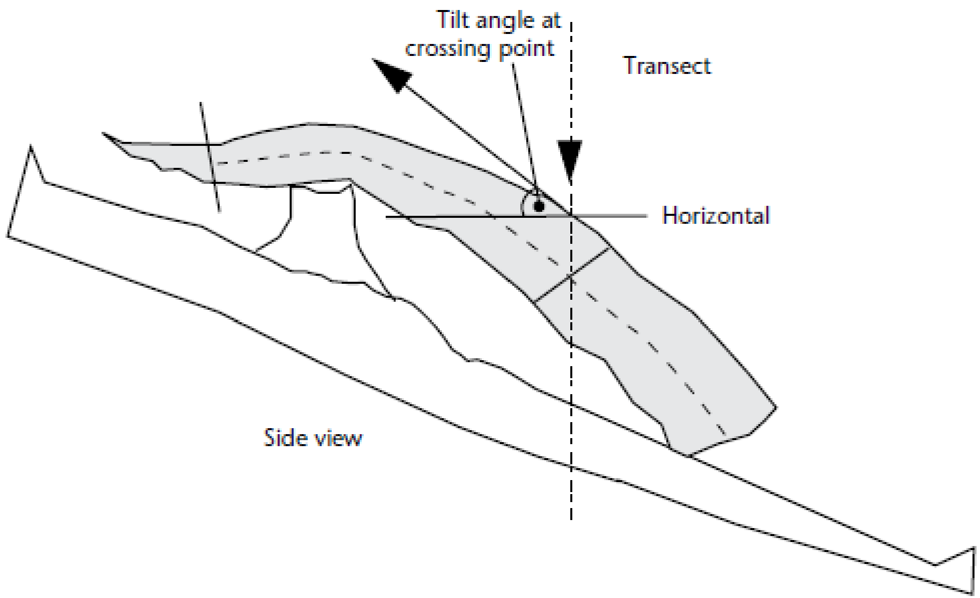


Figure 3-4. Recording the tilt angle of coarse woody debris.

12 Record the **length** of each piece to the nearest 0.1 m (see **Figure 3-5a**).

- If a log has broken lengthwise but is still partially held together, record the equivalent length as if the piece were whole.
- If the end(s) of the piece are broken, visually fold in the broken sections to compensate for the missing parts.
- Piece length is from the largest end down to the 7.5 cm diameter limit.

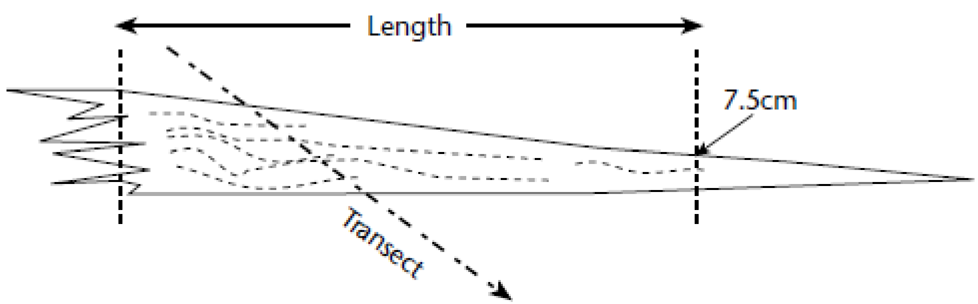


Figure 3-5a.

Measurement of stems from attached roots:

- For main boles with exposed roots, piece length is measured only down to the root collar (see **Figure 3-5b**).

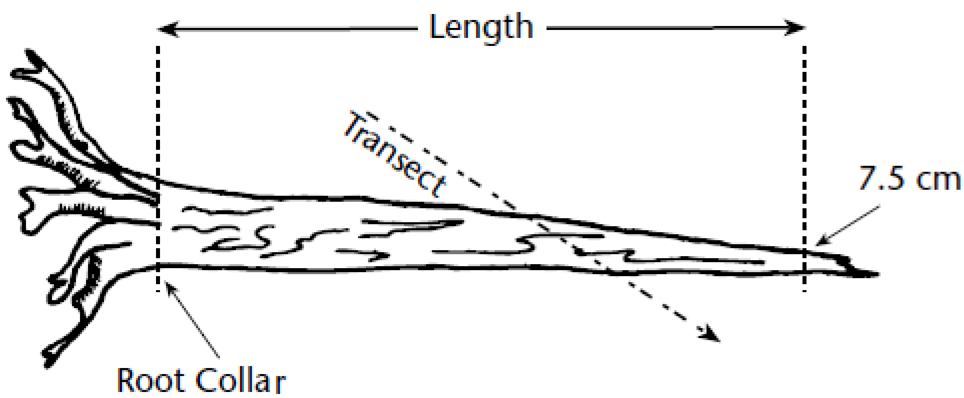


Figure 3-5b.

- If a root mass is transected, piece length for individual roots (larger than the minimum diameter) is measured only up to the root collar (see **Figure 3-5c**).

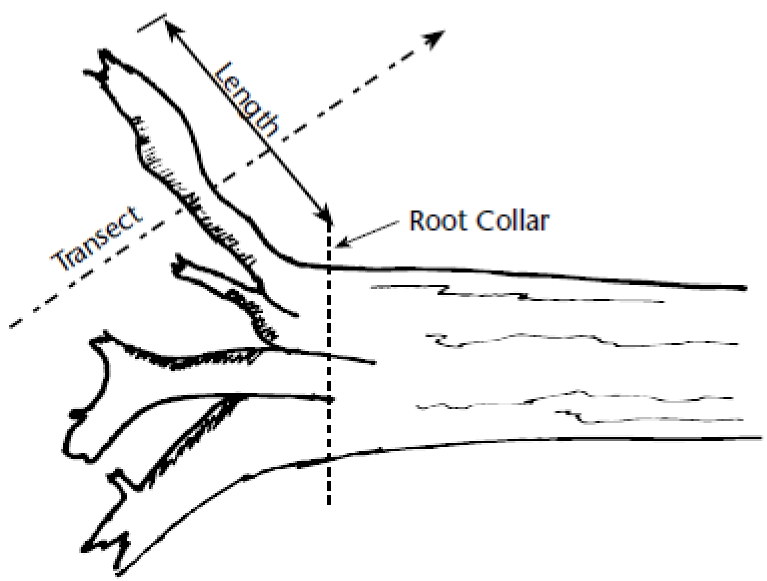


Figure 3-5c.

Measurement of forked stems:

- Where one of the forks transected is determined (by largest diameter) to be a continuation of the main bole then the length will be measured to the ends of the main piece (see **Figure 3-5d**).

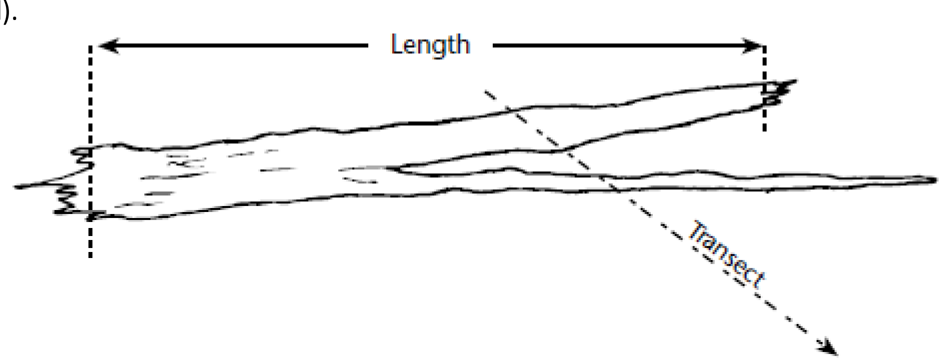


Figure 3-5d.

- The piece length of the smaller stem(s) (smaller diameter) will be measured only to the junction with the main bole (see **Figure 3-5e**).

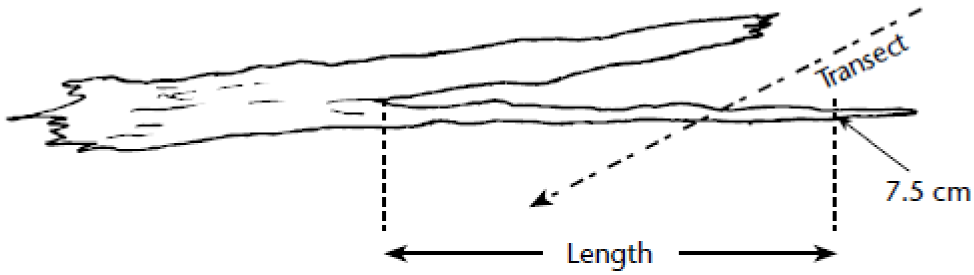


Figure 3-5e.

- For forks of nearly equal stature make a determination as above and measure accordingly.

Measurement of pieces that are crossed more than once on the transect:

- Pieces broken but still physically attached are measured as one piece at each transect point. The length measurement is taken along the central axis of the piece (see **Figure 3-5f**).

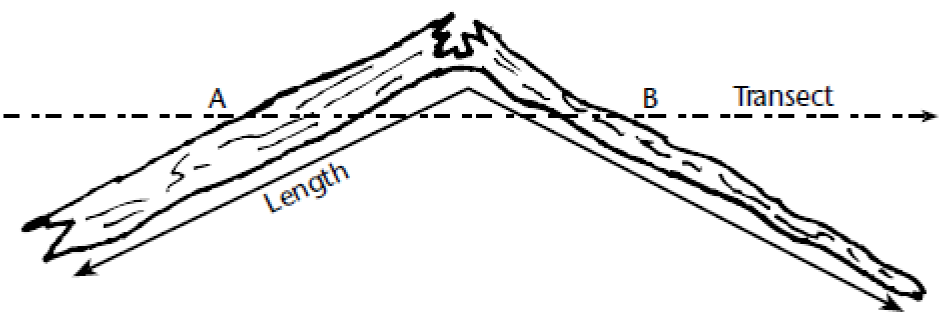


Figure 3-5f.

- The full piece length of curved/crooked pieces is measured at both crossings (see **Figure 3-5g**).

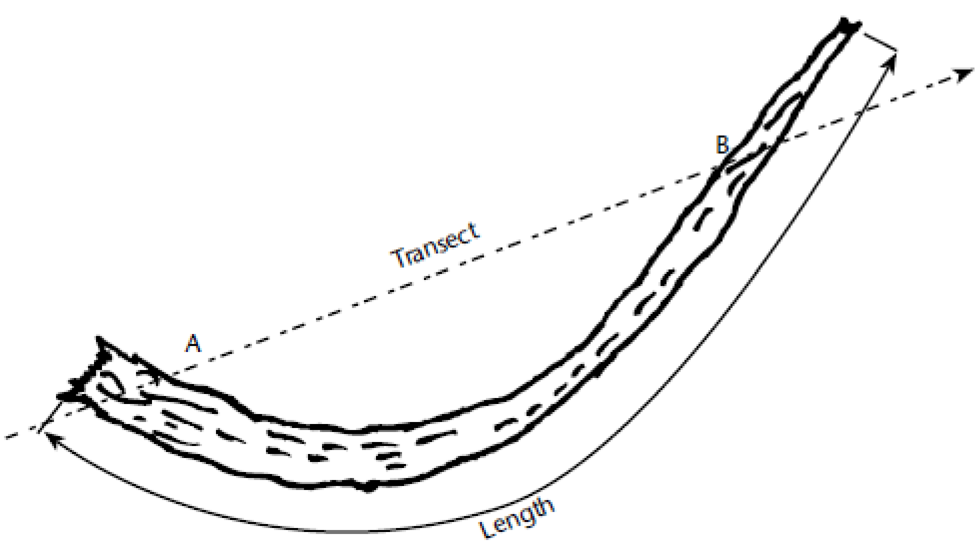


Figure 3-5g.

Figure 3-5. Rules for measuring the length of coarse woody debris.

In the same manner as above, record the full piece length twice where the same piece is crossed by two transects at right angles to each other.

13 This is the **height** above ground of the central axis of the lowest end of each piece of CWD, measured to the nearest cm. The lowest end is defined as the end of the piece that is in closest contact with the ground, not necessarily the end that is at the lowest altitude.

14 At the transect crossing measure and record the **angle** of the ground, following the same procedure for determining CWD piece tilt. It may be necessary to measure the ground angle over a 1 to 2 m (or more) distance if the surface is irregular.

Record this angle to the nearest degree and indicate whether it is positive or negative (e.g. -07, +12). When measuring the angle of the ground, face in the direction that gives a positive tilt angle for the piece of CWD. The angle of ground measured by sighting in that direction may be positive or negative.

15 Record the **size of the pile** by measuring the **length**, **width**, and **height** to the nearest 0.1 m.

16 Record, to the nearest cm, the average **diameter** of pieces of CWD composing the pile.

17 Using the codes in **Table 3-5**, estimate the size of **interstitial spaces**. This not intended to indicate which species will use the pile.

Table 3-5. Codes for the size of interstitial spaces.

Code	Class	Description
S	Small	Most interstitial spaces are the size of, or smaller than, a squirrel
M	Medium	Most interstitial spaces are the size of a lynx
L	Large	Most interstitial spaces are the size of, or larger than, the average black bear

18 Note any additional features and the photo number for each tree in the **notes and photo numbers** section. All photos taken for this form need the photo number recorded, and a brief description of what is shown in the photo. If more space is needed, use the back of the field sheet and indicate with a large and bold arrow that more information is recorded on the back of the form.

19 To indicate if some information on the form needs **review** before final submission (e.g., review species identification) write the word yes in this field. Indicate in the notes space which field(s) need to be reviewed as well as the date the review was completed.

20 Not to be completed in the field. Data should be entered into a spreadsheet as soon as possible, ideally completed daily. Once data are entered into the spreadsheet, fill in the date entered and who entered it. Data entry should be reviewed by a second person and any discrepancies discussed with the original surveyor. Enter the name of the QA/QC reviewer once completed.

4.0 WILDLIFE HABITAT ASSESSMENT

4.1 Equipment and Materials

Field forms for printing can be found in Appendix A; all hard copies brought into the field should be printed on waterproof paper. Where possible, electronic equipment should also be waterproof. The field data collection contractor is responsible for their own field safety protocols, which includes the planning of field safety gear.

4.1.1 General Field Equipment

- Hard copies of field forms
- Hard copies of SOP
- Hard copies of survey location coordinates and field maps
- Hard copy of *Ecosites of Ontario* (ELC Working Group 2009)
- Pen/pencils
- Waterproof notebook
- Clipboard
- Binoculars
- Camera
- GPS unit
- Tablet or smartphone with georeferenced map
- Compass
- Large spool measuring tape
- Small measuring tape
- Rangefinder (optional)

4.1.2 Habitat Assessment Specific Equipment

- Wildlife and wildlife signs identification book(s)

4.2 Field Procedure

1. Each day, a route should be determined using the List of Sites and Site Information in Appendix B and Map of Field Sampling Locations in Appendix C. Each daily route plan should ensure any sites not visited the previous day due to time limitations are included in the next day's route. The field data collection contractor should note any required use of helicopters to assist access or speed up fieldwork.
2. When in the field, follow the day's route to navigate to the next site. Sites have been determined using a GRTS design to create stratified and randomized points. As part of this design method, some points are pre-selected as PanelOne (P1) for sampling or OverSample (OS). If a P1 site is determined after a reasonable effort to be inaccessible, an OS site can be used in place of the P1 site. If the OS site is also deemed inaccessible after reasonable effort, the next OS site can be visited/considered. The field data collection contractor should take care not to skip points too quickly and without effort in favour of randomized points that happen to occur next to easily accessible areas (roads, cleared forest); this may impose a site selection bias meant to be diminished via the use of pre-selected, random points. While points should be visited in order, wherever possible, logistical constraints due to difficulty accessing areas may render it necessary to deviate from the ordering from P1 points and OS points from time to time, such that points can be planned to be visited along hiking routes (e.g., in a situation where there is only one way into a large, difficult to access area). In such cases, the replacement of any P1 sites with an OS site should be noted in the notes section of the ***Site and Soil Description Form***.
3. Using the *List of Sites and Site Information* in Appendix B, determine survey type (Full, Ground, or Visual).
4. Locate and mark plot boundaries (20m x 20m square) for Full plots or plot center for Ground plots (no marking required for visual plots).

5. Become familiar with the character of the terrain, soil, and vegetation by traversing the plot and consulting with plant ecologist and soil scientist.

4.2.1 Full/Ground/Visual Wildlife Habitat Assessment Procedure

1. Photograph the plot. It is a good idea to take 4 photos in each cardinal direction (begin looking north and turn clockwise), as well as one that shows canopy cover (up) per site. Photographs should also be taken of any notable features, wildlife signs or observations, and any examples of exceptional wildlife habitat.
2. On the ***Wildlife Habitat Assessment Form***, enter the information in the header (date, time form was completed, polygon number, wildlife surveyors' names, weather, survey type, page number).
3. Record evidence of use in plot and in ecosystem unit represented by the plot.
4. List project species and additional species noted during the visit.
5. Record the habitat use and the season for each species.
6. Confer with plant ecologist and soil scientist about ecosite classification, values, and site management concerns.
7. Ensure that relevant wildlife habitat data are filled out on the site description and vegetation forms.
8. Assess the value of the plot-type for each species (not necessary for incidentally recorded species). Be sure that the plot-type assessment is completed before the plot-in-context assessment. The *Wildlife Habitat Assessment Cheat Sheets* in Appendix E provide guidance for rating habitats in the field.
9. Assess the value of the plot-in-context for each species based on the spatial context of the plot. The *Wildlife Habitat Assessment Cheat Sheets* in Appendix E provide some guidance on determining plot-in-context ratings.
10. Record comments at the bottom of the form, cross-referencing to species.
11. Photograph the plot to illustrate important wildlife habitat features or evidence of animal use.
12. Check that all the required information has been collected and noted on the form.
13. On the ***Significant Wildlife Habitat Survey Form,*** enter the information in the header on both pages (date, time form was completed, polygon number, wildlife surveyors' names, predetermined ecosite code, and final ecosite code).
14. Using the *Field Summary of Significant Wildlife Habitat Criteria Schedules for Ecoregion 3W* found in Appendix F, check the yes or no box if the ecosite codes listed for the Wildlife Habitat matches the plot's final ecosite code.
15. Using the *Field Summary of Significant Wildlife Habitat Criteria Schedules for Ecoregion 3W* found in Appendix F, check the yes, no, or unknown box if the habitat criteria listed for the Wildlife Habitat matches what is found in or around the plot. The unknown box should only be ticked if the criteria cannot be determined at the time of the survey to be present or not, likely due to seasonal timing (e.g., the survey is conducted in the summer so spring phenomenon cannot be observed).
16. Take a photo that shows each habitat criteria and record the photo reference number.
17. Fill in any details about the habitat criteria and the rationale for the decision. If multiple criteria are listed, specify which criteria is met. If the unknown box was checked, the reason why the habitat criteria could not be observed must be noted.

18. Check that all the required information has been collected and noted on the form. If any fields require review or completion at a later date (e.g., confirmation of species identification), indicate this at the bottom of the form.
19. If other surveyors are still working once the forms are completed, spend remaining time looking and listening for wildlife signs or observations.

4.3 Field Form

Date (MM-DD-YYYY)	Time Com. (hh:mm)	Polygon Num	Surveyor(s)	Survey Type	Non-Hab. Feature	Type				Page	Of
1	2	3	4	F/G ☐VIS. 5		Dist.		6		7	

ASSESSMENT	Hab Use/Sen		Plot Type				Plot in Context														
Species	Sp. L.R.	Ssn	FD	SH	TH	Note #	Habitat feature	Conf.	Distance (km)	F/C L.R.	Imp.	Habitat Feature	Conf.	Distance (km)	F/C L.R.	Imp.	FD	SH	TH	Suit.	Note #
Moose	LI	WE																			
8 Moose	LI 9	WL		10							11									12	13
Moose	LI	G																			
Black bear	LI	P																			
Black bear	LI	S																			
Black bear	HI	W																			
Northern flying squirrel	LI	A																			
Snowshoe hare	LI	W																			
Eastern whip-poor-will	RE	G																			
Eastern whip-poor-will	LI (FD)	G		/	/													/	/		

EVIDENCE OF USE	Inside plot						Outside plot and inside ecosite										
Species	Sex	Life Stage	Activity	Des.	No.	Note #	Sex	Life Stage	Activity	Des.	No.	Sex	Life Stage	Activity	Des.	No.	Note #
14	15	16	17	18	19	20	15	16	17	18	19	15	16	17	18	19	20

Notes and Photo Numbers 20

Review needed: 21 Date entered into spreadsheet: 22 Entered by: QA/QC by:

Wildlife Habitat Assessment Form

Significant Wildlife Habitat Survey Form 1					
Date (MM-DD-YYYY) 1	**Time Com. (hh:mm)** 2	**Polygon Num.** 3	**Surveyor(s)** 4	**Predetermined Ecosite** 5	**Final Ecosite** 6

Seasonal Concentration Areas for Wildlife Species			
Wildlife Habitat	**Ecosite Codes**	**Habitat Criteria**	**Habitat Details & Rationale, Photo Reference, UTM**
Waterfowl Stopover & Staging Area (Terrestrial)	☐Yes ☐No 7	☐Yes ☐No ☐ Unknown 8	9
Waterfowl Stopover and Staging Area (Aquatic)	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Shorebird Migratory Stopover Area	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Colonially - Nesting Bird Breeding Habitat (Bank & Cliff)	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Colonially - Nesting Bird Breeding Habitat (Tree/Shrubs)	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Colonially - Nesting Bird Breeding Habitat (Ground)	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Eagle & Osprey Concentration Area	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Sharp-tailed Grouse Lek	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Bat Hibernaculum	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Bat Maternity Colony	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Amphibian Breeding Habitat	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Turtle Wintering Area	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Snake Hibernaculum	☐Yes ☐No	☐Yes ☐No ☐ Unknown	

Animal Movement Corridors			
Habitat	**Ecosite Codes**	**Habitat Criteria**	**Habitat Details & Rationale, Photo Reference, UTM**
Cervid Movement Corridor	☐Yes ☐No 7	☐Yes ☐No ☐ Unknown 8	9
Amphibian Movement Corridor	☐Yes ☐No	☐Yes ☐No ☐ Unknown	

Review needed: 11	Date entered into spreadsheet: 12	Entered by:	QA/QC by:

Significant Wildlife Habitat Survey Form 2				
Date (MM-DD-YYYY) 1	**Time Com. (hh:mm)** 2	**Polygon Number** 3	**Predetermined Ecosite** 5	**Final Ecosite** 6

Specialized Habitat for Wildlife			
Specialized Wildlife Habitat	**Ecosite Codes**	**Habitat Criteria**	**Habitat Details & Rationale, Photo Reference, UTM**
Waterfowl Nesting Area	☐Yes ☐No 7	☐Yes ☐No ☐ Unknown 8	9
Wild Rice Stand	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Milkweed Patch	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Bald Eagle & Osprey Nesting Habitat	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Woodland Raptor Nesting Habitat	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Turtle Nesting Area	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Aquatic Feeding Habitat	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Seeps and Springs	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Mineral Lick	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Mammal Denning Site	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Marsh Bird Breeding Habitat	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Open Country Bird Breeding Habitat	☐Yes ☐No	☐Yes ☐No ☐ Unknown	

Notes and Photo Numbers:

10

Review needed: 11 Date entered into spreadsheet: 12 Entered by: QA/QC by:

Significant Wildlife Habitat Survey Form 3

Date (MM-DD-YYYY)	Time Com. (hh:mm)	Polygon Number	Predetermined Ecosite	Final Ecosite
1	2	3	5	6

Rare Vegetation Community

Rare Vegetation Community	Ecosite Codes	Habitat Criteria	Habitat Details & Rationale, Photo Reference, UTM
Cliff and Cliff Rim	☐Yes ☐No 7	☐Yes ☐No 8 ☐ Unknown	9
Talus Slope	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Rock Barren	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Rare Treed Type: Red and White Pine	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Rare Treed Type: Red and Sugar Maple	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Sand Dunes	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Rare Arctic-Alpine communities	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Diverse and Sensitive Orchid communities	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Provincially Rare Veg communities	☐Yes ☐No	☐Yes ☐No ☐ Unknown	

Notes and Photo Numbers:

10

Review needed: 11 Date entered into spreadsheet: 12 Entered by: QA/QC by:

4.4 Completing the Form

4.4.1 Wildlife Habitat Assessment Form

Field Label	Description and Instructions
	Assessment
1	Enter the **date** in MM-DD-YYYY format. (e.g., 02-01-2020 for February 1st, 2020).
2	Enter the **time** the form was completed in hh:mm (24 hr) format (e.g., 13:00 for 1pm). Note that if more than one form is used, the same time should be entered on all form to indicate when all forms were completed.
3	Enter the **polygon number** where the plot is taking place.
4	Enter vegetation **surveyor(s)** first initial and last name.
5	Check the box for **survey type** being completed, either full/ground or visual plot.
6	Enter up to two types of human activity or other **non-habitat feature** (N-hab. feat.) near the plot that may affect usage by wildlife. A non-habitat feature is a feature of the environment that influences the amount of use of the plot by wildlife. A nonhabitat feature can be distinguished from a habitat feature because non-habitat features do not affect habitat attributes (i.e., something measurable to describe habitat) and therefore do not affect suitability.

Type:
Identify the type of prolonged human activity or other non-habitat feature near the plot using the codes in **Table 4-1**.

Table 4-1. Codes for types of non-habitat features.

Code	Type	Code	Type
FA	Farming	**OT**	Other (Specify in Notes)
FE	Fence	**RF**	Road traffic, four lanes
GD	Garbage dump	**RO**	Road traffic, one lane
LO	Logging activity	**RN**	Railroad
LR	Logging road	**RT**	Road traffic, two lanes
MI	Mining activity	**RR**	Rural

Distance:
Enter a code (1–5) indicating the approximate distance (dst.) from the plot to the nearest sites of prolonged human activity or other non-habitat features that may affect wildlife. See **Table 4-2** for distance codes.

Table 4-2. Code for distances to nearest non-habitat features.

Code	Distance
1	0-100m
2	100-250m
3	250-1000m
4	1-5 km
5	>5 km

7 Enter digit for the **page number**. Complete the total number of pages once the survey is complete in case multiple pages are used.

8 Indicate the **species** for which the habitat is being assessed.

9 For each **habitat use** (Hab use) to be assessed, use one row on the form.

Specified Life Requisite:

Specify the life requisite (SpLR) for which the habitat will be used with a two-letter code from **Table 4-3**.

Table 4-3. Specified life requisite codes.

Code	Specified life requisite	Description
AP*	Avoiding pests	Habitat used for avoiding pests
CO	Courting	Habitat used for courting; involves enticing a conspecific of the opposite sex into copulation, courtship feeding, and defence of mates. e.g., Rutting areas for ungulates.
DE	Denning/Roosting	Habitat used for sleeping or hiding in a cavity, cave, or burrow; does not include hibernating nor reproducing-birthing
FS	Feeding seasonal (e.g. berry patch)	Habitat used for feeding on a particular abundant/dominant food source at the site that is only present or ripe at a particular time of year
HI	Hibernating	Habitat used for hibernating
LI*	Living	Habitat used for activities other than; denning, birthing, courting etc.
MD*	Migrating daily	Habitat used for regular, daily travelling, including travelling away from or towards a communal habitat; e.g., habitat used by a bat for daily flights to and from a roosting site
MS*	Migrating seasonally	Habitat used for regular, annual travelling; habitat used for travelling away from or towards a communal habitat such as a hibernaculum
RB	Reproducing – birthing	Habitat used specifically for giving birth to live young; habitat used by amphibians, birds, and reptiles for the hatching of eggs is recorded as habitat used for reproduction by eggs (RE)
RE	Reproducing – eggs	Habitat used for building a nest, laying eggs, incubation, hatching, and feeding non-mobile young; reserved for amphibians, birds, and reptiles; specialized habitat used by some mammals to give birth to young is recorded as reproducing-birthing (RB) habitat
SG*	Staging	Habitat used for staging during spring or fall migrations

*Activities for which a season needs to be indicated (see below). The season is implied for all other activities.

Season:
If required, indicate the season (Ssn.) for which the habitat is being assessed. Use the codes listed in **Table 4-4**. Seasons are species specific; definitions for the seasons and dates will be provided in the species accounts for each species.

Table 4-4. Codes for the season of use.

Code	Season	Code	Season
A	All seasons	WE*	Early Winter
G	Growing	WL*	Late Winter
W	Winter	PE*	Early Spring
P	Spring	PL*	Late Spring
S	Summer		
F	Fall		

*Early Spring, Late Spring, Early Winter and Late Winter seasons should only be used for black bear. Also, Early Spring can be used to distinguish Early Spring feeding habitat from Spring feeding habitat for moose.

10 Assess the food (FD), security habitat (SH) and thermal habitat (TH) provided by the plot type for the species, life requisite use, and season being considered. For these assessments, **disregard plot size and shape, and position relative to other habitats**. Instead, imagine that the plot type covers a sufficiently large area to maximize its value for the species, use and season being considered. These data will be used to establish suitability ratings for the ecosystem unit represented by the plot. For assessments of relative quality and suitability use codes in **Table 4-5**.

Food (FD):
For species that require food (FD) for the use and season being considered, rate the ability of the plot type to fulfill food requirements.

Security habitat (SH):
For species that require security habitat (SH) for the use and season being considered, rate the ability of the plot type to fulfill security requirements. Security habitat is used for protection or hiding from predators.

Thermal habitat (TH):
For species that require thermal habitat (TH) for the use and season being considered, rate the ability of the plot type to fulfill thermal requirements.

For species where it is known that thermal habitat plays a significant role in overall suitability, but for which thermal qualities of the plot type cannot be assessed separately from the security qualities, do not attempt to enter a rating in the TH column—only use the SH column to enter a rating.

Table 4-5. Relative quality classes for assessing the plot type quality relative to the best in Ontario. The lower and upper limit ranges indicate how similar the plot is to the best habitat example in Ontario. For example, 100 would mean the site is at the highest limit of the best habitat in Ontario.

Class Quality	Suitability/ capability	Lower limit (%)	Upper limit (%)	
H	High	>75	≤100	Equivalent or slightly less
M	Moderate	>25	≤75	Moderately less
L	Low	>0	≤25	Substantially less
N	Nil	0	0	Habitat or attribute is absent

Notes:
To provide additional information about the plot-type assessment, or to clarify an entry made on this line, enter a numeric code (Com.). Enter the same code in the Notes section of the form, followed by the pertinent information.

11 **Given the location of the plot,** assess the quality and accessibility of food (FD), security habitat (SH) and thermal habitat (TH) for the species, use, and season being considered. This assessment includes the adjacent habitat features that are accessible to the species, for the specified use and season. These data will be used to develop a suitability rating for the specific plot in the area. For assessments of quality and suitability use coding from **Table 4-5**.

Habitat features:
A habitat feature is a feature of the environment that influences the amount of use of the plot by providing food, security or thermal habitat and thereby affects suitability (e.g., a nearby agricultural field may provide food and influence plot usage). Enter up to two habitat features (**Table 4-6**) that may affect the suitability of the plot.

Table 4-6. Habitat features codes for plot-in-context assessment [a].

Code	Habitat feature	Definition
AL [b]	Alkaline pond	Body of freshwater with a pH greater than 7 and a depth less than 2 m
AS	Aspect	Area which has an aspect associated with it, in which the aspect is the attribute important to the species, use, and season being considered
BE [b]	Beach	Area of sorted sediments reworked in recent time by wave action; at the edge of fresh or saltwater bodies
BF [b]	Blockfields, Blockslopes, Blockstreams	Level or gently sloping areas covered with moderately, sized or large, angular blocks of rock derived from the underlying bedrock or drift by weathering and/or frost heave
BU	Building	
BY	Berry Patch	Cluster of several berry bushes
CA [b]	Canal	Artificial watercourse created for transport, drainage, and/or irrigation purposes

CB [b]	Cutbank	Part of a road corridor or river course situated upslope of the road or river; created by excavation and/or erosion of the hillside
CF [b]	Cultivated field	Flat or gently rolling, non-forested, open area subject to human agricultural practices
CH	Clearcut, herbaceous	
CL [b]	Cliff	Steep, vertical or overhanging rock face
CO [b]	Cultivated Orchard	Agricultural area of fruit trees planted in rows
CS	Clearcut, shrubby	
CU	Clearcut, unvegetated	
DU	Dune	Mound or ridge of wind-blown, loose sediment
EK	Esker	A long, narrow, winding ridge composed of stratified sand and gravel deposited first by a stream in or on a glacier, then on the ground once the glacier rapidly melts
ES [b]	Exposed soil	Area of exposed soil; not included in any of the other definitions
ET	Electrical transmission line	
EY	Estuary	
FC	Forest, commercially thinned	
FE	Fence	
FM [f]	Forest, mature	
FO [f]	Forest, old	
FY [f]	Forest, young	
GB [b]	Gravel bar	Elongated landform generated by waves and currents; a mix of cobbles, pebbles, stones, and/or sand
GC [b]	Golf course	Grass-covered fairways and open areas for the playing of golf
GP [b]	Gravel pit	Area exposed for the removal of sand and gravel
GR	Grassland	
LA [b]	Lake	Naturally occurring, static body of water > 2 m deep (> 50 ha)
MI [b]	Mine	Unvegetated area for the extraction of mineral ore and other materials
ML	Mineral Lick	A natural source of salt and other minerals for some wildlife
MO [b]	Moraine	Unvegetated landform of unstratified glacial drift
MU [b]	Mudflat sediment	Flat plain-like areas of fine-textured sediment

NB	Nest boxes	
OT	Other	
OW [b]	Shallow open water	Wetland of permanent shallow open water (< 2 m deep); lacking extensive emergent plant cover
PA	Pasture	
PD [b]	Pond	A small body of water > 2 m deep (< 50 ha)
PI	Pipeline right-of-way	
PS [b]	Permanent snow	Snow or ice, not part of a glacier, but found during summer months
RD	Ridge	Area which has a ridge associated with it; the ridge is the feature important to the species, use, and season being considered
RE [b]	Reservoir	Artificial basin created by the impoundment of water behind a human-made structure such as a dam, berm, dike, or wall
RI [b]	River	Watercourse formed when water flows between continuous, definable banks
RN [b]	Railway surface	Roadbed with fixed rails for possibly single or multiple rail lines
RO [b]	Rock outcrop	Gentle to steep, bedrock escarpment or outcropping, with little soil development and sparse vegetation
RP [b]	Road surface	Area cleared and compacted for vehicle trans port
RR [b]	Rural	Area of residences and other human developments scattered and intermingled with forest, range, farmland, and native vegetation or cultivated crops
RU [b]	Rubble	Small angular rock fragments (between 2 and 256 mm) deposited by gravity or ice
WB	Wetland – Bog	Bogs are peat covered areas or peat-filled depressions with a high water table and a surface carpet of mosses, primarily *Sphagnum*.
WF	Wetland – Fen	Fens are peatlands characterized by surface layers of poorly to moderately decomposed peat, often with well-decomposed peat near the base and less than 25% live tree cover.
WM	Wetland – Marsh	Marshes are wet areas periodically inundated with standing or slowly moving water, and/or permanently inundated areas characterized by robust emergent, and to a lesser extent, anchored floating plants and submergents.
WS	Wetland – Swamp	Swamp wetlands are wooded wetlands with 25% cover or more trees or tall shrubs.

a This is not a comprehensive list of habitat features. Other habitat features can be recorded by using the OT (other) code and adding a comment.
b Habitat features derived from Table 3.1 Symbology and definitions for non-vegetated, sparsely vegetated, and anthropogenic units in Standards for Terrestrial Ecosystem Mapping in B.C.

Confidence:
Use the codes in **Table 4-7** to identify a level of confidence (Conf.) in the assessment of habitat features (i.e., how confident you are that the habitat feature affects the species, use, and season being considered). Base this on your knowledge of the species' habitat requirements and on your knowledge of the quality and quantity of habitat present in the habitat feature.

Table 4-7. Confidence level codes for assessment of habitat features.

Code	Level of confidence	Description
1	Confident	Excellent knowledge of habitat attributes available in the habitat feature **and** of species' habitat requirements
2	Moderately confident	Excellent knowledge of habitat attributes available in the habitat feature **and** moderate knowledge of species' habitat requirements; **or**, moderate knowledge of habitat attributes available in the habitat feature **and** excellent knowledge of species' habitat requirements
3	Not confident	Moderate knowledge of habitat attributes available in the habitat **and** of species' habitat requirements

Distance:
Indicate, in kilometres, the distance from plot centre to the habitat feature.

Food/Cover life requisite:
Identify the life requisite (F/C L.R.) (**Table 4-8**) that the described habitat feature provides. If the habitat feature provides more than one life requisite, then use a combination of codes (e.g., FS indicates that both food and security are provided by the habitat feature).

Table 4-8. Food/cover life requisite codes provided by the plot-in-context habitat feature(s) noted from Table 4-6.

Code	Food /cover life requisite	Description
FD	Food	Provides habitat used for consuming food items, including searching for and consuming food simultaneously such as is done by grazers, browsers, flying insectivores, ducks, and other species with similar feeding habits; includes habitat used for searching for, pursuing and killing prey
SH	Security	Provides habitat used for protection or hiding from predators
TH	Thermal	Provides habitat used for protection from heat, cold, or precipitation

Impact:
Assess the impact (Imp.) of the habitat feature using codes from **Table 4-9**. Given the presence of the habitat feature, the impact is a measurement of the increase or decrease in the quality and accessibility of the food/cover life requisite(s) relative to quality and accessibility if the plot type extended indefinitely.

Table 4-9. Impact of habitat feature on suitability rating.

Code	Description
1	Large increase
2	Moderate increase
3	Low increase
4	No effect
5	Low decrease
6	Moderate decrease
7	Large decrease

Food:
Considering the context of the plot, for species that require food (FD) for the use and season being considered, rate the overall quality and accessibility of food. Use coding from **Table 4-5**.

Security habitat:
Considering the context of the plot, for species that require security habitat (SH) for the use and season being considered, rate the overall quality and accessibility of security habitat. Use coding from **Table 4-5**.

Thermal habitat:
Considering the context of the plot, for species that require thermal habitat (TH) for the use and season being considered, rate the overall quality and accessibility of thermal habitat. Use coding from **Table 4-5**.

12 Assign a **suitability** rating (Suit.), using the codes in Table 5.5, for the plot-in-context, for the species, use, and season being considered. Base the suitability on the ratings entered in the food (FD), security habitat (SH), and thermal habitat (TH) columns. The suitability rating should be an average or weighted average of the three food/cover life requisite ratings.

13 To provide additional information about the habitat assessment, or to clarify an entry on this line on the form, enter a numeric code (**Note #**). Enter the same code in the **notes and photo numbers** section of the form, followed by the pertinent information.

Evidence of Use

14 Indicate the **species** for which the evidence of use is being recorded.

15 Note the **sex** of the animal. Code as M (male), F (female), or U (unknown).

16 Record the **life stage** of the animal using the codes in **Table 4-10**.

Table 4-10. Codes for life stages for wildlife evidence of use.

Code	Life stage	Description

E	Egg	Amphibian, bird, insect, and reptile eggs
N	Nestling	Nestling birds and newly hatched or newborn or neonate newborn amphibians, birds, insects, mammals, and reptiles; only used when it is apparent that the nest site is within the plot type
J	Juvenile	Amphibian larvae, fledged birds before their first winter, insect larvae, and mammals older than neonates, but still requiring parental care; reptiles do not have a juvenile stage
S	Subadult	Animal that is older than the juvenile stage, does not require parental care, and has not reached sexual maturity; includes amphibians and reptiles which have not reached adult size, but have adult form; insects have no subadult stage
A	Adult	Old enough to breed
U	Undetermined	

17 Code up to two different types or signs of **activity** relevant to the identified species (**Table 4-11**). If an animal is present in the plot, or in the ecosystem unit represented by the plot, record the type of activity it is engaged in on the appropriate section of the form. If there are signs that an animal was present, record the type of activity which caused the signs.

Table 4-11. Codes for activities and signs of activity.

Code	Activity	Description
AL [a]	Alert	Activity with the purpose of detecting predators; e.g., guard or sentry duty or a heads-up rigid stance
AN [b]	Antler	A cast, solid, annually deciduous horn of a cervid
AP	Avoiding pests	Avoiding pests
BA	Basking	Behaviour for the purpose of gathering warmth; e.g., a marmot or snake lying on warm rocks, or marmot hair and soiling stains on flat rocks
BE	Bedding	Bedding, sleeping, or resting above ground, including bedding for the purpose of cud-chewing, and roosting and resting of birds
BP[b]	Body	Incidental portions of an animal's body which are parts left behind, but do not indicate the animal is dead; e.g., feathers, hairs, and shed skins; shed antlers are recorded as "AN"
BU	Building	Building a nest, bed, burrow, den, lodge, or other dwelling
CA	Casting	Discharging bodily waste from the mouth; e.g., an owl or snake casting pellets
CO	Courtship	Behaviour for the purpose of enticing a conspecific of the opposite sex into copulation, including copulation, courtship feeding, and defence of mates
CR[b]	Carcass	A carcass, or portions of a carcass, that indicates the animal is dead

DE	Denning	Sleeping or hiding in a cavity, cave, or burrow; does not include hibernating; if the same den is used for hibernating and general denning, record as hibernating
DI[a]	Disturbed	Behaviour for the purpose of avoiding the observer; use only if the activity before disturbance is not known
DR[a]	Drinking	Drinking
EX	Excreting	Discharging waste through the anus
FD	Feeding	Consuming food items, including feeding by animals that search for food and eat simultaneously; e.g., grazers, browsers, flying insectivores, and filter feeders; does not include hunting
FL	Fleeing	Hurried movement to avoid conspecifics or other animals; does not include fleeing to avoid the observer
GR	Grooming	Behaviour for the purpose of arranging and protecting the fur, feathers, skin, etc., including scratching and rubbing of antler velvet
HI	Hibernating	If the same den is used for hibernating and general denning, record as hibernating
HU	Hunting	Searching for, pursuing, and killing prey
IN	Incubation	Incubating, protecting, or laying eggs
LI	Living	Activity could not be specified due to ignorance or the activity was too diverse
MD	Migrating daily	Travelling that is a regular daily activity, including travelling to or away from a communal habitat; e.g., a bat on its daily flight to or from a roosting site
MS	Migrating seasonally	Travelling that is a regular annual activity; e.g., a snake travelling away from a communal habitat such as a hibernaculum
RB	Reproducing, birthing	Giving birth to live young; preparing a birthing reproduction site, such as a den
RE	Reproducing, eggs	Laying eggs (amphibians, reptiles and birds), building a nest, and feeding non-mobile young
RR	Rearing	Adults feeding neonates and juveniles
SH	Security habitat	Using habitat for protection or hiding from predators
ST	Security and/or thermal	Using habitat for its security and/or thermal values; used when differentiating between the two values is difficult or impossible

TE	Territoriality	Behaviour for the purpose of marking or defending a territory; e.g., singing, drumming, winnowing, howling, antler rubbing, wallowing, or scraping the ground
TF [a]	Travelling, flying	Used when the purpose of flying is not known; if known, use a more specific description such as hunting
TH	Thermal habitat	Using habitat for protection from heat, cold, or precipitation
TP	Travelling on a path	Walking on a trail that is embedded in the ground due to animals walking the same route for many years
TR	Travelling	Travelling by a method other than flying, swimming, and walking; usually used for animals that do not normally fly, swim, or walk; includes seeing an isolated track; does not include running if the purpose for running is known
TS [a]	Travelling, swimming	Used when the specific purpose of swimming is not known; if known, use a more specific description such as fleeing
TW	Travelling, walking	Used when the purpose of walking is not known; if known, use a more specific description such as migrating; does not include travelling on a path (see "TP")
UR	Urinating	Urinating

a Code is only associated with seeing or hearing an animal

b Code is only associated with sign of an animal

18 Enter a coded **descriptor** (Des) that indicates whether the animal was observed or heard in the plot or ecosystem unit or gives the probable age or season of the sign (**Table 4-12**).

Table 4-12. Codes for descriptors of wildlife evidence of use.

Code	Meaning
S	The animal was seen
H	The animal was heard
F	Fresh sign (<1 week old)
Y	Sign is <1 year old but >1 week old
O	Old (> 1-year-old)
U	Undetermined (age of sign is unknown)
W	Sign is from the winter season
G	Sign is from the growing season

19 Record the **number** (No.) of animals present or the number of sign elements. Codes for relative abundance can be used for sign elements instead of numbers (i.e., H [high], M [moderate], L [low], or T [trace]).

20 To provide additional information about the evidence of use, or to clarify an entry on this line on the form, enter a numeric code (**Note #**). Enter the same code in the **notes and photo numbers**

section of the form, followed by the pertinent information. For every plot-in-context habitat feature entered, an explanatory note is required to describe the feature and how it was considered in the final ranking. This will allow the surveyor to explain the contributions of the habitat feature and whether they were sufficient enough to affect the ranking.

All photos taken for this form need the photo number recorded, and a brief description of what is shown in the photo. If more space is needed, use the back of the field sheet and indicate with a large and bold arrow that more information is recorded on the back of the form.

21	To indicate if some information on the form needs **review** before final submission (e.g., review species identification) write the word yes in this field. Indicate in the notes space which field(s) need to be reviewed as well as the date the review was completed.
22	Not to be completed in the field. Data should be entered into a spreadsheet as soon as possible, ideally completed daily. Once data are entered into the spreadsheet, fill in the date entered and who entered it. Data entry should be reviewed by a second person and any discrepancies discussed with the original surveyor. Enter the name of the QA/QC reviewer once completed.

4.4.2 Significant Wildlife Habitat Survey Form

Field Label	Description and Instructions
1	Enter the **date** in MM-DD-YYYY format. (e.g., 02-01-2020 for February 1st, 2020).
2	Enter the **time** the forms were completed in hh:mm (24 hr) format (e.g., 13:00 for 1pm). Note that the same time should be written on all pages of the *Significant Wildlife Habitat Survey Form* to indicate when all forms were completed.
3	Enter the **polygon number** where the plot is taking place.
4	Enter vegetation **surveyor(s)** first initial and last name.
5	Using the *List of Sites and Site Information* in Appendix B and record the **predetermined ecosite code.**
6	Consult with the vegetation and soil specialist and record the **final ecosite code**.
7	Using the *Field Summary of Significant Wildlife Habitat Criteria Schedules for Ecoregion 3W* found in Appendix C, check the yes or no if the **ecosite codes** listed for the Wildlife Habitat matches the plot's final ecosite code.
8	Using the *Field Summary of Significant Wildlife Habitat Criteria Schedules for Ecoregion 3W* found in Appendix C, check the yes, no, or unknown box if the **habitat criteria** listed for the Wildlife Habitat matches what is found in or around the plot. The unknown box should only be ticked if the criteria cannot be determined at the time of the survey to be present or not, likely due to seasonal timing (e.g., the survey is conducted in the summer so spring phenomenon cannot be observed).
9	Fill in the **habitat details & rationale, photo reference, UTM**. Include a brief description of the habitat criteria that is present. If multiple criteria are listed, specify which criteria is met. If the unknown box was checked, the reason why the habitat criteria could not be observed must be noted. Record photo number of the habitat and UTM coordinates if different from the plot coordinates. If more space is needed, then use the notes space with a code to the extra note. If the no box was checked for habitat criteria, this box can be left blank.

10 Use **notes and photo numbers** space to record important features not described elsewhere (e.g., important wildlife habitats not considered SWH), or for explanatory notes keyed to other entries on the form. All photos taken for this form need the photo number recorded, and a brief description of what is shown in the photo. If more space is needed, use the back of the field sheet and indicate with a large and bold arrow that more information is recorded on the back of the form.

11 To indicate if some information on the form needs **review** before final submission (e.g., review species identification) write the word yes in this field. Indicate in the notes space which field(s) need to be reviewed as well as the date the review was completed.

12 Not to be completed in the field. Data should be entered into a spreadsheet as soon as possible, ideally completed daily. Once data are entered into the spreadsheet, fill in the date entered and who entered it. Data entry should be reviewed by a second person and any discrepancies discussed with the original surveyor. Enter the name of the QA/QC reviewer once completed.

5.0 REFERENCES

BC MFR, and BC MOE. 2010. Field Manual for Describing Terrestrial Ecosystems. Page Land Management Handbook. 2nd edition. B.C. Ministry of Forests and Range and B.C. Ministry of Environment.

ELC Working Group. 2009. Ecosites of Ontario - Operational Draft. Ecological Land Classification Working Group, Ministry of Natural Resources.

Marshall, P. L., G. Davis, and V. M. LeMay. 2000. Using Line Intersect Sampling for Coarse Woody Debris. Page Forest Research Technical Report TR-003. Research Section, Vancouver Forest Region, BCMOF.

OMNR. 2015. Field Guide to the Substrates of Ontario. Ontario Ministry of Natural Resources.

RIC. 1998. Standard for Terrestrial Ecosystem Mapping in British Columbia. Prepared by Ecosystem Working Group, Terrestrial Ecosystems Task Force, Resources Inventory Committee.

APPENDIX A: FIELD FORMS FOR PRINTING

(see next page – formatted for printing)

Site and Soil Description Form

Date (MM-DD-YYYY)	Time Completed (hh:mm)	All Surveyors	Weather Conditions:	Page	Of

Wind Direction:	Wind Speed (km/h):	Temperature (°C):	Rain last 24hr (mm):	Snow past 24hr (cm):

Predetermined Site Information

UTM Zone	Easting/Lat.	Northing/Long.	Station ID	Polygon Number	Ecosite	Survey Type: Full ☐ Gr. ☐ Vis. ☐

Information Determined at Site

UTM Zone	Easting/Lat.	Northing/Long.	GPS Accur. (m)	Elevation (m)	Ecosite	Rational for Ecosite Change

Site Description

Slope %	Aspect °	Surface Shape: CCV ☐ CVX ☐ STR ☐	Microtop Feature	Meso Slope Pos.: Crest ☐ Upper ☐ Mid ☐ Lower ☐ Toe ☐ Level ☐ Dep. ☐ Gully ☐	Floodplain? Y☐ N☐	Drainage (1-7)

Site dist.	Humus/ Organic Form	Seepage
☐ n/a ☐ fire ☐ site prep ☐ terrain ☐ soil dist. ______ ______ ☐ harvest ☐ planted ☐ biotic ☐ other ______ ______	☐ Mull ☐ Fibrimor ☐ Peatymor ☐ Moder ☐ Humimor ☐ Anmoor	☐n/a _____cm

Humus Thickness _____cm	Ah? ☐ Ae? ☐ _______cm	Soil Pit Depth _______cm	Estimated Rooting Depth _____cm	R.Z. Coarse Frag %	R.Z. Text.

TLFH	TSOM	Dep. Mot.	Dep. Gley.	Dep. Water T.	Dep. Imp. Lay.	Dep. Tex. Chg.
cm	cm	cm	cm	cm	cm	cm

Dep. Bedrock	Dep. Of Data	Texture B Hor.	Texture C Hor.	Effec. Texture	Moisture Reg.	Substrate Series
cm	cm	cm	cm	cm		

Site Diagram

Notes and Photo Numbers:

Review needed: Date entered into spreadsheet: Entered by: QA/QC by:

Vegetation Survey Form

Date (MM-DD-YYYY)	Time Completed (hh:mm)	Polygon Num.	Surveyor(s)	Struc. Stage	Ave. Stand Height	Survey Type Full ☐ Grd. ☐	Page	Of

COL.	TREES	A1	A2	A3	A	B1	B2	B

COL.	SHRUBS	B1	B2	B

COL.	HERB LAYER (C)	%

COL.	MOSS/LICHEN/SEEDLING (D)	%

COL.	ADDITIONAL SPECIES	Layer	%

Notes and Photo Numbers:

% Cover by Layer	TREE (A)	SHRUB (B)	HERB (C)	MOSS/LICHEN (D)

Review needed: Date entered into spreadsheet: Entered by: QA/QC by:

Tree Attributes for Wildlife Survey Form

Date (MM-DD-YYYY)	Time Completed (hh:mm)	Polygon Number	Surveyor(s)	BAF (M^2/Ha)	Minimum DBH (cm)	Page	Of

Tree no.	Species	Stand/Fall	DBH (cm)	M or E	Rem. Bark (%)	Length: Top (%)	Length: Bot. (%)	Length: Bot. Pos. (m)	Length: Slope Distance (m)	Estimated Length (m)	Cr. Class	Height to Live Crown	Wildlife Codes: Appear	Wildlife Codes: Crown	Wildlife Codes: Bark	Wildlife Codes: Wood	Wildlife Codes: Lichen	Wildlife Codes: Wildlife Use	Num Cavity or Crevice	Notes and Photo Numbers
01																				
02																				
03																				
04																				
05																				
06																				
07																				
08																				
09																				
10																				
11																				
12																				
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				

Review needed: Date entered into spreadsheet: Entered by: QA/QC by:

Date (MM-DD-YYYY)	Time Completed (hh:mm)	Polygon Number	Surveyor(s)	Page	Of

Tree no.	Transect #1							Transect #2						
	Azimuth			(0-359)	Sampled		of 24m	Azimuth			(0-359)	Sampled		of 24m
	Species	Diameter (cm)	Class	Tilt Angle	Length (m)	Height of end (cm)	Angle grnd.	Species	Diameter (cm)	Class	Tilt Angle	Length (m)	Height of end (cm)	Angle grnd.
01														
02														
03														
04														
05														
06														
07														
08														
09														
10														
11														
12														
13														
14														
15														
16														
17														
18														

Degree and Type of Piling (in plot boundaries)					
Pile #	Size of pile (m)			Diam	Inter.
	Length	Width	Height	(cm)	space
1					
2					
3					
4					
5					
6					
7					
8					

Notes and Photo Numbers	

Review needed: Date entered into spreadsheet: Entered by: QA/QC by:

Coarse Woody Debris Survey Form

Date (MM-DD-YYYY)	Time Com. (hh:mm)	Polygon Num	Surveyor(s)	Survey Type F/G ☐ VIS. ☐	Non-Hab. Feature	Type Dist.				Page	Of

ASSESSMENT	Hab Use/Sen		Plot Type				Plot in Context														
Species	**Sp. L.R.**	**Ssn**	**FD**	**SH**	**TH**	**Note #**	**Habitat feature**	**Conf.**	**Distance (km)**	**F/C L.R.**	**Imp.**	**Habitat Feature**	**Conf.**	**Distance (km)**	**F/C L.R.**	**Imp.**	**FD**	**SH**	**TH**	**Suit.**	**Note #**
Moose	LI	WE																			
Moose	LI	WL																			
Moose	LI	G																			
Black bear	LI	P																			
Black bear	LI	S																			
Black bear	HI	W																			
Northern flying squirrel	LI	A																			
Snowshoe hare	LI	W																			
Eastern whip-poor-will	RE	G																			
Eastern whip-poor-will	LI (FD)	G																			

EVIDENCE OF USE	Inside plot							Outside plot and inside ecosite													
Species	**Sex**	**Life Stage**	**Activity**		**Des.**	**No.**	**Note #**	**Sex**	**Life Stage**	**Activity**		**Des.**	**No.**	**Sex**	**Life Stage**	**Activity**		**Des.**	**No.**	**Note #**

Notes and Photo Numbers

Review needed: Date entered into spreadsheet: Entered by: QA/QC by:

Wildlife Habitat Assessment Form

Significant Wildlife Habitat Survey Form 1					
Date (MM-DD-YYYY)	**Time Com. (hh:mm)**	**Polygon Num.**	**Surveyor(s)**	**Predetermined Ecosite**	**Final Ecosite**

Seasonal Concentration Areas for Wildlife Species			
Wildlife Habitat	**Ecosite Codes**	**Habitat Criteria**	**Habitat Details & Rationale, Photo Reference, UTM**
Waterfowl Stopover & Staging Area (Terrestrial)	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Waterfowl Stopover and Staging Area (Aquatic)	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Shorebird Migratory Stopover Area	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Colonially - Nesting Bird Breeding Habitat (Bank & Cliff)	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Colonially - Nesting Bird Breeding Habitat (Tree/Shrubs)	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Colonially - Nesting Bird Breeding Habitat (Ground)	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Eagle & Osprey Concentration Area	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Sharp-tailed Grouse Lek	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Bat Hibernaculum	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Bat Maternity Colony	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Amphibian Breeding Habitat	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Turtle Wintering Area	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Snake Hibernaculum	☐Yes ☐No	☐Yes ☐No ☐ Unknown	

Animal Movement Corridors			
Habitat	**Ecosite Codes**	**Habitat Criteria**	**Habitat Details & Rationale, Photo Reference, UTM**
Cervid Movement Corridor	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Amphibian Movement Corridor	☐Yes ☐No	☐Yes ☐No ☐ Unknown	

Review needed: Date entered into spreadsheet: Entered by: QA/QC by:

Significant Wildlife Habitat Survey Form 2				
Date (MM-DD-YYYY)	**Time Com. (hh:mm)**	**Polygon Number**	**Predetermined Ecosite**	**Final Ecosite**

Specialized Habitat for Wildlife			
Specialized Wildlife Habitat	**Ecosite Codes**	**Habitat Criteria**	**Habitat Details & Rationale, Photo Reference, UTM**
Waterfowl Nesting Area	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Wild Rice Stand	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Milkweed Patch	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Bald Eagle & Osprey Nesting Habitat	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Woodland Raptor Nesting Habitat	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Turtle Nesting Area	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Aquatic Feeding Habitat	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Seeps and Springs	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Mineral Lick	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Mammal Denning Site	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Marsh Bird Breeding Habitat	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Open Country Bird Breeding Habitat	☐Yes ☐No	☐Yes ☐No ☐ Unknown	

Notes and Photo Numbers:

Review needed: Date entered into spreadsheet: Entered by: QA/QC by:

Significant Wildlife Habitat Survey Form 3

Date (MM-DD-YYYY)	Time Com. (hh:mm)	Polygon Number	Predetermined Ecosite	Final Ecosite

Rare Vegetation Community

Rare Vegetation Community	Ecosite Codes	Habitat Criteria	Habitat Details & Rationale, Photo Reference, UTM
Cliff and Cliff Rim	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Talus Slope	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Rock Barren	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Rare Treed Type: Red and White Pine	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Rare Treed Type: Red and Sugar Maple	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Sand Dunes	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Rare Arctic-Alpine communities	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Diverse and Sensitive Orchid communities	☐Yes ☐No	☐Yes ☐No ☐ Unknown	
Provincially Rare Veg communities	☐Yes ☐No	☐Yes ☐No ☐ Unknown	

Notes and Photo Numbers:

Review needed: Date entered into spreadsheet: Entered by: QA/QC by:

APPENDIX B: LIST OF SITES AND SITE INFORMATION

(see next page – formatted for printing)

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
4	Full	552164.6286	5477138.816	1	555481676	IG_E004_F_1
7	Full	558913.4252	5486100.246	1	555480724	IG_E007_F_1
7	Ground	559103.7555	5486227.147	1	555480742	IG_E007_G_1
7	Oversample	558937.8725	5486207.893	1	555480731	IG_E007_O_1
7	Visual	559183.0673	5486191.486	1	555480725	IG_E007_V_1
12	Full	554899.9957	5481818.219	1	555480235	IG_E012_F_1
12	Full	560136.4001	5487467.465	2	555480989	IG_E012_F_2
12	Ground	556670.1474	5489296.934	1	555482035	IG_E012_G_1
12	Ground	557872.341	5490278.729	2	555481442	IG_E012_G_2
12	Ground	548732.2267	5487673.479	3	555482010	IG_E012_G_3
12	Ground	552908.5134	5489149.123	4	555481258	IG_E012_G_4
12	Ground	553493.0143	5477956.373	5	555480033	IG_E012_G_5
12	Ground	550863.9855	5487726.926	6	555482024	IG_E012_G_6
12	Ground	559197.5135	5484329.736	7	555480468	IG_E012_G_7
12	Oversample	550221.6203	5487783.548	1	555481017	IG_E012_O_1
12	Oversample	554608.1477	5487713.831	2	555481068	IG_E012_O_2
12	Oversample	553495.8792	5489391.792	3	555481286	IG_E012_O_3
12	Oversample	551788.5294	5489621.712	4	555481313	IG_E012_O_4
12	Oversample	557739.537	5483498.989	5	555480398	IG_E012_O_5
12	Oversample	550199.3953	5487891.96	6	555482023	IG_E012_O_6
12	Oversample	549195.3617	5486227.63	7	555480767	IG_E012_O_7
12	Oversample	552884.7942	5488193.795	8	555481811	IG_E012_O_8
12	Oversample	560754.332	5487199.73	9	555480895	IG_E012_O_9
12	Oversample	551738.9948	5489514.885	10	555481295	IG_E012_O_10
12	Oversample	550989.8506	5489706.459	11	555481345	IG_E012_O_11
12	Oversample	552724.4485	5478747.26	12	555480064	IG_E012_O_12
12	Oversample	551183.9897	5488695.021	13	555481139	IG_E012_O_13
12	Oversample	552593.1897	5484951.923	14	555480540	IG_E012_O_14
12	Oversample	557211.2289	5484841.656	15	555481892	IG_E012_O_15
12	Oversample	557342.9144	5484998.923	16	555481891	IG_E012_O_16
12	Oversample	554284.0185	5487144.128	17	555480888	IG_E012_O_17
12	Oversample	552454.9263	5477802.833	18	555480026	IG_E012_O_18
12	Oversample	552377.0624	5487082.702	19	555482059	IG_E012_O_19
12	Oversample	551988.6469	5490409.448	20	555481470	IG_E012_O_20
12	Oversample	552604.0648	5483258.973	21	555480397	IG_E012_O_21
12	Oversample	553275.7721	5488223.367	22	555481079	IG_E012_O_22
12	Oversample	552613.9829	5487262.969	23	555480936	IG_E012_O_23
12	Oversample	556835.0524	5484753.559	24	555480534	IG_E012_O_24
12	Oversample	555029.8658	5489029.751	25	555481223	IG_E012_O_25
12	Oversample	553234.9723	5479284.937	26	555481819	IG_E012_O_26
12	Oversample	556362.7785	5487890.048	27	555482042	IG_E012_O_27
12	Oversample	557944.1748	5484694.267	28	555480524	IG_E012_O_28
12	Oversample	555912.9349	5481926.107	29	555480227	IG_E012_O_29
12	Visual	560209.4871	5487285.393	1	555480942	IG_E012_V_1
12	Visual	551917.3353	5486597.153	2	555480798	IG_E012_V_2
12	Visual	555451.1437	5489409.498	3	555481277	IG_E012_V_3
12	Visual	553061.4245	5488602.634	4	555481157	IG_E012_V_4
12	Visual	551606.829	5489578.587	5	555481320	IG_E012_V_5
12	Visual	557429.7779	5485001.524	6	555480551	IG_E012_V_6

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
12	Visual	554217.1796	5487759.019	7	555482061	IG_E012_V_7
12	Visual	557970.3355	5483209.001	8	555480380	IG_E012_V_8
12	Visual	553690.5777	5477415.357	9	555480014	IG_E012_V_9
12	Visual	551967.8638	5486865.156	10	555480847	IG_E012_V_10
12	Visual	554473.3837	5487336.298	11	555480954	IG_E012_V_11
12	Visual	549507.0637	5486657.908	12	555480822	IG_E012_V_12
12	Visual	557294.6838	5485866.327	13	555480663	IG_E012_V_13
12	Visual	557396.7278	5485960.977	14	555480712	IG_E012_V_14
12	Visual	559460.8691	5484536.733	15	555482089	IG_E012_V_15
12	Visual	554807.5604	5488027.082	16	555481033	IG_E012_V_16
12	Visual	550532.2007	5481605.209	17	555480213	IG_E012_V_17
12	Visual	553574.5198	5482425.08	18	555480273	IG_E012_V_18
12	Visual	552150.1357	5490978.686	19	555481583	IG_E012_V_19
12	Visual	551952.3311	5490668.365	20	555481545	IG_E012_V_20
12	Visual	549536.2394	5485739.354	21	555482020	IG_E012_V_21
12	Visual	557072.6749	5484776.017	22	555480511	IG_E012_V_22
12	Visual	553147.0106	5490171.059	23	555481497	IG_E012_V_23
12	Visual	555458.5431	5482627.818	24	555480299	IG_E012_V_24
12	Visual	552454.7075	5483382.841	25	555480378	IG_E012_V_25
12	Visual	554482.2804	5489263.556	26	555481254	IG_E012_V_26
12	Visual	553187.7334	5484921.657	27	555480527	IG_E012_V_27
16	Full	550547.0286	5480953.719	1	555480192	IG_E016_F_1
33	Full	556394.9571	5490349.57	1	555481447	IG_E033_F_1
33	Ground	550200.4765	5488923.391	1	555481181	IG_E033_G_1
33	Oversample	550367.7389	5489024.615	1	555481256	IG_E033_O_1
34	Full	556617.2077	5489982.883	1	555481415	IG_E034_F_1
34	Ground	556356.6337	5490154.552	1	555481418	IG_E034_G_1
34	Ground	556906.3978	5489524.295	2	555481396	IG_E034_G_2
34	Oversample	556771.5412	5490780.901	1	555481534	IG_E034_O_1
34	Oversample	549954.4012	5491268.488	2	555481640	IG_E034_O_2
34	Oversample	551645.3573	5485660.596	3	555480685	IG_E034_O_3
34	Oversample	556502.8766	5489950.947	4	555481494	IG_E034_O_4
34	Visual	561147.1546	5487548.563	1	555480988	IG_E034_V_1
34	Visual	561349.3122	5488235.231	2	555481087	IG_E034_V_2
34	Visual	556436.1606	5490745.71	3	555481527	IG_E034_V_3
34	Visual	556183.1121	5490734.445	4	555481525	IG_E034_V_4
35	Full	556009.4559	5490496.503	1	555481481	IG_E035_F_1
35	Ground	556261.0267	5490795.57	1	555482029	IG_E035_G_1
35	Oversample	555967.2787	5490607.629	1	555481491	IG_E035_O_1
35	Visual	556720.3189	5490846.329	1	555481554	IG_E035_V_1
40	Full	555898.2844	5490528.199	1	555481512	IG_E040_F_1
46	Full	553549.7639	5491593.814	1	555481669	IG_E046_F_1
46	Ground	554079.5284	5491093.998	1	555481665	IG_E046_G_1
48	Full	551143.3199	5488662.555	1	555481143	IG_E048_F_1
48	Ground	560988.586	5487905.33	1	555481031	IG_E048_G_1
49	Full	553167.1952	5478079.641	1	555480037	IG_E049_F_1
49	Full	552523.6184	5477988.04	2	555480057	IG_E049_F_2
49	Full	557309.4021	5486059.065	3	555480708	IG_E049_F_3
49	Full	551298.0093	5486668.77	4	555480825	IG_E049_F_4

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
49	Full	557011.8957	5482399.223	5	555480297	IG_E049_F_5
49	Full	552319.6473	5486047.96	6	555480740	IG_E049_F_6
49	Full	554739.5865	5482981.202	7	555480367	IG_E049_F_7
49	Full	559781.6441	5485941.809	8	555480720	IG_E049_F_8
49	Ground	553376.6434	5483122.167	1	555480386	IG_E049_G_1
49	Ground	552667.9648	5476998.918	2	555481677	IG_E049_G_2
49	Ground	560088.7127	5489673.652	3	555481348	IG_E049_G_3
49	Ground	557970.9902	5486651.687	4	555481965	IG_E049_G_4
49	Ground	560158.5203	5484131.457	5	555480434	IG_E049_G_5
49	Ground	548171.9862	5488395.543	6	555481082	IG_E049_G_6
49	Ground	551231.1723	5486344.36	7	555480823	IG_E049_G_7
49	Ground	555142.2001	5481533.622	8	555480204	IG_E049_G_8
49	Ground	557043.0949	5487216.451	9	555480899	IG_E049_G_9
49	Ground	556307.2554	5486322.439	10	555480882	IG_E049_G_10
49	Ground	551420.9661	5490200.699	11	555481420	IG_E049_G_11
49	Ground	551503.3899	5487164.873	12	555480922	IG_E049_G_12
49	Ground	556889.7787	5489921.908	13	555481385	IG_E049_G_13
49	Ground	556577.984	5485288.076	14	555480594	IG_E049_G_14
49	Ground	549459.9336	5491378.443	15	555481644	IG_E049_G_15
49	Ground	558772.5659	5483012.455	16	555480334	IG_E049_G_16
49	Ground	556462.4207	5485373.19	17	555480624	IG_E049_G_17
49	Ground	556785.9793	5487972.728	18	555481026	IG_E049_G_18
49	Ground	553153.0142	5481736.454	19	555480217	IG_E049_G_19
49	Ground	552409.9933	5486077.415	20	555480736	IG_E049_G_20
49	Ground	552422.4236	5478593.408	21	555480061	IG_E049_G_21
49	Ground	551022.8142	5489462.776	22	555481395	IG_E049_G_22
49	Ground	551353.5469	5487626.288	23	555480998	IG_E049_G_23
49	Ground	557574.3324	5485067.075	24	555480566	IG_E049_G_24
49	Ground	554689.2327	5486793.088	25	555480852	IG_E049_G_25
49	Ground	553130.4964	5486754.18	26	555480935	IG_E049_G_26
49	Ground	561490.8894	5485003.27	27	555480579	IG_E049_G_27
49	Ground	559555.6632	5485342.908	28	555480618	IG_E049_G_28
49	Ground	557605.8871	5486134.275	29	555481944	IG_E049_G_29
49	Ground	558408.5565	5483745.663	30	555480412	IG_E049_G_30
49	Ground	560274.0139	5485439.382	31	555480673	IG_E049_G_31
49	Ground	554607.3401	5482768.679	32	555480312	IG_E049_G_32
49	Ground	560975.297	5482449.028	33	555480286	IG_E049_G_33
49	Ground	556273.173	5488933.471	34	555481191	IG_E049_G_34
49	Ground	552384.1029	5477423.845	35	555480011	IG_E049_G_35
49	Ground	549872.2855	5488526.026	36	555481105	IG_E049_G_36
49	Ground	554567.0572	5488562.002	37	555481815	IG_E049_G_37
49	Ground	556195.1289	5486799.1	38	555480848	IG_E049_G_38
49	Ground	551504.2509	5483211.84	39	555480381	IG_E049_G_39
49	Ground	555072.6945	5487124.768	40	555480981	IG_E049_G_40
49	Ground	559604.5056	5490572.317	41	555481484	IG_E049_G_41
49	Ground	552354.2717	5477328.042	42	555480013	IG_E049_G_42
49	Oversample	552942.8478	5487250.463	1	555480939	IG_E049_O_1
49	Oversample	556932.3336	5488862.92	2	555481216	IG_E049_O_2
49	Oversample	549924.2416	5487742.981	3	555480991	IG_E049_O_3

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
49	Oversample	548857.8983	5486209.945	4	555480789	IG_E049_O_4
49	Oversample	552019.6902	5487613.564	5	555480977	IG_E049_O_5
49	Oversample	559635.726	5487740.946	6	555481049	IG_E049_O_6
49	Oversample	548887.5877	5487701.524	7	555482012	IG_E049_O_7
49	Oversample	557897.8168	5485843.513	8	555480755	IG_E049_O_8
49	Oversample	551683.8254	5490050.118	9	555481378	IG_E049_O_9
49	Oversample	550448.2267	5485181.325	10	555480597	IG_E049_O_10
49	Oversample	561272.361	5488617.376	11	555481128	IG_E049_O_11
49	Oversample	553296.0473	5488525.294	12	555481130	IG_E049_O_12
49	Oversample	556582.2806	5487515.296	13	555480974	IG_E049_O_13
49	Oversample	555644.8918	5484095.476	14	555480611	IG_E049_O_14
49	Oversample	555077.2317	5482350.57	15	555480291	IG_E049_O_15
49	Oversample	551247.3032	5487868.758	16	555482027	IG_E049_O_16
49	Oversample	558530.2318	5489789.338	17	555481353	IG_E049_O_17
49	Oversample	554907.75	5485759.702	18	555480691	IG_E049_O_18
49	Oversample	553800.8136	5484198.381	19	555480578	IG_E049_O_19
49	Oversample	555548.6988	5486433.917	20	555480804	IG_E049_O_20
49	Oversample	549439.1871	5488861.04	21	555481211	IG_E049_O_21
49	Oversample	557099.4471	5489477.265	22	555481292	IG_E049_O_22
49	Oversample	557863.8559	5485678.221	23	555480644	IG_E049_O_23
49	Oversample	558193.7962	5485080.299	24	555481933	IG_E049_O_24
49	Oversample	553515.2477	5487871.704	25	555481070	IG_E049_O_25
49	Oversample	557312.4198	5485843.131	26	555480668	IG_E049_O_26
49	Oversample	557357.8302	5484827.81	27	555480522	IG_E049_O_27
49	Oversample	557998.675	5490352.515	28	555481448	IG_E049_O_28
49	Oversample	548240.8373	5489990.551	29	555481394	IG_E049_O_29
49	Oversample	548759.8739	5487372.16	30	555480973	IG_E049_O_30
49	Oversample	551673.0974	5484049.658	31	555480474	IG_E049_O_31
49	Oversample	555873.3899	5488032.152	32	555481048	IG_E049_O_32
49	Oversample	554975.4594	5486774.641	33	555480908	IG_E049_O_33
49	Oversample	554761.9008	5487040.567	34	555482072	IG_E049_O_34
49	Oversample	557400.3666	5481917.644	35	555480232	IG_E049_O_35
49	Oversample	554517.701	5488646.377	36	555481146	IG_E049_O_36
49	Oversample	550622.7215	5479264.48	37	555480086	IG_E049_O_37
49	Oversample	560940.2266	5484850.395	38	555480538	IG_E049_O_38
49	Oversample	559670.8417	5486351.924	39	555480758	IG_E049_O_39
49	Oversample	557008.8068	5481347.581	40	555480196	IG_E049_O_40
49	Oversample	561412.2392	5484100.539	41	555481894	IG_E049_O_41
49	Oversample	549996.9524	5480931.17	42	555480174	IG_E049_O_42
49	Oversample	557759.1672	5490165.891	43	555481413	IG_E049_O_43
49	Oversample	555665.7593	5485942.882	44	555480745	IG_E049_O_44
49	Oversample	554324.7608	5478175.011	45	555480046	IG_E049_O_45
49	Oversample	557523.155	5483106.915	46	555480387	IG_E049_O_46
49	Oversample	552206.6024	5486573.602	47	555480793	IG_E049_O_47
49	Oversample	547986.1383	5488752.962	48	555481145	IG_E049_O_48
49	Oversample	560449.4969	5489324.093	49	555482075	IG_E049_O_49
49	Oversample	559091.4939	5487201.058	50	555480911	IG_E049_O_50
49	Oversample	550754.6727	5487880.316	51	555481020	IG_E049_O_51
49	Oversample	559913.0136	5484527.697	52	555480477	IG_E049_O_52

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
49	Oversample	556057.8451	5482929.494	53	555480355	IG_E049_O_53
49	Oversample	556397.3565	5487984.676	54	555481037	IG_E049_O_54
49	Oversample	549441.6949	5491522.966	55	555481647	IG_E049_O_55
49	Oversample	557219.3197	5483579.543	56	555480410	IG_E049_O_56
49	Oversample	550121.8387	5490172.567	57	555482004	IG_E049_O_57
49	Oversample	553285.5104	5485648.885	58	555480657	IG_E049_O_58
49	Oversample	557141.2034	5486411.025	59	555481960	IG_E049_O_59
49	Oversample	556791.3447	5489823.792	60	555482032	IG_E049_O_60
49	Oversample	554099.668	5485423.157	61	555480638	IG_E049_O_61
49	Oversample	553706.1176	5486909.649	62	555480860	IG_E049_O_62
49	Oversample	552904.1246	5486376.016	63	555482070	IG_E049_O_63
49	Oversample	556350.5181	5489110.977	64	555482036	IG_E049_O_64
49	Oversample	560861.6302	5482262.524	65	555480254	IG_E049_O_65
49	Oversample	553741.0056	5483060.354	66	555480340	IG_E049_O_66
49	Oversample	551001.3812	5478629.07	67	555480063	IG_E049_O_67
49	Oversample	559415.5286	5483027.912	68	555480339	IG_E049_O_68
49	Oversample	561515.0239	5485256.447	69	555480584	IG_E049_O_69
49	Oversample	558353.5383	5482931.085	70	555480336	IG_E049_O_70
49	Oversample	560231.6247	5489078.027	71	555481971	IG_E049_O_71
49	Oversample	556149.697	5483836.496	72	555482087	IG_E049_O_72
49	Oversample	553841.0267	5481119.214	73	555480194	IG_E049_O_73
49	Oversample	556899.701	5487886.167	74	555481018	IG_E049_O_74
49	Oversample	549217.0624	5490385.147	75	555481560	IG_E049_O_75
49	Oversample	550762.3616	5490264.704	76	555481446	IG_E049_O_76
49	Oversample	550969.0318	5487460.873	77	555480979	IG_E049_O_77
49	Oversample	554454.3332	5482318.802	78	555480257	IG_E049_O_78
49	Oversample	551517.6425	5489769.245	79	555481377	IG_E049_O_79
49	Oversample	550709.6364	5488503.962	80	555481117	IG_E049_O_80
49	Oversample	560844.5246	5490062.573	81	555481979	IG_E049_O_81
49	Oversample	553899.7928	5482600.078	82	555480359	IG_E049_O_82
49	Oversample	561316.7627	5490878.351	83	555481565	IG_E049_O_83
49	Oversample	550416.3575	5486895.477	84	555482068	IG_E049_O_84
49	Oversample	558659.7901	5485929.423	85	555482091	IG_E049_O_85
49	Oversample	550753.3906	5480262.901	86	555480131	IG_E049_O_86
49	Oversample	551970.8513	5488063.429	87	555482095	IG_E049_O_87
49	Oversample	561269.0526	5482930.795	88	555480320	IG_E049_O_88
49	Oversample	557671.4964	5483949.995	89	555480417	IG_E049_O_89
49	Oversample	560540.5585	5489804.681	90	555482076	IG_E049_O_90
49	Oversample	552235.1601	5486676.906	91	555480872	IG_E049_O_91
49	Oversample	558671.7997	5483698.967	92	555480403	IG_E049_O_92
49	Oversample	559003.2471	5482728.064	93	555480352	IG_E049_O_93
49	Oversample	550523.1419	5489299.272	94	555481266	IG_E049_O_94
49	Oversample	555799.7105	5481339.382	95	555480206	IG_E049_O_95
49	Oversample	551363.3689	5484036.507	96	555480467	IG_E049_O_96
49	Oversample	560968.9322	5488479.693	97	555481104	IG_E049_O_97
49	Oversample	551839.6077	5484460.227	98	555480537	IG_E049_O_98
49	Oversample	560275.5099	5486669.283	99	555481935	IG_E049_O_99
49	Oversample	559791.9302	5489902.886	100	555481975	IG_E049_O_100
49	Oversample	549301.2031	5488687.726	101	555481135	IG_E049_O_101

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
49	Oversample	556894.7793	5490604.735	102	555481526	IG_E049_O_102
49	Oversample	557911.9625	5482073.014	103	555480244	IG_E049_O_103
49	Oversample	550522.0854	5489695.673	104	555482005	IG_E049_O_104
49	Oversample	558347.4062	5490389.116	105	555481443	IG_E049_O_105
49	Oversample	558298.0678	5484025.376	106	555480459	IG_E049_O_106
49	Oversample	551119.655	5484994.952	107	555480542	IG_E049_O_107
49	Oversample	555506.6758	5487573.8	108	555481071	IG_E049_O_108
49	Oversample	556339.317	5487636.33	109	555481110	IG_E049_O_109
49	Oversample	553358.2161	5484536.927	110	555480516	IG_E049_O_110
49	Oversample	552265.8167	5483228.416	111	555480402	IG_E049_O_111
49	Oversample	551301.9859	5484694.595	112	555480545	IG_E049_O_112
49	Oversample	554157.2705	5488705.457	113	555481164	IG_E049_O_113
49	Oversample	553242.6297	5489792.847	114	555481417	IG_E049_O_114
49	Oversample	560694.8754	5484790.097	115	555480575	IG_E049_O_115
49	Oversample	561227.8973	5487916.165	116	555481057	IG_E049_O_116
49	Oversample	554635.014	5487410.869	117	555480950	IG_E049_O_117
49	Oversample	560496.886	5485912.34	118	555480710	IG_E049_O_118
49	Oversample	558755.8017	5485927.327	119	555480694	IG_E049_O_119
49	Oversample	557655.8783	5481102.442	120	555480181	IG_E049_O_120
49	Oversample	561159.1379	5486740.487	121	555480850	IG_E049_O_121
49	Oversample	555282.0671	5488242.927	122	555481080	IG_E049_O_122
49	Oversample	550883.5297	5479994.28	123	555480136	IG_E049_O_123
49	Oversample	550041.6269	5485622.539	124	555480637	IG_E049_O_124
49	Oversample	557781.6478	5487088.61	125	555482073	IG_E049_O_125
49	Oversample	561120.3291	5488392.629	126	555481102	IG_E049_O_126
49	Oversample	561319.2931	5484690.012	127	555480559	IG_E049_O_127
49	Oversample	554630.7212	5478336.993	128	555480051	IG_E049_O_128
49	Oversample	553683.0627	5482771.107	129	555481871	IG_E049_O_129
49	Oversample	554553.1564	5478703.238	130	555480088	IG_E049_O_130
49	Oversample	557507.9216	5486494.606	131	555480814	IG_E049_O_131
49	Oversample	559042.8998	5483388.302	132	555480414	IG_E049_O_132
49	Oversample	553074.5489	5482830.417	133	555480315	IG_E049_O_133
49	Oversample	557024.8372	5487862.154	134	555481245	IG_E049_O_134
49	Oversample	551355.4948	5486940.193	135	555480913	IG_E049_O_135
49	Oversample	552270.2215	5479117.952	136	555481816	IG_E049_O_136
49	Oversample	559736.2726	5487340.983	137	555480933	IG_E049_O_137
49	Oversample	555022.6337	5483256.75	138	555480371	IG_E049_O_138
49	Oversample	551109.9223	5484399.029	139	555480475	IG_E049_O_139
49	Oversample	559147.5044	5486488.659	140	555480815	IG_E049_O_140
49	Oversample	553470.5257	5487676.927	141	555480992	IG_E049_O_141
49	Oversample	553285.4797	5483150.485	142	555480362	IG_E049_O_142
49	Oversample	551192.8996	5487291.067	143	555480932	IG_E049_O_143
49	Oversample	551122.5178	5480731.23	144	555480168	IG_E049_O_144
49	Oversample	551102.1183	5490386.62	145	555481465	IG_E049_O_145
49	Oversample	558447.6841	5489966.989	146	555481403	IG_E049_O_146
49	Oversample	551485.2358	5489639.401	147	555481347	IG_E049_O_147
49	Oversample	559726.454	5483784.691	148	555480444	IG_E049_O_148
49	Oversample	553420.3002	5484908.737	149	555480613	IG_E049_O_149
49	Oversample	548071.5369	5489621.263	150	555481302	IG_E049_O_150

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
49	Oversample	555321.6455	5486220.914	151	555480763	IG_E049_O_151
49	Oversample	557538.3923	5490826.255	152	555481559	IG_E049_O_152
49	Oversample	552281.0643	5483992.423	153	555480546	IG_E049_O_153
49	Oversample	550851.2905	5487963.538	154	555481042	IG_E049_O_154
49	Oversample	554820.1063	5482297.297	155	555480259	IG_E049_O_155
49	Oversample	560242.2121	5489395.241	156	555481402	IG_E049_O_156
49	Oversample	560214.1513	5485923.086	157	555480863	IG_E049_O_157
49	Oversample	554857.8563	5488556.604	158	555481120	IG_E049_O_158
49	Oversample	558467.8651	5486454.814	159	555480784	IG_E049_O_159
49	Oversample	551240.5346	5489975.668	160	555481371	IG_E049_O_160
49	Oversample	558350.6774	5486519.945	161	555480876	IG_E049_O_161
49	Oversample	550596.013	5489322.89	162	555481263	IG_E049_O_162
49	Oversample	548093.3969	5489133.321	163	555481240	IG_E049_O_163
49	Oversample	553800.8106	5489840.349	164	555481376	IG_E049_O_164
49	Oversample	556785.6615	5485465.286	165	555480601	IG_E049_O_165
49	Oversample	551436.4669	5488161.491	166	555481095	IG_E049_O_166
49	Oversample	558169.644	5483712.44	167	555480406	IG_E049_O_167
49	Oversample	557746.6341	5489692.133	168	555481361	IG_E049_O_168
49	Oversample	551159.5463	5483396.536	169	555480379	IG_E049_O_169
49	Oversample	561086.7192	5486573.749	170	555480799	IG_E049_O_170
49	Oversample	553192.3379	5486433.71	171	555480849	IG_E049_O_171
49	Oversample	553015.9476	5482553.31	172	555481820	IG_E049_O_172
49	Oversample	549144.2078	5485991.515	173	555480735	IG_E049_O_173
49	Oversample	552378.3971	5484542.644	174	555480487	IG_E049_O_174
49	Oversample	552539.8545	5491697.694	175	555481659	IG_E049_O_175
49	Oversample	556926.194	5486214.438	176	555482092	IG_E049_O_176
49	Oversample	554921.2631	5488834.457	177	555481175	IG_E049_O_177
49	Oversample	550576.2645	5486988.754	178	555482067	IG_E049_O_178
49	Oversample	551723.8484	5486663.241	179	555480811	IG_E049_O_179
49	Oversample	561126.5194	5485171.145	180	555480567	IG_E049_O_180
49	Oversample	557240.7636	5490103.293	181	555481401	IG_E049_O_181
49	Oversample	559211.8109	5484728.667	182	555480650	IG_E049_O_182
49	Oversample	551831.752	5482762.472	183	555480325	IG_E049_O_183
49	Oversample	548345.862	5489627.545	184	555481319	IG_E049_O_184
49	Oversample	560105.892	5488150.408	185	555481067	IG_E049_O_185
49	Oversample	554191.0858	5478337.896	186	555480047	IG_E049_O_186
49	Oversample	551638.2483	5479026.023	187	555480081	IG_E049_O_187
49	Oversample	561257.1316	5487111.283	188	555480883	IG_E049_O_188
49	Oversample	559725.959	5482138.113	189	555480240	IG_E049_O_189
49	Oversample	552449.907	5489585.543	190	555481340	IG_E049_O_190
49	Oversample	554452.9302	5487767.442	191	555481024	IG_E049_O_191
49	Oversample	557477.0028	5485564.691	192	555480672	IG_E049_O_192
49	Oversample	559335.7288	5485806.673	193	555481934	IG_E049_O_193
49	Oversample	551175.3246	5481751.996	194	555480219	IG_E049_O_194
49	Oversample	552636.8059	5484674.665	195	555481951	IG_E049_O_195
49	Oversample	552424.3046	5483853.665	196	555480418	IG_E049_O_196
49	Oversample	554843.7506	5487649.103	197	555480983	IG_E049_O_197
49	Oversample	556834.9532	5491169.888	198	555481630	IG_E049_O_198
49	Oversample	554505.8565	5487149.19	199	555480889	IG_E049_O_199

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
49	Visual	553064.3931	5478630.451	1	555480062	IG_E049_V_1
49	Visual	559375.703	5486845.209	2	555480993	IG_E049_V_2
49	Visual	557816.9302	5484712	3	555480532	IG_E049_V_3
49	Visual	556819.962	5484121.827	4	555480433	IG_E049_V_4
49	Visual	552373.1352	5482701.061	5	555480314	IG_E049_V_5
49	Visual	561212.7546	5482623.67	6	555480316	IG_E049_V_6
49	Visual	556710.7588	5488264.342	7	555481097	IG_E049_V_7
49	Visual	557828.5039	5487793.993	8	555480996	IG_E049_V_8
49	Visual	550262.0543	5480095.4	9	555480129	IG_E049_V_9
49	Visual	558502.1815	5484687.006	10	555480506	IG_E049_V_10
49	Visual	553300.5641	5490264.119	11	555481599	IG_E049_V_11
49	Visual	553623.7886	5480804.653	12	555480170	IG_E049_V_12
49	Visual	553135.2224	5483359.249	13	555480382	IG_E049_V_13
49	Visual	561686.3525	5485039.091	14	555480580	IG_E049_V_14
49	Visual	557688.9483	5490748.026	15	555481524	IG_E049_V_15
49	Visual	558068.7111	5489627.758	16	555481315	IG_E049_V_16
49	Visual	561332.4817	5487781.371	17	555480994	IG_E049_V_17
49	Visual	549881.529	5485282.963	18	555480592	IG_E049_V_18
49	Visual	559137.9097	5488682.218	19	555481984	IG_E049_V_19
49	Visual	560845.9112	5486738.404	20	555480880	IG_E049_V_20
49	Visual	554332.5804	5483726.767	21	555480421	IG_E049_V_21
49	Visual	550567.801	5484166.714	22	555480503	IG_E049_V_22
49	Visual	553067.8471	5478276.913	23	555480058	IG_E049_V_23
49	Visual	551957.4773	5484208.721	24	555480437	IG_E049_V_24
49	Visual	554852.8303	5485868.737	25	555480688	IG_E049_V_25
49	Visual	555727.8272	5486825.237	26	555480878	IG_E049_V_26
49	Visual	557454.2785	5490097.87	27	555481400	IG_E049_V_27
49	Visual	557509.0147	5481359.237	28	555480193	IG_E049_V_28
49	Visual	559824.6607	5484335.946	29	555480447	IG_E049_V_29
49	Visual	560569.8654	5486018.775	30	555480794	IG_E049_V_30
49	Visual	556721.0671	5487812.746	31	555481002	IG_E049_V_31
49	Visual	553409.7424	5480697.646	32	555480158	IG_E049_V_32
49	Visual	553585.8862	5480996.785	33	555480177	IG_E049_V_33
49	Visual	555002.0336	5488463.118	34	555481134	IG_E049_V_34
49	Visual	557516.8052	5482566.782	35	555480324	IG_E049_V_35
49	Visual	548705.0854	5488238.418	36	555481122	IG_E049_V_36
49	Visual	554462.053	5484448.113	37	555480469	IG_E049_V_37
49	Visual	560605.2603	5488814.915	38	555481206	IG_E049_V_38
49	Visual	548144.0094	5489577.047	39	555481322	IG_E049_V_39
49	Visual	559369.1049	5488377.379	40	555481109	IG_E049_V_40
49	Visual	559458.8134	5482347.438	41	555480262	IG_E049_V_41
49	Visual	555717.7375	5488783.634	42	555481153	IG_E049_V_42
49	Visual	550637.387	5481969.536	43	555480238	IG_E049_V_43
49	Visual	556282.1757	5485696.465	44	555480647	IG_E049_V_44
49	Visual	550315.4037	5484487.331	45	555480480	IG_E049_V_45
49	Visual	549936.154	5490057.423	46	555481387	IG_E049_V_46
49	Visual	549504.9172	5490427.132	47	555481586	IG_E049_V_47
49	Visual	550241.0179	5480611.347	48	555480150	IG_E049_V_48
49	Visual	557698.118	5484283.488	49	555480457	IG_E049_V_49

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
49	Visual	558195.8911	5485731.552	50	555480642	IG_E049_V_50
49	Visual	553459.8563	5483291.337	51	555480435	IG_E049_V_51
49	Visual	560984.5673	5484384.568	52	555481895	IG_E049_V_52
49	Visual	552813.3221	5487822.897	53	555481038	IG_E049_V_53
49	Visual	557734.2207	5490549.51	54	555481508	IG_E049_V_54
49	Visual	554191.8596	5478749.497	55	555480069	IG_E049_V_55
49	Visual	557580.5086	5486080.422	56	555481945	IG_E049_V_56
49	Visual	556564.6833	5485446.219	57	555480602	IG_E049_V_57
49	Visual	560787.6052	5487525.602	58	555480948	IG_E049_V_58
49	Visual	561552.395	5485376.403	59	555480590	IG_E049_V_59
49	Visual	551554.7724	5478242.592	60	555480050	IG_E049_V_60
49	Visual	555563.6454	5486696.055	61	555480832	IG_E049_V_61
49	Visual	561020.8227	5487069.744	62	555480887	IG_E049_V_62
49	Visual	548102.0267	5488590.189	63	555481178	IG_E049_V_63
49	Visual	556092.918	5485890.575	64	555481956	IG_E049_V_64
49	Visual	558447.9469	5486090.924	65	555480718	IG_E049_V_65
49	Visual	550953.6093	5481252.581	66	555480188	IG_E049_V_66
49	Visual	561764.2234	5484956.101	67	555480531	IG_E049_V_67
49	Visual	549754.279	5489655.023	68	555481318	IG_E049_V_68
49	Visual	556871.4285	5482868.743	69	555480341	IG_E049_V_69
49	Visual	551055.2718	5485088.918	70	555480608	IG_E049_V_70
49	Visual	560533.199	5482643.839	71	555480351	IG_E049_V_71
49	Visual	557048.4802	5485688.453	72	555481958	IG_E049_V_72
49	Visual	551271.7866	5487020.957	73	555480858	IG_E049_V_73
49	Visual	561195.2412	5482776.663	74	555480302	IG_E049_V_74
49	Visual	548924.0597	5487986.859	75	555481090	IG_E049_V_75
49	Visual	550437.2896	5488913.066	76	555481275	IG_E049_V_76
49	Visual	554727.068	5482362.236	77	555480260	IG_E049_V_77
49	Visual	557093.9422	5485878.082	78	555480674	IG_E049_V_78
49	Visual	550854.5672	5479148.284	79	555480097	IG_E049_V_79
49	Visual	551586.7721	5488527.804	80	555481111	IG_E049_V_80
49	Visual	550934.0295	5487381.494	81	555480934	IG_E049_V_81
49	Visual	557234.8848	5481272.171	82	555480222	IG_E049_V_82
49	Visual	556301.725	5487332.339	83	555480978	IG_E049_V_83
49	Visual	557505.6146	5482407.913	84	555480304	IG_E049_V_84
49	Visual	556770.4867	5482504.381	85	555480277	IG_E049_V_85
49	Visual	555443.5763	5487530.45	86	555480967	IG_E049_V_86
49	Visual	555132.8647	5486497.436	87	555480800	IG_E049_V_87
49	Visual	553296.58	5480533.076	88	555480155	IG_E049_V_88
49	Visual	553916.4166	5484775.762	89	555480605	IG_E049_V_89
49	Visual	548962.1111	5491052.897	90	555481592	IG_E049_V_90
49	Visual	552593.485	5484730.313	91	555480509	IG_E049_V_91
49	Visual	560104.7533	5485652.708	92	555480678	IG_E049_V_92
49	Visual	549700.6561	5489917.559	93	555481419	IG_E049_V_93
49	Visual	552849.8506	5484958.689	94	555480541	IG_E049_V_94
49	Visual	559668.4476	5489251.234	95	555481260	IG_E049_V_95
49	Visual	555003.9062	5486340.552	96	555480770	IG_E049_V_96
49	Visual	558317.1234	5486928.955	97	555480877	IG_E049_V_97
49	Visual	550672.8128	5488807.265	98	555481195	IG_E049_V_98

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
49	Visual	552953.74	5483302.73	99	555480395	IG_E049_V_99
49	Visual	553606.4705	5481322.506	100	555480199	IG_E049_V_100
49	Visual	548327.4807	5488810.967	101	555481188	IG_E049_V_101
49	Visual	556988.9214	5490931.911	102	555481568	IG_E049_V_102
49	Visual	551293.1497	5486884.397	103	555480862	IG_E049_V_103
49	Visual	554189.2281	5488173.561	104	555481076	IG_E049_V_104
49	Visual	551057.2417	5484630.879	105	555480489	IG_E049_V_105
49	Visual	551750.5216	5485383.628	106	555480658	IG_E049_V_106
49	Visual	555273.721	5488757.417	107	555481159	IG_E049_V_107
49	Visual	561032.9696	5487210.062	108	555480916	IG_E049_V_108
49	Visual	549476.9679	5485739.669	109	555480693	IG_E049_V_109
49	Visual	559678.8136	5488556.987	110	555481193	IG_E049_V_110
49	Visual	550127.5739	5487576.781	111	555480959	IG_E049_V_111
49	Visual	550711.1782	5489957.555	112	555481398	IG_E049_V_112
49	Visual	552876.1244	5484522.395	113	555481888	IG_E049_V_113
49	Visual	559454.0601	5484029.147	114	555480430	IG_E049_V_114
49	Visual	560066.5564	5490273.934	115	555481422	IG_E049_V_115
49	Visual	555506.2363	5488530.612	116	555481132	IG_E049_V_116
49	Visual	552377.5703	5483227.725	117	555480400	IG_E049_V_117
49	Visual	555283.6541	5487787.555	118	555482094	IG_E049_V_118
49	Visual	554197.3144	5481525.849	119	555480220	IG_E049_V_119
49	Visual	557151.1225	5485362.839	120	555480646	IG_E049_V_120
49	Visual	553895.3997	5486072.091	121	555480709	IG_E049_V_121
49	Visual	557710.7122	5482368.985	122	555480281	IG_E049_V_122
49	Visual	551112.9902	5483634.566	123	555480419	IG_E049_V_123
49	Visual	553817.8505	5483827.207	124	555480424	IG_E049_V_124
49	Visual	553885.9301	5478386.182	125	555480052	IG_E049_V_125
49	Visual	549397.3593	5487690.885	126	555481021	IG_E049_V_126
49	Visual	560320.9105	5487198.382	127	555480910	IG_E049_V_127
49	Visual	548609.3047	5488459.612	128	555481113	IG_E049_V_128
49	Visual	555803.8106	5482812.186	129	555480318	IG_E049_V_129
49	Visual	553608.1162	5485506.32	130	555480606	IG_E049_V_130
49	Visual	554664.2176	5478409.72	131	555481750	IG_E049_V_131
49	Visual	557847.4959	5486230.275	132	555480830	IG_E049_V_132
49	Visual	556653.108	5485552.171	133	555480614	IG_E049_V_133
49	Visual	554220.3667	5484602.481	134	555480565	IG_E049_V_134
49	Visual	553070.6871	5486337.73	135	555480752	IG_E049_V_135
49	Visual	552698.8734	5477226.779	136	555480010	IG_E049_V_136
49	Visual	558750.8792	5486232.684	137	555480734	IG_E049_V_137
49	Visual	557870.4456	5485197.048	138	555480631	IG_E049_V_138
49	Visual	553172.7497	5488833.61	139	555481187	IG_E049_V_139
49	Visual	556656.0362	5481580.006	140	555480214	IG_E049_V_140
49	Visual	552678.5654	5476872.553	141	555480001	IG_E049_V_141
49	Visual	554171.9059	5482947.617	142	555480361	IG_E049_V_142
49	Visual	555569.2198	5482401.642	143	555480285	IG_E049_V_143
49	Visual	558426.3747	5488413.004	144	555482039	IG_E049_V_144
49	Visual	552088.0308	5486727.674	145	555480891	IG_E049_V_145
49	Visual	556274.8059	5486787.42	146	555481957	IG_E049_V_146
49	Visual	549862.0275	5486663.819	147	555480820	IG_E049_V_147

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
49	Visual	557642.7219	5490400.793	148	555481452	IG_E049_V_148
49	Visual	560257.0776	5487813.898	149	555481000	IG_E049_V_149
49	Visual	553278.6453	5489785.13	150	555481383	IG_E049_V_150
49	Visual	552709.7956	5485131.438	151	555480686	IG_E049_V_151
49	Visual	552372.914	5490073.633	152	555481510	IG_E049_V_152
49	Visual	552031.8324	5484692.979	153	555480500	IG_E049_V_153
49	Visual	559745.8642	5484718.007	154	555481932	IG_E049_V_154
49	Visual	560126.7612	5488484.975	155	555481158	IG_E049_V_155
49	Visual	559588.0806	5484658.162	156	555480494	IG_E049_V_156
49	Visual	552579.3197	5488486.459	157	555481129	IG_E049_V_157
49	Visual	557094.914	5490222.284	158	555481495	IG_E049_V_158
49	Visual	557105.5826	5490740.554	159	555481575	IG_E049_V_159
49	Visual	554522.5504	5490508.712	160	555481531	IG_E049_V_160
49	Visual	549765.2744	5485557.971	161	555480648	IG_E049_V_161
49	Visual	559156.2763	5486827.312	162	555480856	IG_E049_V_162
49	Visual	551159.5166	5489810.709	163	555481769	IG_E049_V_163
49	Visual	557349.5171	5482356.135	164	555480258	IG_E049_V_164
49	Visual	561055.7158	5488803.312	165	555481221	IG_E049_V_165
49	Visual	557620.6677	5488635.564	166	555482037	IG_E049_V_166
49	Visual	549829.6947	5486130.433	167	555480757	IG_E049_V_167
49	Visual	553942.8954	5485674.531	168	555480698	IG_E049_V_168
49	Visual	550374.6219	5485535.625	169	555480643	IG_E049_V_169
49	Visual	558170.9013	5484217.186	170	555480504	IG_E049_V_170
49	Visual	553936.8278	5483386.347	171	555480456	IG_E049_V_171
49	Visual	559454.3056	5485959.485	172	555480711	IG_E049_V_172
49	Visual	553388.0956	5482570.54	173	555480293	IG_E049_V_173
49	Visual	551243.5009	5487404.202	174	555480952	IG_E049_V_174
49	Visual	561669.7332	5485254.255	175	555480585	IG_E049_V_175
49	Visual	559901.1558	5485473.886	176	555480623	IG_E049_V_176
49	Visual	556203.4098	5482087.48	177	555480265	IG_E049_V_177
49	Visual	550288.3047	5488653.921	178	555481162	IG_E049_V_178
49	Visual	561162.6922	5484416.526	179	555480472	IG_E049_V_179
49	Visual	556842.1404	5485965.56	180	555480743	IG_E049_V_180
49	Visual	559953.3777	5484482.331	181	555480479	IG_E049_V_181
49	Visual	550219.633	5489727.554	182	555481351	IG_E049_V_182
49	Visual	553926.1086	5488762.298	183	555481174	IG_E049_V_183
49	Visual	555288.4869	5481792.887	184	555480224	IG_E049_V_184
49	Visual	558441.2611	5484428.853	185	555480471	IG_E049_V_185
49	Visual	556405.9278	5485834.934	186	555480687	IG_E049_V_186
49	Visual	548724.8605	5487764.95	187	555482011	IG_E049_V_187
49	Visual	550343.682	5489468.907	188	555481276	IG_E049_V_188
49	Visual	550652.3577	5488008.749	189	555481041	IG_E049_V_189
49	Visual	554254.5515	5483574.489	190	555480391	IG_E049_V_190
49	Visual	550985.6338	5479627.125	191	555480106	IG_E049_V_191
49	Visual	560441.4707	5491003.958	192	555481594	IG_E049_V_192
49	Visual	551266.636	5488264.806	193	555481060	IG_E049_V_193
49	Visual	556382.5223	5482170.846	194	555480263	IG_E049_V_194
50	Full	550570.1602	5481372.694	1	555480200	IG_E050_F_1
50	Full	559791.1696	5488909	2	555481184	IG_E050_F_2

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
50	Full	559583.0683	5488460.015	3	555481107	IG_E050_F_3
50	Ground	548713.209	5485318.149	1	555482014	IG_E050_G_1
50	Ground	557452.067	5484589.761	2	555480529	IG_E050_G_2
50	Ground	558315.2104	5489168.114	3	555481252	IG_E050_G_3
50	Ground	550358.2808	5485751.366	4	555481953	IG_E050_G_4
50	Ground	550052.3172	5480892.888	5	555480179	IG_E050_G_5
50	Ground	551439.8863	5489981.948	6	555481386	IG_E050_G_6
50	Ground	557510.6648	5490173.092	7	555481440	IG_E050_G_7
50	Ground	560830.4765	5482966.46	8	555480331	IG_E050_G_8
50	Ground	551461.0426	5489457.613	9	555481300	IG_E050_G_9
50	Ground	552440.0882	5478705.335	10	555480067	IG_E050_G_10
50	Ground	561112.8334	5490471.7	11	555481532	IG_E050_G_11
50	Ground	553745.0541	5479072.6	12	555480089	IG_E050_G_12
50	Ground	550085.7648	5485227.94	13	555480589	IG_E050_G_13
50	Oversample	550195.0783	5484840.569	1	555480528	IG_E050_O_1
50	Oversample	552362.4497	5487569.986	2	555480966	IG_E050_O_2
50	Oversample	552846.097	5487106.982	3	555480885	IG_E050_O_3
50	Oversample	549350.402	5489045.548	4	555482008	IG_E050_O_4
50	Oversample	554303.3197	5488207.604	5	555481081	IG_E050_O_5
50	Oversample	550916.0042	5490980.895	6	555481597	IG_E050_O_6
50	Oversample	551537.3658	5479878.977	7	555480132	IG_E050_O_7
50	Oversample	549003.0613	5486500.759	8	555480833	IG_E050_O_8
50	Oversample	549325.4843	5488668.254	9	555481131	IG_E050_O_9
50	Oversample	550456.1791	5485684.701	10	555480641	IG_E050_O_10
50	Oversample	553767.6134	5477888.881	11	555480036	IG_E050_O_11
50	Oversample	560250.1032	5483801.213	12	555480408	IG_E050_O_12
50	Oversample	548601.1698	5489114.087	13	555481233	IG_E050_O_13
50	Oversample	558618.407	5489366.651	14	555481284	IG_E050_O_14
50	Oversample	548197.4121	5486317.421	15	555480765	IG_E050_O_15
50	Oversample	552243.586	5482460.93	16	555480284	IG_E050_O_16
50	Oversample	553899.9189	5491854.87	17	555481674	IG_E050_O_17
50	Oversample	559363.085	5490242.445	18	555481455	IG_E050_O_18
50	Oversample	551014.0416	5480685.244	19	555480156	IG_E050_O_19
50	Oversample	549610.0896	5489424.538	20	555481273	IG_E050_O_20
50	Oversample	551300.4907	5479937.369	21	555480139	IG_E050_O_21
50	Oversample	554655.3749	5487275.3	22	555480957	IG_E050_O_22
50	Oversample	548630.8093	5489098.413	23	555481991	IG_E050_O_23
50	Oversample	549159.5279	5488245.554	24	555481119	IG_E050_O_24
50	Oversample	548251.4685	5490240.56	25	555481456	IG_E050_O_25
50	Oversample	553331.3641	5478334.438	26	555480044	IG_E050_O_26
50	Oversample	551632.7154	5484600.735	27	555480486	IG_E050_O_27
50	Oversample	553469.6178	5479535.458	28	555480112	IG_E050_O_28
50	Oversample	553119.0571	5480788.346	29	555480187	IG_E050_O_29
50	Oversample	560316.6273	5488321.82	30	555481121	IG_E050_O_30
50	Oversample	550091.3572	5486926.124	31	555480851	IG_E050_O_31
50	Oversample	554229.5866	5478076.73	32	555480035	IG_E050_O_32
50	Oversample	553637.0913	5488142.984	33	555481179	IG_E050_O_33
50	Oversample	548279.3456	5490473.428	34	555481461	IG_E050_O_34
50	Oversample	553204.5006	5482539.681	35	555480306	IG_E050_O_35

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
50	Oversample	551166.8185	5482134.448	36	555480280	IG_E050_O_36
50	Oversample	558790.5765	5490336.172	37	555481436	IG_E050_O_37
50	Oversample	549723.904	5489007.271	38	555481210	IG_E050_O_38
50	Oversample	551055.6002	5482657.056	39	555480346	IG_E050_O_39
50	Oversample	549046.1019	5489491.944	40	555481283	IG_E050_O_40
50	Oversample	559833.9104	5484725.39	41	555480713	IG_E050_O_41
50	Oversample	557987.5698	5487590.13	42	555480985	IG_E050_O_42
50	Oversample	548577.5127	5487189.215	43	555480951	IG_E050_O_43
50	Oversample	553006.527	5478233.678	44	555480060	IG_E050_O_44
50	Oversample	549734.212	5489780.788	45	555481360	IG_E050_O_45
50	Oversample	557121.7907	5489754.186	46	555481352	IG_E050_O_46
50	Oversample	552707.352	5477758.859	47	555480029	IG_E050_O_47
50	Oversample	557820.5807	5489248.594	48	555481294	IG_E050_O_48
50	Oversample	558106.2406	5486549.019	49	555480869	IG_E050_O_49
50	Oversample	560063.4361	5490826.739	50	555481550	IG_E050_O_50
50	Oversample	552425.8965	5476922.605	51	555480002	IG_E050_O_51
50	Oversample	552693.611	5486324.491	52	555481950	IG_E050_O_52
50	Oversample	550024.5273	5484452.991	53	555480555	IG_E050_O_53
50	Oversample	554011.9482	5491095.696	54	555481609	IG_E050_O_54
50	Oversample	550449.6436	5480747.958	55	555480164	IG_E050_O_55
50	Oversample	556302.8292	5488199.268	56	555481297	IG_E050_O_56
50	Oversample	554214.5502	5491053.522	57	555482083	IG_E050_O_57
50	Oversample	552657.2388	5488782.675	58	555481212	IG_E050_O_58
50	Oversample	554690.747	5487643.949	59	555480975	IG_E050_O_59
50	Oversample	554400.7818	5486585.735	60	555480838	IG_E050_O_60
50	Oversample	557333.7158	5486984.933	61	555480894	IG_E050_O_61
50	Visual	549213.4764	5485462.237	1	555482015	IG_E050_V_1
50	Visual	550853.2429	5483919.686	2	555480431	IG_E050_V_2
50	Visual	553923.6847	5481618.788	3	555480216	IG_E050_V_3
50	Visual	559993.0614	5490306.621	4	555481492	IG_E050_V_4
50	Visual	555262.9549	5490342.972	5	555481487	IG_E050_V_5
50	Visual	549088.2316	5488865.996	6	555481189	IG_E050_V_6
50	Visual	551344.7715	5487250.513	7	555480921	IG_E050_V_7
50	Visual	549670.2627	5489892.35	8	555481359	IG_E050_V_8
50	Visual	560915.8787	5490239.946	9	555481978	IG_E050_V_9
50	Visual	559590.2429	5489159.699	10	555481247	IG_E050_V_10
50	Visual	560611.5849	5485413.93	11	555480655	IG_E050_V_11
50	Visual	550270.7758	5481776.282	12	555480218	IG_E050_V_12
50	Visual	549475.6875	5488858.456	13	555481194	IG_E050_V_13
50	Visual	554821.5508	5487131.59	14	555480915	IG_E050_V_14
50	Visual	554272.7162	5486082.771	15	555480756	IG_E050_V_15
50	Visual	559591.8695	5489931.116	16	555481466	IG_E050_V_16
50	Visual	551798.2958	5480260.709	17	555480140	IG_E050_V_17
50	Visual	560212.2027	5488671.523	18	555481156	IG_E050_V_18
50	Visual	552951.1589	5487344.722	19	555480940	IG_E050_V_19
50	Visual	548645.5048	5487875.832	20	555481036	IG_E050_V_20
50	Visual	561031.2585	5489622.253	21	555481317	IG_E050_V_21
50	Visual	550504.7771	5481214.5	22	555480190	IG_E050_V_22
50	Visual	550474.713	5480491.323	23	555480159	IG_E050_V_23

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
50	Visual	549248.284	5489227.444	24	555481255	IG_E050_V_24
50	Visual	551395.2288	5482053.057	25	555480288	IG_E050_V_25
50	Visual	550210.227	5480290.025	26	555480135	IG_E050_V_26
50	Visual	548150.4484	5489100.664	27	555481238	IG_E050_V_27
50	Visual	553346.215	5479369.956	28	555480100	IG_E050_V_28
50	Visual	548853.7889	5485987.017	29	555480661	IG_E050_V_29
50	Visual	553298.252	5491913.543	30	555481673	IG_E050_V_30
50	Visual	548615.5617	5489412.854	31	555481280	IG_E050_V_31
50	Visual	552229.3383	5478706.699	32	555480076	IG_E050_V_32
50	Visual	560997.6579	5489732.116	33	555481980	IG_E050_V_33
50	Visual	550800.388	5490258.708	34	555481500	IG_E050_V_34
50	Visual	551249.6981	5478961.118	35	555480087	IG_E050_V_35
50	Visual	553913.9756	5478609.239	36	555480105	IG_E050_V_36
50	Visual	550881.5322	5482282.508	37	555480337	IG_E050_V_37
50	Visual	551140.9439	5484711.706	38	555480523	IG_E050_V_38
50	Visual	548273.2195	5488518.362	39	555481992	IG_E050_V_39
50	Visual	555178.2681	5490362.137	40	555481480	IG_E050_V_40
50	Visual	548613.9566	5488974.745	41	555482000	IG_E050_V_41
50	Visual	553380.1354	5487269.282	42	555480963	IG_E050_V_42
50	Visual	552531.0258	5484205.387	43	555480462	IG_E050_V_43
50	Visual	555838.642	5485662.391	44	555480689	IG_E050_V_44
50	Visual	554001.6083	5486249.542	45	555480865	IG_E050_V_45
50	Visual	557704.1778	5487668.525	46	555481009	IG_E050_V_46
50	Visual	552703.9349	5484234.585	47	555480453	IG_E050_V_47
50	Visual	548368.8135	5489883.72	48	555481367	IG_E050_V_48
50	Visual	550618.278	5483812.765	49	555480439	IG_E050_V_49
50	Visual	552509.9241	5491369.944	50	555481648	IG_E050_V_50
50	Visual	549064.8619	5488067.685	51	555481052	IG_E050_V_51
50	Visual	548364.6333	5490333.67	52	555481460	IG_E050_V_52
50	Visual	551901.0139	5490376.488	53	555481544	IG_E050_V_53
50	Visual	548408.4945	5485900.422	54	555480696	IG_E050_V_54
50	Visual	549438.2641	5487658.648	55	555481004	IG_E050_V_55
50	Visual	552134.8586	5479125.154	56	555480082	IG_E050_V_56
50	Visual	551442.6728	5487428.219	57	555480943	IG_E050_V_57
50	Visual	550980.4278	5479062.989	58	555480079	IG_E050_V_58
50	Visual	548872.5345	5485560.426	59	555480619	IG_E050_V_59
50	Visual	556114.3813	5490578.867	60	555481520	IG_E050_V_60
52	Full	549873.4754	5484758.676	1	555481952	IG_E052_F_1
52	Ground	552242.0264	5482221.004	1	555480255	IG_E052_G_1
52	Ground	550090.8497	5484776.756	2	555480526	IG_E052_G_2
52	Ground	552849.1564	5481159.796	3	555480195	IG_E052_G_3
52	Oversample	558862.9083	5490727.506	1	555481537	IG_E052_O_1
52	Oversample	551462.9553	5480754.179	2	555480163	IG_E052_O_2
52	Oversample	548641.1538	5489606.696	3	555481328	IG_E052_O_3
52	Oversample	551255.5659	5484909.891	4	555480544	IG_E052_O_4
52	Oversample	553011.8512	5480013.746	5	555480123	IG_E052_O_5
52	Oversample	552909.9296	5480742.466	6	555480171	IG_E052_O_6
52	Oversample	549389.9241	5488610.947	7	555481168	IG_E052_O_7
52	Oversample	550466.5734	5481178.236	8	555480186	IG_E052_O_8

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
52	Oversample	552594.5533	5480069.31	9	555480122	IG_E052_O_9
52	Oversample	552002.9969	5480795.586	10	555480160	IG_E052_O_10
52	Oversample	548007.1184	5486553.307	11	555480795	IG_E052_O_11
52	Visual	551057.7356	5481133.461	1	555480189	IG_E052_V_1
52	Visual	548584.0374	5489390.53	2	555481268	IG_E052_V_2
52	Visual	552350.8811	5480623.558	3	555480154	IG_E052_V_3
52	Visual	548847.1674	5489480.544	4	555481349	IG_E052_V_4
52	Visual	550834.8116	5480685.083	5	555480161	IG_E052_V_5
52	Visual	548483.3832	5489344.756	6	555481990	IG_E052_V_6
52	Visual	549127.1704	5489733.714	7	555481375	IG_E052_V_7
52	Visual	550567.0139	5481919.664	8	555480249	IG_E052_V_8
52	Visual	550936.513	5480929.587	9	555480169	IG_E052_V_9
52	Visual	553050.7508	5480340.388	10	555480137	IG_E052_V_10
55	Full	548383.5052	5490215.53	1	555481469	IG_E055_F_1
55	Ground	553204.4997	5477501.547	1	555480023	IG_E055_G_1
55	Ground	551931.7294	5480017.311	2	555480124	IG_E055_G_2
55	Ground	551004.3238	5480516.902	3	555480119	IG_E055_G_3
55	Ground	552014.4789	5479008.015	4	555480091	IG_E055_G_4
55	Ground	556281.9418	5488580.013	5	555481141	IG_E055_G_5
55	Oversample	551464.2088	5491110.736	1	555481618	IG_E055_O_1
55	Oversample	552286.2464	5476985.917	2	555480003	IG_E055_O_2
55	Oversample	551009.488	5479697.19	3	555480115	IG_E055_O_3
55	Oversample	549283.5011	5489022.321	4	555481208	IG_E055_O_4
55	Oversample	551926.2616	5477547.646	5	555480032	IG_E055_O_5
55	Oversample	551992.4728	5482901.418	6	555480347	IG_E055_O_6
55	Oversample	550824.4138	5481766.199	7	555480226	IG_E055_O_7
55	Oversample	549288.7921	5491358.726	8	555481645	IG_E055_O_8
55	Oversample	561137.1789	5489836.055	9	555481410	IG_E055_O_9
55	Oversample	551642.6595	5490900.315	10	555481587	IG_E055_O_10
55	Oversample	548548.6428	5490725.706	11	555481570	IG_E055_O_11
55	Oversample	548765.4109	5490680.399	12	555481572	IG_E055_O_12
55	Oversample	553854.1634	5487317.151	13	555480928	IG_E055_O_13
55	Oversample	556414.0746	5487093.096	14	555480879	IG_E055_O_14
55	Oversample	549215.4669	5490840.621	15	555481585	IG_E055_O_15
55	Oversample	550882.0804	5479429.38	16	555482084	IG_E055_O_16
55	Oversample	550799.6783	5482107.349	17	555480250	IG_E055_O_17
55	Oversample	552412.3518	5490302.147	18	555482103	IG_E055_O_18
55	Oversample	550549.07	5483975.786	19	555480428	IG_E055_O_19
55	Visual	552456.7968	5482137.965	1	555480267	IG_E055_V_1
55	Visual	551157.6352	5483228.168	2	555480376	IG_E055_V_2
55	Visual	560398.7461	5485157.695	3	555480588	IG_E055_V_3
55	Visual	551539.5499	5478185.761	4	555481749	IG_E055_V_4
55	Visual	551015.8748	5479504.381	5	555480101	IG_E055_V_5
55	Visual	556121.4052	5488015.857	6	555481050	IG_E055_V_6
55	Visual	548530.622	5490674.471	7	555481504	IG_E055_V_7
55	Visual	549730.3987	5491164.741	8	555481762	IG_E055_V_8
55	Visual	551399.3053	5478659.446	9	555480070	IG_E055_V_9
55	Visual	550208.6397	5480812.08	10	555480167	IG_E055_V_10
55	Visual	552780.8587	5477058.911	11	555480004	IG_E055_V_11

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
55	Visual	558946.897	5489426.643	12	555481274	IG_E055_V_12
55	Visual	550524.6153	5480472.459	13	555480145	IG_E055_V_13
55	Visual	560811.9294	5490790.23	14	555481546	IG_E055_V_14
55	Visual	550918.2943	5479870.166	15	555480116	IG_E055_V_15
55	Visual	554106.2613	5482121.543	16	555480242	IG_E055_V_16
55	Visual	548427.848	5489403.28	17	555481350	IG_E055_V_17
55	Visual	548578.3687	5488744.063	18	555481169	IG_E055_V_18
55	Visual	551194.0888	5478417.159	19	555480066	IG_E055_V_19
62	Full	552662.7759	5491001.615	1	555481619	IG_E062_F_1
65	Full	553353.7201	5487923.479	1	555481058	IG_E065_F_1
65	Full	551887.1957	5487642.063	2	555480976	IG_E065_F_2
65	Full	554516.2722	5482362.745	3	555480266	IG_E065_F_3
65	Ground	554882.4555	5487303.45	1	555480924	IG_E065_G_1
65	Ground	557289.8097	5489547.795	2	555481312	IG_E065_G_2
65	Ground	555958.0615	5482489.384	3	555480313	IG_E065_G_3
65	Ground	554705.1643	5488657.448	4	555481177	IG_E065_G_4
65	Ground	552177.4685	5489655.506	5	555481323	IG_E065_G_5
65	Ground	557492.9517	5481439.316	6	555480198	IG_E065_G_6
65	Ground	549738.608	5490956.375	7	555481588	IG_E065_G_7
65	Ground	557273.6401	5481705.829	8	555480221	IG_E065_G_8
65	Ground	557866.5703	5487300.214	9	555481015	IG_E065_G_9
65	Ground	560273.1843	5487870.101	10	555481040	IG_E065_G_10
65	Ground	552938.2161	5485946.004	11	555480669	IG_E065_G_11
65	Ground	552948.8105	5482032.456	12	555480231	IG_E065_G_12
65	Ground	560740.3448	5488300.99	13	555481065	IG_E065_G_13
65	Ground	551128.1382	5486543.747	14	555482069	IG_E065_G_14
65	Oversample	560511.8914	5487957.01	1	555481029	IG_E065_O_1
65	Oversample	555033.7636	5488402.49	2	555481100	IG_E065_O_2
65	Oversample	557435.1863	5490754.382	3	555481557	IG_E065_O_3
65	Oversample	559329.5344	5485007.506	4	555480571	IG_E065_O_4
65	Oversample	551802.8987	5484269.029	5	555480465	IG_E065_O_5
65	Oversample	560211.4381	5488993.819	6	555481969	IG_E065_O_6
65	Oversample	549268.7445	5490981.509	7	555481600	IG_E065_O_7
65	Oversample	558910.9848	5485833.846	8	555480679	IG_E065_O_8
65	Oversample	559544.4377	5486474.053	9	555480788	IG_E065_O_9
65	Oversample	551544.6288	5488645.212	10	555481160	IG_E065_O_10
65	Oversample	551020.9013	5487729.043	11	555481013	IG_E065_O_11
65	Oversample	549943.0669	5485359.43	12	555480600	IG_E065_O_12
65	Oversample	555037.444	5490286.981	13	555481430	IG_E065_O_13
65	Oversample	552497.4501	5488417.736	14	555481103	IG_E065_O_14
65	Oversample	551967.3382	5489879.387	15	555481356	IG_E065_O_15
65	Oversample	558972.2396	5483000.934	16	555480335	IG_E065_O_16
65	Oversample	559186.0285	5483837.034	17	555480409	IG_E065_O_17
65	Oversample	551437.5997	5484482.22	18	555480498	IG_E065_O_18
65	Oversample	556572.817	5487158.941	19	555480907	IG_E065_O_19
65	Oversample	550486.0671	5489516.282	20	555481381	IG_E065_O_20
65	Oversample	560166.5235	5488175.312	21	555481045	IG_E065_O_21
65	Oversample	549358.2285	5490360.888	22	555481435	IG_E065_O_22
65	Oversample	550516.2569	5486002.44	23	555480870	IG_E065_O_23

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
65	Oversample	553575.4937	5482633.901	24	555480290	IG_E065_O_24
65	Oversample	554533.3572	5486821.394	25	555480868	IG_E065_O_25
65	Oversample	559000.8626	5486263.011	26	555480762	IG_E065_O_26
65	Oversample	553483.8752	5488511.4	27	555481154	IG_E065_O_27
65	Oversample	552773.1325	5485984.055	28	555480702	IG_E065_O_28
65	Oversample	552811.1562	5488927.267	29	555482006	IG_E065_O_29
65	Oversample	557773.92	5490371.475	30	555481451	IG_E065_O_30
65	Oversample	558160.295	5490160.393	31	555481457	IG_E065_O_31
65	Oversample	549706.5715	5491228.023	32	555481632	IG_E065_O_32
65	Oversample	553244.9236	5485401.409	33	555480705	IG_E065_O_33
65	Oversample	556601.3207	5481660.27	34	555480234	IG_E065_O_34
65	Oversample	555114.5105	5485865.033	35	555480662	IG_E065_O_35
65	Oversample	557371.9355	5488199.47	36	555481092	IG_E065_O_36
65	Oversample	552140.0972	5487306.882	37	555480938	IG_E065_O_37
65	Oversample	554807.287	5487555.535	38	555480964	IG_E065_O_38
65	Oversample	557734.6287	5485106.216	39	555480556	IG_E065_O_39
65	Oversample	558187.6846	5487860.883	40	555481007	IG_E065_O_40
65	Oversample	559121.0823	5485699.219	41	555480640	IG_E065_O_41
65	Oversample	550652.835	5479321.473	42	555480093	IG_E065_O_42
65	Oversample	561388.0379	5487774.827	43	555481011	IG_E065_O_43
65	Oversample	556533.1349	5485944.574	44	555480697	IG_E065_O_44
65	Oversample	557022.4249	5481274.794	45	555481821	IG_E065_O_45
65	Oversample	554090.2028	5486388.675	46	555480896	IG_E065_O_46
65	Oversample	553176.7788	5484326.974	47	555480458	IG_E065_O_47
65	Oversample	554319.2456	5486718.269	48	555480818	IG_E065_O_48
65	Oversample	552527.7756	5488930.685	49	555481201	IG_E065_O_49
65	Oversample	559794.9242	5482271.337	50	555480247	IG_E065_O_50
65	Oversample	552446.2271	5490791.87	51	555481562	IG_E065_O_51
65	Oversample	556845.4271	5482461.532	52	555480282	IG_E065_O_52
65	Oversample	551178.2992	5488136.321	53	555482026	IG_E065_O_53
65	Oversample	557189.9324	5482131.822	54	555480239	IG_E065_O_54
65	Oversample	550584.1074	5484473.312	55	555481917	IG_E065_O_55
65	Oversample	554328.3731	5482498.049	56	555480360	IG_E065_O_56
65	Oversample	548944.1181	5490781.897	57	555481555	IG_E065_O_57
65	Oversample	551303.9676	5480705.708	58	555480165	IG_E065_O_58
65	Oversample	548475.0411	5490309.03	59	555481489	IG_E065_O_59
65	Oversample	552781.4894	5489828.735	60	555481358	IG_E065_O_60
65	Oversample	554141.5342	5486895.056	61	555480900	IG_E065_O_61
65	Oversample	551879.7345	5478852.7	62	555481751	IG_E065_O_62
65	Oversample	557962.2549	5489613.266	63	555481321	IG_E065_O_63
65	Oversample	554915.3541	5483656.357	64	555480413	IG_E065_O_64
65	Visual	556748.0665	5485660.479	1	555480677	IG_E065_V_1
65	Visual	549618.072	5486484.952	2	555480840	IG_E065_V_2
65	Visual	553030.2179	5482221.025	3	555480317	IG_E065_V_3
65	Visual	553487.2184	5480556.397	4	555480173	IG_E065_V_4
65	Visual	558684.1716	5488789.611	5	555481192	IG_E065_V_5
65	Visual	552893.5985	5481343.969	6	555480202	IG_E065_V_6
65	Visual	557634.9442	5482582.36	7	555480301	IG_E065_V_7
65	Visual	552287.3778	5489342.333	8	555481264	IG_E065_V_8

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
65	Visual	549368.1692	5487792.265	9	555481027	IG_E065_V_9
65	Visual	550875.2669	5490429.526	10	555481566	IG_E065_V_10
65	Visual	556156.7762	5489175.648	11	555481248	IG_E065_V_11
65	Visual	560311.8692	5488129.029	12	555481094	IG_E065_V_12
65	Visual	554994.7759	5482033.314	13	555480271	IG_E065_V_13
65	Visual	551954.8106	5486317.08	14	555480751	IG_E065_V_14
65	Visual	559506.5228	5485860.067	15	555480682	IG_E065_V_15
65	Visual	557098.9545	5489579.629	16	555481310	IG_E065_V_16
65	Visual	549385.7834	5491045.735	17	555481616	IG_E065_V_17
65	Visual	554063.6688	5490602.274	18	555481493	IG_E065_V_18
65	Visual	557341.2949	5489812.115	19	555481364	IG_E065_V_19
65	Visual	552639.3882	5490836.625	20	555481553	IG_E065_V_20
65	Visual	557495.2475	5490487.981	21	555481479	IG_E065_V_21
65	Visual	558553.1118	5488481.096	22	555481166	IG_E065_V_22
65	Visual	560559.1532	5486897.384	23	555480853	IG_E065_V_23
65	Visual	551375.2755	5484416.607	24	555480466	IG_E065_V_24
65	Visual	555725.6663	5481657.552	25	555480228	IG_E065_V_25
65	Visual	554074.2669	5488243.611	26	555482082	IG_E065_V_26
65	Visual	554190.8971	5489194.682	27	555481287	IG_E065_V_27
65	Visual	557296.0811	5482590.037	28	555480303	IG_E065_V_28
65	Visual	561522.7491	5484135.835	29	555481893	IG_E065_V_29
65	Visual	554417.9154	5478938.258	30	555480074	IG_E065_V_30
65	Visual	558743.2679	5489639.706	31	555481357	IG_E065_V_31
65	Visual	553203.3735	5480507.86	32	555480151	IG_E065_V_32
65	Visual	559681.305	5488465.167	33	555481123	IG_E065_V_33
65	Visual	554530.0169	5487769.897	34	555481044	IG_E065_V_34
65	Visual	556247.2197	5486645.672	35	555480816	IG_E065_V_35
65	Visual	559002.7974	5488464.468	36	555482109	IG_E065_V_36
65	Visual	554320.7473	5478253.951	37	555480048	IG_E065_V_37
65	Visual	558209.2893	5490405.107	38	555481454	IG_E065_V_38
65	Visual	551418.9977	5486648.813	39	555480813	IG_E065_V_39
65	Visual	560417.25	5485441.395	40	555480633	IG_E065_V_40
65	Visual	554069.6309	5483277.158	41	555480392	IG_E065_V_41
65	Visual	560320.985	5487991.726	42	555481966	IG_E065_V_42
65	Visual	548527.0184	5488127.219	43	555482007	IG_E065_V_43
65	Visual	560228.5895	5488953.708	44	555481970	IG_E065_V_44
65	Visual	552051.698	5477223.519	45	555480009	IG_E065_V_45
65	Visual	549370.9846	5491125.439	46	555481767	IG_E065_V_46
65	Visual	552110.3514	5478901.154	47	555480075	IG_E065_V_47
65	Visual	560964.4888	5487583.879	48	555480980	IG_E065_V_48
65	Visual	559416.0933	5488248.507	49	555481069	IG_E065_V_49
65	Visual	551486.5099	5479838.925	50	555480113	IG_E065_V_50
65	Visual	552739.7108	5477540.04	51	555480017	IG_E065_V_51
65	Visual	557549.9018	5490084.567	52	555481405	IG_E065_V_52
65	Visual	558148.1655	5486187.39	53	555480746	IG_E065_V_53
65	Visual	549456.0217	5490096.577	54	555481414	IG_E065_V_54
65	Visual	548209.4599	5490040.533	55	555481988	IG_E065_V_55
65	Visual	556752.242	5490705.056	56	555481528	IG_E065_V_56
65	Visual	555007.8319	5487669.206	57	555481054	IG_E065_V_57

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
65	Visual	551449.3495	5483487.074	58	555480394	IG_E065_V_58
65	Visual	550947.7776	5479713.63	59	555480108	IG_E065_V_59
65	Visual	553737.8038	5490093.609	60	555481408	IG_E065_V_60
65	Visual	550082.0434	5487734.554	61	555481039	IG_E065_V_61
65	Visual	550721.9493	5481538.042	62	555480207	IG_E065_V_62
65	Visual	555297.3306	5488307.507	63	555481089	IG_E065_V_63
67	Full	548437.4005	5489957.843	1	555481380	IG_E067_F_1
67	Ground	553200.3834	5480623.028	1	555480157	IG_E067_G_1
67	Oversample	550744.3508	5484374.752	1	555482088	IG_E067_O_1
67	Visual	548773.7617	5490193.265	1	555481509	IG_E067_V_1
68	Full	553346.7655	5487809.656	1	555481008	IG_E068_F_1
70	Full	553038.9412	5482352.53	1	555480278	IG_E070_F_1
70	Ground	551507.2368	5490980.797	1	555481604	IG_E070_G_1
70	Ground	551978.3639	5483895.879	2	555480449	IG_E070_G_2
70	Oversample	548190.6435	5489570.601	1	555481293	IG_E070_O_1
70	Oversample	550398.3385	5480902.002	2	555480175	IG_E070_O_2
70	Oversample	553291.5091	5481481.071	3	555480205	IG_E070_O_3
70	Oversample	553984.1293	5478340.463	4	555480055	IG_E070_O_4
70	Oversample	551840.1111	5477968.118	5	555480049	IG_E070_O_5
70	Oversample	550707.756	5480312.413	6	555480147	IG_E070_O_6
70	Oversample	549877.1742	5487821.41	7	555481010	IG_E070_O_7
70	Visual	551443.7298	5478624.456	1	555480072	IG_E070_V_1
70	Visual	550993.2498	5482154.695	2	555480295	IG_E070_V_2
70	Visual	552386.9846	5478653.343	3	555480065	IG_E070_V_3
70	Visual	555654.9048	5489172.601	4	555481243	IG_E070_V_4
70	Visual	553385.8019	5482104.194	5	555480245	IG_E070_V_5
70	Visual	548533.5015	5489335.632	6	555481285	IG_E070_V_6
97	Full	555676.4122	5489336.79	1	555482051	IG_E097_F_1
98	Full	552296.6387	5490994.539	1	555481602	IG_E098_F_1
98	Ground	554744.2006	5489980.163	1	555481392	IG_E098_G_1
98	Ground	550333.2493	5488590.484	2	555481144	IG_E098_G_2
98	Ground	555641.2977	5489586.713	3	555481382	IG_E098_G_3
98	Ground	553059.5431	5491536.431	4	555481657	IG_E098_G_4
98	Oversample	554886.5631	5490441.369	1	555481498	IG_E098_O_1
98	Oversample	549911.603	5487085.771	2	555480953	IG_E098_O_2
98	Oversample	551564.0612	5488306.465	3	555481073	IG_E098_O_3
98	Oversample	556752.6708	5491061.65	4	555481589	IG_E098_O_4
98	Oversample	550139.3368	5491367.372	5	555481641	IG_E098_O_5
98	Oversample	551514.4856	5490070.26	6	555481397	IG_E098_O_6
98	Oversample	551039.5771	5487632.375	7	555480961	IG_E098_O_7
98	Oversample	551722.0942	5488579.992	8	555481127	IG_E098_O_8
98	Oversample	552785.8474	5488023.481	9	555481091	IG_E098_O_9
98	Oversample	554346.7398	5489630.906	10	555481339	IG_E098_O_10
98	Oversample	550597.3098	5488997.767	11	555481227	IG_E098_O_11
98	Oversample	555872.5355	5488583.945	12	555481155	IG_E098_O_12
98	Oversample	554772.7676	5489108.192	13	555481288	IG_E098_O_13
98	Oversample	555186.5652	5489549.826	14	555481368	IG_E098_O_14
98	Oversample	553636.4726	5491048.844	15	555481631	IG_E098_O_15
98	Visual	556161.4295	5489357.756	1	555481366	IG_E098_V_1

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
98	Visual	555646.2177	5488147.039	2	555482043	IG_E098_V_2
98	Visual	553560.3455	5491318.208	3	555481646	IG_E098_V_3
98	Visual	551600.0942	5488279.395	4	555481099	IG_E098_V_4
98	Visual	555875.5275	5489077.962	5	555481251	IG_E098_V_5
98	Visual	549951.7122	5488247.308	6	555481114	IG_E098_V_6
98	Visual	555330.9532	5490582.361	7	555481488	IG_E098_V_7
98	Visual	555217.3471	5489055.31	8	555481271	IG_E098_V_8
98	Visual	557345.6756	5491008.591	9	555481637	IG_E098_V_9
98	Visual	551734.5653	5490194.511	10	555481437	IG_E098_V_10
98	Visual	555578.2368	5490029.811	11	555481558	IG_E098_V_11
98	Visual	557766.8391	5491563.618	12	555481653	IG_E098_V_12
98	Visual	550258.0445	5487301.394	13	555480946	IG_E098_V_13
98	Visual	550246.9072	5491177.098	14	555481633	IG_E098_V_14
98	Visual	550884.1926	5488569.735	15	555481151	IG_E098_V_15
99	Full	552640.9734	5491825.924	1	555481667	IG_E099_F_1
99	Ground	553459.3496	5491265.651	1	555481655	IG_E099_G_1
99	Ground	552603.7529	5491196.881	2	555481650	IG_E099_G_2
99	Oversample	553368.9921	5491684.997	1	555481658	IG_E099_O_1
99	Oversample	553779.5483	5491084.888	2	555482081	IG_E099_O_2
99	Oversample	552983.6096	5492079.665	3	555481675	IG_E099_O_3
99	Oversample	550259.5323	5488238.038	4	555481106	IG_E099_O_4
99	Oversample	554723.0774	5490064.04	5	555481391	IG_E099_O_5
99	Visual	552363.3921	5490615.709	1	555481552	IG_E099_V_1
99	Visual	557937.3224	5491275.743	2	555481639	IG_E099_V_2
99	Visual	548931.6172	5491141.373	3	555481608	IG_E099_V_3
99	Visual	553936.9114	5491189.921	4	555481626	IG_E099_V_4
99	Visual	548954.3884	5490168.854	5	555481521	IG_E099_V_5
101	Full	554835.2866	5490634.594	1	555481503	IG_E101_F_1
101	Ground	551018.425	5488312.434	1	555481093	IG_E101_G_1
101	Oversample	548715.1695	5490451.709	1	555481547	IG_E101_O_1
104	Full	553068.5238	5491817.255	1	555481663	IG_E104_F_1
104	Ground	555901.8892	5490093.913	1	555481390	IG_E104_G_1
104	Oversample	552783.0964	5490788.597	1	555481615	IG_E104_O_1
104	Oversample	553479.7607	5491555.372	2	555481654	IG_E104_O_2
104	Visual	552982.8405	5491945.917	1	555481672	IG_E104_V_1
104	Visual	549306.8022	5486736.512	2	555480960	IG_E104_V_2
114	Full	556870.5813	5491151.218	1	555481634	IG_E114_F_1
114	Ground	554581.5111	5490258.748	1	555481427	IG_E114_G_1
114	Ground	555220.509	5490189.715	2	555481441	IG_E114_G_2
114	Ground	557429.2957	5491578.117	3	555481649	IG_E114_G_3
114	Oversample	552116.7635	5490885.288	1	555481578	IG_E114_O_1
114	Oversample	549735.7098	5487450.8	2	555480955	IG_E114_O_2
114	Oversample	552469.9977	5490974.082	3	555481596	IG_E114_O_3
114	Oversample	550055.9049	5486224.499	4	555480764	IG_E114_O_4
114	Oversample	553830.3952	5490919.821	5	555481638	IG_E114_O_5
114	Oversample	550963.668	5490035.82	6	555481407	IG_E114_O_6
114	Oversample	554964.5691	5489871.992	7	555481362	IG_E114_O_7
114	Oversample	551590.7788	5487626.028	8	555482022	IG_E114_O_8
114	Oversample	556120.2508	5489993.991	9	555481393	IG_E114_O_9

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
114	Oversample	551847.6633	5486869.207	10	555480902	IG_E114_O_10
114	Oversample	556030.8851	5489398.973	11	555481309	IG_E114_O_11
114	Oversample	554985.2393	5489013.432	12	555481209	IG_E114_O_12
114	Oversample	554484.9335	5490350.243	13	555481538	IG_E114_O_13
114	Visual	555347.6192	5489959.571	1	555481369	IG_E114_V_1
114	Visual	554337.4705	5490410.533	2	555481603	IG_E114_V_2
114	Visual	553917.5947	5491072.938	3	555482058	IG_E114_V_3
114	Visual	550860.1788	5488757.428	4	555481170	IG_E114_V_4
114	Visual	557608.1663	5491444.858	5	555481651	IG_E114_V_5
114	Visual	557267.1558	5491060.647	6	555481595	IG_E114_V_6
114	Visual	551432.1829	5490679.605	7	555481516	IG_E114_V_7
114	Visual	553274.2802	5490978.184	8	555481591	IG_E114_V_8
114	Visual	553564.0598	5490910.972	9	555481574	IG_E114_V_9
114	Visual	552491.1257	5488496.548	10	555482060	IG_E114_V_10
114	Visual	555731.0388	5490342.888	11	555481445	IG_E114_V_11
114	Visual	552102.8099	5487167.02	12	555480909	IG_E114_V_12
114	Visual	550734.9715	5491123.674	13	555481610	IG_E114_V_13
116	Full	550068.1366	5488709.257	1	555482009	IG_E116_F_1
116	Ground	551693.492	5490264.485	1	555481433	IG_E116_G_1
116	Oversample	550565.1399	5490863.337	1	555481761	IG_E116_O_1
116	Oversample	550330.0807	5490904.21	2	555481582	IG_E116_O_2
116	Visual	552330.3161	5490549.82	1	555481548	IG_E116_V_1
116	Visual	555975.4357	5490154.474	2	555481467	IG_E116_V_2
117	Full	552914.531	5486808.023	1	555480956	IG_E117_F_1
119	Full	551472.376	5487670.144	1	555482028	IG_E119_F_1
119	Ground	552755.0437	5491723.923	1	555481664	IG_E119_G_1
119	Ground	553517.2073	5491988.699	2	555481671	IG_E119_G_2
119	Oversample	553048.0636	5491838.909	1	555481670	IG_E119_O_1
119	Oversample	552600.0068	5491412.636	2	555481656	IG_E119_O_2
119	Oversample	553530.6972	5491768.614	3	555481660	IG_E119_O_3
119	Oversample	552990.9407	5488910.983	4	555481180	IG_E119_O_4
119	Visual	551303.4086	5488047.312	1	555481047	IG_E119_V_1
119	Visual	553356.4278	5491522.087	2	555481662	IG_E119_V_2
119	Visual	550840.9953	5488266.791	3	555481096	IG_E119_V_3
126	Full	551837.8704	5478966.228	1	555480080	IG_E126_F_1
126	Ground	553457.5778	5484769.817	1	555480519	IG_E126_G_1
126	Oversample	554309.1609	5484724.515	1	555480514	IG_E126_O_1
126	Oversample	559851.516	5483742.78	2	555480426	IG_E126_O_2
126	Visual	557113.2983	5482315.938	1	555481869	IG_E126_V_1
127	Full	559037.6083	5484181.111	1	555480450	IG_E127_F_1
127	Full	550897.9764	5487107.918	2	555480906	IG_E127_F_2
127	Ground	559925.9699	5487012.933	1	555481940	IG_E127_G_1
127	Ground	557628.6388	5490696.362	2	555481517	IG_E127_G_2
127	Ground	560040.7194	5483909.691	3	555481846	IG_E127_G_3
127	Ground	554189.3281	5481674.392	4	555480208	IG_E127_G_4
127	Ground	557068.4813	5491153.44	5	555481624	IG_E127_G_5
127	Ground	552162.7044	5489316.073	6	555481261	IG_E127_G_6
127	Ground	561220.5432	5490835.88	7	555481549	IG_E127_G_7
127	Oversample	555922.1755	5482256.075	1	555480269	IG_E127_O_1

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
127	Oversample	554527.3569	5489828.767	2	555481438	IG_E127_O_2
127	Oversample	561126.2169	5486583.929	3	555480802	IG_E127_O_3
127	Oversample	560223.8335	5485578.172	4	555480615	IG_E127_O_4
127	Oversample	561199.9406	5485118.085	5	555480577	IG_E127_O_5
127	Oversample	555096.7541	5483224.349	6	555480377	IG_E127_O_6
127	Oversample	554497.0455	5485296.905	7	555481890	IG_E127_O_7
127	Oversample	556582.9472	5482475.091	8	555480272	IG_E127_O_8
127	Oversample	548443.5318	5490050.656	9	555481399	IG_E127_O_9
127	Oversample	548872.5821	5490012.033	10	555481389	IG_E127_O_10
127	Oversample	559067.1716	5482411.811	11	555480268	IG_E127_O_11
127	Oversample	560185.7276	5483020.418	12	555480343	IG_E127_O_12
127	Oversample	552313.0313	5477151.433	13	555481680	IG_E127_O_13
127	Oversample	561846.4806	5485110.629	14	555480582	IG_E127_O_14
127	Oversample	560044.4269	5485458.227	15	555480632	IG_E127_O_15
127	Oversample	557184.985	5490262.91	16	555481444	IG_E127_O_16
127	Oversample	551109.408	5489060.878	17	555481262	IG_E127_O_17
127	Oversample	552395.1269	5485467.428	18	555480630	IG_E127_O_18
127	Oversample	557856.5894	5491133.266	19	555481622	IG_E127_O_19
127	Oversample	557816.1631	5491320.518	20	555481642	IG_E127_O_20
127	Oversample	558308.9179	5482949.292	21	555480348	IG_E127_O_21
127	Oversample	558592.6959	5484927.837	22	555480549	IG_E127_O_22
127	Oversample	558861.8994	5482511.202	23	555480275	IG_E127_O_23
127	Oversample	550751.6065	5489266.563	24	555481246	IG_E127_O_24
127	Oversample	552575.988	5483212.084	25	555480401	IG_E127_O_25
127	Oversample	549602.8109	5487632.422	26	555481003	IG_E127_O_26
127	Oversample	555380.8999	5483700.081	27	555480422	IG_E127_O_27
127	Oversample	553730.5273	5480599.331	28	555480148	IG_E127_O_28
127	Oversample	550234.7492	5488525.336	29	555481108	IG_E127_O_29
127	Oversample	549587.7762	5487955.806	30	555481023	IG_E127_O_30
127	Oversample	561097.6907	5484758.063	31	555480510	IG_E127_O_31
127	Oversample	554290.164	5490187.233	32	555482052	IG_E127_O_32
127	Oversample	553839.9084	5491398.885	33	555481661	IG_E127_O_33
127	Visual	553473.5757	5480800.838	1	555480162	IG_E127_V_1
127	Visual	554453.9693	5478373.404	2	555480054	IG_E127_V_2
127	Visual	557402.256	5482126.894	3	555480253	IG_E127_V_3
127	Visual	557959.3189	5489832.018	4	555481363	IG_E127_V_4
127	Visual	552223.6463	5477290.412	5	555481679	IG_E127_V_5
127	Visual	556391.5773	5484928.507	6	555480610	IG_E127_V_6
127	Visual	559921.7995	5483750.605	7	555480423	IG_E127_V_7
127	Visual	548242.2195	5488818.485	8	555481199	IG_E127_V_8
127	Visual	549992.2811	5491076.999	9	555481763	IG_E127_V_9
127	Visual	560862.1677	5482291.386	10	555480251	IG_E127_V_10
127	Visual	554755.7422	5483937.587	11	555480432	IG_E127_V_11
127	Visual	550937.3918	5478490.715	12	555480053	IG_E127_V_12
127	Visual	552479.6644	5477263.672	13	555480008	IG_E127_V_13
127	Visual	552524.368	5487658.059	14	555480984	IG_E127_V_14
127	Visual	561273.8917	5487518.413	15	555480947	IG_E127_V_15
127	Visual	558383.2536	5484651.21	16	555480507	IG_E127_V_16
127	Visual	551375.5494	5486449.953	17	555480772	IG_E127_V_17

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
127	Visual	558928.1522	5484463.674	18	555480483	IG_E127_V_18
127	Visual	558900.226	5484388.417	19	555480461	IG_E127_V_19
127	Visual	549769.6849	5486291.072	20	555480761	IG_E127_V_20
127	Visual	554710.7715	5483246.914	21	555480368	IG_E127_V_21
127	Visual	557827.4701	5488628.73	22	555481125	IG_E127_V_22
127	Visual	560113.4902	5485916.198	23	555480671	IG_E127_V_23
127	Visual	554002.4063	5479168.682	24	555480090	IG_E127_V_24
127	Visual	550705.512	5485160.623	25	555480572	IG_E127_V_25
127	Visual	555003.9113	5484346.257	26	555480455	IG_E127_V_26
127	Visual	555389.5342	5489548.141	27	555482053	IG_E127_V_27
127	Visual	559752.9824	5484242.685	28	555480442	IG_E127_V_28
127	Visual	560134.3461	5489507.003	29	555481306	IG_E127_V_29
127	Visual	552515.7267	5477233.314	30	555481678	IG_E127_V_30
127	Visual	557685.854	5483342.141	31	555480411	IG_E127_V_31
127	Visual	559725.2189	5488736.61	32	555481972	IG_E127_V_32
128	Full	560597.5048	5489031.63	1	555481205	IG_E128_F_1
128	Full	558457.2107	5484215.257	2	555480436	IG_E128_F_2
128	Full	559489.6381	5489710.832	3	555481326	IG_E128_F_3
128	Full	556662.2901	5489027.013	4	555482034	IG_E128_F_4
128	Ground	557239.8878	5487473.23	1	555480982	IG_E128_G_1
128	Ground	548116.4386	5486449.719	2	555480809	IG_E128_G_2
128	Ground	557091.7397	5485170.743	3	555480617	IG_E128_G_3
128	Ground	561305.7102	5485093.169	4	555480574	IG_E128_G_4
128	Ground	551617.2247	5479739.424	5	555480109	IG_E128_G_5
128	Ground	548600.066	5486506.203	6	555480792	IG_E128_G_6
128	Ground	559856.8837	5487066.258	7	555480920	IG_E128_G_7
128	Ground	558721.9165	5486316.043	8	555480768	IG_E128_G_8
128	Ground	550942.949	5485232.877	9	555480581	IG_E128_G_9
128	Ground	548967.3805	5486041.752	10	555480729	IG_E128_G_10
128	Ground	549110.8185	5485648.733	11	555480659	IG_E128_G_11
128	Ground	558505.8978	5489185.659	12	555481239	IG_E128_G_12
128	Ground	559037.905	5490246.471	13	555481428	IG_E128_G_13
128	Ground	557488.4495	5485203.523	14	555480576	IG_E128_G_14
128	Ground	553896.1233	5486502.221	15	555480786	IG_E128_G_15
128	Ground	549137.6532	5486628.76	16	555480805	IG_E128_G_16
128	Ground	557353.9558	5483905.695	17	555480415	IG_E128_G_17
128	Ground	551407.3075	5486995.128	18	555480861	IG_E128_G_18
128	Ground	555210.7365	5489293.363	19	555481265	IG_E128_G_19
128	Ground	553520.7169	5487244.955	20	555480912	IG_E128_G_20
128	Ground	554889.7393	5486847.924	21	555482071	IG_E128_G_21
128	Oversample	556022.4496	5486181.725	1	555480750	IG_E128_O_1
128	Oversample	557278.4163	5485638.935	2	555480651	IG_E128_O_2
128	Oversample	558032.0158	5490510.042	3	555481476	IG_E128_O_3
128	Oversample	558590.2474	5483981.506	4	555480427	IG_E128_O_4
128	Oversample	560753.734	5484417.141	5	555480491	IG_E128_O_5
128	Oversample	555038.5714	5483546.825	6	555480396	IG_E128_O_6
128	Oversample	549980.9984	5481004.639	7	555480176	IG_E128_O_7
128	Oversample	549723.403	5487662.662	8	555480965	IG_E128_O_8
128	Oversample	551187.1283	5488833.729	9	555481214	IG_E128_O_9

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
128	Oversample	556217.6396	5486267.35	10	555480783	IG_E128_O_10
128	Oversample	556866.2326	5486756.577	11	555480854	IG_E128_O_11
128	Oversample	557860.547	5485470.116	12	555481947	IG_E128_O_12
128	Oversample	558535.6338	5485612.159	13	555480654	IG_E128_O_13
128	Oversample	553273.7314	5477515.872	14	555480016	IG_E128_O_14
128	Oversample	550971.0139	5485092.022	15	555480563	IG_E128_O_15
128	Oversample	551944.09	5488756.351	16	555481202	IG_E128_O_16
128	Oversample	551945.3442	5488925.245	17	555481218	IG_E128_O_17
128	Oversample	552928.5537	5489511.553	18	555481332	IG_E128_O_18
128	Oversample	555852.4724	5481673.077	19	555480233	IG_E128_O_19
128	Oversample	551564.1101	5489324.025	20	555481296	IG_E128_O_20
128	Oversample	553405.407	5487095.853	21	555481949	IG_E128_O_21
128	Oversample	560565.4682	5488707.597	22	555481148	IG_E128_O_22
128	Oversample	555920.7558	5486858.184	23	555480843	IG_E128_O_23
128	Oversample	558667.7302	5486212.072	24	555480747	IG_E128_O_24
128	Oversample	554795.8186	5488312.503	25	555481086	IG_E128_O_25
128	Oversample	557281.5108	5491120.919	26	555481635	IG_E128_O_26
128	Oversample	555574.6971	5486020.151	27	555480738	IG_E128_O_27
128	Oversample	554534.3037	5489444.715	28	555481308	IG_E128_O_28
128	Oversample	557292.6913	5490980.691	29	555481584	IG_E128_O_29
128	Oversample	557081.0243	5484364.065	30	555480464	IG_E128_O_30
128	Oversample	548594.2595	5487338.699	31	555481034	IG_E128_O_31
128	Oversample	558918.8546	5490005.18	32	555481409	IG_E128_O_32
128	Oversample	555406.3596	5488029.187	33	555481083	IG_E128_O_33
128	Oversample	556352.5657	5488779.981	34	555481228	IG_E128_O_34
128	Oversample	552503.5428	5483802.01	35	555480405	IG_E128_O_35
128	Oversample	560131.7953	5490993.158	36	555481580	IG_E128_O_36
128	Oversample	551667.6349	5487520.252	37	555480969	IG_E128_O_37
128	Oversample	557990.6356	5482869.877	38	555480322	IG_E128_O_38
128	Oversample	553809.1538	5488888.224	39	555481225	IG_E128_O_39
128	Oversample	551846.4564	5477816.016	40	555480025	IG_E128_O_40
128	Oversample	551192.872	5483632.297	41	555480416	IG_E128_O_41
128	Oversample	556578.3923	5485545.029	42	555480621	IG_E128_O_42
128	Oversample	553669.8317	5485793.146	43	555481955	IG_E128_O_43
128	Oversample	560561.8484	5485453.562	44	555480607	IG_E128_O_44
128	Oversample	557304.2024	5486784.63	45	555481962	IG_E128_O_45
128	Oversample	558115.6558	5489922.275	46	555481372	IG_E128_O_46
128	Oversample	556212.6547	5485940.31	47	555480754	IG_E128_O_47
128	Oversample	557010.5601	5486946.189	48	555480842	IG_E128_O_48
128	Oversample	548334.5184	5486365.912	49	555480779	IG_E128_O_49
128	Oversample	560783.1422	5485851.472	50	555480664	IG_E128_O_50
128	Oversample	558369.4703	5489321.893	51	555481298	IG_E128_O_51
128	Oversample	559099.7665	5489555.786	52	555481330	IG_E128_O_52
128	Oversample	556959.7184	5484798.46	53	555480561	IG_E128_O_53
128	Oversample	557607.7242	5482369.241	54	555480276	IG_E128_O_54
128	Oversample	554595.8986	5488148.382	55	555481072	IG_E128_O_55
128	Oversample	554791.4377	5485558.321	56	555480629	IG_E128_O_56
128	Oversample	555433.7279	5490684.825	57	555481511	IG_E128_O_57
128	Oversample	555181.1671	5487062.419	58	555480897	IG_E128_O_58

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
128	Oversample	549964.1413	5488854.018	59	555481171	IG_E128_O_59
128	Oversample	554936.8883	5490258.713	60	555481425	IG_E128_O_60
128	Oversample	550384.2323	5480317.284	61	555480138	IG_E128_O_61
128	Oversample	555449.7029	5488646.383	62	555481137	IG_E128_O_62
128	Oversample	557350.2247	5486323.329	63	555480778	IG_E128_O_63
128	Oversample	551072.5556	5484648.646	64	555480497	IG_E128_O_64
128	Oversample	553052.6294	5490103.071	65	555481449	IG_E128_O_65
128	Oversample	558287.7075	5488108.279	66	555481066	IG_E128_O_66
128	Oversample	552431.6317	5487378.109	67	555480941	IG_E128_O_67
128	Oversample	560438.1355	5489236.644	68	555481250	IG_E128_O_68
128	Oversample	561084.4757	5489087.881	69	555481279	IG_E128_O_69
128	Oversample	556563.8846	5483403.605	70	555480383	IG_E128_O_70
128	Oversample	556378.6273	5487251.533	71	555480930	IG_E128_O_71
128	Oversample	560115.8181	5489079.548	72	555481220	IG_E128_O_72
128	Oversample	558442.5558	5485748.025	73	555480649	IG_E128_O_73
128	Oversample	557797.7659	5488658.019	74	555482038	IG_E128_O_74
128	Oversample	559700.1312	5483341.193	75	555480373	IG_E128_O_75
128	Oversample	560761.2283	5487386.597	76	555481937	IG_E128_O_76
128	Oversample	557031.3443	5483403.513	77	555480389	IG_E128_O_77
128	Oversample	555545.8824	5487460.284	78	555480944	IG_E128_O_78
128	Oversample	553265.0853	5480986.401	79	555480180	IG_E128_O_79
128	Oversample	560327.8501	5488330.149	80	555481074	IG_E128_O_80
128	Oversample	561292.9648	5487166.714	81	555480893	IG_E128_O_81
128	Oversample	559387.9231	5489747.246	82	555481974	IG_E128_O_82
128	Oversample	556865.5955	5486562.568	83	555481959	IG_E128_O_83
128	Oversample	557264.7021	5490402.021	84	555481464	IG_E128_O_84
128	Oversample	558491.4971	5486397.194	85	555480782	IG_E128_O_85
128	Oversample	555500.9931	5482590.835	86	555480294	IG_E128_O_86
128	Oversample	558714.2771	5489591.419	87	555481314	IG_E128_O_87
128	Oversample	556453.7843	5481366.701	88	555480197	IG_E128_O_88
128	Oversample	551088.4544	5480073.25	89	555480121	IG_E128_O_89
128	Oversample	560649.7084	5488418.631	90	555481101	IG_E128_O_90
128	Oversample	548273.0196	5486391.848	91	555480791	IG_E128_O_91
128	Oversample	557726.5907	5486910.782	92	555481964	IG_E128_O_92
128	Oversample	557203.7123	5488680.707	93	555481176	IG_E128_O_93
128	Oversample	559543.1875	5488953.833	94	555481985	IG_E128_O_94
128	Oversample	551552.6872	5486689.768	95	555480806	IG_E128_O_95
128	Oversample	556242.6289	5481970.27	96	555480230	IG_E128_O_96
128	Oversample	552745.7188	5478001.128	97	555481682	IG_E128_O_97
128	Oversample	560911.2194	5487998.391	98	555481030	IG_E128_O_98
128	Visual	559462.7732	5485400.2	1	555480635	IG_E128_V_1
128	Visual	552877.2745	5484998.791	2	555480557	IG_E128_V_2
128	Visual	548449.2938	5486121.451	3	555482019	IG_E128_V_3
128	Visual	550875.8391	5489128.025	4	555481231	IG_E128_V_4
128	Visual	557284.4723	5490783.538	5	555481543	IG_E128_V_5
128	Visual	557225.2938	5485862.293	6	555480683	IG_E128_V_6
128	Visual	551659.5195	5489267.083	7	555482054	IG_E128_V_7
128	Visual	558926.7123	5490026.431	8	555481406	IG_E128_V_8
128	Visual	553800.1809	5487631.161	9	555480971	IG_E128_V_9

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
128	Visual	552388.2957	5488038.728	10	555481098	IG_E128_V_10
128	Visual	557621.101	5481254.275	11	555480191	IG_E128_V_11
128	Visual	560946.8296	5486669.822	12	555481936	IG_E128_V_12
128	Visual	555599.2109	5484086.334	13	555480443	IG_E128_V_13
128	Visual	550218.8213	5488943.153	14	555481234	IG_E128_V_14
128	Visual	557995.3309	5484463.934	15	555480482	IG_E128_V_15
128	Visual	552796.119	5489553.522	16	555481299	IG_E128_V_16
128	Visual	555419.5429	5486332.49	17	555480766	IG_E128_V_17
128	Visual	558219.7537	5483235.844	18	555480370	IG_E128_V_18
128	Visual	561332.3723	5484292.822	19	555480448	IG_E128_V_19
128	Visual	555972.5676	5483857.949	20	555480420	IG_E128_V_20
128	Visual	549894.8264	5489136.11	21	555481236	IG_E128_V_21
128	Visual	558184.9707	5485885.774	22	555481941	IG_E128_V_22
128	Visual	555684.5069	5486530.469	23	555480828	IG_E128_V_23
128	Visual	558170.3659	5486763.928	24	555480817	IG_E128_V_24
128	Visual	555206.3382	5484436.589	25	555480583	IG_E128_V_25
128	Visual	552078.6782	5484541.648	26	555480535	IG_E128_V_26
128	Visual	558763.5968	5487390.847	27	555480929	IG_E128_V_27
128	Visual	557430.1372	5491307.335	28	555481643	IG_E128_V_28
128	Visual	557441.3529	5486194.678	29	555480808	IG_E128_V_29
128	Visual	560376.9189	5490407.545	30	555481453	IG_E128_V_30
128	Visual	557876.0001	5484699.905	31	555480502	IG_E128_V_31
128	Visual	557075.3063	5485684.366	32	555480645	IG_E128_V_32
128	Visual	557368.3907	5485959.356	33	555480676	IG_E128_V_33
128	Visual	557980.3882	5486781.018	34	555480836	IG_E128_V_34
128	Visual	556030.033	5488038.639	35	555481055	IG_E128_V_35
128	Visual	552752.9869	5477826.391	36	555480024	IG_E128_V_36
128	Visual	554944.3297	5486393.641	37	555480777	IG_E128_V_37
128	Visual	560360.1815	5488857.563	38	555481172	IG_E128_V_38
128	Visual	557878.536	5487179.885	39	555480901	IG_E128_V_39
128	Visual	559190.3029	5485322.507	40	555480591	IG_E128_V_40
128	Visual	550766.663	5479624.644	41	555480107	IG_E128_V_41
128	Visual	560745.0449	5482633.922	42	555480298	IG_E128_V_42
128	Visual	559312.0979	5488581.362	43	555481124	IG_E128_V_43
128	Visual	560112.5025	5490873.7	44	555481563	IG_E128_V_44
128	Visual	552734.0448	5482443.463	45	555480289	IG_E128_V_45
128	Visual	550010.1862	5489843.212	46	555481373	IG_E128_V_46
128	Visual	558311.6275	5490306.4	47	555481982	IG_E128_V_47
128	Visual	556969.3823	5489212.35	48	555481259	IG_E128_V_48
128	Visual	556857.6761	5486167.967	49	555480771	IG_E128_V_49
128	Visual	550107.7326	5488604.654	50	555481152	IG_E128_V_50
128	Visual	551481.4034	5487799.31	51	555481025	IG_E128_V_51
128	Visual	557782.4912	5490624.888	52	555481513	IG_E128_V_52
128	Visual	560055.1963	5484320.033	53	555481847	IG_E128_V_53
128	Visual	549702.0051	5488823.151	54	555481185	IG_E128_V_54
128	Visual	551650.5811	5486983.406	55	555480881	IG_E128_V_55
128	Visual	558717.4878	5489208.281	56	555482031	IG_E128_V_56
128	Visual	560787.7109	5487157.203	57	555481938	IG_E128_V_57
128	Visual	558097.0097	5488290.751	58	555481987	IG_E128_V_58

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
128	Visual	552416.8709	5478074.526	59	555480034	IG_E128_V_59
128	Visual	555289.1745	5486122.856	60	555480723	IG_E128_V_60
128	Visual	559995.9334	5487621.239	61	555481939	IG_E128_V_61
128	Visual	553661.1333	5487845.288	62	555481022	IG_E128_V_62
128	Visual	553783.7817	5481791.389	63	555480246	IG_E128_V_63
128	Visual	556889.3936	5483021.981	64	555480338	IG_E128_V_64
128	Visual	557891.8028	5487831.259	65	555481078	IG_E128_V_65
128	Visual	552111.9632	5477589.072	66	555480021	IG_E128_V_66
128	Visual	558469.4506	5483563.248	67	555480390	IG_E128_V_67
128	Visual	550401.8441	5489462.139	68	555481424	IG_E128_V_68
128	Visual	549380.6795	5488420.432	69	555481118	IG_E128_V_69
128	Visual	551264.0823	5489349.685	70	555481270	IG_E128_V_70
128	Visual	554294.9046	5478792.926	71	555480068	IG_E128_V_71
128	Visual	560194.5542	5486971.213	72	555480874	IG_E128_V_72
128	Visual	558250.5209	5482953.131	73	555480349	IG_E128_V_73
128	Visual	558098.1	5486659.048	74	555480831	IG_E128_V_74
128	Visual	559345.4539	5485982.815	75	555480716	IG_E128_V_75
128	Visual	553686.8753	5489197.715	76	555481230	IG_E128_V_76
128	Visual	554215.9846	5488918.645	77	555481186	IG_E128_V_77
128	Visual	549970.3653	5489174.125	78	555481249	IG_E128_V_78
128	Visual	554738.7329	5486472.281	79	555480790	IG_E128_V_79
128	Visual	557629.0164	5490614.235	80	555481490	IG_E128_V_80
128	Visual	557862.1585	5486342.524	81	555481943	IG_E128_V_81
128	Visual	550803.8351	5484805.933	82	555480533	IG_E128_V_82
128	Visual	560963.5569	5488264.748	83	555481085	IG_E128_V_83
128	Visual	555099.6086	5487824.231	84	555482045	IG_E128_V_84
128	Visual	553574.3995	5489074.55	85	555481215	IG_E128_V_85
128	Visual	559032.649	5486113.391	86	555480717	IG_E128_V_86
128	Visual	558801.9223	5485147.71	87	555480568	IG_E128_V_87
128	Visual	554367.7852	5487220.728	88	555480923	IG_E128_V_88
128	Visual	550097.1447	5488152.045	89	555482013	IG_E128_V_89
128	Visual	561034.3331	5488530.845	90	555481116	IG_E128_V_90
128	Visual	552366.8803	5488676.897	91	555481167	IG_E128_V_91
128	Visual	553864.6688	5490168.931	92	555481468	IG_E128_V_92
128	Visual	557464.7939	5486791.122	93	555481963	IG_E128_V_93
128	Visual	557811.4922	5486158.067	94	555481942	IG_E128_V_94
128	Visual	549097.5224	5488030.756	95	555481046	IG_E128_V_95
128	Visual	550515.8544	5481970.487	96	555480229	IG_E128_V_96
129	Full	548441.6782	5485993.817	1	555480803	IG_E129_F_1
129	Ground	549545.1516	5488144.254	1	555481088	IG_E129_G_1
130	Full	551244.6135	5480432.723	1	555480146	IG_E130_F_1
130	Ground	550814.6769	5480129.256	1	555480125	IG_E130_G_1
130	Oversample	552986.1297	5491735.582	1	555481668	IG_E130_O_1
130	Oversample	548800.9756	5485352.282	2	555480595	IG_E130_O_2
130	Oversample	551211.2728	5487276.07	3	555482093	IG_E130_O_3
130	Visual	548164.2135	5488732.223	1	555482001	IG_E130_V_1
130	Visual	551302.2503	5479709.042	2	555480110	IG_E130_V_2
133	Full	558315.3386	5486328.979	1	555480769	IG_E133_F_1
135	Full	556108.2337	5489828.825	1	555481365	IG_E135_F_1

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
135	Full	554949.3614	5490286.16	2	555481421	IG_E135_F_2
135	Full	548592.1118	5490081.794	3	555482100	IG_E135_F_3
135	Ground	549505.0787	5491229.898	1	555481625	IG_E135_G_1
135	Ground	559025.3622	5488178.014	2	555481986	IG_E135_G_2
135	Ground	557981.1034	5490478.785	3	555481471	IG_E135_G_3
135	Ground	548721.1702	5490454.282	4	555481518	IG_E135_G_4
135	Ground	552551.7438	5490648.06	5	555481519	IG_E135_G_5
135	Ground	556097.5906	5490188.665	6	555481432	IG_E135_G_6
135	Ground	552810.7147	5489093.314	7	555481219	IG_E135_G_7
135	Ground	556172.57	5489611.904	8	555481342	IG_E135_G_8
135	Ground	552661.1374	5482839.598	9	555480311	IG_E135_G_9
135	Ground	557624.458	5489252.808	10	555481235	IG_E135_G_10
135	Ground	549594.4991	5491095.402	11	555481612	IG_E135_G_11
135	Ground	552851.4549	5491251.629	12	555481629	IG_E135_G_12
135	Ground	555351.4333	5488091.149	13	555482044	IG_E135_G_13
135	Oversample	556272.8288	5490169.508	1	555481416	IG_E135_O_1
135	Oversample	553145.2741	5489012.673	2	555481204	IG_E135_O_2
135	Oversample	556366.6411	5487601.486	3	555482041	IG_E135_O_3
135	Oversample	548922.359	5488775.249	4	555481165	IG_E135_O_4
135	Oversample	553798.1331	5490704.504	5	555481551	IG_E135_O_5
135	Oversample	552904.76	5482048.832	6	555480236	IG_E135_O_6
135	Oversample	553767.6915	5486299.197	7	555480773	IG_E135_O_7
135	Oversample	556680.7839	5489562.142	8	555481307	IG_E135_O_8
135	Oversample	553496.7592	5486084.937	9	555480721	IG_E135_O_9
135	Oversample	549271.1665	5488291.283	10	555481084	IG_E135_O_10
135	Oversample	548424.4614	5489798.168	11	555481354	IG_E135_O_11
135	Oversample	548220.1073	5489828.492	12	555481431	IG_E135_O_12
135	Oversample	554943.6011	5487439.089	13	555480958	IG_E135_O_13
135	Oversample	552687.017	5486069.78	14	555480719	IG_E135_O_14
135	Oversample	553016.4085	5487518.218	15	555480970	IG_E135_O_15
135	Oversample	555798.6429	5486910.115	16	555480839	IG_E135_O_16
135	Oversample	551161.3001	5486738.56	17	555480846	IG_E135_O_17
135	Oversample	554253.4992	5487017.002	18	555481948	IG_E135_O_18
135	Oversample	554741.4173	5482469.827	19	555482085	IG_E135_O_19
135	Oversample	548983.0805	5489684.297	20	555481324	IG_E135_O_20
135	Oversample	561282.4217	5487876.288	21	555481006	IG_E135_O_21
135	Oversample	556681.4083	5490600.11	22	555481530	IG_E135_O_22
135	Oversample	548615.9794	5489807.269	23	555481989	IG_E135_O_23
135	Oversample	549305.8234	5491095.235	24	555481614	IG_E135_O_24
135	Oversample	555855.2016	5487183.474	25	555480886	IG_E135_O_25
135	Oversample	558097.9309	5485657.894	26	555480627	IG_E135_O_26
135	Oversample	550516.8748	5486642.419	27	555480834	IG_E135_O_27
135	Oversample	560375.0681	5485827.543	28	555480667	IG_E135_O_28
135	Oversample	549104.9178	5490923.167	29	555481605	IG_E135_O_29
135	Oversample	549141.4907	5489368.748	30	555481269	IG_E135_O_30
135	Oversample	551224.4388	5479849.259	31	555481817	IG_E135_O_31
135	Oversample	554785.0438	5490294.301	32	555481613	IG_E135_O_32
135	Oversample	554078.3031	5490904.42	33	555481617	IG_E135_O_33
135	Oversample	554525.0915	5490210.976	34	555481458	IG_E135_O_34

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
135	Oversample	549674.1772	5487039.3	35	555481931	IG_E135_O_35
135	Oversample	554014.2183	5484944.936	36	555480521	IG_E135_O_36
135	Oversample	555358.0631	5486333.895	37	555480774	IG_E135_O_37
135	Oversample	553941.8351	5491083.372	38	555482110	IG_E135_O_38
135	Oversample	550028.1001	5486665.047	39	555480819	IG_E135_O_39
135	Oversample	554666.1124	5482431.307	40	555480274	IG_E135_O_40
135	Oversample	553392.6473	5477492.34	41	555480022	IG_E135_O_41
135	Oversample	551649.4899	5480480.791	42	555480143	IG_E135_O_42
135	Oversample	557913.2197	5489384.319	43	555481282	IG_E135_O_43
135	Oversample	550553.1059	5487449.926	44	555480945	IG_E135_O_44
135	Oversample	552553.2883	5489776.709	45	555481344	IG_E135_O_45
135	Oversample	553835.1982	5491116.495	46	555481636	IG_E135_O_46
135	Oversample	552345.8629	5486359.161	47	555480775	IG_E135_O_47
135	Oversample	551608.0913	5488679.718	48	555481133	IG_E135_O_48
135	Oversample	557526.822	5485193.662	49	555481946	IG_E135_O_49
135	Oversample	555658.435	5482921.611	50	555480329	IG_E135_O_50
135	Oversample	551649.6654	5484559.597	51	555480513	IG_E135_O_51
135	Oversample	560207.5698	5488958.523	52	555481222	IG_E135_O_52
135	Oversample	549211.1279	5489648.873	53	555481316	IG_E135_O_53
135	Oversample	558246.3981	5488896.309	54	555481224	IG_E135_O_54
135	Oversample	550640.8633	5490776.156	55	555481542	IG_E135_O_55
135	Oversample	551790.0929	5485895.002	56	555480675	IG_E135_O_56
135	Oversample	556303.9172	5489559.163	57	555481301	IG_E135_O_57
135	Visual	557542.1907	5490482.777	1	555481482	IG_E135_V_1
135	Visual	552231.7505	5489818.532	2	555481423	IG_E135_V_2
135	Visual	556956.9771	5490962.699	3	555481579	IG_E135_V_3
135	Visual	556507.9675	5489557.566	4	555481303	IG_E135_V_4
135	Visual	557260.7325	5489997.71	5	555482033	IG_E135_V_5
135	Visual	553684.8647	5485778.125	6	555480781	IG_E135_V_6
135	Visual	555723.1368	5490489.706	7	555481474	IG_E135_V_7
135	Visual	561334.8131	5487835.446	8	555481001	IG_E135_V_8
135	Visual	552480.3656	5489164.435	9	555481241	IG_E135_V_9
135	Visual	549838.9043	5488974.697	10	555481217	IG_E135_V_10
135	Visual	550767.3114	5485347.393	11	555480593	IG_E135_V_11
135	Visual	553544.1884	5482822.682	12	555480365	IG_E135_V_12
135	Visual	551380.564	5489689.415	13	555481331	IG_E135_V_13
135	Visual	556936.2239	5489457.32	14	555481278	IG_E135_V_14
135	Visual	554984.6211	5482540.124	15	555480283	IG_E135_V_15
135	Visual	548907.4599	5488693.621	16	555481190	IG_E135_V_16
135	Visual	549051.6351	5490831.47	17	555481561	IG_E135_V_17
135	Visual	556843.3277	5489412.274	18	555481272	IG_E135_V_18
135	Visual	548919.7538	5489789.091	19	555481346	IG_E135_V_19
135	Visual	552738.0894	5482793.673	20	555480308	IG_E135_V_20
135	Visual	551018.2495	5485015.939	21	555480553	IG_E135_V_21
135	Visual	549997.0351	5486397.272	22	555480835	IG_E135_V_22
135	Visual	551805.9223	5485745.175	23	555481954	IG_E135_V_23
135	Visual	559802.4719	5488299.88	24	555481075	IG_E135_V_24
135	Visual	559855.1884	5488501.322	25	555481147	IG_E135_V_25
135	Visual	554885.1132	5485827.476	26	555480700	IG_E135_V_26

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
135	Visual	551564.2306	5487029.047	27	555480914	IG_E135_V_27
135	Visual	554995.8404	5483403.438	28	555481886	IG_E135_V_28
135	Visual	556468.6534	5489538.459	29	555481311	IG_E135_V_29
135	Visual	552863.9868	5485015.886	30	555482090	IG_E135_V_30
135	Visual	554075.6245	5478206.119	31	555481748	IG_E135_V_31
135	Visual	550273.4501	5490035.888	32	555481766	IG_E135_V_32
135	Visual	554366.6688	5483287.082	33	555480375	IG_E135_V_33
135	Visual	553645.7052	5479177.003	34	555480094	IG_E135_V_34
135	Visual	553258.2574	5485481.508	35	555480604	IG_E135_V_35
135	Visual	552856.2851	5491227.51	36	555481621	IG_E135_V_36
135	Visual	551179.7895	5487213.169	37	555480927	IG_E135_V_37
135	Visual	550324.4114	5484616.974	38	555480488	IG_E135_V_38
135	Visual	553575.3159	5482671.997	39	555480328	IG_E135_V_39
135	Visual	550120.9209	5490898.47	40	555481611	IG_E135_V_40
135	Visual	553648.0664	5488632.561	41	555481813	IG_E135_V_41
135	Visual	553093.9023	5491089.777	42	555481601	IG_E135_V_42
135	Visual	551627.1313	5485876.667	43	555480665	IG_E135_V_43
135	Visual	552962.2157	5486455.874	44	555480776	IG_E135_V_44
135	Visual	553923.7427	5486305.644	45	555480875	IG_E135_V_45
135	Visual	561066.9357	5487724.286	46	555480990	IG_E135_V_46
135	Visual	560732.0465	5487817.414	47	555480997	IG_E135_V_47
135	Visual	550698.4201	5484289.159	48	555481930	IG_E135_V_48
135	Visual	560456.0765	5489145.962	49	555481968	IG_E135_V_49
135	Visual	560362.375	5488633.997	50	555481126	IG_E135_V_50
135	Visual	560649.5637	5487885.908	51	555481016	IG_E135_V_51
135	Visual	552465.3565	5489032.17	52	555481289	IG_E135_V_52
135	Visual	555110.2306	5482607.59	53	555480296	IG_E135_V_53
135	Visual	549795.8856	5485747.7	54	555480737	IG_E135_V_54
135	Visual	552898.0829	5482779.387	55	555480307	IG_E135_V_55
136	Full	557628.3103	5490912.64	1	555481573	IG_E136_F_1
136	Full	552721.7785	5477978.661	2	555480030	IG_E136_F_2
136	Full	558827.7567	5485459.563	3	555480599	IG_E136_F_3
136	Ground	557151.1816	5485023.954	1	555480570	IG_E136_G_1
136	Ground	553129.9033	5487892.85	2	555481019	IG_E136_G_2
136	Ground	553856.3819	5479031.786	3	555480083	IG_E136_G_3
136	Ground	553940.6922	5478701.949	4	555480078	IG_E136_G_4
136	Ground	553680.0721	5481079.025	5	555480182	IG_E136_G_5
136	Ground	560218.6271	5490645.727	6	555481514	IG_E136_G_6
136	Ground	556915.2695	5485370.519	7	555480598	IG_E136_G_7
136	Ground	553132.825	5480385.85	8	555480144	IG_E136_G_8
136	Ground	554631.015	5483309.905	9	555481843	IG_E136_G_9
136	Ground	558372.1553	5490579.301	10	555481496	IG_E136_G_10
136	Ground	559432.4198	5486794.751	11	555480841	IG_E136_G_11
136	Ground	557129.758	5481376.741	12	555480270	IG_E136_G_12
136	Oversample	558580.4934	5487131.918	1	555480905	IG_E136_O_1
136	Oversample	555781.07	5485566.799	2	555480628	IG_E136_O_2
136	Oversample	552102.4812	5477694.277	3	555480019	IG_E136_O_3
136	Oversample	561265.5953	5490471.98	4	555481475	IG_E136_O_4
136	Oversample	548792.7737	5485895.757	5	555480812	IG_E136_O_5

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
136	Oversample	555506.7968	5484679.595	6	555480517	IG_E136_O_6
136	Oversample	560918.9376	5484785.801	7	555480505	IG_E136_O_7
136	Oversample	554168.167	5483913.716	8	555480481	IG_E136_O_8
136	Oversample	560153.9267	5490570.651	9	555481502	IG_E136_O_9
136	Oversample	552800.6028	5477867.895	10	555480028	IG_E136_O_10
136	Oversample	560892.3164	5489725.788	11	555481967	IG_E136_O_11
136	Oversample	559759.2662	5486917.591	12	555480859	IG_E136_O_12
136	Oversample	558044.4164	5485706.507	13	555480749	IG_E136_O_13
136	Oversample	561278.2592	5487251.852	14	555480925	IG_E136_O_14
136	Oversample	553807.7704	5480908.343	15	555480172	IG_E136_O_15
136	Oversample	554745.9808	5484247.455	16	555480478	IG_E136_O_16
136	Oversample	554693.8167	5478191.434	17	555480039	IG_E136_O_17
136	Oversample	555707.5329	5487084.56	18	555480866	IG_E136_O_18
136	Oversample	556083.4268	5484759.914	19	555480512	IG_E136_O_19
136	Oversample	559487.5154	5484366.183	20	555480463	IG_E136_O_20
136	Oversample	551349.2087	5478367.848	21	555480059	IG_E136_O_21
136	Oversample	560207.3489	5487115.907	22	555480903	IG_E136_O_22
136	Oversample	560586.9829	5485518	23	555480612	IG_E136_O_23
136	Oversample	557703.867	5486767.908	24	555480829	IG_E136_O_24
136	Oversample	560071.2025	5489897.029	25	555481370	IG_E136_O_25
136	Oversample	551440.5775	5479781.576	26	555480111	IG_E136_O_26
136	Oversample	551720.6472	5478222.221	27	555480041	IG_E136_O_27
136	Oversample	552634.1003	5485250.009	28	555480609	IG_E136_O_28
136	Oversample	552934.8098	5477997.405	29	555480031	IG_E136_O_29
136	Oversample	552356.4655	5486887.871	30	555480855	IG_E136_O_30
136	Oversample	558534.7224	5483364.597	31	555480385	IG_E136_O_31
136	Oversample	560351.5192	5487177.298	32	555480904	IG_E136_O_32
136	Oversample	561245.4124	5490753.543	33	555481541	IG_E136_O_33
136	Oversample	555594.4347	5488843.948	34	555481196	IG_E136_O_34
136	Oversample	553943.5612	5486687.871	35	555480892	IG_E136_O_35
136	Oversample	555785.1869	5488706.416	36	555481138	IG_E136_O_36
136	Oversample	560613.8496	5487157.186	37	555480926	IG_E136_O_37
136	Oversample	559272.6706	5489293.604	38	555481253	IG_E136_O_38
136	Oversample	556438.1491	5483890.309	39	555480425	IG_E136_O_39
136	Oversample	554342.9657	5481879.863	40	555480225	IG_E136_O_40
136	Oversample	552241.8977	5477100.618	41	555481681	IG_E136_O_41
136	Oversample	560757.4377	5489237.929	42	555481384	IG_E136_O_42
136	Oversample	554116.0121	5489974.689	43	555481388	IG_E136_O_43
136	Oversample	557899.2579	5490551.468	44	555481477	IG_E136_O_44
136	Oversample	557843.4839	5485195.615	45	555480573	IG_E136_O_45
136	Oversample	559032.8005	5486543.371	46	555480821	IG_E136_O_46
136	Oversample	553542.2938	5489588.948	47	555481329	IG_E136_O_47
136	Oversample	555135.8413	5484443.699	48	555480470	IG_E136_O_48
136	Oversample	559700.0244	5489181.855	49	555481229	IG_E136_O_49
136	Oversample	553692.6419	5488748.269	50	555481814	IG_E136_O_50
136	Oversample	554602.7042	5488946.072	51	555481200	IG_E136_O_51
136	Oversample	557561.9248	5486057.249	52	555480728	IG_E136_O_52
136	Oversample	560735.9182	5490018.143	53	555481472	IG_E136_O_53
136	Oversample	557213.8149	5486079.766	54	555480733	IG_E136_O_54

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
136	Oversample	552208.2995	5484739.748	55	555480564	IG_E136_O_55
136	Oversample	554785.0055	5484907.797	56	555481889	IG_E136_O_56
136	Oversample	561228.0409	5487470.147	57	555480949	IG_E136_O_57
136	Visual	559561.328	5490441.468	1	555481459	IG_E136_V_1
136	Visual	560369.5523	5490322.297	2	555481478	IG_E136_V_2
136	Visual	554937.7756	5484599.697	3	555480499	IG_E136_V_3
136	Visual	561954.4481	5485104.001	4	555480560	IG_E136_V_4
136	Visual	557751.3128	5485695.543	5	555480652	IG_E136_V_5
136	Visual	554304.4425	5487653.44	6	555480986	IG_E136_V_6
136	Visual	550129.7695	5488970.131	7	555482003	IG_E136_V_7
136	Visual	559288.8659	5482323.59	8	555480256	IG_E136_V_8
136	Visual	557800.8196	5486085.362	9	555480715	IG_E136_V_9
136	Visual	561281.9646	5484973.776	10	555480536	IG_E136_V_10
136	Visual	559583.9912	5489599.819	11	555481337	IG_E136_V_11
136	Visual	556855.9267	5485617.658	12	555480653	IG_E136_V_12
136	Visual	554927.813	5481652.914	13	555480215	IG_E136_V_13
136	Visual	557865.9776	5487613.214	14	555480995	IG_E136_V_14
136	Visual	560609.9872	5490754.005	15	555481976	IG_E136_V_15
136	Visual	557093.0995	5485964.505	16	555480704	IG_E136_V_16
136	Visual	560257.6061	5486555.821	17	555480797	IG_E136_V_17
136	Visual	549301.7085	5488261.553	18	555481061	IG_E136_V_18
136	Visual	556491.3256	5488544.629	19	555481115	IG_E136_V_19
136	Visual	559140.9566	5484296.097	20	555480441	IG_E136_V_20
136	Visual	555081.3311	5482247.347	21	555480248	IG_E136_V_21
136	Visual	557204.2591	5487650.38	22	555481053	IG_E136_V_22
136	Visual	553919.8383	5489761.747	23	555481426	IG_E136_V_23
136	Visual	558415.6121	5490108.44	24	555481462	IG_E136_V_24
136	Visual	555447.6269	5481948.708	25	555480237	IG_E136_V_25
136	Visual	551818.6094	5478027.815	26	555480038	IG_E136_V_26
136	Visual	558456.5325	5490122.704	27	555481411	IG_E136_V_27
136	Visual	552340.9658	5478132.297	28	555480042	IG_E136_V_28
136	Visual	556986.2419	5484897.31	29	555480548	IG_E136_V_29
136	Visual	549622.0789	5488702.938	30	555481150	IG_E136_V_30
136	Visual	556648.2992	5485850.802	31	555480681	IG_E136_V_31
136	Visual	560431.2144	5490817.111	32	555481593	IG_E136_V_32
136	Visual	560050.2828	5483084.809	33	555480342	IG_E136_V_33
136	Visual	552234.2464	5484774.394	34	555480515	IG_E136_V_34
136	Visual	557340.7186	5486238.171	35	555480748	IG_E136_V_35
136	Visual	559216.5586	5485942.535	36	555480701	IG_E136_V_36
136	Visual	552894.0018	5487501.695	37	555481014	IG_E136_V_37
136	Visual	560978.8894	5486698.792	38	555480824	IG_E136_V_38
136	Visual	558886.189	5490431.887	39	555481515	IG_E136_V_39
136	Visual	559037.6816	5489222.572	40	555481244	IG_E136_V_40
136	Visual	551189.8572	5478916.665	41	555480077	IG_E136_V_41
136	Visual	552408.757	5477263.631	42	555480006	IG_E136_V_42
136	Visual	559420.4003	5487375.229	43	555480972	IG_E136_V_43
136	Visual	556850.9193	5484625.869	44	555480525	IG_E136_V_44
136	Visual	552331.4713	5476884.051	45	555480007	IG_E136_V_45
136	Visual	560103.4092	5490769.344	46	555481539	IG_E136_V_46

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
136	Visual	558227.9766	5489874.946	47	555481983	IG_E136_V_47
136	Visual	558413.0122	5490676.526	48	555481529	IG_E136_V_48
136	Visual	555330.07	5488601.285	49	555481112	IG_E136_V_49
136	Visual	559683.2031	5490550.139	50	555481523	IG_E136_V_50
136	Visual	556046.4286	5482371.12	51	555480305	IG_E136_V_51
136	Visual	554149.9759	5488198.546	52	555481062	IG_E136_V_52
136	Visual	557208.1145	5486835.878	53	555481961	IG_E136_V_53
136	Visual	559449.6123	5490453.877	54	555481486	IG_E136_V_54
136	Visual	554749.3972	5488897.917	55	555481237	IG_E136_V_55
139	Full	551843.8477	5478910.7	1	555480073	IG_E139_F_1
139	Ground	560188.7264	5482610.849	1	555480292	IG_E139_G_1
139	Ground	552465.427	5482911.065	2	555480333	IG_E139_G_2
139	Ground	552488.3702	5489096.867	3	555481232	IG_E139_G_3
139	Oversample	550562.1094	5486709.87	1	555480807	IG_E139_O_1
139	Oversample	553281.7294	5483235.634	2	555480384	IG_E139_O_2
139	Oversample	549660.4524	5488628.631	3	555481140	IG_E139_O_3
139	Oversample	560121.549	5490814.191	4	555481576	IG_E139_O_4
139	Oversample	550024.6209	5485518.209	5	555480639	IG_E139_O_5
139	Oversample	553274.7596	5484200.319	6	555480438	IG_E139_O_6
139	Oversample	557446.3684	5490258.001	7	555481450	IG_E139_O_7
139	Oversample	553367.6451	5488843.698	8	555481197	IG_E139_O_8
139	Oversample	556780.4886	5487793.149	9	555481005	IG_E139_O_9
139	Oversample	549974.9335	5490271.659	10	555481765	IG_E139_O_10
139	Oversample	552223.2491	5489174.703	11	555481770	IG_E139_O_11
139	Visual	552290.4465	5477640.702	1	555480018	IG_E139_V_1
139	Visual	552913.142	5480905.587	2	555480166	IG_E139_V_2
139	Visual	552511.2692	5482811.132	3	555480309	IG_E139_V_3
139	Visual	558697.0165	5484779.668	4	555480508	IG_E139_V_4
139	Visual	559898.6275	5488823.679	5	555481163	IG_E139_V_5
139	Visual	553569.4047	5481041.726	6	555480184	IG_E139_V_6
139	Visual	552777.2192	5489717.955	7	555481336	IG_E139_V_7
139	Visual	550471.9261	5490083.355	8	555481412	IG_E139_V_8
139	Visual	555045.5528	5483794.07	9	555480407	IG_E139_V_9
139	Visual	560438.2301	5484650.535	10	555480492	IG_E139_V_10
139	Visual	560713.1984	5487292.894	11	555480918	IG_E139_V_11
140	Full	557945.4053	5482970.71	1	555480330	IG_E140_F_1
140	Full	557848.4927	5483713.893	2	555480399	IG_E140_F_2
140	Ground	556928.1788	5483069.902	1	555480357	IG_E140_G_1
140	Ground	552700.3892	5490994.742	2	555481581	IG_E140_G_2
140	Ground	553667.5904	5486398.59	3	555480780	IG_E140_G_3
140	Ground	553681.1994	5477767.996	4	555480020	IG_E140_G_4
140	Ground	558745.1693	5489477.551	5	555481281	IG_E140_G_5
140	Ground	551989.7145	5483581.228	6	555480446	IG_E140_G_6
140	Ground	561001.5486	5484526.161	7	555480485	IG_E140_G_7
140	Oversample	548228.3461	5486024.534	1	555480692	IG_E140_O_1
140	Oversample	560110.8807	5486461.204	2	555480785	IG_E140_O_2
140	Oversample	556792.3974	5483213.77	3	555480366	IG_E140_O_3
140	Oversample	551896.2505	5482706.937	4	555480310	IG_E140_O_4
140	Oversample	551404.0276	5480279.982	5	555480134	IG_E140_O_5

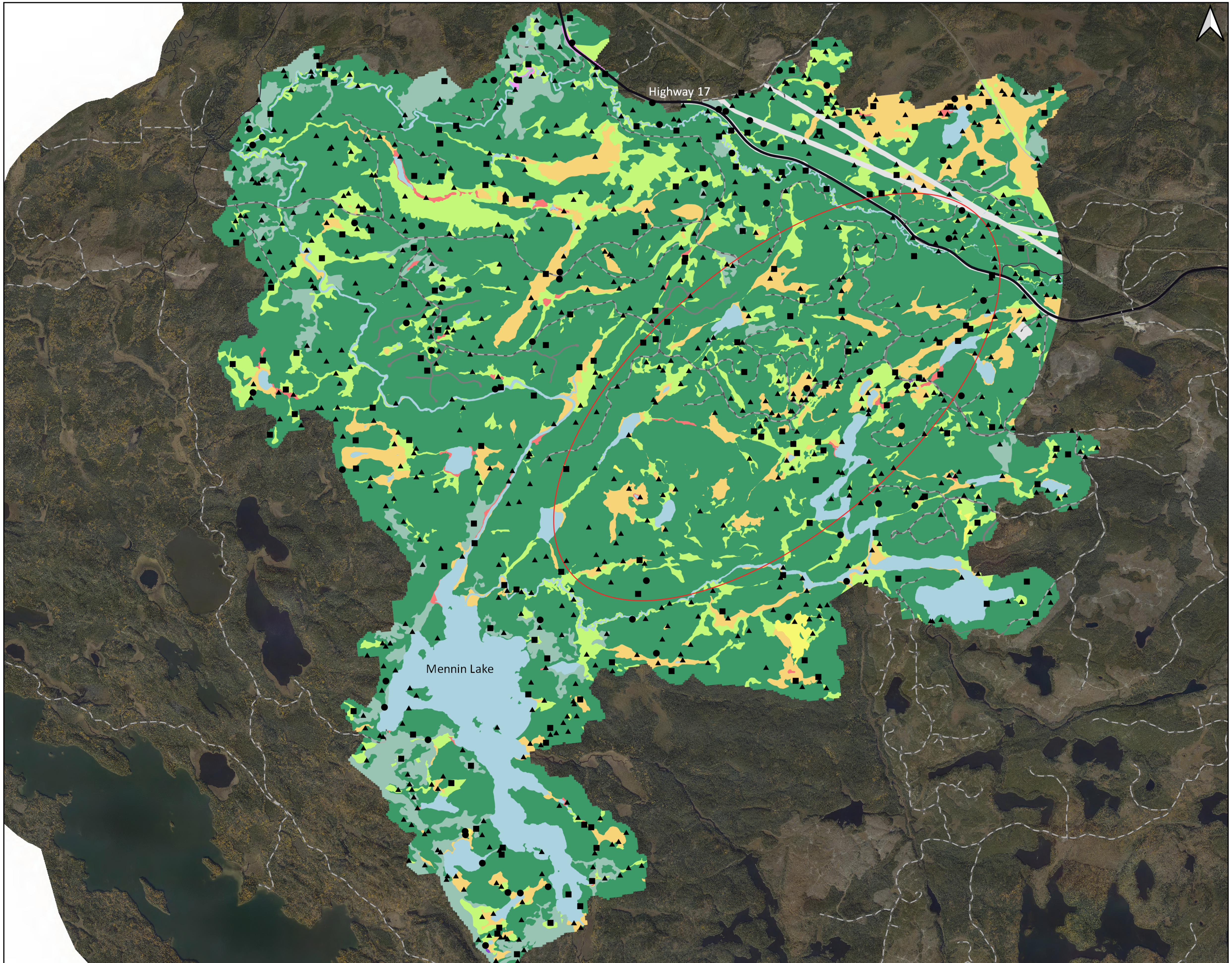
Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
140	Oversample	553297.2453	5485886.98	6	555480690	IG_E140_O_6
140	Oversample	558304.5213	5483557.105	7	555480404	IG_E140_O_7
140	Oversample	551959.8124	5482784.995	8	555480332	IG_E140_O_8
140	Oversample	552898.616	5489700.376	9	555481327	IG_E140_O_9
140	Oversample	559548.9199	5482857.871	10	555480327	IG_E140_O_10
140	Oversample	556800.6355	5483175.46	11	555480356	IG_E140_O_11
140	Oversample	553621.0067	5488836.072	12	555481182	IG_E140_O_12
140	Oversample	560011.427	5486369.231	13	555480760	IG_E140_O_13
140	Oversample	555551.4746	5488406.327	14	555482047	IG_E140_O_14
140	Oversample	552458.7926	5477349.833	15	555480012	IG_E140_O_15
140	Oversample	557351.064	5483012.336	16	555480345	IG_E140_O_16
140	Oversample	554935.8403	5485856.471	17	555480714	IG_E140_O_17
140	Oversample	548471.6886	5486249.16	18	555482018	IG_E140_O_18
140	Oversample	550357.5954	5480656.572	19	555480152	IG_E140_O_19
140	Oversample	553183.4895	5479602.542	20	555480103	IG_E140_O_20
140	Oversample	555802.7405	5486958.717	21	555480864	IG_E140_O_21
140	Oversample	553060.6669	5478160.702	22	555480040	IG_E140_O_22
140	Oversample	551935.9682	5483460.959	23	555480372	IG_E140_O_23
140	Oversample	551165.9299	5482084.677	24	555480241	IG_E140_O_24
140	Oversample	550825.5835	5485867.905	25	555480666	IG_E140_O_25
140	Oversample	559594.0816	5484741.06	26	555480501	IG_E140_O_26
140	Oversample	554357.865	5485585.052	27	555480634	IG_E140_O_27
140	Oversample	550238.5091	5484966.947	28	555480552	IG_E140_O_28
140	Oversample	560846.3853	5490566.117	29	555481506	IG_E140_O_29
140	Visual	557308.5907	5482812.758	1	555480319	IG_E140_V_1
140	Visual	558253.0514	5483120.507	2	555480350	IG_E140_V_2
140	Visual	556375.2864	5487211.251	3	555480962	IG_E140_V_3
140	Visual	554457.0039	5485306.45	4	555480586	IG_E140_V_4
140	Visual	551793.0176	5483359.674	5	555480388	IG_E140_V_5
140	Visual	556929.2076	5483184.036	6	555480364	IG_E140_V_6
140	Visual	553416.5682	5488167.623	7	555481136	IG_E140_V_7
140	Visual	557236.2553	5483012.126	8	555480344	IG_E140_V_8
140	Visual	553975.1269	5483156.191	9	555480363	IG_E140_V_9
140	Visual	558827.9767	5490654.864	10	555481533	IG_E140_V_10
140	Visual	559997.7288	5486612.994	11	555480801	IG_E140_V_11
140	Visual	557990.1182	5484338.912	12	555480452	IG_E140_V_12
140	Visual	551401.5618	5479639.705	13	555480104	IG_E140_V_13
140	Visual	551691.0464	5478240.452	14	555480043	IG_E140_V_14
140	Visual	560476.077	5490761.547	15	555481540	IG_E140_V_15
140	Visual	558915.4022	5486014.125	16	555480707	IG_E140_V_16
140	Visual	559784.9869	5483024.889	17	555480354	IG_E140_V_17
140	Visual	554589.4261	5481786.755	18	555480223	IG_E140_V_18
140	Visual	552773.1267	5480148.082	19	555480127	IG_E140_V_19
140	Visual	558353.2051	5483460.636	20	555480393	IG_E140_V_20
140	Visual	561443.3553	5484342.991	21	555480476	IG_E140_V_21
140	Visual	550729.8898	5485811.74	22	555480680	IG_E140_V_22
140	Visual	552879.4809	5480363.228	23	555480142	IG_E140_V_23
140	Visual	559178.978	5489298.695	24	555481973	IG_E140_V_24
140	Visual	553105.2808	5481054.43	25	555480185	IG_E140_V_25

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
140	Visual	557751.2759	5490453.963	26	555481473	IG_E140_V_26
140	Visual	553580.7098	5477489.479	27	555480015	IG_E140_V_27
140	Visual	555321.244	5481699.533	28	555480212	IG_E140_V_28
141	Full	559676.367	5490694.832	1	555481522	IG_E141_F_1
142	Full	552113.7345	5478457.633	1	555480056	IG_E142_F_1
142	Ground	553871.3598	5478171.086	1	555480045	IG_E142_G_1
142	Ground	555362.9203	5488149.467	2	555481063	IG_E142_G_2
142	Ground	558588.5217	5485789.677	3	555480670	IG_E142_G_3
142	Ground	552095.4969	5485138.582	4	555480562	IG_E142_G_4
142	Ground	559445.9349	5486282.41	5	555480787	IG_E142_G_5
142	Oversample	551108.5511	5488098.178	1	555481035	IG_E142_O_1
142	Oversample	555062.5448	5487728.139	2	555482046	IG_E142_O_2
142	Oversample	559309.2078	5486161.035	3	555480722	IG_E142_O_3
142	Oversample	548586.275	5486580.448	4	555482017	IG_E142_O_4
142	Oversample	553131.9772	5489040.237	5	555481213	IG_E142_O_5
142	Oversample	557762.6652	5485069.015	6	555480569	IG_E142_O_6
142	Oversample	552599.7831	5489793.872	7	555481809	IG_E142_O_7
142	Oversample	551617.8866	5484999.442	8	555480550	IG_E142_O_8
142	Oversample	551719.1294	5484676.472	9	555480520	IG_E142_O_9
142	Oversample	553085.1563	5485299.914	10	555480603	IG_E142_O_10
142	Oversample	553130.3108	5487389.637	11	555482063	IG_E142_O_11
142	Oversample	553319.4372	5487544.009	12	555482064	IG_E142_O_12
142	Oversample	553703.9372	5479132.605	13	555481818	IG_E142_O_13
142	Oversample	551639.8082	5480418.775	14	555480141	IG_E142_O_14
142	Oversample	551908.013	5489147.205	15	555481242	IG_E142_O_15
142	Oversample	550626.4303	5480585.965	16	555482099	IG_E142_O_16
142	Oversample	550874.8226	5489343.316	17	555481325	IG_E142_O_17
142	Oversample	552295.1831	5486235.428	18	555480744	IG_E142_O_18
142	Oversample	551417.1864	5482892.025	19	555482108	IG_E142_O_19
142	Oversample	555490.2799	5485487.617	20	555480616	IG_E142_O_20
142	Oversample	556996.5358	5481514.659	21	555480201	IG_E142_O_21
142	Visual	558116.6353	5490480.367	1	555481981	IG_E142_V_1
142	Visual	558299.8475	5485706.007	2	555480636	IG_E142_V_2
142	Visual	553129.1506	5481576.858	3	555480203	IG_E142_V_3
142	Visual	551548.1402	5486948.236	4	555480844	IG_E142_V_4
142	Visual	554640.8121	5484310.764	5	555480454	IG_E142_V_5
142	Visual	552520.506	5489782.392	6	555481341	IG_E142_V_6
142	Visual	555814.1491	5486866.942	7	555480845	IG_E142_V_7
142	Visual	552367.53	5486240.048	8	555480739	IG_E142_V_8
142	Visual	553471.0814	5479420.528	9	555480099	IG_E142_V_9
142	Visual	558302.5099	5484881.016	10	555480530	IG_E142_V_10
142	Visual	550797.3261	5489765.916	11	555481355	IG_E142_V_11
142	Visual	552896.7705	5491047.596	12	555481607	IG_E142_V_12
142	Visual	559537.7887	5490548.809	13	555481485	IG_E142_V_13
142	Visual	551074.7128	5479330.058	14	555480096	IG_E142_V_14
142	Visual	559689.0121	5484647.545	15	555481898	IG_E142_V_15
142	Visual	553419.7513	5488890.086	16	555481812	IG_E142_V_16
142	Visual	549088.8644	5485953.239	17	555482016	IG_E142_V_17
142	Visual	558293.912	5485641.503	18	555480625	IG_E142_V_18

Ecosite Code	Survey Type	UTM x	UTM y	Order Number	Polygon ID	Station ID
142	Visual	551213.9394	5489105.461	19	555481305	IG_E142_V_19
142	Visual	552536.079	5484564.673	20	555480518	IG_E142_V_20
146	Full	559905.34	5490560.122	1	555481977	IG_E146_F_1
146	Ground	559728.7992	5486820.072	1	555480827	IG_E146_G_1
146	Oversample	559789.2582	5483230.72	1	555480369	IG_E146_O_1
146	Oversample	556645.7156	5483213.097	2	555480353	IG_E146_O_2
146	Oversample	556278.4048	5487083.711	3	555482040	IG_E146_O_3
146	Oversample	559632.2716	5484647.609	4	555481899	IG_E146_O_4
146	Visual	559800.6057	5490171.398	1	555481429	IG_E146_V_1
146	Visual	558287.9178	5485980.393	2	555480730	IG_E146_V_2
146	Visual	559320.2797	5482321.62	3	555480252	IG_E146_V_3
222	Full	555939.7979	5488999.815	1	555481226	IG_E222_F_1

APPENDIX C: MAP OF FIELD SAMPLING LOCATIONS

(see next page – formatted for printing)



NWMO Biodiversity Impact Studies

TEM Fieldwork Locations

Area of Interest (AOI)

Fieldwork Locations
- Full [63]
- Ground [180]
- Visual [729]

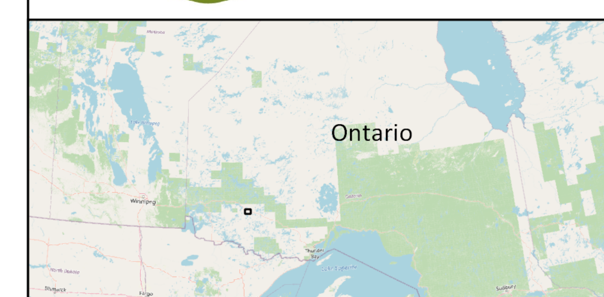
Ecosite Groups
- Marsh
- Fen
- Bog
- Swamp
- Hardwood
- Conifer
- Shrub
- Vertical or Active Mineral
- Water
- Cleared
- Compact Gravelled Surface
- Pavement/Concrete

Roads
- Highway or Arterial Road
- Local Road
- Resource/Recreation Road

1:60,000

0 1 2 km

ZOETICA

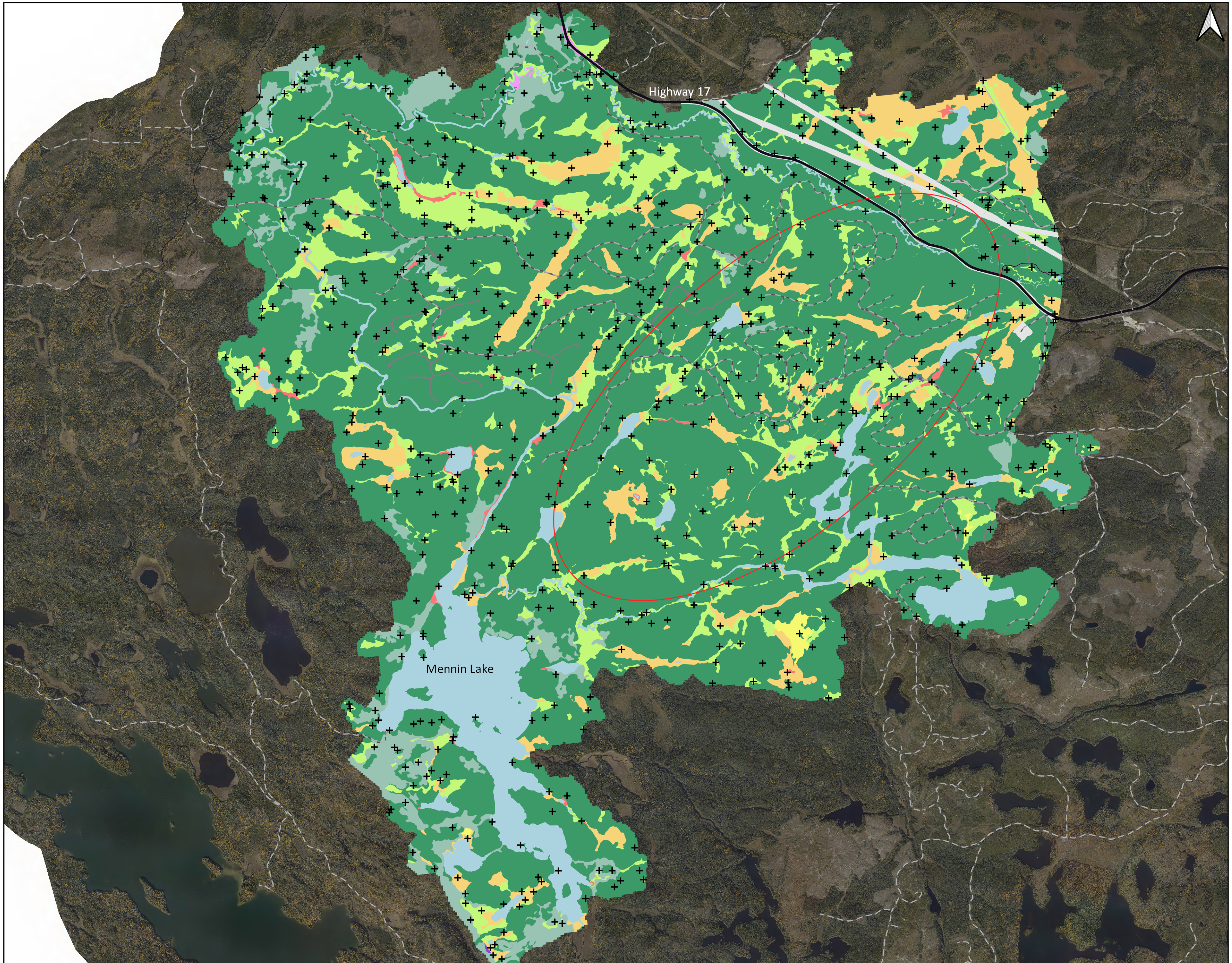


Inset Basemap © OpenStreetMap contributors

Data received from:
Ontario GeoHub — OHN Watercourse (MNRF); MNRF Road Segments (MNRF)
NWMO — AOI; Basemap Imagery

Project CRS: NAD83 / UTM zone 15N

Author: DM	Verified by: CC
April 21, 2021	Map ID: NWMO_BIS_060



NWMO Biodiversity Impact Studies

TEM Oversample Fieldwork Locations

Area of Interest (AOI)

Fieldwork Locations

+ Oversample [755]

Ecosite Groups

- Marsh
- Fen
- Bog
- Swamp
- Hardwood
- Conifer
- Shrub
- Vertical or Active Mineral
- Water
- Cleared
- Compact Gravelled Surface
- Pavement/Concrete

Roads

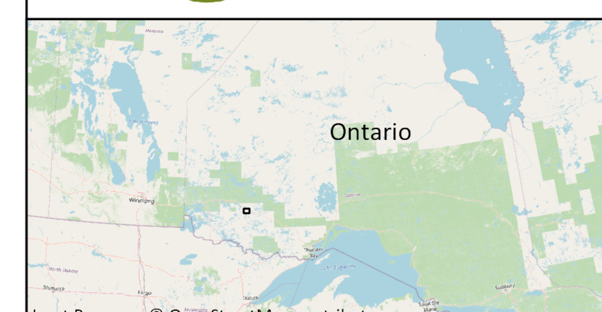
- Highway or Arterial Road
- Local Road
- Resource/Recreation Road

Oversample points are to be used to replace planned points if they are found inaccessible in the field.

1:60,000

0 1 2 km

ZOETICA



Data received from:
Ontario GeoHub — OHN Watercourse (MNRF); MNRF Road Segments (MNRF)
NWMO — AOI; Basemap Imagery

Project CRS: NAD83 / UTM zone 15N	
Author: DM	Verified by: CC
April 21, 2021	Map ID: NWMO_BIS_060

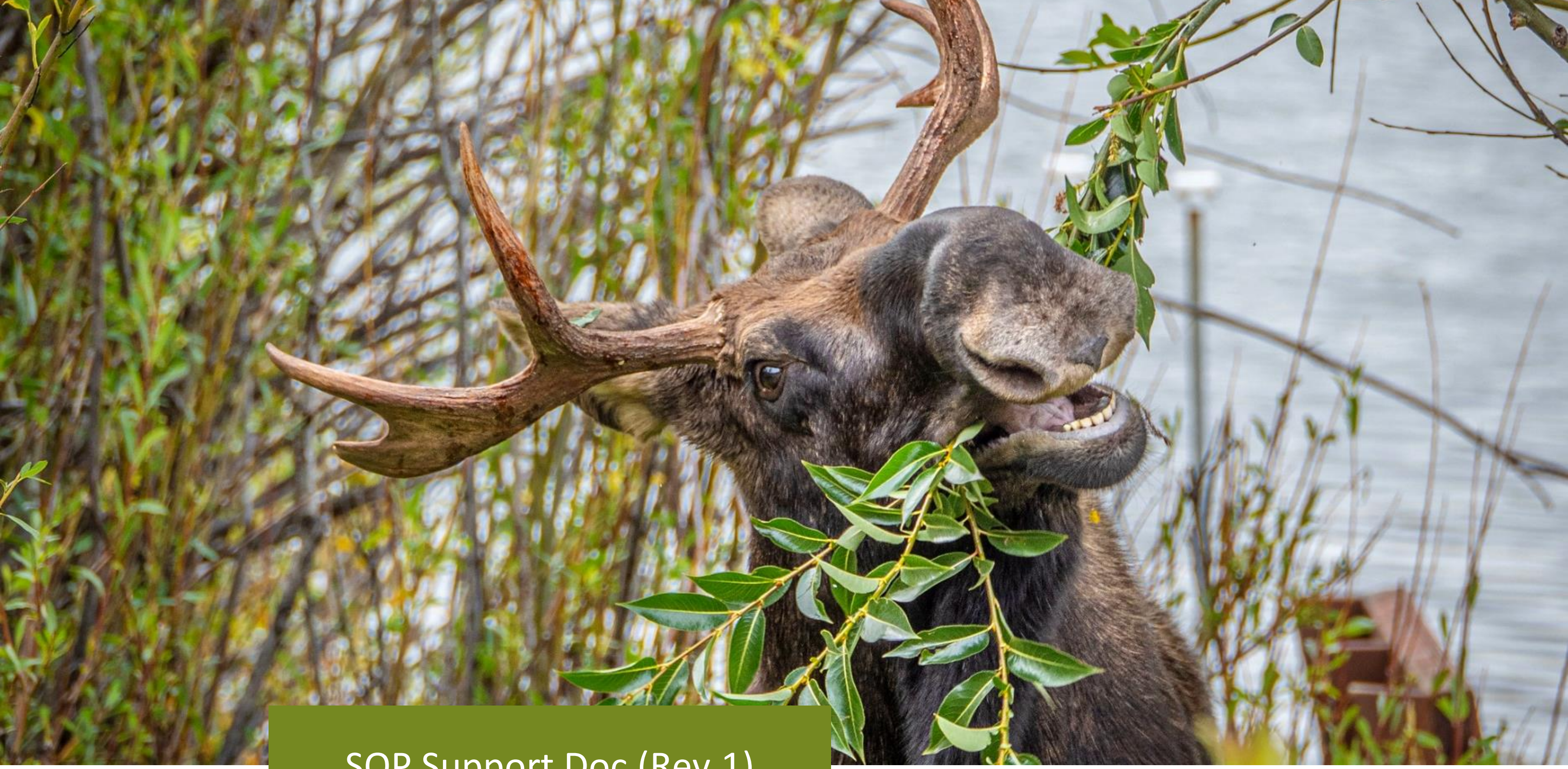
APPENDIX D: LIST OF PLANT SPECIES FOR GROUND PLOTS

Type codes include: A - Aquatic; MR - Moist/Riparian; R-Riparian

Scientific Name	Type	Scientific Name	Type	Scientific Name	Type
Abies balsamea	R	*Equisetum sylvaticum*	R	*Potamogeton epihydrus*	A
Acer negundo	R	*Eurybia macrophylla*		*Potamogeton filiformis*	
Acer rubrum	R	*Fragaria virginiana*	R	*Potamogeton richardsonii*	A
Acer spicatum	R	*Fraxinus nigra*	R	*Potamogeton spp.*	A
Achillea millefolium		*Fraxinus pennsylvanica*	R	*Prunus pensylvanica*	R
Alnus crispa	R	*Galium triflorum*		*Ptilium crista-castrensis*	
Alnus incana	R	*Gaultheria hispidula*		*Quercus rubra*	R
Alnus spp.	R	*Gymnocarpium dryopteris*		*Rhamnus alnifolia*	R
Alnus viridis	R	*Hudsonia tomentosa*		*Rhododendron groenlandicum*	
Amelanchier spp.		*Hylocomium splendens*		*Rhytidialephus triquestrus*	
Amelanchier stolonifera		*Juncus vaseyi*		*Ribes lacustre*	R
Andromeda polifolia	R	*Larix laricina*	R	*Ribes oxyacanthoides*	R
Anemone canadensis		*Linnaea borealis*	R	*Ribes triste*	R
Aralia nudicaulis	R	*Lonicera canadensis*	R	*Rosa acicularis*	R
Arctostaphylus uva-ursi	R	*Lupinus* spp.		*Rubus pubescens*	
Betula alleghaniensis	R	*Lycopodium annotinum*		*Salix bebbiana*	R
Betula papyrifera	R	*Lycopodium obscurum*		*Salix discolor*	R
Betula pumila	R	*Maianthemum canadense*		*Salix pedicellaris*	R
Betula spp.	R	*Maianthemum trifolium*		*Salix* spp.	R
Calamagrostis canadensis	R	*Menyanthes trifoliata*	R	*Sarracenia purpurea*	
Caltha palustris		*Mitella nuda*		*Scorpidium scorpiodes*	
Campylium stellatum		*Mnium* spp.		*Shepherdia canadensis*	R
Carex chordorrhiza	MR	*Muhlenbergia glomerata*		*Solidago* spp.	R
Carex exilis	MR	*Myriophyllum verticillatum*		*Solidago uliginosa*	
Carex lasiocarpa	MR	*Nitella spp.*	A	*Sorbus decora*	
Carex rostrata	MR	*Nitella* spp.		*Sphagnum capillifolium*	
Carex spp.	MR	*Nuphar lutea*	A	*Sphagnum girgensohnii*	
Chamaedaphne calyculata	R	*Nuphar* spp.	A	*Sphagnum magellanicum*	
Chamerion angustifolium	R	*Nuphar variegata*	A	*Streptopus lanceolatus*	
Chara spp.		*Petasites frigidus var. palmatus*		*Thuja occidentalis*	R
Cladina rangiferina		*Petasites frigidus* var. *sagittatus*		*Tilia americana*	
Clintonia borealis		*Picea glauca*	R	*Trientalis borealis*	
Comarum palustre	R	*Picea mariana*	R	*Ulmus americana*	R
Coptis trifolia		*Picea* spp.	R	*Ultricularia vulgaris*	
Cornus canadensis	R	*Pinus banksiana*		*Utricularia cornuta*	A-MR
Cornus sericea	R	*Pinus resinosa*		*Utricularia intermedia*	A-MR
Corylus cornuta	R	*Pinus strobus*	R	*Utricularia macrorhiza*	A-MR
Dicranum fuscescens		*Plagiomnium cuspidatum*		*Utricularia* spp.	A-MR
Dicranum polysetum		*Pleurozium schreberi*		*Vaccinium angustifolium*	
Diervilla lonicera	R	*Populus balsamifera*	R	*Vaccinium macrocarpon*	
Dryopteris carthusiana		*Populus grandidentata*	R	*Vaccinium myrtilloides*	
Dryopteris spinulosa		*Populus* spp.	R	*Vaccinium oxycoccos*	R
Elymus canadensis		*Populus tremuloides*	R	*Viburnum edule*	R
Epilobium spp.		*Potamogeton alpinus*	A	*Viola adunca*	
Equisetum fluviatile	R	*Potamogeton amplifolius*	A	*Viola renifolia*	

APPENDIX E: WILDLIFE HABITAT ASSESSMENT CHEAT SHEETS

(see next page – formatted for printing)



SOP Support Doc (Rev.1)

File Name: FieldTrainingCheatSheets_WHM_2021_IG (R001)

HSM RATING CHEAT SHEETS - NW ONTARIO

July 22, 2021

PREPARED BY Zoetica Environmental Consulting Services

SUBMITTED TO Melissa Mayhew
Nuclear Waste Management Organization
22 St. Clair Avenue East
Fourth Floor, Toronto, ON
M4T 2S3, Canada

ZOETICA
ENVIRONMENTAL CONSULTING SERVICES

OFFICE 102-22351 St Anne Ave, Maple Ridge, BC, V2X 2E7
PHONE 604 467 1111
WEBSITE www.zoeticaenvironmental.com

Revision History

Project Title: NWMO Biodiversity Impact Studies

Document Title: HSM Rating Cheat Sheets - NW Ontario

Document File Name: FieldTrainingCheatSheets_WHM_2021_IG (R000)

Rev. #	Issue Date	Description	Prepared By	Reviewed By	Approved By
R000	07-Jun-2021	Wildlife Habitat Suitability Modelling “cheat sheets” for 2021 field training	H. Bears, A. Hamilton, A. Buckman, C. Chui	H. Bears, C. Chui	H. Bears
R001	22-Jul-2021	Updates to cheat sheet based on Gerry Racey feedback	A.Buckman	H. Bears	H. Bears

Signature Page

Section	Written By	Reviewed By	Senior Reviewed and Approved by
1.0-2.1	H. Bears	C. Chui	A. Buckman
2.2-2.3	A. Hamilton	H. Bears	H. Bears
2.4	A. Buckman	H. Bears	H. Bears
2.5	C. Chui	H. Bears	H. Bears

Signatures:

Heather Bears
Principal, Senior Ecologist (M.Sc., Ph.D., R.P.Bio.)

Andrea Buckman
Senior Ecologist (Ph.D., R.P.Bio.)

Celia Chui
Wildlife Biologist (M.Sc., R.P.Bio.)

Amanda Hamilton
Wildlife Biologist (B.Sc., M.Sc., M.F.)

Table of Contents

List of Figures

List of Tables

1.0 SPECIES, SEASONS, LIFE REQUISITES AND RATING SCHEMES

Five species were selected for habitat suitability modelling for the APM Project study areas in Northwestern Ontario: Moose, Black Bear, Snowshoe Hare, Northern Flying Squirrel, and Eastern Whip-poor-will. Their seasonal life requisites and rating scheme applied to their models are provided in **Table 1-1**. The wildlife habitat rating and habitat suitability rating class schemes are outlined in **Table 1-2**.

Caution and caveat: habitat rating personnel should be experienced rating habitats for these species within Northwestern Ontario and should not exclusively rely on these cheat sheets in making their ratings. Percentages herein are from available studies, which are sometimes limited or have not been done within this particular part of Ontario. They are to provide guidance only and should not be taken as exact cutoff points delineating one rating from another. Evidence of use (e.g., dense trails and scat) and context can also be used in their field to help inform the habitat rating.

Table 1-1. Focal Species and Habitats Rated[1]

Species Rated	Season[2]	Life Requisite[3]	Rating Scheme
Moose (3-Season)[4]	Early Winter (W-E)	LI (FD, SH, TH)	4 class
	Late Winter (W-L)	LI (FD, SH, TH)	
	Growing (G)	LI (FD, SH, TH)	
Black Bear (3-Season)	Spring (P)	LI (FD, ST)	4 class
	Summer (S)	LI (FD, ST)	
	Winter (W)	HI	
Northern Flying Squirrel (1-Season)	All Seasons (A)	LI (FD emphasis for rating)	4 class
Snowshoe Hare (1-Season)	Winter (W)	LI (FD, ST)	4 class
Eastern Whip-poor-will (1-Season)[5]	Growing (G)	RE, LI (FD)	4 class

1. As described in RISC (1999).
2. W-E = Early Winter, W-L = Late Winter, P = Spring, S = Summer, F = Fall; and G = Growing, which generally includes spring, summer, and fall (i.e., not winter).
3. LI = Living. Habitat used for general living activities, which includes other life history requisites such as FD (food), ST (security/thermal), TH (Thermal), SH (Security), CO (courtship), HI (hibernating), MS (migrating), RB (reproducing/birthing), RE (reproducing eggs), or SG (staging).
4. For moose, Significant Wildlife Habitat (SWH) features, required under the *Planning Act* of Ontario, will eventually capture a large portion of important moose aquatic feeding areas (MAFAs) through the course of the BIS program.
5. Season does not need to be entered for evaluation of RE habitat as the timing is implied.

Table 1-2. Wildlife Habitat Rating (WHR) and Suitability Rating (HSR) 4-Class Scheme[1]

Rating Class	**Rating Code**
	4-class Scheme
High	H
Moderate	M
Low	L
Nil	N
1. As described in RISC (1999).	

2.0 SPECIES RATINGS CHEAT SHEETS

2.1 Moose

The field contractor should be familiar with all potential dietary items used by moose in all seasons. However, a list of commonly consumed items (non-exhaustive) is provided below in **Table 2-1** and **Table 2-2**.

Table 2-1. A table of common, preferred browse[1] and forb[2] forage plants eaten by moose. Asterisk indicates species known to be consumed by moose in Northern Ontario (McNichol et al. 1980, Thompson and Vukelich 1981).

Common Name	**Scientific Name**	**Spring/Summer**	**Fall**	**Winter**
Trembling aspen*	*Populus tremuloides*	x	x	x
White birch*	*Betula papyrifera*	x	x	x
Balsam poplar/ Black cottonwood*	*Populus balsamifera*			x
Balsam fir*	*Abies balsamea*		x	x
Willow*	*Salix* spp.	x		
American mountain ash*	*Sorbus americana*	x	x	x
Mountain maple*	*Acer spicatum*	x	x	x
Red-osier dogwood*	*Cornus sericea*	x	x	x
Beaked hazel*	*Corylus cornuta*	x	x	x
Pin cherry*	*Prunus pensylvanica*	x	x	x
Juneberry*	*Amelanchier stolonifera*	x	x	x
Green alder	*Alnus crispa*	x	x	
Forbs[2]				
Lupine	*Lupinus* spp.	x		
Fireweed	*Epilobium* spp.	x		
Horsetail	*Equisetum* spp.	x		
[1]Note: Some browse species can dominate some upland sites in the study area (e.g., green alder) and there is a risk of over-estimating browse value in the absence of other information. Thus, caution should be used in the field to adjust considerations to local conditions and local use of species by moose. [2]Many other forbs have been described as being used by moose, depending on relative abundance. For example, shield fern (*Dryopteris carthusiana*), twisted stalk (*Streptopus lanceolatus*), bunchberry (*Cornus canadensis*), and grasses are used. The field contractor should be knowledgeable about moose dietary items in the area. Note: for species without an asterisk, there is potential for moose to consume these items though no confirmation in the literature was found.				

Table 2-2. Common aquatic plants eaten by moose during the growing season. Asterisk indicates species known to be consumed by moose in Northwestern Ontario (Cobus 1972, Fraser et al. 1984).

Common Name	Scientific Name	Emergent or Submergent
Yellow pond lily*	*Nuphar variegata*	Emergent
Pond lily	*Nuphar* spp.	Emergent
Pond weeds*	*Potamogeton filiformis*	Submergent
	P. amplifolius	Submergent
	P. richardsonii	Submergent
	P. alpinus	Submergent
	P. epihydrus	Submergent
	Potamogeton spp.	Submergent
Macroscopic algae	*Nitella* spp.	Submergent
	Chara spp.	Submergent
Bladderwort*	*Ultricularia vulgaris*	Submergent
Water milfoil*	*Myriophyllum verticillatum*	Submergent
Note: for species without an asterisk, there is potential for moose to consume these items though no confirmation in the literature was found.		

2.1.1 Seasons of Use

Moose require feeding, security, and thermal habitat throughout the year. **Table 2-3** summarizes the life requisites for moose for each month of the year that they will be rated. Three seasons will be rated for moose: Winter (Early and Late Winter), and Growing (Spring, Summer, and Fall).

Table 2-3. Life history requisites for moose for each month of the year that will be rated. Three seasons will be rated for moose: early winter season (when at an energy deficit), late winter season (when snow depth is limiting) and growing season (when in a net positive caloric energy budget)

Life requisites	Month of Use	Season Code
Food (FD), Security (SH), Thermal (TH)	May-September	G (Growing)
Food (FD), Security (SH), Thermal (TH)	October-April	W-E & W-L (Late Winter/Early Winter[1])
1. Late winter does not refer to a precise date range but to conditions wherein snowpack depth is limiting to moose (>70 cm) and influences habitat selection differently than in early winter.		

Habitats specifically used for reproduction appear highly variable in the literature and are therefore not included in the following tables.

2.1.2 General Rating Guidance

- Areas with dense shrubs, including regenerating burns and cutblocks (*ca.* 5-20 years of age), are valuable feeding habitat in the winter and summer seasons.
- High-quality moose feeding habitat often has a minimum of approximately 50% shrub cover, and moderately high value winter feeding areas have less, but appreciable amounts (about >30% shrub cover) with relatively low mature tree density (*ca.* <200 stems/ha) and gentle slopes (e.g., *ca.* <7%).

- In winter, food value ratings may be based primarily on the presence of preferred food items or the accessibility of these food items. It is assumed that, within the BIS study areas, all habitats are accessible to moose in early winter and the growing season, but that some habitats in the lower structural stages and lowlands will be inaccessible or less desirable/selected against due to deep snow during the late winter period. Moose mobility begins to be affected at snow depths of approximately 65 cm (cows and calves) to 70 cm (adult moose), with a critical snow depth of *ca.* 90-100 cm. To avoid deep snow in the late winter, moose often move upland into forests with sufficient cover for snow interception and access to forage within close proximity to this cover.
- Moose spend the dormant winter season in areas of high browse production. However, interspersion of accessible food patches of sufficient quality and quantity with suitable winter cover, particularly in the late winter season, is important as it reduces energy use, minimizes metabolic demands, and maximizes winter survival. Winter browse mainly includes the reachable current year's twig growth (*ca.* <2.8 m) from deciduous trees and shrubs, plus the twigs and needles of balsam fir (*Abies balsamea*) (see **Table 2-1**).
- Thermal/snow interception cover habitats for moose in winter consist of closed-canopy coniferous forests (or largely coniferous dominated), which intercept snow, provide shelter, and minimize radiation of heat to the open sky. In the late winter, particularly in extreme years, mature coniferous-dominated forests may become especially important. Coniferous forests provide good thermal and security cover and will have higher foraging values when snow depths are restrictive. They may also facilitate travel due to reduced snow depths.
- Regenerating burns and cutblocks may possess a lack of suitable thermal and security cover in the winter. However, these features can be used heavily for feeding when adjacent (especially within *ca.* 80-100 m) of suitable security and thermal cover.
- In the winter season, thermal habitat may become more important to moose when temperatures reach below -20°C or go above -5 to 0°C.
- Habitat units with very sparse understory will provide less security cover. Coniferous shrubs will provide better visual screening (e.g., from predators and hunters) than deciduous shrubs in winter (when deciduous trees lose their leaves). Larger trees (with larger diameter at breast height (dbh)) will provide better security than smaller trees, as will more coarse woody debris (CWD) and structural diversity.
- Forests with structural stages 3b, and 5-7 should provide thermal cover with ratings varying based on consideration of the site characteristics, % cover, and dominance of conifer versus deciduous trees and the thermal conditions being buffered against (e.g., sun/temperature, snowfall, extreme cold, lateral wind).
- Wetlands, ponds, and beaver ponds are rated very highly in the growing season, particularly when identified as SWH or candidate SWH (i.e., MAFAs that may be ranked 3 or 4 by MNRF). Cool moist lowland habitats are preferred in summer because they provide opportunities for regulation of body temperature, lush forage and aquatic plants, and refuge from flies. Dense forage is often found around the margins of wetlands and ponds.
- In the growing season, open deciduous and mixedwood forests will likely have moderate to high value. Coniferous forest will generally have lower values due to lower understory shrub and herb development. However, stands with canopy openings can sometimes provide good forage within different vertical forest strata.

- Care is needed to consider the impacts of neighbouring human influences, as moose are negatively impacted by roads, particularly as their densities increase, and anthropogenic developments and activities.

2.1.2.1 Winter

Feeding (FD), thermal (TH), and security (SH) cover are modelled for early winter and late winter moose habitat. They are rated in the field during TEM work at the site level and considering known or visible modifying consideration. The following guidance is provided. Personnel doing ratings should have expertise on moose habitat by season in Ontario.

2.1.2.1.1 Early Winter

Early winter moose habitat generally consists of mature or over-mature forest, open canopy, mixed wood stands with sufficient understory browse species eaten by moose. Structural stage 7 generally rated higher than structural stage 6, as the former is associated with more understory shrubs (Rating of H-M).

Suggested rating tables for early winter security cover, thermal cover, and feeding habitat are included below.

Security (SH):

Description	Suggested Rating
Mature stands of coniferous trees (structural stage 6, 7), particularly those with a high dbh, may protect moose from predators in winter. Understory coniferous shrubs provide superior security cover than deciduous. As structural stage 7 is associated with more understory shrubs, it is generally rated higher than structural stage 6 overall for moose early winter.	H-M
Structural stages 3b and 5 will also provide varying degrees of security habitat, with the presence of any conifer shrubs increasing the value.	M
Structural stages 1 and 2 would have relatively low security or thermal (ST) cover value depending on vertical structure, or recent clearcuts and burns.	L
Barren areas of moss, open water likely to freeze over, compacted gravel.	N

Thermal (TH):

Description	Suggested Rating
Closed or semi-closed canopy coniferous forests, which intercept snow, provide shelter, and minimize radiation of heat to the open sky (structural stage 7, 6). As structural stage 7 is associated with more understory shrubs, it is generally rated higher than structural stage 6 overall for moose early winter. Stands composed of *ca.* >60% coniferous species of sufficient height (*ca.* >10.6 m) provide maximum thermal protection and lower snow depths.	H-M
Young forests (structural stage 5) may provide moderate to high thermal habitat, with rating depending on forage availability, ecosite.	M

Structural stage 3b will provide varying degrees of thermal habitat depending on site characteristics, with conifers generally better (M) than deciduous dominated (L).	M-L
Structural stages 1 and 2 would have relatively low value.	L
Barren areas of moss, low grass, open ice, compacted gravel, recent clearcut or burn with little to no regeneration.	N

Figure 2-1. Examples of moderate- to high-quality moose **early winter** habitat for **security and thermal**: mature coniferous or mixedwood forest with understory of coniferous shrubs/subcanopy. Also considered moderate- to high-quality moose **late winter** habitat for **security**. Photos of "northern mesic mixed forest" (above) and "northern dry-sand pine woodland" (below) from MNDNR (2021). The presence of more mature trees with larger trunks (as in **Figure 2-6**) compared to this photo, along with a similar composition of conifer understory as shown here, would increase the value of the habitat to high-quality.

Food (FD):

Description	Suggested Rating
Structural stage 3 (low and high shrub) with sufficient cover of browse selected by moose would likely provide the most suitable early winter foraging habitat. Moderately high to high value winter feeding areas often have *ca.* >30% shrub cover, relatively low mature tree density (*ca.* <200 stems/ha) and gentle slopes (*ca.* <7%). High quality moose feeding habitat typically has a minimum of 50% shrub cover.	H-M
Vegetation units that support an abundant growth of preferred forage shrub species, especially willows. Cutblocks, shrublands, or burns with sufficient deciduous regrowth (*ca.* 5-20 years old) and sufficient adjacent cover habitat (i.e., within 80-100 m), riparian edges with sufficient browse (e.g., willow) along wetlands, streams, rivers and lakes, and Willow-Alder units will have high feeding value.	H-M
Forested sites with substantial winter forage under the canopy, generally associated with more open-canopied mature (structural stage 7) coniferous dominated forests. This type of habitat could be found within more nutrient-rich regimes (mesic to wet forest) and in some drier forests.	H-M
Mature, closed forests with less winter forage under the canopy, generally associated with structural stage 6 coniferous dominated forests. This type of habitat could be found within more nutrient-rich regimes (mesic to wet forest) and in some drier forests.	M-L
Waterways and gravel bars associated with riparian corridors that support a sparse to moderate distribution of preferred winter forage (e.g., willow).	M-L
Open areas of structural stage 2 (herb and grass stage) vegetation that support small pockets of preferred winter shrub forage.	M-L
Lakes or ponds that would be frozen during winter but capable of providing some sparse amounts of rooted forage around the shores.	L
Areas with relatively low winter forage such as dry herb vegetation, or closed canopy conifer forest with very low amounts of winter shrub forage in the understory (*ca.* <5%).	L
Habitats that virtually lack forage in the form of shrubby vegetation and that are unlikely to be able to produce any (e.g., bedrock covered in moss, previously disturbed site with compaction/gravel, permanent areas of rock, ice) considered of nil value.	N

Figure 2-2. Examples of high-quality moose **early and late winter** habitat for **food**: forested sites with abundant preferred forage shrub species, such as trembling aspen, paper/white birch, balsam fir, beaked hazelnut, and juneberries. Photos of "northern wet-mesic boreal hardwood-conifer forest" (above) and "northern dry-mesic mixed woodland" (below) from MNDNR (2021).

2.1.2.1.2 Late Winter

Late winter habitat typically consists of denser stands of mature conifer with good overhead cover. Mixed stands made up of >50% mature conifer should also be considered as late winter habitat if pure conifer stands are not available. Upland sites are preferred.

Security (SH):

Description	**Suggested Rating**
Mature stands of coniferous trees (structural stage 6, 7), particularly those with a high dbh, may protect moose from predators in winter. Understory coniferous shrubs provide superior security cover than deciduous.	H-M
Structural stages 3b and 5 will also provide varying degrees of security habitat with the presence of any conifer shrubs increasing the value.	M
Structural stages 1 and 2 would have relatively low security or thermal (ST) cover value depending on vertical structure, or recent clearcuts and burns.	L
Barren areas of moss, open ice, compacted gravel.	N

Thermal (TH):

Description	**Suggested Rating**
Dense, mature, upland coniferous dominated forests (e.g., structural stage 6) provides good thermal protection due to the closed canopy. Ideal late winter cover comprises coniferous tree canopy closure *ca.* ≥75% and a minimum stand height >6 m. Dense stands provide maximum protection from low temperatures and wind chill as well as lower snow. The quality of winter cover increases as the proportion of conifers in the stand increases.	H
Mature, upland coniferous dominated forests (e.g., structural stage 6,7) with canopy closure of *ca.* 60-75%, high density stands with tree heights of > 6 m, and/or canopy closure values of 40-60% would receive a moderate rating.	M
Canopy closure values of *ca.* <40%, lower density stands, tree of inadequate minimum height.	L
Structural stages 3b-5, deciduous dominates shrub to forest units.	L
Barren areas of moss, low grass, open ice, compacted gravel, recent clearcuts or burns with little to no regeneration.	N

Figure 2-3. Example of high-quality moose late winter habitat for thermal: mature upland coniferous forest with dense canopy cover. Photo of "northern poor dry-mesic mixed woodland" from MNDNR (2021).

Food (FD):

Description	Suggested Rating
Old, upland forests (structural stage 7) provide the best food availability in winter.	H-M
Late winter foraging habitat could be found in structural stage 3; however, adequate mature forest (structural stage 6 or 7) cover needs to be present nearby (e.g., *ca.* <80-100 m) for forage to be used (suitability of M-L depending on availability of cover).	M-L
Structural stage 1,2 and 4 has minimal late winter value if not interspersed or adjacent to more mature structural stages.	M-L
Areas with closed canopy conifer forest with very low amounts of winter shrub forage in the understory (*ca.* <5%).	L
Habitats that virtually lack forage in the form of shrubby vegetation and that are unlikely to be able to produce any shrubby vegetation or browse (e.g., bedrock covered in moss, previously disturbed site with compaction/gravel, permanent areas of rock, ice) considered of nil value.	N

2.1.2.2 Growing

High quality growing season (spring, summer, fall) habitat includes wetlands and ponds with abundant submergent and emergent aquatic vegetation and lush surrounding vegetation (e.g., willows with leaves). Open deciduous and mixedwood forests are also of moderate-high value for forage. Note that for the growing season the importance of good shade, moist/cool forest floor, and extent of stand conditions that meet this may be provided by dense thickets and not simply conifer cover and structural stage; thus, it is important to consider local conditions and habitat use by moose in interpreting the descriptions below. For example, dense thickets that are also used for growing season habitat, including some spruce swamps should not be overlooked.

Thermal (TH):

Description	**Suggested Rating**
Refugia habitats such as lakes, rivers and ponds, closed-canopy tall shrublands, and closed-canopy forests (*ca.* >66%, stage 5, 6, 7) for use during high temperature days (*ca.* >20-25°C).	H-M
Seclusion sites used for calving, such as islands in waterbodies, peninsulas, shorelands, or poorly drained areas near water; or small and isolated patches of forest secluded from the surrounding terrain.	M
Forests of various ages and compositions classes from structural stages 3 to 5, which provide varying levels of buffering from temperature, but with more open canopies, or smaller, less mature trees/shrubs.	M-L
Structural stages 1 to 2 would have relatively low security or thermal (ST) cover value.	L
Barren areas of moss, low grass, open ice, compacted gravel, etc.	N

Security (SH):

Description	**Suggested Rating**
Seclusion sites used for calving, such as islands in waterbodies, peninsulas, shorelands, or poorly drained areas near water; or small and isolated patches of forest secluded from the surrounding terrain.	H-M
Forests of various ages and compositions that provide varying levels of buffering from temperature and predator impacts, including visual shielding from predators and shading from the sun.	H-L
Structural stages 1 to 2 would have relatively low security or thermal (ST) cover value.	L
Barren areas of moss, low grass, open ice, compacted gravel, etc.	N

Food (FD):

Description	**Suggested Rating**
Wetland habitats identified and ranked according to Ranta (1997) for their potential as MAFAs based on aquatic vegetation, size, and accessibility will have corresponding habitat suitability ratings. MAFAs ranked 3 or 4 by MNRF are considered SWH. • MAFA rank 4 (very high potential) – High • MAFA rank 3 (high potential) – High • MAFA rank 2 (moderate potential) – Moderate	H-N

• MAFA rank 1 (low potential) – Low • MAFA rank 0 (nil potential) – Nil	
Structural stages 2 and 3 provide abundant forage in the form of consumed leaves and will be rated moderately high during the growing season, when adjacent to security habitat. Structural stage 2-3 areas with very high shrub diversity may be rated slightly higher than areas with little shrub variety.	H-M
Areas with rich herbaceous plants eaten by moose (e.g., shield fern (*Dryopteris carthusiana*), twisted stalk (*Streptopus lanceolatus*), bunchberry (*Cornus canadensis*), and grasses). Note that the overall % of herbaceous food ingested is considered small compared with leaves and aquatics.	M
Upland, closed canopy forests with little understory and far from water.	L
Barren rocky areas or that contain little to no forage.	N

Figure 2-4. Examples of potentially high-quality moose **growing season** habitat for **thermal** and **food**: lakes, rivers, and open water wetlands with an abundance of submergent and emergent vegetation (preferred species need to be confirmed). Seclusion sites for calving (**security**) may also occur nearby in isolated forest patches/islands.[1]

2.1.3 Ratings Adjustment Considerations

Adjustments to ratings may incorporate: 1) landscape connectivity; 2) habitats adjacent to significant anthropogenic disturbance regimes (e.g., roads, settlements); 3) interspersion of different ecosystems for meeting life requisites within the landscape; and 4) presence of mineral lick (relevant to FD rating).

[1] Photo credits: "Moose Nest" by Eugene Kim, CC BY 2.0, https://flickr.com/photos/eekim/ (above), and "Boundary Waters-BWCA – Ely Minnesota – Moose River – Echo Trail" by Andy Witchger, CC BY 2.0, https://flickr.com/photos/42878734@N06/ (below).

2.2 Black Bear

The field contractor should be familiar with all potential dietary items used by black bear in all seasons. However, a list of commonly consumed items (non-exhaustive) is provided below in **Table 2-4**.

Table 2-4. A table of common, preferred berries, fruit, flowers, leaves, and nuts eaten by black bears[1]. Asterisk indicates species that have been documented to be consumed by black bear in Ontario (OMNR 2009).

Species	Latin name	Spring	Growing (Summer and Fall)
Fruits and Berries			
Dogwood*	*Cornus* spp.	X	X
Cranberry	*Vaccinium* spp.	X	X
Blueberries*		X	X
Strawberries*	*Fragaria* spp.	X	X
Raspberries*	*Rubus* spp.	X	X
Currants*	*Ribes* spp.	X	X
Choke cherry*	*Prunus virginiana*	X	X
Pin cherry*	*Prunus pensylvanica*	X	X
Wild sarsaparilla*	*Aralia nudicaulis*	X	X
Bristly sarsaparilla*	*Aralia hispida*	X	X
Flowers			
Dandelions*	*Taraxacum* spp.	X	X
Clover*	*Trifolium* spp.	X	X
Willow catkins*	*Salix* spp.	X	X
Roses	*Rosa* spp.	X	X
Lupine	*Lupinus* spp.	X	X
Fireweed	*Epilobium angustifolium*	X	X
Cow parsnip	*Heracleum maximum*	X	X
Angelica	*Angelica atropurpurea*	X	X
Grasses and Leaves			
Aspen*	*Populus* spp.	X	X
Grasses*	*Poaceae* spp.	X	X
Sedges	*Carex* spp.	X	X
Horsetail	*Equisetum* spp.	X	X
Skunk cabbage	*Symplocarpus foetidus*	X	X
Lady fern	*Athyrium filix-femina*	X	X
Nuts and Acorns			
Mountain ash acorns*	*Sorbus americana*		X
Beech nuts*	*Fagus* spp.		X
Hazel nuts*	*Corylus* spp.		X
Oak acorns*	*Quercus spp.*		X

Notes: [1] Berries, fruit, flowers, leaves, and nuts make up most of the diet of black bears, however they are omnivorous and therefore also feed on alternative protein-rich foods in the summer and fall before hibernation. Protein-rich foods include ant colonies, nests of bumblebees and wasps, fish, and ungulate species, such as moose and white-tailed deer. Note: for species without an asterisk, there is potential for moose to consume these items though no confirmation in the literature was found.

2.2.1 Seasons of Use

Black bears require feeding, security, and thermal habitat throughout the year. **Table 2-5** summarizes the life requisites for black bears for each season of the year. Three seasons will be rated for bears: hibernation (winter), spring, and growing (summer and fall). Security and thermal habitat remain constant throughout the year, therefore, only one table will describe the habitat quality for all seasons. As for hibernation, which occurs during the winter months, a separate life requisite table will describe and rate hibernation habitat. As for food, forage remains the same in summer and fall; however, it differs in the spring. Therefore, feeding habitat will be divided into spring and summer[2]. All life requisite habitats will be rated with a 4-class scheme (see **Table 1-1**).

Table 2-5. Life history requisites for black bears for each month of the year that will be rated. Three main seasons will be rated: hibernation (winter), spring, and summer.

Life Requisites	Month	Season
Hibernation	November-March	Winter
Food (FD), Security (SH), Thermal (TH)	April-May	Spring
Food (FD), Security (SH), Thermal (TH)	June-October	Summer and Fall

2.2.2 General Rating Guidance

- Since security and thermal habitat are relatively similar to one another, and remain consistent all year-round, they have been combined into one habitat rating table for all seasons.
- Old-growth forests having large trees with a dbh of >60 cm provide high quality habitat for both security and thermal cover, as well as hibernation.
- Black bears use similar forage habitat during summer and fall; therefore, both seasons were classified as growing season, and considered together for food security habitat.
- Riparian areas are important for feeding year-round.
- Open areas, wetlands, and meadows provide the best vegetation for bears, and therefore rate higher in the food tables.
- Important vegetation includes dogwood (*Cornus* spp.), *Vaccinium* spp. (e.g., cranberry, blueberry, currants), choke cherry (*Prunus virginiana*), pin cherry (*Prunus pensylvanica*), sarsaparilla (*Aralia* spp.), dandelions (*Taraxacum* spp.), clover (*Trifolium* spp.), roses (*Rosa* spp.), willow catkins (*Salix* spp.), lupine (*Lupinus* spp.), horsetail (*Equisetum* spp.), aspen leaves (*Populus* spp.), skunk cabbage (*Symplocarpus foetidus*), lady fern (*Athyrium filix-femina*), fireweed (*Epilobium angustifolium*), cow parsnip *(Heracleum maximum*), and angelica (*Angelica atropurpurea)*, and grasses, sedges, and rushes (see **Table 2-4**).
- Structural stage 4 forests rate lower for all seasons for food habitat, as these areas are more difficult to forage in, and understory can be shaded out.
- Hibernation (Winter):
    - Forests of structural stage 1-5 rate low or nil assuming no old-growth stumps remain. Should old-growth stumps be present, the habitat may rate higher, as they could provide denning structures for bears.

[2] Black bear habitat differs slightly from summer in the fall, whereas they move towards plants that are more resilient to the change in season and late-season berries. Fall will not be considered for habitat ratings, as the difference from the summer food habitat is not significant enough.

  - Denning materials are important for insulation and should be considered; however, the materials can be site-specific and therefore difficult to rate.[3]
  - It remains unknown whether human disturbances impact den selection or hibernation, and future research must be done to quantify variables of the urban environment that influences bear use.
- This rating does not consider other factors such as disease, competition, and hunting by humans.

2.2.2.1 All Seasons

Security and thermal habitat remain constant for all seasons. Using the knowledge on security/thermal habitat preference, a 4-class rating scheme was used.

Security/Thermal (ST):

Description	**Suggested Rating**
Old-growth or mature forest with dense canopy cover and rock overhangs for shelter from cold precipitations, as well as shade relief from hot weather. Areas close to open water such as ponds, lakes, rivers, etc., or cool sandy areas, which can be used as heat and insect relief. Large trees with a dbh of >60 cm, which bears, more importantly cubs, can use as escape trees by climbing them. Dense shrubs, thick understory, and forest cover also provide security during all season. Structural stages 6-7.	H
Structural stage 4-5, which provides moderate security and thermal cover.	M
Structural stage 2-3, which provides lower security and thermal cover.	L
Urban and developed areas with human settlements. Open areas with no large trees to use for shade relief during hotter months, for cover from cold precipitation, or for protection from humans and other threats. Structural stage 1.	N

2.2.2.2 Hibernation (Winter)

Black bears hibernate between October and May. They select underground dens on the forest floor, typically under the roots of larger trees. The most used den sites include live and dead tree cavities, ground level tree dens, ground nest dens, excavations, human made structures, and rock cavities. Other types of denning sites include rock caves and crevices, fallen logs, or underground excavations. To survive the harsh winter months, dens must be enclosed to avoid snow and rain, as wet conditions make it difficult to retain body heat and conserve energy. Using the knowledge on hibernation habitat preference, a 4-class rating scheme was used. The tables and ratings below provide a guide for rating bear hibernating habitat from literature reviews; however, care should be taken to consider local conditions that may provide the necessary conditions required for bear hibernation. For example, although good hibernation sites may be a scarce resource within the study area, consideration of other possible alternatives (e.g.,

[3] An example of adequate denning materials includes the east-central Ontario study by Kolenosky & Strathearn (1987) where they found 87% of bears line the chambers and close the den entrances with raked leaves, grass, moss, ferns, and rotted wood, making areas with these types of vegetation valuable for winter as they provide insulation and warmth.

upturned stumps, fallen treetops, or logging slash piles) which are known to be used in Ontario should not be overlooked.

Hibernating (HI):

Description	**Suggested Rating**
Old-growth forest with deep-fine-textured soils, dry-moisture-shedding sites, higher elevation, steep slope site between 20° and 30°, coarse woody debris, and large diameter trees (>25 cm in diameter). Thick understory vegetation with a simple depression in leaf litter but can become deeper with use. Preferred tree species often used for denning include white pine (*Pinus strobus*), white spruce (*Picea glauca*), or white cedars (*Thuja occidentalis*). Structural stage 7.	H
Mature forests with medium-textured soils rate moderately, as stage 6 forests provide high value denning habitat; however, rates lower than old growth forests.	M
Second-growth forests moderately suitable if remnants of old-growth forest components, such as stumps, are present.	M
Young forests rate low, as smaller trees are unideal for denning. Structural stage 5.	L
Open, barren areas with no large trees or vegetation available to use for denning or shelter from winter rain and snow. Lowlands dominated by tree species that require soils with moderate to poor drainage such as black spruce (*Picea mariana*), and larch (*Larix laricina*). Other poorly drained areas unideal for denning include swamps and marshes. Structural stages 1-4.	N

Figure 2-5. Examples of high-quality black bear **hibernating** habitat: mature forested sites on upland slopes with preferred denning species such as white pine, white spruce, or white cedar. Photos of "northern mesic hardwood (cedar) forest" (above) and "northern mesic mixed forest" (below) from MNDNR (2021).

2.2.2.3 Spring

Following hibernation, the most important diet requirement for black bears includes high-energy vegetation, such as berries, flowers, grasses, and sedges. Frequented areas in the spring include green-up areas where new vegetation begins to grow. Using the knowledge on food habitat in spring, a 4-class rating scheme was used.

Food (FD):

Description	**Suggested Rating**
Early successional stage or berry-producing shrub communities where important calorically appropriate vegetation is most abundant. Important berries include various currants, dogwoods, strawberries, raspberries, pin and chokecherries, blueberries, and wild and bristly sarsaparilla. Structural stage 2-3.	H
Wetlands with succulent and calorically appropriate vegetation. Other preferred areas include wet meadows, riparian areas, ridgetops, and skunk cabbage swamps. Structural stage 2.	H
Logging roads, clear cuts, burns, and avalanche chutes also important during the spring, due to early vegetation growth or green up. Important vegetation in these areas include rushes, sedges, grasses, horsetails, and forbs such as lady fern, fireweed, skunk cabbage, cow parsnip, and angelica. Structural stage 2.	H
Thicker forest areas are more difficult to forage in; however, food availability in understory increases as the stand grows and opens up. Structural stage 6-7.	M
Grasslands with limited forage, and limited succulent new growth rate higher than low quality habitat should areas used to dig for ants, wasps, and grubs be present. Structural stage 2 has a moderate quality rating, rather than a high, should grasslands lack important vegetation and forage. As mentioned above, the exception would be rare structural stage 2 habitats with an abundance of preferred black bear forage, which could be rated higher.	M
Structural stage 4-5, as understory important for foraging can be shaded out and therefore not as abundant in these areas. Rates lower than structural stage 6-7, as less understory vegetation is available in these younger but shaded forests.	L
Urban and developed, or barren rocky areas with no soil development or vegetation to feed on. Xeric sites less preferred. Structural stage 1.	N

2.2.2.4 Summer

In summer, bears primarily feed on protein-rich ant colonies, and nests of bumblebees and wasps, which they excavate. Insects make up half of the diet in late spring and early summer, as fruits and berries become less abundant during this time. Bears also feed on fish along spawning rivers and streams. Near the end of summer, bears prefer to feed on high-energy foods found in the deciduous forests, such as hazelnuts, mountain ash acorns and beechnuts, which prepare them for winter denning. Using the knowledge on food habitat in summer, a 4-class rating scheme was used.

Food (FD):

Description	**Suggested Rating**
Clear-cuts or fires with 5-15 years of regeneration, which typically include areas with high fruit production, and 15-30% total shrub cover. Rocky areas also important, as bears will feed on insects and larvae by turning over boulders. Structural stage 2-3 with abundant forage, as these shrub/herb communities have higher fruit production in the growing season.	H
Areas close to aquatic habitats, such as rivers and streams, with spawning fish, also rate high, as fish are a high energy food for bears to feed on before hibernation. Areas with berry-producing areas close to streams.	H
Old-growth and mid-seral forests provide green leaf vegetation and wild berries for food in the summer and fall. Important vegetation in these forests include hazelnuts (*Corylus americana*), mountain ash acorns (*Sorbus americana*), and beechnuts (*Fagus grandifolia*). Structural stage 6-7.	M
Structural stage 4-5, as understory important for foraging can be shaded out and therefore not as abundant in these areas. Rates lower than structural stage 6-7, as less understory vegetation is available in these younger but shaded forests.	L
Urban and developed, or barren rocky areas with no soil development or vegetation to feed on. Xeric sites less preferred. Structural stage 1.	N

2.2.3 Ratings Adjustment Considerations

Adjustments to habitat ratings for black bear may incorporate: 1) landscape connectivity and availability of movement corridors, such as game trails, human trails, open edges, shorelines, ridges, creek beds, avalanche chutes, logging roads, sandbars, or rivers, which bears use to travel between habitats; 2) distance between spring and growing food habitat, as bears prefer them near to one another, or at least be easily accessible with adequate connectivity between the foraging patches; 3) overall aspect of area, as bears prefer warm southerly slopes at lower elevations where green-ups may occur in spring, but begin to move to the northerly and easterly slopes at higher elevations as the growing season progresses; 4) abundance of fish in streams, which bears will feed on, for growing season food habitat; 5) proximity to agriculture, as black bears can cover large ranges and move towards these areas to feed on livestock and crops with grains and orchards; 6) proximity to urbanization, as the scent of humans, waste, and garbage may attract bears to these areas; and 7) occurrence of registered or unregistered hunting in the area, which pose a threat to black bear.

2.3 Northern Flying Squirrel

2.3.1 Seasons of Use

The northern flying squirrel forages in the same habitat type for the same type of food all year-round. Therefore, with an emphasis on food (FD), habitat ratings for the northern flying squirrel consider all life history requisites (Living, LI) during all seasons. Other life requisites for habitat suitability ratings will include security (SH), and thermal cover (TH); however, many characteristics of the highest quality habitat correlate with all life history requisites (i.e., a high understory gives security from predators, but also provides an important food source and thermal cover).

2.3.2 General Rating Guidance

- Old-growth and mature stands of conifer and mixed-conifer are the most valuable habitats for all life requisites during all seasons.
- Important habitat characteristics for Living requisites include:
  - Abundant standing and downed snags,
  - Live and dead trees with cavities used to rest or sleep during the day,
  - High understory sapling density,
  - Dense canopy with few gaps,
  - Multi-layered canopies, and
  - Coarse woody debris.
- Areas near surface waters such as swamps or streams, and mature coniferous forests adjacent to a permanent water source can also be considered high quality habitat. Water sources create shallow soils that facilitate the growth of important tree species such as firs which provide hypogeous fungi in their root systems.
- Areas also considered high quality include those with high availability of hypogeous (truffles) and epigeous (mushrooms) fungi, which are part of their diet requirements year-round.
- Areas with arboreal lichens also important, as they supply alternative food sources during winter when foraging for fungi may be restricted due to snow.
- Additional important vegetation and tree species include:
  - Northern hardwood patches used for denning during the day,
  - Spruce or mixed-spruced-northern hardwood patches used for foraging during the night,
  - Yellow birch (*Betula alleghaniensis*) are the most often selected tree species for dens, and
  - Balsam fir (*Abies balsamea*) also critical tree species for denning and food.
- Moderate quality habitat includes deciduous-dominated stands, secondary hardwood forests, and riparian woods.
- Eastern white cedar (*Thuja occidentalis*) in moderate-quality secondary hardwood forests provide optimal resources for nesting material, such as shredded bark, as they provide nest-protection and thermoregulation.
- Disturbed areas due to anthropogenic causes such as logging or prescribed fires, and climate change such as drought, fire, and pine beetle, are low quality habitats for squirrels, having both short-term and long-term consequences.
- Partially harvested areas also have low quality suitability as important biological features used for food, travel, nesting, and shelter, such as the number of snags, decaying trees, and overall understory, is typically reduced.

- Squirrels will use open areas when old-growth forests become unavailable; however, these areas are low quality and not ideal.

Living (FD, SH, and TH):

Description	**Suggested Rating**
Mature stands of conifer and mixed-conifer forests. Abundant amount of standing and downed snags with cavities and woody debris. High understory sapling density and dense, multi-layered canopy cover with few gaps. High availability of hypogeous (truffles) and epigeous (mushrooms) fungi, and arboreal lichens as alternative food sources during winter. Important tree species include northern hardwoods, yellow birch, and balsam fir. Near surface waters such as swamps or streams, specifically spruce swamps with large diameter trees having epiphytes such as witch's broom which they can use for denning, as well as mature coniferous forests adjacent to a permanent water source. Both live and dead trees with cavities are important for denning. Structural stage 6-7.	H
Deciduous-dominated, riparian, or secondary hardwood forests. Moderate amount of standing and downed snags with cavities. Moderate understory density and canopy cover. In secondary hardwood forests, eastern white cedar provides optimal shredded bark used for nesting material. Structural stage 4-5.	M
Disturbed areas due to logging, prescribed fire, wildfire, drought, and/or pine beetles. Areas where trees, snags, and understory have been partially removed. Areas with smaller patches and low landscape connectivity. Low amount of standing and downed snags with cavities. Low understory density and canopy cover. In secondary hardwood forests, tree platforms such as large limbs, epicormic branching, irregular forking, and witch's broom may all be used as external or subterranean dens. Structural stage 2-3.	L
Clear-cuts, meadows, or other developed/disturbed areas where trees, snags, and understory have been completely removed. No standing or downed snags, understory density, or canopy cover. Structural stage 1.	N

Figure 2-6. Example of high-quality northern flying squirrel **living** habitat: mature coniferous or mixedwood forest with dense canopy of preferred denning species, such as yellow birch and other northern hardwoods, dense subcanopy and shrub layers, and abundant coarse woody debris. Photo of “northern mesic hardwood (cedar) forest” from MNDNR (2021).

Figure 2-7. Another example of high-quality northern flying squirrel **living** habitat: spruce swamp with dense canopy of preferred denning structures, such as large-diameter trees with witch’s broom, dense subcanopy and shrub layers, and abundant coarse woody debris. Photo of “northern rich spruce swamp” from MNDNR (2021).

Figure 2-8. Another example of high-quality northern flying squirrel living habitat: northern wet-mesic forest with dense canopy of preferred denning species, such as yellow birch and northern hardwoods, dense subcanopy and shrub layers, thick understory rich in lichens, and abundant coarse woody debris. Photo of "northern wet-mesic hardwood forest" from MNDNR (2021).

2.3.3 Ratings Adjustment Considerations

Adjustments to habitat ratings for northern flying squirrel may incorporate: 1) landscape connectivity, as small patches and low connectivity may lead to thermoregulatory pressures during winter, and increased difficulty with recolonization between patches following local extinction events, 2) abundance of mustelids and other squirrels, which could increase competition for cavity dens, and 3) areas of recent deforestation and habitat loss which squirrels can be sensitive to, having both short-term and long-term consequences on the species.

Snowshoe Hare

Snowshoe hare consume a range of foods, within a vertical band consisting of 1 to 1.5 m, dependent on availability. During the summer months snowshoe hare forage on forbs, grasses and leaves. In the winter snowshoe hare switch to a diet consisting of buds, small twigs, needles, and bark of a variety of woody shrubs and trees. The field contractor should be familiar with all potential dietary items used by snowshoe
2.4 hare in all seasons. However, a list of commonly consumed items (non-exhaustive) is provided below in **Table 2-6** and **Table 2-7**.

Table 2-6 . Common, preferred browse[1] and forb[2] forage plants eaten by snowshoe hare. Asterisk indicates species known to be consumed by snowshoe hare in Ontario

Species	Latin Name	Study Area	Source
Trembling aspen	*Populus tremuloides*		
White birch	*Betula papyrifera*	• Elliot Lake, ON	• Clulow et al. 1997
Balsam fir	*Abies balsamea*		
Willow	*Salix* spp.	• Elliot Lake, ON, • Sorrel Lake, ON	• Clulow et al. 1997 • Morris 2005
Service berry	*Amelanchier* spp.		
Prickly rose	*Rosa acicularis*		
Red raspberry	*Rubus idaeus*	• Sorrel Lake, ON	• Morris 2005
Wild lowbush blueberry	*Vaccinium angustifolium*		
Common blueberry	*Vaccinium myrtilloides*		
Northern bush honeysuckle	*Diervilla lonicera*		

Table 2-7. Additional commonly preferred coniferous and deciduous species eaten by snowshoe hare outside of Ontario that also grow in the province

Species	Latin Name	Study Area	Source
Coniferous species			
Jack pine	*Pinus banksiana*	• Northern New Brunswick	• Parker 1986
Red pine	*Pinus resinosa*	• Northern New Brunswick	• Parker 1986
Black Spruce	*Picea mariana*	• Northern New Brunswick	• Parker 1986
Tamarack	*Larix laricina*	• West-central Alberta	• Hoover et al. 1999
White cedar	*Thuja occidentalis*	• In captivity	• Walski and Mautz 1977
Deciduous species			
Alder	*Alnus* spp.		
Dogwood	*Cornus* spp.		
Elderberry	*Sambucus* spp.	• Northern New Brunswick	• Parker 1986
Sugar maple	*Acer saccharum*		
American Beech	*Fagus grandifolia*		
Hazelnut	*Corylus* spp.		

2.4.1 Seasons of Use

Snowshoe hare require security/thermal (ST) and food habitat throughout the year. Habitats for winter are limiting for snowshoe hare and it is assumed that herbaceous forage during the summer is available nearby winter habitat. Thus, only winter season will be rated for snowshoe hare and food requirements of growing season can be used to adjust ratings.

2.4.2 General Rating Guidance

2.4.2.1 Winter

- Understory cover is considered the most important factor for snowshoe hare winter habitat
  - Provides security/thermal cover and food
  - Winter habitat for snowshoe hare is highly correlated to seral stage of forests
  - Conifer shrubs are considered the best for cover as they provide superior security and thermal cover relative to deciduous shrubs, and are a winter food source
- Supply of winter browse can limit snowshoe hare winter habitat
  - Winter browse consists of available twigs, buds, needles, and woody debris (e.g., bark)
    - Within 50 cm above the snowline (< 1.5 m in height from bare ground)
    - Preferred species include willow, aspen, birch, rose, and white spruce.
    - Preference for small twigs (less than 3 mm in diameter) but can ingest twigs up to 1.5 cm in diameter.

The following tables provide guidance for rating snowshoe hare winter habitat. However, it is noted that while conifer may be required to provide the highest level of thermal protection, consideration should be given to local conditions, and habitat use by snowshoe hare. For example, an experienced biologist with over 40 years of field experience in wildlife and forest ecology with extensive experience in Northwestern Ontario, noted that some of the densest signs of winter use (observations) can occur in alder thickets which provide very high-quality security cover but less optimal thermal habitat (Gary Racey, Pers. Obs, July 19, 2021).

Security/Thermal (ST):

Description	**Suggested Rating**
Young forest and lower structural stages (3b-5) will provide security habitat and a varying degree of thermal habitat with rating depending on forage availability and ecological context. Structural stage 4 with dense understory and taller trees (but under 40 feet and with canopy closures less than 60%) may provide the best cover for both security and thermal. Understories with >60% visual obstruction. Conifer stands rated higher than deciduous stands (deciduous stands without conifer may be downgraded to moderate).	H
Structural stage 7 is associated with both understory shrub growth and canopy layers and can provide both thermal and security cover; thus, is considered adequate (moderate) habitat.	M
Mature forest and old forest, with patchy shrub and herb understories (structural stages 6, 7) are rated low. Understories with <40% visual obstruction.	L

Sparse or barren areas of moss, low grass, open ice, compacted gravel, etc., are considered nil habitat for snowshoe hare. Herb (structural stage 2 or less) would have minimal security and thermal cover value.	N

Figure 2-9. Examples of high-quality snowshoe hare **security and thermal** habitat: forested habitats with dense coniferous understory. Photos of "northern mesic mixed forest" (above) and "northern dry-sand pine woodland" (below) from MNDNR (2021).

Food (FD):

Description	**Suggested Rating**
Browse ≤ 3 mm diameter. Preferable species present: willow, aspen, birch, rose, and white spruce (needles) and shrub and young tree heights of 0 to 1.5 m. Vegetation types that support an abundant growth of preferred forage shrub species, especially willows, will be rated highly due to the value of foliage the growing season and the growth of twigs in the winter. Cutblocks, shrublands, or burns with deciduous regrowth, and willow units will have high feeding value for snowshoe hare.	H
Thick shrubby vegetated sites with woody browse >3 mm but less than 1 cm diameter typically associated with can provide moderate forage habitat. Preferred vegetation: dense spruce thickets, willow, aspen, birch, rose.	M
Sparsely vegetated understory sites with woody browse of all diameters under 1.5 cm (i.e., diameters within edible range and low abundance). Woody browse 1–1.5 cm diameter considered in the low range for snowshoe hare forage value and typically occur when the more desirable diameters are over-browsed by snowshoe hare or other species (deer, moose).	L
Sparse or barren areas of moss, low grass, open ice, compacted gravel, etc., are considered nil feeding habitat for snowshoe hare, as are areas of understory with no woody browse (twigs) <1.5 cm in diameter.	N

2.4.3 Ratings Adjustment Considerations

Adjustments to ratings may incorporate: 1) landscape connectivity (especially for base cover); 2) habitats adjacent to significant anthropogenic disturbance regimes (e.g., roads, settlements); 3) interspersion of different ecosystems for meeting life requisites within the landscape including suitable summer foraging habitat which can be provided by edge habitat; and habitat created in mature woodlots with sparse understory cover if alternative cover and forage habitat is present (e.g., brush piles and cuttings from beaver foraging activities).

2.5 Eastern Whip-poor-will

2.5.1 Seasons of Use

As noted in **Table 1-1**, habitat ratings for eastern whip-poor-will are presented for the Reproducing – eggs (RE) and Food (FD) life requisites for the Growing (G) season. As this migratory bird species is a breeding visitor in Ontario, habitat ratings are intended for the spring/summer breeding season. For the Dryden, Kenora, and Quetico ecodistricts in northwestern Ontario, eastern whip-poor-will are expected to be nesting between mid-May through the end of July.

2.5.2 General Rating Guidance

- Eastern whip-poor-will is listed as threatened under both the Ontario *Endangered Species Act* and the federal *Species at Risk Act*. Provincial and federal recovery strategies have been developed for this species, which include a description of the biophysical attributes of suitable habitats. These characteristics form the basis of the high- and moderate-quality habitat ratings described below.

- Furthermore, the MNRF has developed a General Habitat Description (GHD) for the eastern whip-poor-will, a technical, science-based description of the area of habitat protected for the species. The GHD includes three habitat categories, centred around a nest or approximated defended territory, that the eastern whip-poor-will depends on for nesting, rearing young, feeding, and resting.
- Nesting and foraging habitat descriptions for eastern whip-poor-will, as described in the GHD, *Significant Wildlife Habitat Technical Guide*, the Cornell Lab of Ornithology's *Birds of the World* research database, and reference therein, have also been incorporated into the high-quality habitat ratings.
- Low-quality habitat ratings are derived from habitat types that may not meet the species' life history requirements or lack important habitat features and tend to be avoided. For example, habitats deep within a dense forest (>200 m from the edge) may be suitable for nesting but they are too far from good (open) foraging habitat; an extensive closed canopy decreases the amount of moonlight that can penetrate and thus reduces nocturnal foraging success.
- Other information about low-quality habitat was gathered from studies that suggested a potential minimum forest patch size in northwestern Ontario and the need for abundant aerial insect prey(English et al. 2017); and inferred from human disturbance that could increase mortality or reduce reproductive success.
- Nesting and foraging habitats of the eastern whip-poor-will are usually defined by vegetation structure rather than forest composition; as such, there are no preferred tree, shrub, or herbaceous species listed for the habitat ratings.
- From the species' recovery strategies, the *regional context* of eastern whip-poor-will suitable habitat is a mosaic formed by forests (e.g., deciduous, mixedwood, coniferous, treed wetlands) and open habitats (e.g., shrublands, fallow fields, regeneration following fires or clearcuts, rock and sand outcrops, shrubby wetlands).
- Therefore, the field data collection contractor should be cognizant of the habitat within 1,250 m of the surveyed plot – the maximum movement observed in eastern whip-poor-will during the breeding season. In the field, the area context should be noted by looking at the georeferenced field map with ecosite information, observing the landscape during helicopter transport and drop-off, and noting habitat characteristics on the ground while travelling to the survey location.
- After field-based wildlife habitat rating data are collected, Zoetica will conduct desk-based ratings adjustments afterward to develop and refine the habitat suitability model for eastern whip-poor-will for the BIS study areas.

Figure 2-10. Example of high-quality eastern whip-poor-will nesting and foraging habitat: dry-mesic mixed woodland with moderate tree cover, moderate shrub cover, and well-drained sandy or loamy soils. Photo of “northern dry-mesic mixed woodland” from MNDNR (2021).

Reproducing (RE):

Description	**Suggested Rating**
Habitats suitable for both nesting and foraging: Forests with sparse (<25%) to moderate (25-75%) tree cover or open habitats **AND** sparse to moderate shrub and herbaceous cover **AND** well-drained soils (e.g., sand, sandy-loam). Includes all corresponding areas of 3 ha or more.	H
Habitats suitable for nesting only (must be adjacent to foraging habitats): Forests with a dense (>75%) tree cover **AND** sparse to moderate shrub and herbaceous cover **AND** well-drained soils (e.g., sand, sandy-loam). Includes all corresponding areas up to 30 m on the interior side of the forest edge.	H
Forest habitats: dry deciduous and mixed woodlands of small to medium trees with lots of clearings and shaded leaf-litter (early to mid successional forest, structural stages 4-5); particularly oak or beech, oak-pine, and coniferous woodlands.	H
Perching and roosting sites are important features found within suitable breeding habitats; roosts are typically located on a low branch or directly on the ground.	H
Nest site: Eggs are laid on leaf litter or the bare ground, partially shaded by a short herbaceous plant, shrub, or sapling, often near fallen tree limbs or rocks that can be used as perches to roost during the day.	H
Habitats that meet some but not all of the biophysical attributes for suitable nesting habitat as described above. Examples: • Forests with dense tree cover, sparse to moderate shrub and herbaceous cover, and moderately-drained soils.	M

• Forests with dense tree cover, dense shrub and herbaceous cover, and well-drained soils. • Forests with moderate tree cover, dense shrub and herbaceous cover, and well-drained soils.	
Habitats that meet the biophysical attributes for suitable nesting habitat as described above, except for adjacency requirements. Example: dense forests >30 m from the edge.	M
Habitats that meet only one of the biophysical attributes for suitable nesting habitat as described above. Examples: • Forests with dense tree cover, dense shrub and herbaceous cover, and well-drained soils. • Forests with sparse tree cover, sparse to moderate shrub and herbaceous cover, and poorly drained soils. • Forests with sparse tree cover, dense shrub and herbaceous cover, and well-drained soils.	L
Interior (>200 m from the edge) of large, heavily forested areas with extensive and closed canopy (late successional forest, structural stages 6-7).	L
Small, isolated patches of forest (<3 ha).	L
Habitats in proximity to human activities that could lead to the unintentional destruction of ground nests, eggs, nestlings, and/or adults (e.g., vehicle/ATV/human traffic).	L
Habitats that do not meet any of the biophysical attributes for suitable nesting habitat as described above. Examples: • Forests with sparse tree cover, dense shrub and herbaceous cover, and poorly drained soils. • Non-forested habitats	N

Figure 2-11. Example of high-quality eastern whip-poor-will **nesting** habitat: mesic deciduous forest with dense canopy, moderate shrub and ground cover, and well-drained loamy soils. Fallen logs may be used as perching or roosting sites. Photo of “northern rich mesic hardwood forest” from MNDNR (2021).

Figure 2-12. Another example of high-quality eastern whip-poor-will **nesting** habitat: dry-mesic conifer or mixed woodland with dense canopy, sparse shrub and ground cover, and well-drained loamy soils. Fallen logs may be used as perching or roosting sites. Photo of "northern poor dry-mesic mixed woodland" from MNDNR (2021).

Food (FD):

Description	**Suggested Rating**
Habitats suitable for both nesting and foraging: Forests with sparse (<25%) to moderate (25-75%) tree cover or open habitats **AND** sparse to moderate shrub and herbaceous cover **AND** well-drained soils (e.g., sand, sandy-loam). Includes all corresponding areas of 3 ha or more.	H
Habitats suitable for foraging only (must be adjacent to nesting habitats): Forests with sparse tree cover or open habitats **AND** dense (>75%) shrub cover **AND** soil drainage is deficient. Includes all corresponding areas up to 1,250 m from the edge with suitable nesting habitat.	H
Open habitats (structural stages 1-3): open and shrubby wetlands, rock barrens with scattered trees, regenerating clearcuts and burns, open areas created by low-intensity forest management.	H
Habitats that meet some but not all of the biophysical attributes for suitable foraging habitat as described above. Examples: • Forests with sparse tree cover, dense shrub cover, and well-drained soils. • Forests with sparse tree cover or open habitats, sparse to moderate shrub cover, and soil drainage is deficient. • Forests with moderate tree cover, dense shrub cover, and soil drainage is deficient.	M

Habitats that meet the biophysical attributes for suitable foraging habitat as described above except for adjacency requirements. Example: cleared areas >1,250 m from the edge of suitable nesting habitat.	M
Habitats that meet only one of the biophysical attributes for suitable foraging habitat as described above. Examples: • Forests with sparse tree cover or open habitats, sparse shrub cover, and well-drained soils. • Forests with dense tree cover, dense shrub cover, and well-drained soils. • Forests with dense tree cover, sparse shrub cover, and soil drainage is deficient.	L
Forests with dense tree cover, late successional forest (structural stages 6-7).	L
Habitats in proximity to human activities that can influence insect prey populations through habitat degradation and pesticide/herbicide use (e.g., ROWs, forestry).	L
Habitats that do not meet any of the biophysical attributes for suitable foraging habitat as described above. Example: • Forests with dense tree cover, sparse or no shrub cover, and well-drained soils.	N

Figure 2-13. Example of high-quality eastern whip-poor-will foraging habitat: black spruce bog with sparse canopy and dense understory of shrubs, graminoids, and *Sphagnum* hummocks. Photo of "northern spruce bog" from MNDNR (2021).

2.5.3 Ratings Adjustment Considerations

Adjustments to habitat ratings for eastern whip-poor-will may incorporate: 1) regional context, as described in the species' recovery strategies for suitable habitat (a mosaic of forested and open habitats); 2) habitats adjacent to significant anthropogenic disturbance regimes (e.g., roads, settlements); 3) species presence observed during field work, especially (possible) evidence of breeding as determined by territorial singing males, nest distraction displays, or identification of eggs/chicks; and 4) abundance of flying insect prey observed during field work.

3.0 PLOT IN CONTEXT

The purpose of recording plot-in-context is to understand if and how the habitat ratings require modification based on local ground and adjacency conditions. This exercise is meant to be an independent assessment based on professional judgement by species experts such that information received from the field assessments can verify the applicability of the model based on habitat of the polygon alone. The role of the field contractor is to identify these local scenarios in the field and provide sound judgement by species-specific habitat experts who are familiar with how adjacent stressors, developments, or habitats could cause a species to be more or less likely to use that plot. As this should be done independently of desk-based modelling, providing prescriptive guidance to be followed by the field assessment team would no longer lead to an independent assessment based on professional, intimate, and local knowledge about the species' habitat use by experts. This emphasizes the importance of field crew leads being species experts with intimate local knowledge of habitat use, and modifying influences of habitat use, by each of the species in northwestern Ontario.

In addition to having an independent field assessment, there are simply too many potential permutations and combinations and nuances to provide prescriptive guidance for plot-in-context to cover every situation (e.g., downgrade by 1 for an adjacent road) when contextual and local information could easily render such an equation ecologically unsound. For example, we might suggest that a plot that has roads on two sides is less likely to be used by moose, but the assessor needs to consider the traffic rates and size of those roads, the size of the polygon between them, and whether they are close enough to reduce the probability of the polygon being used by moose. Inversely, roadside habitat often grows good browse, and that may outweigh the negative influences of the road in an area with low traffic, where the road is derelict or where wolves are not abundant. Such professional judgement and notes on why a downgrade or upgrade was applied for plot in context will help as a check against our models.

When the desk-based habitat suitability models are created, assumptions are made, based on literature, about how certain features affect the use of adjacent plots. When we receive the data back from the field contractor, we will be able to see what they rated the plot as, and the adjustments they have made due to plot-in-context considerations. The habitat adjustments made via the plot in context field will help us to check those desk-based assumptions, and it will also help flag areas that might be automatically delineated as very good or very bad habitat by models and by the plot ratings, but where the plot-in-context information flags a possible need for a closer look at context, or context acting differently than expected, and then model adjustments can be made.

APPENDIX F: FIELD SUMMARY OF SIGNIFICANT WILDLIFE HABITAT CRITERIA SCHEDULES FOR ECOREGION 3W

(see next page – formatted for printing)

Seasonal Concentration Areas for Wildlife Species

Wildlife Habitat	Wildlife Species	Ecosite Codes	Habitat Criteria
Waterfowl Stopover and Staging Area (Terrestrial) **Rationale:** Habitat important to migrating waterfowl.	• Brant • Cackling Goose • Canada Goose • Snow Goose • Ross's Goose • Tundra Swan • Trumpeter Swan • Wood Duck • Gadwall • American Wigeon • American Black Duck • Mallard • Blue-winged Teal • Northern Shoveler • Northern Pintail • Green-winged Teal *Other:* • Sandhill Crane	Focus on sites that have appropriate vegetation and highest likelihood of seasonal water accumulation. These include: B060-062 B077-079 B093-095 B109-111 Plus evidence of annual spring flooding from melt water or run-off within identified ecosites.	Open areas with sheet water during Spring (mid-March to June or September to November). Areas with flooding during spring melt and run-off provide important invertebrate foraging habitat for migrating waterfowl. Cultivated fields with waste grains are commonly used by waterfowl, these are not considered SWH.
Waterfowl Stopover and Staging Area (Aquatic) **Rationale:** Important for local and migrant waterbird populations during the spring or fall migration or both periods combined. Sites identified are usually only one of a few in the ecodistrict.	• Brant • Cackling Goose • Canada Goose • Greater White-fronted Goose • Snow Goose • Ross's Goose • Tundra Swan • Trumpeter Swan • Wood Duck • Gadwall • American Black Duck • American Wigeon • Mallard • Blue-winged Teal • Northern Shoveler • Northern Pintail • Green-winged Teal • Canvasback • Redhead • Ring-necked Duck • Lesser Scaup	B142-152	Ponds, marshes, lakes, bays, coastal inlets, and watercourses used during migration. Sewage treatment ponds and storm water ponds do not qualify as a SWH; however, a reservoir managed as a large wetland or pond/lake does qualify. These habitats may have an abundant food supply (mostly aquatic invertebrates and vegetation in shallow water). Sites with wild rice have a high likelihood of being a waterbird stopover and staging area.

	• Greater Scaup • Harlequin Duck • Surf Scoter • White-winged Scoter • Black Scoter • Long-tailed Duck • Bufflehead • Common Goldeneye • Common Merganser • Hooded Merganser • Red-breasted Merganser • Ruddy Duck Others: • Red-necked Grebe • American Coot • Sandhill Crane • Common Loon • Red-throated Loon Special Concern under Ontario's Endangered Species Act, 2007: • Horned Grebe		
Shorebird Migratory Stopover Area Rationale: High quality shorebird stopover habitat is extremely rare and typically has a long history of use.	• Black-bellied Plover • American Golden-Plover • Semipalmated Plover • Killdeer • Whimbrel • Hudsonian Godwit • Marbled Godwit • Ruddy Turnstone • Stilt Sandpiper • Sanderling • Dunlin • Baird's Sandpiper • Least Sandpiper • White-rumped Sandpiper • Buff-breasted Sandpiper • Pectoral Sandpiper	Potential ecosites include: B005-006 B154-156 B160-162 B170-172 B176-178 B186-188 Includes all other ecosites where criteria have been met	Shorelines of lakes, rivers and wetlands, including beach areas, bars and seasonally flooded, muddy and un-vegetated shoreline habitats or open areas. Great Lakes coastal shorelines, including groynes and other forms of armour rock lakeshores, are extremely important for migratory shorebirds in May to mid-June and late July to early October. Will likely require multiple field visits. Storm water retention ponds, cultivated fields, and sewage lagoons are not considered SWH.

	• Semipalmated Sandpiper • Short-billed Dowitcher • Wilson's Snipe • Spotted Sandpiper • Solitary Sandpiper • Greater Yellowlegs • Lesser Yellowlegs • Wilson's Phalarope		
Colonially - Nesting Bird Breeding Habitat (Bank and Cliff) **Rationale:** Historical use and number of nests in a colony make this habitat significant. An identified colony can be very important to local populations. All swallow populations are declining in Ontario.	• Northern Rough-winged Swallow (this species is not colonial but can be found in Cliff Swallow colonies) • Cliff Swallow **THREATENED** Bank Swallow are protected under Ontario's *Endangered Species Act, 2007*.	Cliff faces, banks, bridge abutments, silos, barns (Cliff Swallows). Habitat may be found in, but not limited to the following ecosites: B001-004 B157-159 B173-175	Any site or areas with exposed soil banks, undisturbed or naturally eroding that is not a licensed/permitted aggregate area. Does not include man-made structures (e.g. bridges or buildings) or recently (2 years) disturbed soil areas, such as berms, soil or aggregate stockpiles. Does not include a licensed/permitted Mineral Aggregate Operation.
Colonially - Nesting Bird Breeding Habitat (Tree/Shrubs) **Rationale:** Large colonies are important to local bird population, typically sites are only known colony in area and are used annually.	• Bonaparte's Gull • Black Tern • Double-crested Cormorant • Great Blue Heron	May include a wide variety of tall treed ecosites. Habitat selection based on close proximity to water body or on island: B011-019 B023-028 B033-043 B048-059 B064-076 B081-092 B097-108 B113-137 B161-162 B177-178 B222-224	Great Blue Herons nest in live or dead standing trees in wetlands, lakeshores, islands, and peninsulas. Shrubs and occasionally emergent vegetation may also be used. Most nests in trees are 11 to 15m from ground, near the top of the tree. Bonaparte's Gulls nest in coniferous trees (preferably spruce-fir) near fens, bogs, swamps, ponds or lakes. Double-crested Cormorants prefer to nest in trees but will nest on the ground as well where trees are limited or have died and fallen.
Colonially - Nesting Bird Breeding Habitat (Ground) **Rationale:**	• Ring-billed Gull • Herring Gull • Common Tern • Caspian Tern	Any rocky island or peninsula (natural or artificial) within a lake or large river (two-lined on a 1;50,000 NTS map) may indicate candidate habitat.	Nesting colonies of gulls and terns are on islands or peninsulas (natural or artificial) associated with open water or in marshy areas, lakes or large rivers (two-lined on a 1:50,000 NTS map). Brewers Blackbird colonies are found loosely on the ground or in low bushes in close proximity to streams and irrigation ditches within farmlands.

Colonies are important to local bird population, typically sites are only known colony in area and are used annually.	• Double-crested Cormorant • Brewer's Blackbird **THREATENED** American White Pelican are protected under Ontario's *Endangered Species Act, 2007*.	B160-165 B169-172 B176-181 B185-188 Close proximity to watercourses in open fields or pastures with scattered trees or shrubs (Brewer's Blackbird). B008-009 B020-021 B030-031 B045-046 B061-062 B078-079 B094-095 B110-111 B142-144	Double-crested Cormorants prefer to nest in trees but will nest on the ground as well where trees are limited or have died and fallen.
Eagle and Osprey Concentration Area **Rationale:** Habitat of annual importance to migrating and/or wintering eagles and ospreys.	• Osprey Special Concern under Ontario's *Endangered Species Act, 2007*: • Bald Eagle **ENDANGERED** Golden Eagle are protected under Ontario's *Endangered Species Act, 2007*.	Important habitat includes forested ecosites within the vicinity of lakes and rivers that receive large runs of salmonids. Undisturbed mature trees or snags distributed evenly along shorelines are important. Most individual trees used for perching are "super canopy" trees.	Most sites have been used for several years. Mostly associated with large river systems and lake confluences. Can be important hunting locations in Spring, Fall or Winter. Storm water waste facilities, retention ponds and sewage lagoons are not considered SWH.
Sharp-tailed Grouse Lek **Rationale:** Leks are an important habitat feature required to maintain populations of sharp-tailed grouse.	• Sharp-tailed Grouse	B029-031 B044-046 B060-062 B077-079 B093-095 B109-111 B126 B136-141	Leks are typically in a grassy field/meadow or peatlands such as fens and bogs separated by >15ha from adjacent shrublands and >30ha from adjacent treed areas. There is often a knoll or slightly elevated rise in topography associated with the site. This is a better drained site less likely to collect water. Field/meadows are to be >15ha when adjacent to shrubland and >30ha when adjacent to deciduous stands. Leks will be used annually if not destroyed by cultivation or invasion by woody plants or tree planting.

Seasonal Concentration Areas for Wildlife Species

Bat Hibernaculum **Rationale:** Bat hibernacula are rare habitats in all Ontario landscapes.	• Big Brown Bat **ENDANGERED** Little Brown Myotis, Northern Long-eared Myotis, Eastern Small-footed Myotis, and Tricolored Bat are protected under Ontario's *Endangered Species Act, 2007*.	Hibernacula may be found in abandoned caves, addits, mine shafts, underground foundations. Caves and mine shafts are the important features. Commonly associated as components of either Cliff or Rock Barren ecosites. Once feature is identified the substrate classification can be used to identify characteristics and potential/suitability of identified or suspected hibernacula.	The locations and site characteristics of bat hibernacula are relatively poorly known. Primary criteria is identification of known feature Buildings are not considered to be SWH)
Bat Maternity Colony **Rationale:** Identification of maternity roosts is difficult. Known locations of treed bat maternity colonies is extremely limited in all Ontario landscapes.	• Big Brown Bat • Silver-haired Bat **ENDANGERED** Little Brown Myotis, Northern Long-eared Myotis, Eastern Small-footed Myotis, Tricolored Bat are protected under Ontario's *Endangered Species Act, 2007*.	Maternity colonies considered SWH are found in treed ecosites. B011-019 B023-028 B033-043 B048-059 B064-076 B081-092 B097-108 B113-125 B126-133 B222-224 Aspen is an important feature in Ecoregion 3W, primarily the presence of larger diameter trees in older mixed-wood stands.	Maternity colonies can be found in tree cavities, vegetation and often in buildings (buildings are not considered to be SWH). Maternity roosts are generally not found in caves and mines in Ontario. Maternity colonies located in Mature (dominant trees >80yrs old) deciduous or mixed forest stands with >10/ha large diameter (>25cm dbh) wildlife trees. Female bats prefer wildlife trees (snags) of decay class 1 or 2 or class 2-4, can be living or with bark mostly intact. Silver-haired Bats prefer older mixed or deciduous forest and form maternity colonies in tree cavities and small hollows. Older forest areas with at least 21 snags/ha are preferred. Buildings are not considered to be SWH).
Amphibian Breeding Habitat **Rationale:** These habitats are extremely important to amphibian biodiversity within Northern Ontario landscapes.	• Eastern (Red-spotted) Newt • Spotted Salamander • Blue-spotted Salamander • American Toad • Gray Treefrog • Boreal Chorus Frog • Wood Frog • Spring Peeper • Northern Leopard Frog	May include swamps and thickets, vernal/seasonal pooling, riparian and variety of wetland interiors and margins B109-156 B223-224	Wetlands and pools (including vernal pools) > 500m2 (about 25m diameter) supporting high species diversity are significant; small or ephemeral habitats may not be identified on MNRF mapping and could be important amphibian breeding habitats. Spotted Salamanders are extremely rare in 3W; candidate wildlife habitat for this species could include artificial wetlands and/or ponds and ditches. Wetlands and pools need to persist until August.

	• Green Frog • Mink Frog • Mudpuppy		Presence of shrubs and logs increase significance of pond for some amphibian species because of available structure for calling, foraging, escape and concealment from predators.
Turtle Wintering Area **Rationale:** Turtle distribution in 3W is very limited and disjunct. Sites with the highest number of individuals are most significant.	• Painted Turtle Special Concern under Ontario's *Endangered Species Act, 2007*: • Snapping Turtle	Lakes, wetlands, ponds, and ecosites: B128-142 B145-152	For most turtles, wintering areas are in the same general area as their core habitat. Water has to be deep enough not to freeze and/or have soft mud substrates. Over-wintering sites can be permanent water bodies, large wetlands, and bogs or fens. Storm water waste facilities, retention ponds and sewage lagoons are not considered SWH. Both Midland and Western Painted Turtles are present in 3W.
Snake Hibernaculum **Rationale:** Generally hibernacula that provide adequate conditions for overwintering in 3W will be limited on the landscape. Sites with the highest number of individuals are most significant.	• Eastern Gartersnake • Northern Redbelly Snake	For all snakes, habitat may be found in any forested ecosite in northern Ontario. Talus, rock barren, crevice and caves are more typically related to these habitats. Many suitable conditions also observed in the very shallow ecosites particularly on fractured bedrock and lower veg cover Open and Sparse Tall/Low Treed or Shrub Systems.	For snakes, hibernation takes place in sites located below frost lines in burrows, rock crevices and other natural locations. Areas of broken and fissured rock are particularly valuable because they provide access to subterranean sites below the frost line. Observation of congregating snakes on sunny warm days in the spring or fall is a good indicator of a hibernaculum. The existence of rock piles or slopes, stone fences, and crumbling foundations. Large numbers of roadkill during period of emergence in spring can also be an indicator that a hibernaculum is nearby. The subspecies of Eastern Gartersnake, Red-sided Gartersnake, occurs in the northwest portion of 3W.

Animal Movement Corridors

Wildlife Habitat	Wildlife Species	Ecosite Codes	Habitat Criteria
Cervid Movement Corridor **Rationale:** Corridors are important for moose to be able to access seasonally important life-cycle habitats or to access new habitat for dispersing individuals by minimizing their vulnerability while travelling.	• Moose	Corridors may be found in all treed ecosites.	Movement corridor must be determined when **Aquatic Feeding Habitat and Mineral Lick** habitat are confirmed from Table 1.2.2 of this schedule. Corridors typically follow riparian areas, woodlots, areas of physical geography (ravines, or ridges). Corridors will be multi-functional i.e. these will function for any smaller mammal species as well.
Amphibian Movement Corridor **Rationale:** Movement corridors for amphibians that are moving from their terrestrial habitat to breeding habitat can be extremely important for local populations.	• Eastern Newt • Blue-spotted Salamander • Spotted Salamander • Northern Leopard Frog • Green Frog • Mink Frog	Corridors may be found in all ecosites associated with water. Corridors will be determined based on identifying the significant breeding habitat for these species in Table 1.2.2.	Movement corridors between breeding habitat and other habitat. Movement corridors must be determined when Amphibian breeding habitat is confirmed as SWH from Table 1.2.2 (**Amphibian Breeding Habitat – Wetland)** of this Schedule.

Specialized Habitat for Wildlife

Wildlife Habitat	Wildlife Species	Ecosite Codes	Habitat Criteria
Waterfowl Nesting Area **Rationale:** Important to local waterfowl populations, sites with greatest number of species and highest number of individuals are significant.	• Trumpeter Swan • Wood Duck • Gadwall • American Wigeon • American Black Duck • Blue-winged Teal • Northern Shoveler • Northern Pintail • Green-winged Teal • Ring-necked Duck • Bufflehead • Common Goldeneye • Hooded Merganser • Red-breasted Merganser • Common Merganser	All upland habitats located adjacent to ELC ecosites; B129-135 B140-152 B224 are Candidate SWH Note: includes adjacency to provincially Significant Wetlands	A waterfowl nesting area extends 120m from a wetland (>0.5ha) or a cluster of 3 or more small (<0.5ha) wetlands within 120m of each individual wetland where waterfowl nesting is known to occur. Upland areas should be at least 120m wide so that predators such as raccoons, skunks, and foxes have difficulty finding nests. Wood Ducks, Bufflehead and Hooded Mergansers utilize large diameter trees in forested habitat for cavity nest sites. Storm water waste facilities, retention ponds and sewage lagoons are not considered SWH.
Wild Rice Stand **Rationale:** Wetlands containing large stands of wild rice are important rearing and migratory stopover locations for waterfowl.	• *Zizania palustris* (Wild Rice)	B142-145 B148-152	Ponds, marshes, lakes, bays, coastal inlets, and watercourses with wild rice. These habitats have an abundant food supply for waterbirds. Sites with wild rice have a high likelihood of being a waterfowl stopover and staging area as well.
Milkweed Patch **Rationale:** Native milkweed patches are extremely rare in 3W and are specialised habitats for Monarch butterflies.	• *Asclepias incarnata* • *Asclepias syriaca*	*Asclepias incarnata* can be found within a variety of habitats. Most likely ecosites include: B126-156 B170-172 B222-224 *Asclepias syriaca* may be found within: B006 B008 B020-021 B029-030 B044-045	Extremely rare in 3W. Potential habitat includes fields and dry or wet meadows as well as shorelines of lakes and rivers. Horticultural or planted sites are not considered SWH.
Bald Eagle and Osprey Nesting Habitat **Rationale:**	• Osprey	Typically nests in treed communities directly adjacent to riparian areas – rivers, lakes, ponds and wetlands.	Nests are associated with lakes, ponds, rivers or wetlands along treed shorelines, islands. Osprey nests are usually at the top of a tree whereas Bald Eagle nests are typically in super canopy trees in a notch within the tree's canopy.

Specialized Habitat for Wildlife

Wildlife Habitat	Wildlife Species	Ecosite Codes	Habitat Criteria
Nests are used annually by these species. Suitable nesting locations may be impacted due to shoreline development.	Special Concern under Ontario's *Endangered Species Act, 2007*: • Bald Eagle	However, species may nest further away from water.	Nests located on man-made objects such as telephone or hydro poles will not normally be considered as SWH, however the MNRF District retains discretion regarding significance of constructed nesting platforms.
Woodland Raptor Nesting Habitat **Rationale:** These habitats may be used annually by some species. Nests sites for these species are rarely identified in advance of site investigations.	*Stick nesters/users:* • Sharp-shinned Hawk • Cooper's Hawk • Northern Goshawk • Broad-winged Hawk • Red-tailed Hawk • Great Horned Owl • Barred Owl • Great Gray Owl • Long-eared Owl • Merlin • Common Raven *Cavity nesters/users:* • Great Horned Owl • Northern Hawk Owl • Barred Owl • Boreal Owl • Northern Saw-whet Owl • American Kestrel (Note: Bufflehead, Common Goldeneye, Wood Duck and Common and Hooded Merganser also use tree cavities for nesting. Northern Flying Squirrel use cavities as roosting sites in winter)	May be found in all forested ELC Ecosites.	All natural or conifer plantation woodland/forest stands. Stick nests found in a variety of intermediate-aged to mature conifer, deciduous or mixed forests within tops or crotches of trees. Common Raven are included because nests may be used in subsequent years by raptors. Species such as Merlin or Coopers Hawk nest along forest edges sometimes on peninsulas or small off-shore islands. Some raptors rely on cavity trees for nesting. They do not excavate their own cavities, but rely on natural cavities of sufficient size and those excavated by Pileated Woodpeckers. Larger diameter trees are used most frequently, with nest cavities most often found in trembling aspen. Nests may be used again, or a new nest may be in close proximity to old nest.
Turtle Nesting Area **Rationale:** These habitats are rare and when identified will often be the only breeding site for local populations of turtles.	• Painted Turtle Special Concern under Ontario's *Endangered Species Act, 2007*: • Snapping Turtle **THREATENED**	May include: B003 B006-007 B031 B171-172 B187-188	Best nesting habitat for turtles is close to water and away from roads and other sites less prone to loss of eggs by predation from skunks, raccoons or other animals. For an area to function as a turtle-nesting area, it must provide sand and gravel that turtles are able to dig in and be located in an open and sunny area. Nesting areas on the sides of municipal or provincial road embankments and shoulders are not SWH.

Specialized Habitat for Wildlife

Wildlife Habitat	Wildlife Species	Ecosite Codes	Habitat Criteria
	Blanding's Turtle are protected under Ontario's *Endangered Species Act, 2007*.		Sand and gravel beaches adjacent to undisturbed shallow weedy areas of marshes, lakes, and rivers are most likely used.
Aquatic Feeding Habitat **Rationale:** Aquatic Feeding Habitats are an extremely important habitat component for moose and other wildlife as they supply important nutrients. Forest cover adjacent to these areas is important as well to provide for summer thermal cover, screening and escape cover.	• Moose	Habitat may be found in all forested ecosites adjacent to water.	MNRF maps these locations on Crown land and rates the site on a scale of 1 – 4, with 4 having the greatest potential. Feeding sites classed 3 or 4 are candidate significant areas. Identification of Aquatic Feeding Habitat for moose should follow the method outlined in MNRF's Selected Wildlife and Habitat Features: Inventory Manual. Wetlands and isolated embayments in rivers or lakes which provide an abundance of submerged aquatic vegetation such as pondweeds, water milfoil and yellow water lily are preferred sites. Adjacent stands of lowland conifer or mixed woods will provide cover and shade.
Seeps and Springs **Rationale:** Seeps/Springs are typical of headwater areas and are often at the source of coldwater streams.	Selected wildlife species that utilize this feature: • Spotted Salamander • Blue-spotted Salamander • Ruffed Grouse • Spruce Grouse • Moose • White-tailed Deer • Black Bear Other species: • Brook Trout **THREATENED** Forest-dwelling Woodland Caribou are protected under Ontario's *Endangered Species Act, 2007*.	Seeps are areas where groundwater emerges and can be identified as zones where surface saturation produces overland flow but there is no obvious source for the surface water. Often they are found within headwater areas within forested habitats. Any forested Ecosite within the headwater areas of a stream could have seeps/springs or ground water recharge areas.	Any forested area within the headwaters of a stream or river system. Seeps and springs are important feeding and drinking areas especially in the winter and will typically support a variety of plant and animal species.
Mineral Lick **Rationale:** Mineral licks are a valuable habitat	• Moose • White-tailed Deer Porcupine and other species may utilize these sites as well	Habitat may be found in all treed ecosites. Most probable in clay ecosities: B110-B125	This habitat component is found in upwelling groundwater and the soil around these seepage areas. It typically occurs in areas of sedimentary and volcanic bedrock. In areas of granitic bedrock, the site is usually overlain with calcareous glacial till.

Wildlife Habitat	Wildlife Species	Ecosite Codes	Habitat Criteria
component but are also very rare on the landscape.	**THREATENED** Woodland Caribou are protected under Ontario's *Endangered Species Act, 2007*.		Does not include anthropogenic sources such as roadsides.
Mammal Denning Site **Rationale:** Species are important fur-bearing mammals and den sites can be a limiting factor in sustaining populations.	• Mink • Otter • Gray Wolf • Coyote • Canada Lynx • Bobcat • Black Bear • Red Fox **Cavity Users** • Marten • Fisher **THREATENED** Algonquin Wolf, Cougar, Gray Fox and Wolverine are protected under Ontario's *Endangered Species Act, 2007*.	Habitat may be found in all treed ecosites.	Mink prefer shorelines dominated by coniferous or mixed forests with dens usually underground. Mink will often use old muskrat lodges. Mink may den in root masses along shorelines of water bodies. Otters prefer undisturbed shorelines along water bodies that support productive fish populations with abundant shrubby vegetation and downed woody debris for denning. They often use old beaver lodges or log jams and crevices in rock piles. Marten and fisher share the same general habitat, requiring large tracts of coniferous or mixed forests of mature or older age classes. Denning sites are often in cavities in large trees or under large downed woody debris. Wolves prefer a more interior forest condition for locating their den sites. Wolves require sandy ground, sloped for excavation (esker areas should be examined as potentially key sites). Lynx den sites are most often associated with the presence of downed woody debris. Black bears, particularly sub-adults, will often den in the base of hollow trees. In 3W such trees are rare and primarily consist of large diameter cedar or sometimes large white spruce.
Marsh Bird Breeding Habitat **Rationale:** Rich wetlands are productive breeding habitats for these bird species and rare in Northern Ontario landscapes.	• Trumpeter Swan • Ring-necked Duck • Green-winged Teal Northern Shoveler • Pied-billed Grebe • Red-necked Grebe • Virginia Rail • Sora • American Coot • Sandhill Crane • Common Loon • American Bittern • Spotted Sandpiper • Sedge Wren	Ecosites: B134-B152	Nesting occurs in wetlands. All wetland habitats are to be considered as long as there is shallow water with emergent aquatic vegetation present. Storm water retention ponds and sewage lagoons are not considered SWH.

Wildlife Habitat	Wildlife Species	Ecosite Codes	Habitat Criteria
	• Marsh Wren Special Concern under Ontario's *Endangered Species Act, 2007*: • Yellow Rail • Black Tern		
Open Country Bird Breeding Habitat **Rationale:** This wildlife habitat is declining throughout Ontario and North America	• Upland Sandpiper • Black-billed Magpie • Western Meadowlark • Eastern Bluebird • Vesper Sparrow • Le Conte's Sparrow Special Concern under Ontario's *Endangered Species Act, 2007*: • Short-eared Owl **THREATENED** Bobolink and Eastern Meadowlark are protected under Ontario's *Endangered Species Act, 2007*.	All field, meadow, open bog or fen, and sparse shrub ecosites: B08-09 B20-21 B29-31 B44-46 B60-62 B77-79 B93-95 B109-111 B136-141	Large field/meadow areas (includes natural and cultural fields and meadows) >30ha. Field/meadow not Class 1 or 2 agricultural lands, and not being actively used for farming (i.e. no row cropping or intensive hay or livestock pasturing in the last 5 years). Field/meadow sites considered significant should have a history of longevity, either abandoned fields, mature hayfields and pasturelands that are at least 5 years or older. The indicator bird species are area sensitive requiring larger field/meadow areas than the common field/meadow species.

Rare Vegetation Communities

Rare Veg. Community	Characteristic Plant Species	Ecosite Codes	Habitat Description
Cliff and Cliff Rim **Rationale:** Cliffs and cliff rims can provide habitat for rare plants and vegetation communities. These sites are particularly sensitive to disturbances such as invasive species and/or trampling.	**Granitic cliff species:** *Polypodium virginianum, Deschampsia cespitosa, Umbilicaria sp.,Betula papyrifera* **Characteristic plant species of basic cliffs include**: *Polypodium virginianum, Woodsia ilvensis, Cystopteris fragilis, Danthonia spicata,* *Dechampsia flexuosa, Aquilegia canadensis, Campanula gieseckiana, Sibbaldiopsis tridentate, Selaginella rupestris, Cladina rangiferina, Cladina mitis, Vaccinium angustifolium, Arctostaphylus uva-ursi, Diervilla lonicera, Betula papyrifera* **Drier/warmer diabase cliff indicator species:** *Umbilicaria sp. Artemisia campestris, Campanula gieseckiana, Heuchera richardsonii, Sibbaldiopsis tridentate, Toxicodendron rydbergii, Parthenocissus inserta* **Cooler/wetter diabase cliff species indicator species:** *Woodsia glabella, Trisetum spicatum, Saxifraga paniculata, Cystopteris laurentiana, Polygonum viviparum, Solidago uliginosa, Cystopteris fragilis*	B157-159	Acidic sites include granitic and sandstones. These sites are nutrient poor, typically with very few plant species. Diabase cliffs are relatively richer sites that tend to have more diverse plant communities and a larger array of potential rare species. Cliffs that are warmer and drier than normal have a better likelihood of containing plants with more southern or prairie affinities. Cliffs that have cooler and wetter microclimates than normal have a better likelihood of containing Arctic-Alpine disjuncts. Cliff: Vertical to near-vertical consolidated bedrock communities with a minimum height of 3 m and a slope of > 60° or 173%. Sites have limited plant growth and species diversification. Ground cover dominated by lichen and bryophytes. Plant communities are tolerant of environmental extremes, well adapted to desiccation, rapid fluctuations in temperature, and low availability of nutrients. Cliff Rim: Exposed bedrock areas on top face of cliff. Typically narrow, with very shallow soil and lacking trees (may be stunted). Plant communities are tolerant of environmental extremes, well adapted to desiccation, rapid fluctuations in temperature, and low availability of nutrients.
Talus Slope **Rationale:** Talus slopes can provide unique and isolated habitat for rare plants and vegetation communities that can be significantly impacted by disturbance such as invasive species and/or trampling or removal of the talus.	**Characteristic plant species of talus include:** *Polypodium virginanum, Agrostis scabra, Aralia hispida, Woodisa ilvensis, Aralia nudicaulis, Cladina rangiferina, Cladina mitis, Diervilla lonicera, Alnus viridis ssp. crispa, Prunus pensylvanica, Betula papyrifera, Populus tremuloides*	B166-168 B182-184	Rock accumulation at the base of cliffs. The substrate is dominated by coarse fragments (>90% rock fragments) with little to no mineral or organic material between the coarse fragments. May be covered by a thin covering of material (mineral <5 cm, organic <10cm). Vascular vegetation <25%. Trees and shrubs stunted. Herbs, (typically Polypodium virginianum) and graminoids limited to patches of organic or mineral soil accumulations. If vascular vegetation >25% then mineral material <15cm (very shallow), organic material of any depth.
Rock Barren **Rationale:**	**Characteristic plant species of rock barrens may include:** *Danthonia spicata, Deschampsia flexuosa, Elymus trachycaulus,*	Basic Rock Barren B180-181	Rock barrens have limited plant growth and species diversification. Ground cover dominated by lichen and

Rare Vegetation Communities

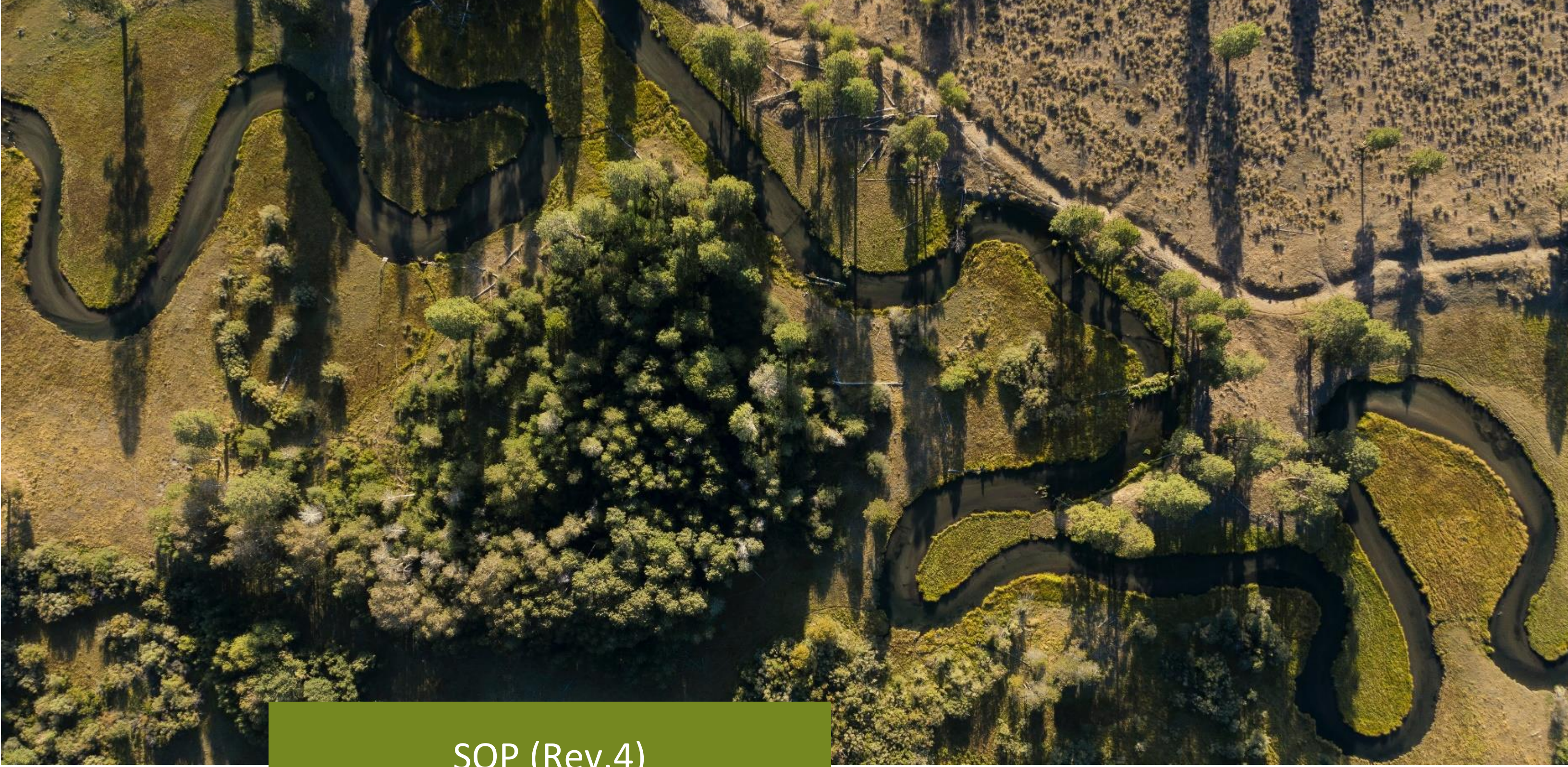
Rare Veg. Community	Characteristic Plant Species	Ecosite Codes	Habitat Description
Rock barrens can provide habitat for rare plants and vegetation communities that can be significantly impacted by disturbance such as invasive species and/or trampling.	*Carex pensylvanica, Corydalis sempervirens, Aralis hispida, Agrostis scabra, Aralia nudicaulis, Pteridium aquilinum , Vaccinium angustifolium, Rubus spp., Diervilla lonicera, Betula papyrifera, Pinus banksiana, Populus tremuloides*	Acidic Rock Barren B163-165	bryophytes. Plant communities are tolerant of environmental extremes, well adapted to desiccation, rapid fluctuations in temperature, and low availability of nutrients. Acidic rock barrens in 3W include granitic and sandstones. These sites are nutrient poor sites with very few plant species. Basic (mainly diabase) rock barrens are relatively richer sites that tend to have more diverse plant communities and a larger array of potential rare species. Exposed bedrock areas (mostly exposed rock with <5cm mineral or <10cm organic material) and <25% vascular vegetation.
Rare Treed Type: Red and White Pine Rationale: Uncommon to rare Ecoregion 3W – they amount to less than 1% of the total forest.	Stands should have >10% absolute cover or >35% relative cover of white and/or red pine	B011 B015 B023 B027 B033 B039 B048 B054 B064 B069 B081 B087 B097 B103 B113 B118	Red and White Pine stands attain their northern limit in 3W. They occur as sporadic, small stands and are generally found on dry, often exposed, south-facing slopes and rocky sites. However, these conditions can vary.
Rare Treed Type: Elm Rationale: Rare in Ecoregion 3W – they amount to less than 1% of the total forest.	Stands should have >10% absolute cover or >35% relative cover of Elm	B019 B043 B056 B059 B071 B076 B089 B092 B105 B108 B120 B125	Elm stands are found within low lying, predominantly alluvial material.

Rare Vegetation Communities

Rare Veg. Community	Characteristic Plant Species	Ecosite Codes	Habitat Description
Rare Treed Type: Red and Sugar Maple **Rationale:** Rare in Ecoregion 3W – they amount to less than 1% of the total forest.	Stands should have >10% absolute cover or >35% relative cover of red and/or sugar maple	B018-B019 B028 B042-B043 B058-B059 B073-B076 B091-B092 B107-B108 B122-B125	Hardwood canopy containing red and/or sugar maple. Generally on warmer-than-normal sites with a higher nutrient regime.
Sand Dunes (Including Freshwater Coastal Dunes) Notably: American Dune Grass Type **Rationale:** Rare and limited in 3W.	**Characteristic plant species of sand dunes grass type include** (Bakowsky and Henson, 2014): *Ammophila breviligulata, Artemisia campestris spp. caudata, Elymus trachycaulus, Leymus mollis, Lathyrus japonicus, Xanthium strumariu, Prunus pumila var. pumila, Hudsonia tomentosa* **Other species may include:** *Anemone multifida, Arabidopsis lyrata, Arctostaphylos uva-ursi, Campanula gieseckiana, Cornus stolonifera, Elymus canadensis, Equisetum hyemale, Festuca saximontana, Juniperus communis, Anthoxanthum hirtum, Maianthemum stellatum, Pinus resinosa, Pinus strobus, Polygonella articulata,Pteridium aquilinum, Salix interior, Salix myricoides, Trisetum melicoides* **THREATENED** Pitcher`s Thistle are protected under Ontario's *Endangered Species Act*, 2007.	B005-B008 B020 B030 B142 B155	Exposed mineral material community often associated with shorelines of lakes or exposed inland mineral material that has been or was shaped by aeolian (wind) processes. **American Dune Grass Type** Open grassy sand dunes with Indicator Species: American dune grass, beach pea, and sand cherry. Scattered white spruce forest islands may also occur.
Rare Arctic-Alpine Plant Communities **Rationale:** Rare and disjunct in Ecoregion 3W. Typically found in colder-than-normal sites.	**Characteristic plant species of arctic-alpine community types include:** *Allium schoenoprasum var. sibiricum, Anemone parviflora, Antennaria rosea, Arenaria humifusa, Arnica cordifolia, Astragalus alpinus, Bistorta vivipara, Calamagrostis purpurascens, Calamagrostis stricta ssp. inexpansa, Carex atratiformis, Carex glacialis, Carex scirpoidea, Carex supina, Castilleja, septentrionalis, Cerastium alpinum, Chamerion latifolium, Chrysosplenium tetrandrum, Cypripedium passerinum, Cystopteris montana, Draba aurea, Draba cana, Draba cinerea, Dryas drummondii, Dryas integrifolia, Empetrum nigrum, Epilobium hornemannii, Erigeron acris, Erigeron hyssopifolius, Erigeron lonchophyllus, Eriophorum brachyantherum, Eriophorum russeolum, Euphrasia hudsoniana, Euphrasia nemorosa, Euphrasia wettsteinii, Hedysarum alpinum, Huperzia appressa, Huperzia selago, Luzula parviflora, Moehringia macrophylla, Neottia borealis, Oxytropis borealis, Oxytropis splendens, Packera indecora, Packera pauciflora, Pinguicula vulgaris, Poa alpina, Poa glauca, Poa pratensis ssp. alpigena, Potentilla bimundorum,*	B161 B162 But can include other ecosites.	Primarily found on the shoreline of Lake Superior on open basic bedrock but can exist elsewhere. Vegetation consists mostly of arctic-alpine species. Inland can be found on rocky shorelines of rivers and streams, cliff tops, canyons, and peatlands.

Rare Vegetation Communities

Rare Veg. Community	Characteristic Plant Species	Ecosite Codes	Habitat Description
	Pyrola grandiflora, Sagina nodosa, Salix myrtillifolia, Salix planifolia, Salix pseudomonticola, Salix pseudomyrsinites, Saxifraga oppositifolia, Saxifraga paniculata, Saxifraga tricuspidata, Selaginella selaginoides, Silene acaulis, Solidago multiradiata, Taraxacum ceratophorum, Tofieldia pusilla, Trichophorum cespitosum, Trisetum spicatum, Vaccinium caespitosum, Vaccinium uliginosum, Viola epipsila, Woodsia alpina, Woodsia glabella		
Diverse and Sensitive Orchid Communities Rationale: Large communities of sensitive orchid species are rare and specialised and sensitive to disturbance in 3W.	**Orchid indicator and sensitive species include:** *Calopogon tuberosus, Cypripedium arietinum, Cypripedium passerinum, Cypripedium reginae, Goodyera oblongifolia, Malaxis monophyllos, Malaxis paludosa, Neottia auriculata,, Neottia borealis, Neottia convallarioides, Platanthera hookeri, Platanthera lacera.* **Other characteristic orchid species of diverse communities may include:** *Arethusa bulbosa, Calypso bulbosa, Corallorhiza maculate, Corallorhiza striata, Corallorhiza trifida, Cypripedium acaule, Cypripedium parviflorum var. pubescens, Dactylorhiza viridis, Galearis rotundifolia, Goodyera repens Goodyera tesselata, Liparis loeselii, Malaxis unifolia, Neottia cordata, Platanthera aquilonis, Platanthera clavellata, Platanthera dilatata, Platanthera huronensis, Platanthera obtusata, Platanthera orbiculata, Platanthera psycodes, Pogonia ophioglossoides, Spiranthes lacera, Spiranthes romanzoffiana*	Will include a wide variety of ecosites. Diverse orchid communities are likely to be found in: B126-139 B222-224	Fungi provide orchids with a carbon source. By consuming the fungi, orchids are able to produce seed via photosynthesis or fungi consumption. In addition to their fungal relationships, many of the indicator and sensitive species of orchids in 3W are associated with hydric sites and are extremely sensitive to water level fluctuations.
Provincially Rare Vegetation Communities Rationale: Rare plant communities that often contain rare species which depend on specific habitats for survival.	At time of publication, rare (S1-S3, SH) plant communities: American Dune Grass – Beach Pea – Sand Cherry Dune Grassland Type (S2), Basic Open Cliff Type (S3S4), Boreal Acidic Sandstone Open Cliff Type (S2), Great Lakes Arctic-Alpine Basic Open Bedrock Shoreline Type (S3), Open Sandstone Cliff Type (S1)	All	All plant community element occurrences (EO).



SOP (Rev.4)

File Name: NWMO_BIS_2020_AHM SOP_IG (R004)

THE NWMO BIODIVERSITY IMPACT STUDIES: STANDARD OPERATING PROCEDURE FOR AQUATIC HABITAT MAPPING – NORTHWESTERN ONTARIO SITE

July 23, 2021

PREPARED BY Zoetica Environmental Consulting Services

SUBMITTED TO Melissa Mayhew
Nuclear Waste Management Organization
22 St. Clair Avenue East
Fourth Floor, Toronto, ON
M4T 2S3, Canada

ZOETICA ENVIRONMENTAL CONSULTING SERVICES

OFFICE 102-22351 St Anne Ave, Maple Ridge, BC, V2X 2E7
PHONE 604 467 1111
WEBSITE www.zoeticaenvironmental.com

Revision History

Project Title: NWMO Biodiversity Impact Studies

Document Title: Standard Operating Procedure for Aquatic Habitat Mapping – Northwestern Ontario Site

Document File Name: NWMO_BIS_2020_AHM SOP_IG (R004)

Rev. #	Issue Date	Description	Prepared By	Reviewed By	Approved By
R000	14-Aug-2020	BIS Year 1 final submission to NWMO	A. Buckman	D. MacKinnon	H. Bears
R001	18-Dec-2020	Revisions for Rev.1 NW Ontario BPD Report: - Edited protocols to match OSAP: Site ID and Site Features ID (5.3, 5.4, App J-M) - Added priority order of surveys (5.2) - Clarified that EMBP will collect bathymetry (5.6.4) - Added stream and waterbody reach tables and maps (App A, F) - Minor copyedits, formatting (throughout)	A. Buckman	C. Chui	H. Bears
R002	21-Apr-2021	Revisions for Rev.2 NW BPD Report: - Minor word edits, formatting (throughout)	A. Buckman	C. Chui	H. Bears
R003	21-Jun-2021	Minor edits for clarity and reorg of Appendix numbering	A. Buckman	D. Mackinnon	H. Bears
R004	23-Jul-2021	Minor edits from UAT and minor edits for clarity	A. Buckman	C. Chui	H. Bears

Table of Contents

List of Figures

GLOSSARY OF TERMS

BIS	Biodiversity Impact studies
CCME	Canadian Council of Ministers of the Environment
DO	Dissolved Oxygen
EC	Electrical Conductivity
EMBP	Environmental Media Baseline Program
GIS	Geographical Information System
GPS	Global Positioning System
GRTS	Generalized Random Tessellation Stratified
LSA_{AQU}	Aquatic Local Study Area
LUB	Left Upper Bank
MNRF	Ministry of Natural Resources and Forestry
MTO	Ministry of Transportation Ontario
NAD	North American Datum
NWMO	Nuclear Waste Management Organization
OS	OverSample
P1	PanelOne
PFD	Personal Floatation Device
QA	Quality Assurance
QC	Quality Control
RIC	Resource Inventory Standards
RISC	Resource Inventory Standards Committee
RSA_{AQU}	Aquatic Regional Study Area
RUB	Right Upper Bank
SAR	Species at Risk
SOP	Standard Operating Procedure
TDS	Total Dissolved Solids
UTM	Universal Transverse Mercator
PanelOne and OverSample points	PanelOne (P1) points are pre-selected points in a Generalized Random Tessellation stratified study design. If a P1 site is found to be inaccessible after reasonable effort, then the surveyor can visit/consider the next OverSample (OS) point as a replacement.

Waterbody	A waterbody is an accumulation of water in an area and includes lakes, ponds, and wetlands that do not have a defined channel that flows through it.
Lake	Open waterbody with a depth greater than 2 m and with less than 25% of its surface area covered with wetland vegetation.
Pond	A pond is a small body of still water formed naturally or by hollowing or embanking. Ponds differ from lakes in that they do not have an atrophic zone (an area deep enough that sunlight cannot reach the bottom).
Stream Reach	A relatively homogenous length of a stream, that flows on a perennial or seasonal basis, having a continuous channel bed and demonstrating fluvial processes (e.g., flowing water has scoured the channel bed or deposited any amount of mineral alluvium within the channel).
Watercourse	A watercourse is a natural or artificial channel through which water flows and includes streams, rivers and wetlands that include a defined channel that flows through them.
Wetland	An area where the water table is at, near, or above the surface, or where soils are saturated with water for sufficient time such that the principal determinants of vegetation and soil development are excess water and low oxygen. Waterbodies less than 2 m deep are considered wetlands. Wetlands are classified into four classes, marsh, swamp, bog, and fen (see Appendix J for definitions of the wetland types).

1.0 PURPOSE AND PRINCIPLE

The objective of this Standard Operating Procedure (SOP) is to provide instructions to the field contractor for conducting the field portion of the aquatic habitat mapping for the APM Project described in the Baseline Design Report. The SOP focusses on field surveying procedures based on available best practices and guidelines for fish habitat mapping; it follows protocols described in the Ontario Stream Assessment Protocol (OSAP) (Stanfield 2017) and is adapted using the Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures (RIC 2001), the Environmental Guide for Fish and Fish Habitat (MTO 2009), and the Ontario Wetland Evaluation System – Northern Manual (MNRF 2014), to align with Ontario standards.

The overall objectives of the baseline aquatic habitat mapping for the Biodiversity Impact Studies (BIS) are listed in Section 2.4.1.1 of the BPD Report.

2.0 GENERAL PRECAUTIONS

Fieldwork comes with inherent risk, especially when working around water. The field contractor should be trained in safety measures for working around water and in boats (for the waterbody surveys) and should be prepared to have all required safety equipment on hand. It is the responsibility of the contractor to ensure that all required personal gear and safety gear is carried in the field.

The location of the APM Project is remote, and access to many reaches may be difficult. Caution should be taken to determine safe access points, including from the air when ground access is not possible. In addition to access, wildlife is prevalent in remote areas of Northern Ontario.

3.0 EQUIPMENT AND MATERIALS

Equipment and materials required for bathymetry, limnology and water chemistry are described in the EMBP (CanNorth 2020). For fish habitat measurements the following equipment will be required:

Equipment for Field Measurements:
- Ruler (meter stick)
- Camera
- Tape measure (50 m)
- Range finder
- Clinometer or Survey equipment
- Hand level & measuring tape
- Water quality meter (e.g., YSI or HydroLab)
- Turbidity meter
- Bathymetry and limnology equipment (see EMBP, CanNorth, 2020)

Equipment for Cleaning:
- Spray bottles
- Rubber or disposable nitrile gloves
- Household bleach
- Tap water
- Distilled water
- Paper towels

General Field Equipment:
- Binoculars
- Waterproof notebook
- Pencils
- Clipboard
- Waterproof data forms
- Maps

General Safety Equipment:
- First aid kit
- Survival kit
- Emergency plan
- High visibility clothing
- Flagging tape
- Radio
- Satellite phone
- Bear spray

Personal Gear
- Rain gear
- Waders and patch kit
- Lunch and water
- Polarized sunglasses
- Clear safety glasses
- Hat with brim
- Sunscreen
- Bug shirt and insect repellent

Navigation Equipment:
- Access maps
- Air photos
- GPS unit
- Compass
- Georeferenced field maps on tablet or phone

Boat Equipment (For Lakes/Ponds/Wetlands/ Large Rivers)
- Boat and motor equipped to meet Coast Guard safety standards (e.g., PFD, oars, bailing can)
- Fuel and oil (for motorboat)
- Tool-kit and spare parts (spark plugs, pull cord)
- Anchor with an adequate line for deep lakes
- The propeller, cotter pins, shear pins

4.0 QUALITY CONTROL

Collection, acquisition, quality assurance (QA) and quality control (QC) of the immense volumes of data generated by large projects demand standardization and well-defined data management procedures. The field data collection contractor is expected to develop their own QA/QC protocols to ensure that field-based activities (e.g., data collection and data entry) meet the expectations of the NWMO. QA/QC protocols must include a method to back up all field data collected and to prevent the loss of data stored in one location or manner (e.g., a lost field form).

Desk-based mapping via air photo analysis will include field checks by the field data collection contractor to note any inconsistencies between field observations and mapped products. High-quality, field verified maps will permit extrapolation of field surveying information to areas that have not been surveyed, and for which maps and air photos are the only information available.

Changes to methodology should be verified with Zoetica before implementation. The field data collection contractor will be supplied with reach tables (**Appendix A** for watercourses and **Appendix B** for waterbodies) that identify reaches for surveying (based on a stratified and randomized design). The list of reaches to be surveyed will include contingency survey reaches in order of selection, in the case where chosen reaches cannot be surveyed (e.g., due to access or safety).

5.0 PROCEDURE

This document outlines the procedure for the aquatic habitat mapping of watercourses and waterbodies in the study area. The procedure section is subdivided into 1) Decontamination Procedures for equipment and personal gear before and between surveying in watercourses and waterbodies; 2) General Procedures for all watercourses and waterbodies; 3) Site Identification procedures; 4) Site Features Identification; 5) Watercourse (Stream) Surveys that include rivers, streams, and tributaries, and wetland reaches that have a clear watercourse running through them; and 6) Waterbody Surveys that include lakes, ponds, and wetlands with no clear channel flowing through them. The field protocol follows the *Ontario Stream Assessment Protocol* (Stanfield 2017), and the *Environmental Guide for Fish and Fish Habitat* (MTO 2009) with adaptations from the *Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures* (RIC 2001).

5.1 Decontamination Procedures

All equipment requires cleaning between survey sites where sites are not hydrologically connected. The Canadian Council of Ministers of the Environment (CCME) *Protocols Manual for Water Quality Sampling in Canada* (CCME 2011) will be followed for the cleaning of surveying equipment and personal gear (e.g., waders, gloves) before surveying, and between sites (where not hydrologically connected). The effective cleaning of survey equipment prevents the transfer of aquatic invasive species from one waterbody to another. Section 5.1.1 briefly summarizes the cleaning protocol:

5.1.1 Decontamination of Equipment Before Fieldwork

1. **Drain** all water from watercraft, including the motor, live well, and bilge at the source or on land.
2. **Clean** and inspect all equipment and personal gear such as waders, watercraft, trailers, boots, gloves. **Remove** all plants, animals, and mud.

3. **Soak** all equipment in a diluted household bleach solution (>5% sodium hypochlorite) at a concentration of 100 ml (~3 ounces) of bleach to 20 L (~5 gallons) of water for at least 60 minutes. Triple-rinse all equipment with tap water. **Rinse** using high pressure, if possible. Extremely hot tap water is preferable (50°C or 120°F). Alternatively, **freeze** all equipment and gear for two or more days.
4. **Dry** all watercraft and gear for at least 5 days in the hot sun.

5.1.2 Decontamination Between Sites

Decontamination must be performed before moving from site to site (i.e., different watercourse, waterbody, or wetland), where sites are not hydrologically connected. Bleach will avoid the spread of invasive species as well as chytrid fungus, ranaviruses, and other amphibian diseases as per protocols found in the *Decontamination Protocol for Field Work with Amphibians and Reptiles in Canada* (Canadian Herpetofauna Health Working Group, 2017).

1. **Set up** a decontamination station by placing 3 tote bins on top of a tarp in a sunny location away from a watercourse or waterbody. Direct sunlight will help break down residual bleach. (Note: it is assumed that there will be no impermeable surfaces within the study area on which to dispose of rinse water.)
2. **Fill** one tote bin with soapy water (add liquid dish soap to tap water). Scrub the soles and sides of your rubber/hiking boots with a scrub brush to remove visible organic matter, dirt, and sediment. **Rinse** with clean tap water into the 3rd tote bin. Note: if it is not possible to carry large quantities of tap water into the field, the field crew can use water from the next surveying site to wash equipment, but rinsing should occur away from the waterbody at the rinse station to avoid contamination.
3. **Prepare** a fresh 1 in 10 dilution of household bleach in a spray bottle, i.e., 1 part bleach, 9 parts water. Fill a 2nd tote bin and a spray bottle with this bleach solution. Wear rubber gloves and safety glasses/goggles – bleach is corrosive!
4. **Immerse** all equipment and gear that may be contaminated (including personal gear such as boots, waders, and gloves) in the bleach solution. Spray larger items to soak thoroughly. Let sit for at least 1 min, then triple rinse with clean tap water into the 3rd tote bin.

<u>Shelf life of decontamination solutions and disposal:</u>

a. Bleach solution in the tote bin and spray bottle can be reused for up to 7 days.
b. Tote bin with soapy water can be reused until it becomes too dirty with visible particulate matter.
c. Tote bin with rinse water should be disposed of daily.
d. To dispose of old solutions, carry the bins back to camp and flush down the drain with plenty of water.

Notes: Even trace amounts of residual bleach can adversely affect amphibians on contact. If it is not feasible to carry large quantities of tap water, consider bringing multiple pairs of boots and change between sites. Decontaminate all boots back at the camp.

5. Watercraft, such as boats and motors, should also be cleaned between non-hydrologically connected sites and thoroughly dried before using it at a new site. All visible mud, vegetation, and biotic material should be removed from watercraft at the site immediately after removal of the watercraft from the. Before moving watercraft to a new waterbody, the watercraft should be

scrubbed down using a brush and bleach solution as described above, triple-rinsed and left to dry in the sun to break down any remaining bleach.

5.2 General Field Procedure

1. Before conducting fieldwork at each identified location for the survey, a field reconnaissance should be conducted using a helicopter to fly over the proposed survey reaches identified in the *Watercourse (Stream) Survey Reach Table and Map* (**Appendix A**) and the *Waterbody (Lake/Pond/Wetland) Survey Reach Table and Map* (**Appendix B**) to i) verify the reach breaks and major inlets and outlets to waterbodies mapped during the desk-based aquatic habitat mapping ii) to identify reaches that are not possible to survey (e.g., due to being dry), and iii) to plan field logistics. Any changes that require being made to reach breaks should be conducted following the procedure outlined in Section 5.5.2. The *Site Identifier Form* (**Appendix C**) with instructions for filling out the form (**Appendix D**) and *the Site Features Form* (**Appendix E)** with instructions **(Appendix F)**, are detailed in Section 5.3 and Section 5.4 and should be used during the field reconnaissance and during each ground visit to a reach to document site identification and site feature information. For stream reaches in major watercourses and lake reaches, site identification and site feature information can be conducted during the formal aquatic habitat surveys and mapping and recorded on the *Site Identifier Form* (**Appendix C**) and the *Site Features Form* (**Appendix E**) at the time of the survey.
2. Each day, a route should be determined using the list of pre-determined reaches and field maps provided in **Appendix A** for watercourses (streams) and **Appendix B** for waterbodies (lakes/ponds/wetlands). Route planning should ensure any sites not visited the previous day, due to time limitations, should be included in the next day's route. The order of survey should prioritize the AOI first, followed by reaches in the LSA_{AQU} and finally the RSA_{AQU}. However, minor modifications for survey efficiency can be implemented. Reach prioritization is listed in reach tables provided in **Appendices A** and **B**. The field data collection contractor should note any required use of helicopters to assist access or speed up field work.
3. When in the field, follow the route planned for the day to navigate to the next site. A list of reaches to be surveyed is provided in the reach tables in this SOP and includes oversample locations in the case that a selected lake or wetland cannot be surveyed. The field contractor should take care, however, not to skip points too quickly and without effort in favour of randomized points that happen to occur next to easily accessible areas (roads, cleared forest) as this may impose a site selection bias meant to be diminished via the use of pre-selected, random points. While points should be visited in order wherever possible, logistical constraints due to difficulty accessing areas may render it necessary to deviate from the ordering presented in the reach tables, (e.g., in a situation where there is only one way into a large, difficult to access area and points can be selected along a hiking route). In such cases, the replacement of any sites with an oversample location should be noted in the comments section of the *Watercourse (Stream) Survey Form* (**Appendix G**) or *the Waterbody (Lake/Pond/Wetland) Survey Form* (**Appendix L**).
4. Using the list of pre-determined reaches, check what type of survey (watercourse or waterbody) is meant to be conducted at each reach visited. Continuous boat surveys may be conducted along all reaches of the major watercourses (e.g., Mennin and Revell Rivers) to document aquatic habitat and fish habitat in these reaches.
5. Assemble required gear for survey type according to the gear lists in Section 3.0.

5.3 Site Identification

Site identification will follow methods established in the *Ontario Stream Assessment Protocol (OSAP)* (Stanfield, 2017). Instructions for conducting site identification and forms to be filled out are adapted from this protocol.

Field studies, for which data will be compared to a standard or among site/years, require that site boundaries be consistent between sampling events for future Tier 2 studies. Site boundary definitions must be consistently defined to standardize data collection and reduce sampling errors. Defining sites using physical boundaries based on geomorphic criteria, such as the riffle-pool sequence, ensures that the data will be comparable across stream types and sizes and through time.

The *Site Identifier Form* (**Appendix C**) and *Guidelines for Filling out the Site Identifier Form* (**Appendix D**) are used for this section of the Aquatic Habitat Mapping Procedure. The *Site Identifier Form* (**Appendix C**) is filled out for each site within a stream reach or lake/pond reach. Note: large lakes may have multiple sites to survey.

5.3.1 Pre-field Activities

1. Record the Station ID, Watercourse/Waterbody ID, Watercourse/Waterbody Name, and Reach Number from the reach tables provided in **Appendix A** and **Appendix B** on the *Site Identifier Form* (**Appendix C**) before heading to the field. Each site within a reach will require filling out a new form. Major inlet and outlets of lakes will also each require a new *Site Identifier Form* to be filled out. Note: for digital forms Station ID will be required to be entered on the form, but Watercourse/Waterbody ID, Watercourse/Waterbody Name, and Reach Number will be pre-populated.

5.3.2 In-Field Procedure

The instructions below are used to fill out the *Site Identifier Form* (**Appendix C**). Further details are provided in the *Guidelines for Filling Out the Site Identifier Form* (**Appendix D**).

1. Record date (in MM-DD-YYYY format)
2. Record unique Crew ID, site number, and sample number. Note: Sample number is 1 if it is the first visit to the site in any given year.
3. Record Weather conditions including sky conditions, wind direction, wind speed (km/hr), air temperature (°C), and precipitation in last 24 hr (e.g., rain in mm or snow in cm).
4. Obtain UTM coordinates for the downstream end of the site and record using NAD 83 datum.
5. Measure and Record Site Length (in m)
    a. Measure the mid-channel length by chaining the site from the downstream end of the site (at one crossover point) to the top (the next crossover point). NOTE: a site must be a minimum of 40 m long and begin and end at a crossover point. Thus, at some locations, multiple crossover sites may be required to define a survey site to achieve the minimum required length of the site. Do not shorten the site length as this may bias the surveys because certain habitats may be under- or over-represented. Where there are no clearly defined crossover points within a site (e.g., channel through a wetland), a survey site will be defined as 100 m for channels less than 10 m wide and 10 time the bankfull width for channels that are greater than 10 m wide.

   b. Chain the center of the stream as outlined in **Figure 5-1**. Use the outer boundaries of the wet channel to determine 'stream width.' This measure includes undercuts and islands in the interpretation of stream width. It does not extend beyond the wetted channel.
   c. One person stands at the downstream end of the site in the middle of the stream to mark the starting point.
   d. A second person proceeds upstream until the stream changes direction (or until the end of the tape). The second person marks the point, measures the distance, and waits for the first person to reach the mark before proceeding upstream to the next mark location.
   e. At the centre of each curve in the stream, the second person marks the location and calls for the first person to move up. NOTE: Do NOT stretch the tape around corners.
   f. This process is repeated until the total site length is measured. Unless the station boundaries have already been marked, crews will typically chain the length of the site and identify the upper boundary.
6. Clearly document the site location so that it can easily be relocated. Use existing structures such as fence lines, healthy distinct trees or corners of buildings as reference points. Alternatively, rebar can be placed well into the ground beside a tree or other object, spray-painted metal survey stakes can be driven into the ground, coloured metal tree tags driven into a tree can be used, or spray paint on large boulders or objects for short term (i.e., annual) markers. Flagging tape can also be used to increase site visibility in the short term and tied to a marker. Site name and date should be written on flagging tape.
7. Fill out the *Site Identifier Form* (**Appendix C**) and photograph the site. The *Guidelines for Filling out the Site Identifier Form* (**Appendix D**) includes a description of identifiers for filling out the forms.
8. Include a sketch of the site on the form, and if access by road is an issue or not easily accessed via GIS mapping, include a second sketch to guide crews to the survey location. The sketch
   a. Site boundaries
   b. Location of site markers
   c. Adjacent landscape features and land uses
   d. Boundaries of vegetation types
   e. Location of any buildings or fence lines
   f. Route used to access the site
   g. The direction of water flow
   h. A north arrow and relative scale.

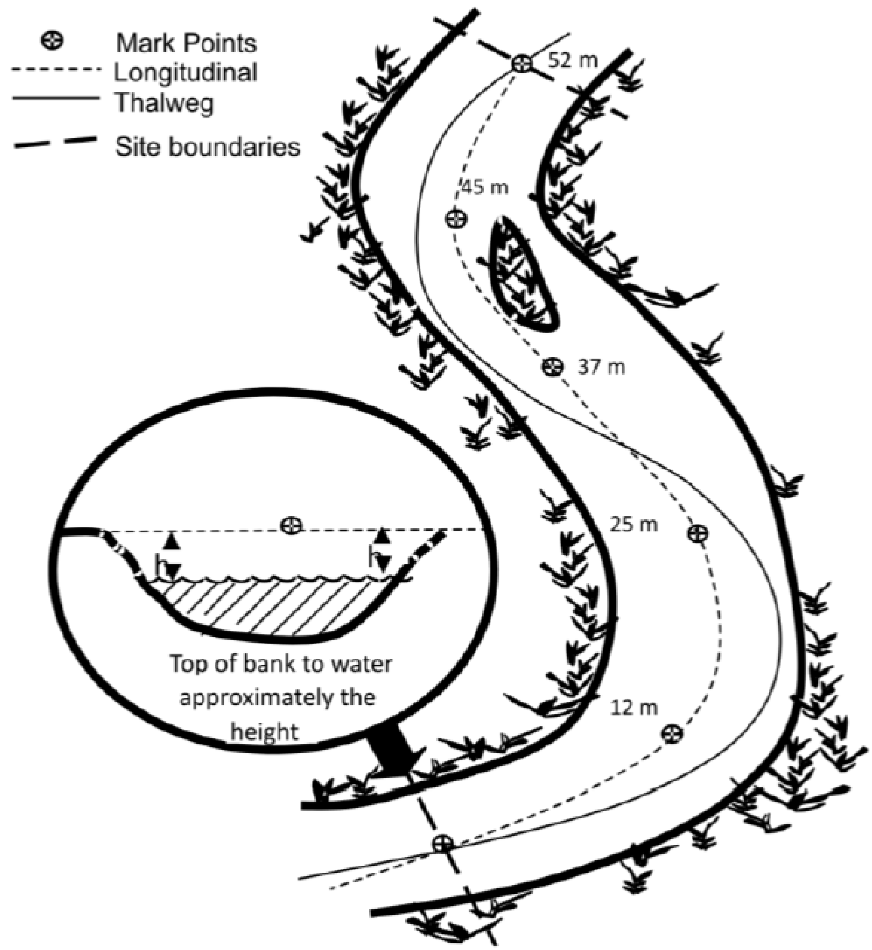


Figure 5-1. Site Boundaries and Length Determination. The first crossover point (half-meander length) occurs at 27 m, therefore, it must continue to the next crossover. From OSAP Manual (Stanfield 2017).

5.4 Site Features Identification

The *Site Features Form* (**Appendix E**) is filled out for each site within a stream reach or lake/pond/wetland reach. Note: large lakes may have multiple sites to survey. Site feature identification generally follows protocols outlined in the *OSAP manual* (Stanfield 2017). The *Site Features Form* (**Appendix E**) and *Guidelines for Filling out the Site Features Form* (**Appendix F**) are used for this section of the Aquatic Habitat Mapping Procedure.

5.4.1 Pre-field Activities

1. Record the Station ID, Watercourse/Waterbody ID and Watercourse/Waterbody Name and Reach number on the datasheets before heading to the field. Note: for digital forms Station ID will be required to enter into the form, but Watercourse/Waterbody ID, Watercourse/Waterbody Name and Reach number will be pre-populated.
2. The Site Features Form is to be filled out during Site Identification for each site within a reach.

5.4.2 In-Field Procedure

The instructions below are used to fill out the *Site Features Form* (**Appendix E**). Further details are provided in the *Guidelines for Filling Out the Site Features Form* (**Appendix F**).

1. Fill in the Date field on the form (MM-DD-YYYY).
2. Fill out Crew ID, Site Number, and Sample Number for each site within a reach.
3. For each land use, check the boxes that apply on the form and fill out the comments to explain any particulars. Include names and numbers of contacts where relevant.
4. Click the box for the source of information collected. See the *Guidelines for Filling Out the Site Features Form* (**Appendix F**) for definitions of sources of information.
5. Determine water temperature (in °C) using either a thermometer or a digital recording thermometer. Place the thermometer in the main flow of the stream (e.g., a run or scour pool), avoiding deep pools as they may be sources of groundwater upwellings. After 30 seconds have elapsed, record the water temperature to the nearest degree. Also, record the time that the water temperature was taken (24 hr clock).
6. Visually examine the vegetation communities occurring along each bank of the stream. Note: **Left and right are defined when standing in the water and facing upstream.** Divide the bank into three zones based on distance from the water as follows: 1.5 to 10 m, 11 to 30 m, and 31 to 100 m, and can be done visually or by measuring the distance to the zone boundaries. For each zone on each bank, record the dominant type of vegetation based on canopy cover by marking an "X" in the appropriate box on the Site Features Form. Record the right and left bank separately. Note: see the *Guidelines for Filling Out the Site Features Form* (**Appendix F**) for definitions of each category. When most of a zone is covered by one vegetation community, this community type is dominant. If it is not apparent which type is dominant, measure the area (total length and width) of each type to sort out conflicts. Note that the classification is hierarchical, ensuring that all riparian zones meet one criterion only.

5.5 Watercourse (Stream) Survey

This section describes the procedures for conducting watercourse (stream) surveys. The *Watercourse Reach Table and Survey Map* (**Appendix A**), the *Watercourse (Stream) Survey Form* (**Appendix G**), the *Watercourse Reference Guide* (**Appendix H**), and the *Aquatic Habitat Mapping Form* (**Appendix I**) accompany this SOP for the watercourse inventory. Stream reach tables (**Appendix A**) include a list of contingency reaches to use in cases where reaches cannot be surveyed due to safety or access concerns. Both the *Watercourse (Stream) Survey Form* and the *Aquatic Habitat Mapping Form* are to be filled out at every site on each reach surveyed. Note that prior to filling out the *Watercourse (Stream) Survey Form* (**Appendix G**) at each site, the *Site Identifier Form* (Section 5.3; **Appendix C**) and the *Site Features Form* (Section 5.4; **Appendix E**) should be filled out.

The SOP below is structured to provide instruction for conducting the field measurements to fill out each section of the *Watercourse (Stream) Survey Form* (**Appendix G**). Detailed instructions and field code definitions for filling out the form can be found in the *Watercourse Reference Guide* (**Appendix H**). Some sections of the form can be filled out by the field-contractor before conducting fieldwork by using the reach table (**Appendix A**). The *Aquatic Habitat Mapping Form* (**Appendix I**) is used to map the habitat characteristics at each site visited. Instructions for Aquatic Habitat Mapping are described in Section 5.7.

Pre-field:

The *Watercourse (Stream) Survey Form* (**Appendix G**) is used to capture data collected in the field. As part of pre-field site referencing, transcribe the Project Number and Project Description (see General Information, Section 1) and reach referencing information (see Location Information, Section 5.5.2) onto the *Watercourse (Stream) Survey Form* (**Appendix G**) before conducting field surveys.

In the field:

The field component of the watercourse (stream) aquatic habitat mapping survey includes the following:

1. description of survey and water conditions (General Information, Section 5.5.1);
2. survey site description (Location Information, Section 5.5.2);
3. watercourse morphology characterization (Reach Section Type and Morphology, Section 5.5.3);
4. channel measurements (Reach Section Type and Morphology, Section 5.5.3);
5. cover and habitat inventory (Cover and Habitat, Section 5.5.4;
6. features identification (e.g., migratory obstructions) (Additional Information, Section 5.5.5);
7. wildlife observations (recorded in comments section) (Additional Information, Section 5.5.5);
8. photography (Photographing Watercourses, Section 5.5.1.1); and,
9. Mapping of reach information on the *Aquatic Habitat Mapping Form* (**Appendix I**) (see Section 5.7).

For wetland reaches, the minimum information required is location information (site referencing), cover estimates, water characteristics (temperature, pH, conductivity, turbidity), photos, and cover and habitat inventory.

5.5.1 General Information

This section details the procedure to fill out the General Information Section of the *Watercourse (Stream) Survey Form* (**Appendix G**) and provides directions for taking watercourse site photos.

1. Record Project information on survey form: **APM BIS Project Number: NWMO-BIS-AQH1**
2. Record Project Description: **Biodiversity Baseline Data Collection**
3. Record Survey Date, Unique Crew ID, Surveyors, and Time Started.
4. Remember to record Time Finished at the end of surveying.
5. Take air temperature and record in °C.
6. Take water temperature, pH, conductivity, and turbidity measurements from mid-stream and mid-depth, if possible, using a portable conductivity meter (e.g., YSI, or HydroLab). If the meter does not automatically standardize to 25°C, record water temperature at the same time as conductivity and use a conductivity nomograph to convert the reading to 25°C. Record information on the survey form.
7. Take photographs of the site following photographic instructions below and record photo numbers and general descriptions on the *Watercourse (Stream) Survey Form* (**Appendix G**) and the *Aquatic Habitat Mapping Form* (**Appendix I**).

5.5.1.1 Photographing Watercourses

Photographs need to be carefully referenced on the *Watercourse (Stream) Survey Form* (**Appendix G**) and the *Aquatic Habitat Mapping Form* (**Appendix I**).

1. Take upstream-oriented and downstream-oriented photographs at each site to show general stream characteristics including:
    a. Channel morphology (e.g., riffles, pools, runs);
    b. Riparian vegetation;
    c. Obstructions to fish passage;
    d. Major disturbances;
    e. Culverts/water crossings (e.g., piers, abutments);
    f. Ditch lines (at crossing structure);
    g. Rare habitat/spawning/nesting sites;
    h. Specific habitat features that may be impacted by the project activities; and,
    i. Areas of potential offsetting (e.g., where habitat has been degraded due to forestry roads).

At road crossings, take the photos of vantage points illustrated in **Figure 5-2**.

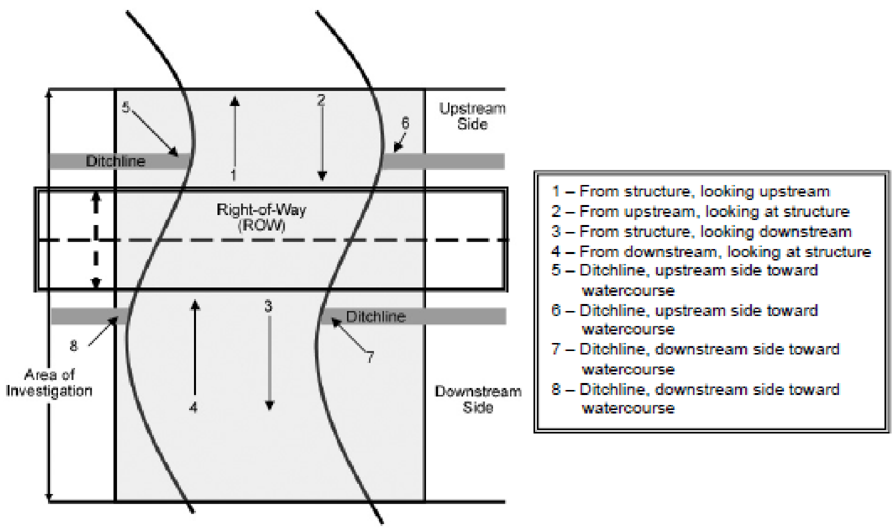


Figure 5-2. Photo vantage points to be taken at crossing locations. From MTO 2009.

2. For each photo record the photo ID (from the camera) and the general direction that each photograph was taken: U/S (upstream), D/S (downstream), X (across the stream), or Bd (towards stream bed) and any relevant descriptions of photos (see the list in bullet #1) on the *Watercourse (Stream) Survey Form*. On the *Aquatic Habitat Mapping Form,* note the location and photo number (from the camera) on the drawn map of all photos taken.

5.5.2 Location Information

This section details how to fill out the Location section of the *Watercourse (Stream) Survey Form* (**Appendix G**) and provides instruction on conducting the in-field verification of the desk-based reach mapping. Some information in this section can be filled into the survey form before heading to the field.

Pre-field:

1. Record whether survey is conducted as part of the inlet/outlet survey for lakes (Y/N). If yes, please see Waterbody Reference Guide (in **Appendix M**) which contains instructions for filling out fields in the next step below, as they differ from the typical stream reach table fields.
2. Record the following information supplied in the reach tables (**Appendix A**) onto the *Watercourse (Stream) Survey Form* (**Appendix G**) before entering the field:
    a. Station ID (unique ID for each reach)
    b. Watercourse ID (desk-based unique ID)
    c. Watercourse Name (gazetted name and/or alias)
    d. Reach Number (derived by Zoetica using GIS and assigned in a sequential upstream order starting at the downstream end of the stream)
    e. GPS Coordinates of the upstream end of reach (UTM Zone/Easting/Northing (NAD 83) based on GIS)

Note: for digital forms Station ID will need to be entered into the form but the remainder of information in step 2 will be pre-populated from the reach table.

In the field:

1. In a helicopter with good visibility, conduct a reconnaissance flight of the reach before landing to survey, to determine if reach breaks are appropriate.
2. If pre-determined reaches provided in the reach table (**Appendix A**) need to be split into separate reaches (e.g., due to non-homogenous characteristics identified in the field, or fish barriers), renumber the split reaches as sub-reaches using a decimal system (e.g., 1, 2.1, 2.2, 2.3, 3…) and record on the *Watercourse (Stream) Survey Form* (**Appendix G**). Take GPS coordinates of each new reach break (at downstream end) and record waypoint numbers in the comments section. Note: it is advisable to mark on the field map where proposed new reach breaks might be made and to verify them in the field once on the ground, if possible.

5.5.3 Reach Section Type and Morphology

This section details the procedures to fill out the information in the Reach Section Type and Morphology section of the *Watercourse (Stream) Survey Form* (**Appendix G**) and provides instruction for conducting physical field measurements at the site.

1. In the field, determine a representative section of the reach to survey.
2. Record Reach or Sub-reach Number (Note: if the Reach Number identified in Location Block is sub-divided further in the field, record Sub-Reach Number here).
3. Record Site Number. Site numbers are given in a sequential, upstream, ascending order and are used when more than one site is surveyed in a reach. A new form is filled out for each new site in a reach.
4. Record Field UTM (the GPS Coordinates) of the downstream end of the site to be surveyed using NAD 83. Record UTM Coordinates (Zone/Easting/Northing) to the meter level (uncertainty).
5. Type: Check the appropriate type (stream/river or channelized) **and** check either permanent, intermittent, or ephemeral.

6. Associated Wetland: Describe the wetland type that appears to be hydrologically connected to stream reach, if present, according to the Ontario Wetland Evaluation System (MNRF 2014). Wetland types include bog (Wb), fen (Wf), marsh (Wm), swamp (Ws), and unknown wetland (Wu) (see **Appendix J** for definitions).
7. Site Length: Copy site length from the *Site Identifier Form.*
8. Gradient % and Code: Measure at a minimum of two locations along the survey site over as long a distance as possible. Measure in upstream and downstream directions to maximize the distance. Measurements are sighted from similar habitat units (e.g., riffle crest to riffle crest). Record the grade to the nearest 0.5% and the method code using the following:

Method Type	**Code**
Ground Estimates	GE
Clinometer	C
Abney type level	AL
Survey equipment	S

9. Stream Discharge: Record the amount of water passing through the channel at the time of the survey
    a. Observe the amount of water in the channel in relation to the bankfull depth.
    b. Look for low flow indicators:
        i. The distinct sequence of riffles and pools, or steps and pools
        ii. Wetted width significantly less than the channel width
        iii. Dry, unvegetated channel bars
    c. Look for high flow indicators:
        i. The distinction between riffles and pools or steps and pools is difficult
        ii. The water level at or over bank tops
        iii. Wetted width similar to or greater than the channel width
        iv. No visible bars or banks
    d. Check the appropriate code:

Definition	**Code**
Low (0 – 30% of Bankfull)	L
Moderate (31 – 90% of Bankfull)	M
High flow (> 90% of Bankfull)	H

10. Subsections: Check all that apply (Run, Pool, Riffle, Flats, Culvert, Other)
11. Percentage Area: for each type of subsection described in #10, record the percentage it accounts for of the site surveyed.
12. Mean Depth Wetted (m): For each type of subsection described in #10, record the mean wetted depth:
    a. Measure the outlet crest depth and subtract it from the maximum upstream pool depth.
    b. Repeat this measurement at a minimum of 6 riffle-pool, cascade-pool, or step-pool sequences within the site.
    c. Classify glides as large morphology.
    d. Record the residual pool measurements to the nearest 0.1 m.

13. Mean Width Wetted (m): For each type of subsection described in #10, record the mean wetted width:
    a. Measure to ± 0.1 m the distance of the wetted surface from the right to the left side of the channel. Repeat a minimum of 6 times at equally spaced intervals in conjunction with the channel measurements.
    b. Include water under undercut banks, protruding rocks, logs, and stumps.
    c. Repeat measurement in conjunction with channel bankfull width measurements (see #15).
    d. Add widths of multiple channels for the total wetted width.
14. Mean Bankfull Width (m): For each type of subsection described in #10, record the mean bankfull width:
    a. Include all unvegetated gravel bars in the measurement.
    b. Where one or more vegetated islands separate multiple channels, measure the width as the sum of all the separate channel widths. The islands are excluded from the overall width measurement (see **Figure 5-3**).
    c. Measure the widths at a minimum of 6 sites, taken at equally spaced intervals. The 6 channel/wetted widths should be equally spaced over the site.
    d. Generally, do not take stream widths near stream crossings, unusually wide or narrow areas (e.g., impoundments), or disturbances.

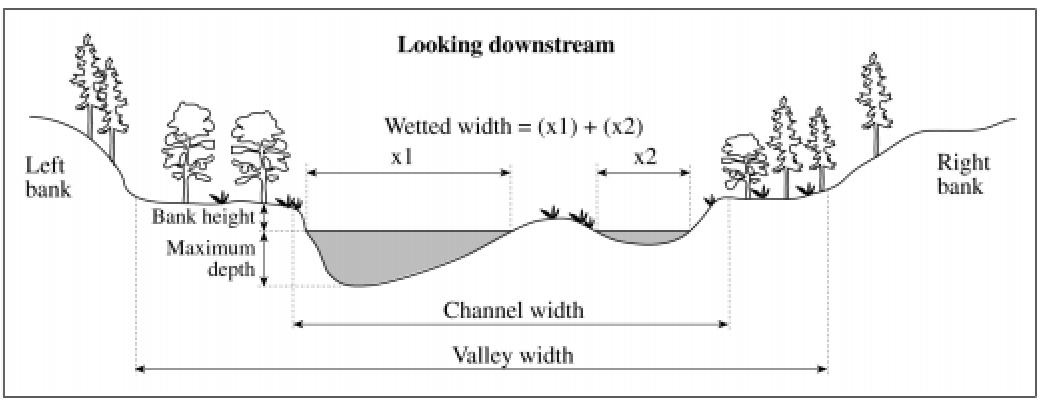


Figure 5-3. Measuring channel bankfull widths. From RIC, 1999.

15. Mean Bankfull Depth (m): For each type of subsection described in #10, record the mean bankfull depth:
    a. Identify the top of both banks.
    b. Extend the meter tape from the left banktop to the right banktop to simulate the bankfull water level.
    c. Use a meter stick to measure the difference in elevation from the tape to the channel bed at a riffle-pool, cascade-pool, or step-pool break beneath the cross-section.
    d. Place the meter stick at the deepest point in the channel along the cross-section at a riffle-pool, cascade-pool, or step-pool break. See **Figure 5-4** for a cross-sectional view of measuring bankfull depth.

e. If there is more than one channel (e.g., where vegetation islands separate flow), measure the bankfull depth in the main channel (usually the channel that is deepest and fastest flowing).
f. Collect a minimum of 3 measurements and record average and range to the nearest 0.1 m.

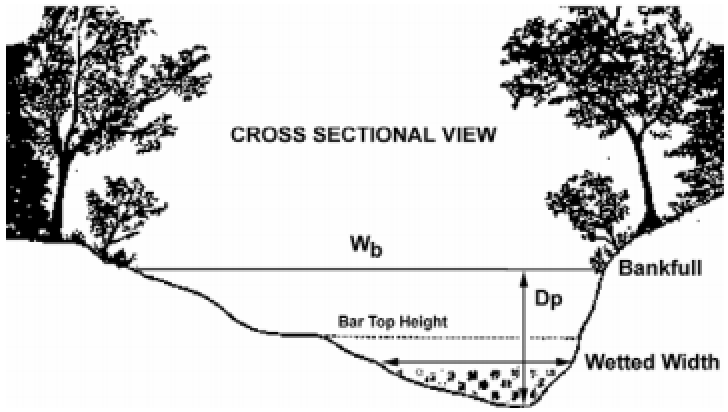


Figure 5-4. Cross-sectional view of measuring the bankfull channel width (Wb) and depth (Dp). From RISC (2008).

16. Substrate Percentage (%):
    a. Visually assess the percent cover of substrate type and record and classify percent type by bedrock, boulder, cobble, gravel.
    b. For fine textures including sand, silt, clay, muck, and detritus, place about ½ to 1 tablespoon of sediment in the palm, feel the mass by rubbing between fingers (see *Watercourse Reference Guide: Stream Reaches* **Appendix H**) and record the percentage of each type.
    c. The total should add to 100%.

17. Bank Stability:
    a. Determine the category of bank stability for the left upstream bank and right upstream bank separately (see *Watercourse Reference Guide: Stream Reaches* in **Appendix H**). Banks are described as:
        i. deposition zone (<45 degree slope);
        ii. protected (for banks with >45 degree slope with non-erodable material);
        iii. vulnerable (no recent sign of erosion); or
        iv. eroding (slumping).

5.5.4 Cover and Habitat

This section details the procedures to fill out the Cover and Habitat section of the *Watercourse (Stream) Survey Form* (**Appendix G**) and instructions for conducting cover and habitat measurements.

1. Instream Cover (% surface area):
    a. Locate the cover types (undercut banks, boulders, cobble, woody debris, vascular macrophytes, other) within the wetted channel or within 1 m above the water surface.

   b. Estimate the relative amount of cover that the individual cover type provides for the entire site.
   c. Record the percent instream cover for each type of cover type.
2. Shore Cover (% stream shaded):
   a. Visually assess the percent of canopy closure provided by streamside/riparian vegetation, which projects over the stream channel to provide shade and is > 1 m above the water surface.
   b. Check off the appropriate percentage on the Watercourse (Stream) Survey Form.
3. Instream Vegetation Type (%) and Predominant Species:
   a. Visually estimate and record the percent of the stream bed covered by each vegetation type (submerged, floating, emergent).
   b. Record the predominant species of each vegetation type.
4. Riparian Vegetation Type and Stage:
   a. Visually assess riparian vegetation types and check the dominant type for stream section.
   b. Check the dominant riparian stage (initial (<5% total cover), shrub/herb, (<10% total cover), pole-sapling, young forest, mature forest) for each bank (left upstream bank and right upstream bank).

5.5.5 Additional Information

1. Migratory Obstructions:
   a. Check off any permanent or seasonal natural (e.g., beaver dams, cascades, waterfalls, water depth and flow) and human-made (e.g., dams, weirs, perched culverts) obstructions that occur within the stream site surveyed.
   b. If barriers are noted outside of site location but within the full reach, note this in the comments section.
2. Potential Critical Habitat/Limiting Habitat:
   a. Record locations of all evidence of spawning and potential groundwater discharge (e.g., springs, watercress, iron ‘floc’ or staining, bank seepage) or other types of habitat that may provide critical habitat functions such as nursery habitat, seasonal refugia, deep holding or staging pools.
3. Potential Enhancement Opportunities:
   a. Note any opportunities that exist for potential enhancement of stream section and reach. Provide as many details as possible.
4. Comments
   a. Note any additional information that may be useful in assessing fish habitat.
   b. Include incidental observations or signs of fish and other wildlife.

5.6 Waterbody (Lakes/Ponds/Wetlands) Survey

This section describes the procedures for conducting aquatic habitat surveys in lakes, ponds, and wetlands. A checklist for information that is required to be collected is supplied in the *Waterbody (Lake/Pond/Wetland) Checklist Form* (**Appendix K)**. The *Waterbody (Lake/Pond/Wetland) Reach Table and Map* (**Appendix B**), the *Waterbody (Lake/Pond/Wetland) Survey Form* (**Appendix L**), and the *Aquatic Habitat Mapping Form* (**Appendix I**) accompany this section of the SOP. The waterbody reach table indicates which lake/pond/wetland reaches will be surveyed in the field. A list of contingency waterbody reaches is also supplied in the case where reaches are not able to be surveyed due to safety or access concerns. Note that prior to filling out the *Waterbody (Lake/Pond/Wetland) Survey Form* (**Appendix L**) at each site, the *Site Identifier Form* (Section 5.3; **Appendix C**) and the *Site Features Form* (Section 5.4; **Appendix E**) should be filled out. Detailed instructions, including definitions for each data field on the *Waterbody (Lake/Pond/Wetland) Survey Form*, are included in a *Waterbody Reference Guide: Lakes, Ponds, and Wetlands* (**Appendix M**). A description of wetland types is provided in the *Wetland Type Reference Guide* (**Appendix J**). Both the survey form and the mapping form are to be filled out at every site for each reach surveyed. The *Waterbody (Lake/Pond/Wetland) Survey Reach Table and Map* is provided in **Appendix B**.

The SOP below is structured to provide instruction for conducting the field measurements to fill out each section of the *Waterbody (Lake/Pond/Wetland) Survey Form* (**Appendix L**). Some sections of the form can be filled out by the field-contractor before conducting fieldwork by using the reach table in **Appendix B**. The *Aquatic Habitat Mapping Form* (**Appendix I**) is used to map the habitat characteristics at each site visited. Instructions for Aquatic Habitat Mapping are described in Section 5.7.

Pre-field:

The *Waterbody (Lake/Pond/Wetland) Survey Form* (**Appendix L**) is used to capture data collected in the field. As part of pre-field site referencing, transcribe the Project Number and Project Description from the General Information section (see Section 5.6.1) and the reach referencing (Location) information (see Section 5.6.2) onto the *Waterbody (Lake/Pond/Wetland) Survey Form* before conducting field surveys.

In the field:

The field component of the waterbody (lake/pond/wetland) aquatic habitat mapping survey includes the following:

1. description of survey and water conditions (General Information, Section 5.6.1);
2. survey site description including the surrounding land use (Location Information, Section 5.6.2);
3. waterbody morphology characterization (Reach Type and Morphology, Section 5.6.3);
4. waterbody major inlet and outlet survey (to be conducted following the watercourse survey protocol on the *Watercourse (Stream) Survey Form* (**Appendix G**)
5. characterization of water quality and limnology (to be coordinated with the EMBP; CanNorth, 2020) and details to be recorded on the EMBP Forms (Limnology, Bathymetry, and Water Chemistry, Section 5.6.4);
6. bathymetric characterization (to be coordinated with the EMBP; CanNorth, 2020) and details to be recorded on the EMBP Forms (Limnology, Bathymetry, and Water Chemistry, Section 5.6.4);
7. bank and shoreline cover and habitat characterization (Cover and Habitat, Section 5.6.5);
8. In-water cover and habitat characterization (Cover and Habitat, Section 5.6.5);
9. wildlife observations (recorded in comments box) (Additional Information, Section 5.6.6);
10. photography (recorded in General Information, Section 5.6.1.1); and,
11. Mapping of waterbody on the *Aquatic Habitat Mapping Form* (**Appendix I**) (see Section 5.7).

For wetland reaches, the minimum information required is site referencing, cover (cover estimates), water characteristics (temperature, pH, conductivity, turbidity), photos, and habitat quality characterization.

5.6.1 General Information

This section details how to fill out the General Information section of the *Waterbody (Lake/Pond/Wetland) Survey Form* and provides directions for conducting measurements and taking waterbody site photos.

1. Record Project information on survey form: **APM BIS Project Number: NWMO-BIS-AQH1**
2. Record Project Description: **Biodiversity Baseline Data Collection**
3. Record Survey Date, Crew ID, Surveyors, Air Temperature, Surface Water Temperature, and Time started.
4. Remember to record Time Finished at the end of surveying.
5. Record surface conditions of the lake.
6. Take photographs of the site following photographic instructions below and record photo numbers and a general description on the survey form.

5.6.1.1 Photographing Lakes and Ponds

Photographs need to be carefully referenced on the *Waterbody (Lake/Pond/Wetland) Survey Form* (**Appendix L**) and the *Aquatic Habitat Mapping Form* (**Appendix I**).

1. Take the following photographs during lake inventories:
    a. Panoramic view of the surrounding area;
    b. Shoreline and riparian conditions;
    c. Inlet and outlet streams;
    d. Aquatic plant communities;
    e. Any other important and relevant features;
    f. Specific habitat features that may be impacted by the project activities; and,
    g. Areas of potential offsetting (e.g., where habitat has been degraded).

2. For each photo, record the photo ID (from the camera) and the general direction that each photograph was taken: North/East/South/West (see the list in bullet #1) on the *Waterbody (Lake/Pond/Wetland) Survey Form* (**Appendix L**). On the *Aquatic Habitat Mapping Form* (**Appendix I**), note the location and photo number (from the camera) on the drawn map of all photos taken.

5.6.2 Location Information

This section details how to fill out the Location section of the *Waterbody (Lake/Pond/Wetland) Survey Form* (**Appendix L**) and provides instruction on conducting the in-field verification of the desk-based reach mapping. Some information can be filled into the survey form before heading to the field.

Pre-field

1. Record the following information supplied in the reach tables (**Appendix B**) onto the *Waterbody (Lake/Pond/Wetland) Survey Form* (**Appendix L**) before entering the field:
    a. Station ID (unique ID for each independent reach)
    b. Waterbody ID/ Polygon ID (desk-based unique ID)
    c. Waterbody Name (gazetted name and/or alias) (if named)
    d. GPS Coordinates (derived by GIS)

Note: for digital forms Station ID will be required to be entered but the remainder of information outlined in step 1 above will be automatically populated from the Station ID.

In the field

1. In a helicopter with good visibility, conduct a reconnaissance flight of each waterbody (reach) before landing to survey, to determine appropriate access sites, verify information provided in the reach table and note major inlets and outlets if they differ from those identified in the reach table in **Appendix B**. Note potential sites to conduct aquatic habitat mapping surveys. Record any changes in the comments section.
2. Upon arriving at the site (during the survey) record field site UTM coordinates (Zone/Easting/Northing) using NAD 83 at the approximate centre of the site.
3. Record Site # (for lakes more than one site may be surveyed. Site number is sequential for each unique site on a lake.

5.6.3 Reach Type and Morphology

This section details how to fill out the information in the Reach Type and Morphology section of the *Waterbody (Lake/Pond/Wetland) Survey Form* (**Appendix L**) and provides instruction for conducting physical field measurements at the site.

1. Check and record waterbody type (large lake, small lake, pond, wetland, reservoir, dug-out).
2. Check waterbody source (intermittent, runoff, spring-fed, not connected, by-pass, in-stream). Note associated wetland types (Bog, Fen Swamp, Marsh) if applicable.
3. Note associated wetland types (Bog (Wb), Fen (Wf), Swamp (Ws), Marsh (Wm), Unknown (Wu)), if applicable.
4. Record estimated waterbody dimensions (length and width) in meters using a range finder.
5. Indicate if the main inlet and outlet streams are surveyed and indicate reach numbers for each. NOTE: Surveys of these stream reaches should be filled out on the *Watercourse (Stream) Survey Form* (**Appendix G**).

5.6.4 Limnology, Bathymetry and Water Chemistry

Limnology and Water Chemistry information is required for Aquatic Habitat Mapping. As these measurements are recorded as part of the EMBP, the Limnology, Water, and Plankton Datasheet - LSA form provided in the EMBP Final Design Report (CanNorth 2020) should be used to collect data in collaboration with the field contractor responsible for water quality measurements. This section outlines the specific requirements for limnological and water chemistry measurements for Aquatic Habitat Mapping as it pertains to fish habitat. Bathymetry is collected in some waterbodies as part of the EMBP.

1. Collect dissolved oxygen concentrations and temperatures at 0.5 m intervals to bottom or a maximum depth of 10 m.
2. Take vertical dissolved oxygen (DO in mg/L) and temperature profiles (in °C) simultaneously using a meter (e.g., YSI or HydroLab).
3. Take two sets of readings at each depth interval: one during descent and the other during ascent to minimize bias due to adjustment of the meter to the water conditions at the subsequent depths.
4. Max Depth: Record max depth during dissolved oxygen measurements.

5. pH: Measure pH in the field using a hand-held pH meter. Ensure that the pH meter has been calibrated using a low ionic strength electrode and calibration standards. pH can be recorded at the same depth measurements as dissolved oxygen profile.
6. Conductivity: Make conductivity measurements from lake surface and bottom samples or to a max depth of 10 m.
    a. Measure electrical conductivity in the field using a portable conductivity meter (e.g., YSI, HydroLab).
    b. Note: Most conductivity meters automatically convert conductivity measurements to 25°C. If the meter does not automatically standardize to 25°C, record the water temperature at the same time as conductivity and use a conductivity nomograph to convert the reading to 25°C.
7. Water Temperature: Record water temperature in °C from the depth where conductivity measurements are made.
8. Determine Secchi depth on the shady side of the boat. Do not wear sunglasses. Take reading as close to mid-day as possible (10 am – 2 pm). Record depths in tenths of meters. Conduct Secchi depth determinations after the dissolved oxygen/temperature profiles have been conducted as not to disturb the water column.
    a. Lower the Secchi disk until it disappears.
    b. Note depth to the nearest tenth of a meter.
    c. Raise Secchi until it reappears.
    d. Note depth.
    e. The Secchi depth is the midpoint between these 2 depths.

5.6.5 Cover and Habitat

This section details how to fill out the Cover and Habitat section of the *Waterbody (Lake/Pond/Wetland) Survey Form* (**Appendix L**) and instructions for conducting cover and habitat measurements.

Bank Habitat:

1. In-Water Cover (% surface area): In-water cover provides an area for resting, shelter and predator avoidance for fish. Different types of cover are important in different habitat types, so it is essential to note in which part of the waterbody the features occur. A cover particle is any object that touches the water within the survey area, is **at least 100 mm wide** along the median axis and of sufficient density to block >75 % of sunlight from reaching the stream bottom. A cover particle can consist of a mat of materials such as twigs, macrophytes, or the bank. The mat must still meet the median diameter size and light penetration restrictions.
    a. Locate the cover types (undercut banks, boulders, cobble, woody debris, vascular macrophytes) within the wetted channel or within 1 m above the water surface.
    b. Estimate the relative amount of cover that the individual cover type provides the entire site.
    c. Record the percent In-water cover for each type of cover type.
2. Near Shore Slope (%):
    a. Use a handheld clinometer to measure nearshore slope.
    b. Tie a ribbon or mark up the shore at eye level.
    c. While standing on the shoreline, use the clinometer to determine the angle of slope.
    d. Record gradient in %.

3. Shoreline Substrate (%):
    a. Visually estimate percent cover of substrate type (bedrock, boulder, cobble, gravel).
    b. For fine substrate types (sand, silt, clay, muck, marl, detritus), place ½ to 1 tablespoon of sediment in the palm. Feel mass by rubbing between fingers and record the percentage of each type.
    c. The total should add to 100%.
4. Shoreline Type:
    a. Visually observe shoreline type and classify by percentage of presence of an appropriate type of shoreline (sand or gravel beach, low rocky shore, cliff or bluff shore, wetland shore, vegetated shore). The percentage should add up to 100%.
5. Shoreline Vegetation Cover:
    a. Visually observe and record the percentage of shoreline coverage
        i. None 0%
        ii. Sparse < 5%
        iii. Moderate 5 – 20%
        iv. Abundant > 20%
    b. Record the predominant species of vegetation observed.

<u>In-Water Habitat</u>

1. Vegetation Type (%):
    a. Visually observe and record the approximate percentage of each type of vegetation (submerged, floating, emergent).
    b. List predominant species of each type of vegetation observed.
2. Underwater Cover (% of surface area): Underwater cover provides an area for resting and predator avoidance for fish. Different types of cover are important in different habitat types, so it is essential to note in which part of the waterbody the features occur. Most types of cover should fit into the categories provided. Any additional features should be identified. The percentage should total 100% (of the surface area).
    a. Visually observe and record underwater cover types and percentage surface area of waterbody of each type (undercut banks, boulders, cobble, woody debris, organic debris, vascular macrophytes).
3. Bottom Substrate: Estimate the percent cover of each substrate type (bedrock, boulder, cobble, gravel, sand, silt, clay, muck, marl, detritus) visually (if possible).

5.6.6 <u>Additional Information</u>

1. Migratory Obstructions:
    a. Check off any permanent or seasonal natural (e.g., beaver dams, cascades, waterfalls, water depth and flow) and human-made (e.g., dams, weirs, perched culverts) obstructions that occur within the lake/pond and outlets surveyed.
2. Potential Enhancement Opportunities:
    a. Note any opportunities that exist for potential enhancement of lake/pond/wetland reach. Provide as many details as possible.
3. Comments
    a. Note any additional information that may be useful in assessing fish habitat.
    b. Include incidental observations of fish and other wildlife.

5.7 Aquatic Habitat Mapping

For watercourses (streams reaches), and waterbodies (lakes/ponds/wetlands), this section describes the instructions for filling out the *Aquatic Habitat Mapping Form* (**Appendix I**). The map scale is expected to be approximately 1 cm = 5 m so that a 100 m section will fit on a letter-sized page. More than one map page may be required for reach sections that are longer than 100 m in length and for larger lakes/ponds/wetlands. Small cross-sectional sketches of representative morphological features (e.g., through pools, runs) should be added, showing the bed and bank profiles. Where a defined valley configuration is present, a cross-sectional diagram should be included to show the entire river valley and floodplain. It may be necessary to estimate the dimensions of the flood plain and river valley for the cross-section diagram. If the vertical scale needs to be exaggerated to show features, then the scale must be recorded on the map.

5.7.1 Suggestions for Mapping Aquatic Habitat

1. Fill out site identifier information on the *Aquatic Habitat Mapping Form* (**Appendix I**).
2. A compass ring is provided on the *Aquatic Habitat Mapping Form* (**Appendix I**), and north should be marked on the page.
3. The length of the site should be measured using a tape measure or hip chain, and marked on the map.

Within the site, the stream banks or lake edge should be outlined on the *Aquatic Habitat Mapping Form* (**Appendix I**).

1. Begin by marking prominent landmarks that are evenly spaced along the section; large trees on the bank or sand bars are suitable landmarks. It is challenging to avoid distorting the map without using landmarks.
2. Outline the wetted width around these landmarks.
3. Any side channels or discharges into the water feature should be included.
4. Hydrologic features should be drawn in the diagram of the water feature using the symbols noted in the legend. Accurate positioning of each habitat feature on the map will allow distances or areas to be measured later (approximate distances should be noted for quick reference).
5. Make a note of the general substrate class and distribution, including locations of large boulders. If there is a definite change in the substrate, mark the transition of the change.
6. Map in-stream vegetation and cover with appropriate symbols (see legend provided on the *Aquatic Habitat Mapping Form* in **Appendix I**). The type, location and distribution of each cover type will allow calculation of distance or areas.
7. Include a cross-sectional diagram with the entire river valley and floodplain illustrated. Dimensions of the wetted channel are available from the Watercourse (Stream) Survey Form. An estimation of the entire flood plain and river valley may be required if it cannot be easily measured, for the cross-section diagram.
8. Note the conditions of the banks, particularly undercut banks, overhanging grasses or shrubs, eroding areas, and heavily stabilized areas.
9. Note any observations of fish or wildlife.
10. Mark all photo locations on the habitat map for reference.

6.0 MAINTENANCE

Maintenance should be conducted on all equipment required for fieldwork to keep equipment in good working order. The calibration of quantitative instruments should be conducted to ensure the accuracy and precision of data collected. If boats are required, regular maintenance of the boat and motor should be conducted to ensure that it is in working order and that it is cleaned between survey locations (e.g., between lakes) not to spread possible invasive species between survey locations. All measurement equipment should similarly be cleaned (see Section 5.1.2) and maintained between survey sites.

The contractor should ensure that spare parts and batteries are at hand at all times and should have a contingency in place if the equipment requires repair. Safety and first aid equipment should be checked regularly and replaced when needed.

7.0 PROCEDURAL NOTE

The field contractor will be supplied with a watercourse (stream) reach table (**Appendix A**), and waterbody (lake/pond/wetland) reach table (**Appendix B**) with identified reaches for surveying (based on a stratified and randomized design). The list of reaches to be surveyed will include contingency survey reaches in order of selection, in the case where chosen reaches cannot be surveyed (e.g., due to access or safety).

8.0 REFERENCES

CanNorth. 2020. Environmental Media Baseline Program Design - Final Report. Page Nuclear Waste Management Organization, Adaptive Phased Management Project – Northwestern Ontario Region. Prepared by Canada North Environmental Services for the Nuclear Waste Management Organization.

CCME. 2011. Protocols Manual for Water Quality Sampling in Canada. Canadian Council of Ministers of the Environment.

MNRF. 2014. Ontario Wetland Evaluation System: Northern Manual. 1st edition. Ministry of Natural Resources and Forestry.

MTO. 2009. Environmental Guide for Fish and Fish Habitat. Page Environmental Standards and Practices. Provincial and Environmental Planning Office, Ministry of Transportation.

RIC. 2001. Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures. Prepared by BC Fisheries, Information Services Branch for the Resources Inventory Committee.

RISC. 2008. Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Site Card Field Guide. Prepared by Ministry of Environment Ecosystems Branch for the Resources Inventory Standards Committee.

Stanfield, L. W. 2017. Ontario Stream Assessment Protocol, Version 10.0. Page (L. Stanfield, Ed.). Government of Ontario.

9.0 APPENDICES

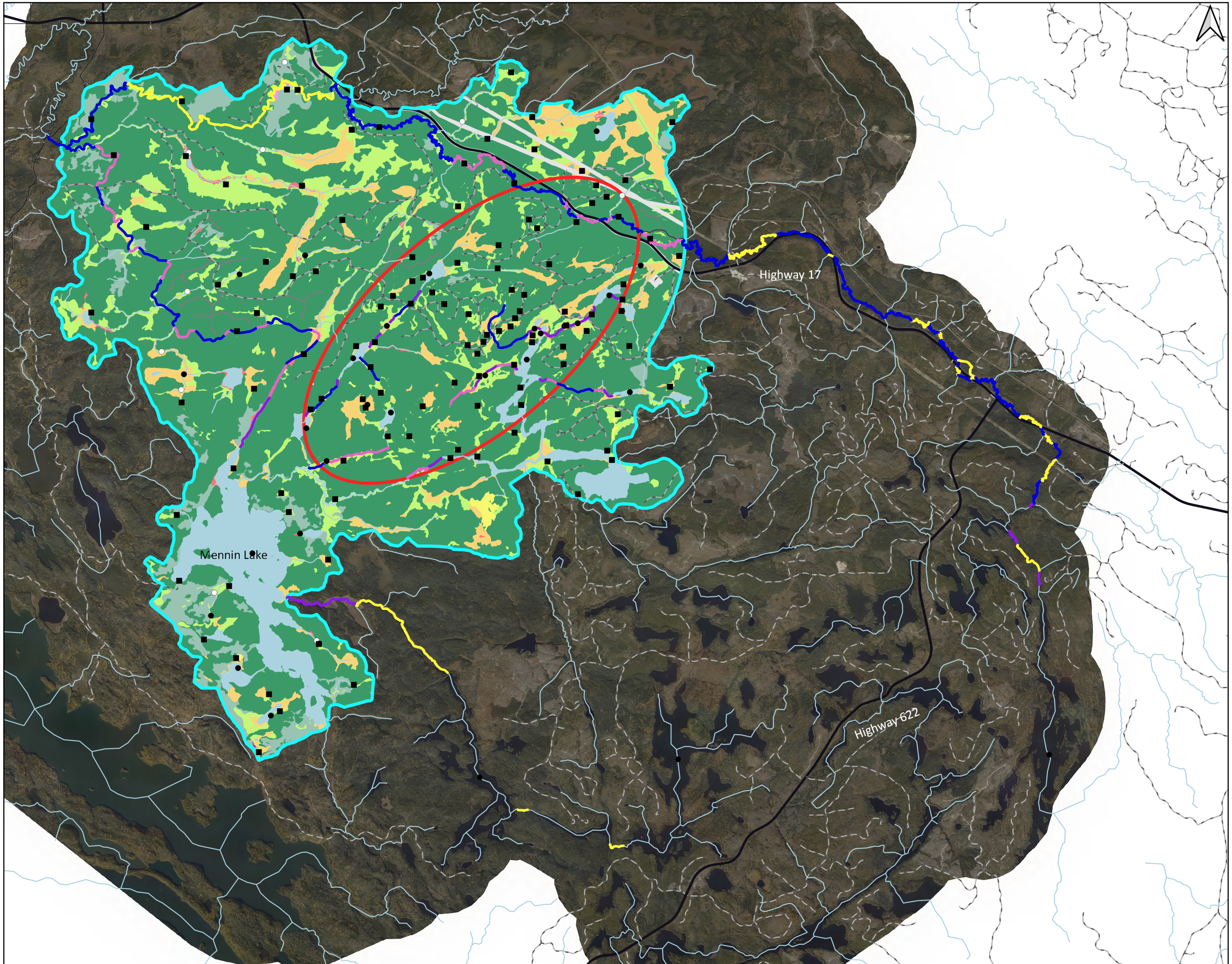
Appendix A: Watercourse (Stream) Survey Reach Table and Map

(see next page)

Station_ID	Watercourse ID	Reach Number	Name	Length	Wetland	Pattern	Confinemen	Segment	Study Area	Priority	UP_NID	DOWN_NID	UP_UTM_x	UP_UTM_y	DOWN_UTM_x	DOWN_UTM_y
IG_S001	100-00000-00000-00000-00000-00000	18	Wabigoon River	476.74368	n	m	u	42	RSA	1	18	17	548187.87	5489828.768	547807.666	5490044.704
IG_S002	100-00000-00000-00000-00000-00000	19	Wabigoon River	2912.77194	n	m	u	43	LSA	1	19	18	549498.3	5491168.431	548187.87	5489828.768
IG_S003	100-00000-00000-00000-00000-00000	28	Wabigoon River	204.06674	n	m	u	46	LSA	1	28	27	553941.663	5491169.066	553843.559	5491029.446
IG_S004	100-00000-00000-00000-00000-00000	29	Wabigoon River	510.3451	n	m	u	47	LSA	1	29	28	554232.564	5490843.904	553941.663	5491169.066
IG_S005	100-29281-00000-00000-00000-00000	1	Mennin River	932.84662	s	m	u	41	LSA	1	1	0	548822.995	5489861.022	548187.87	5489828.768
IG_S006	100-29281-00000-00000-00000-00000	4	Mennin River	462.39422	s	m	u	40	LSA	1	4	3	549013.078	5488585.059	548845.816	5488963.732
IG_S007	100-29281-00000-00000-00000-00000	7	Mennin River	897.22005	s,f	m	u	39	LSA	1	7	6	549540.389	5487615.987	549363.162	5488260.21
IG_S008	100-29281-00000-00000-00000-00000	9	Mennin River	717.77785	n	s	u	38	LSA	1	9	8	550349.884	5487377.791	549753.128	5487675.309
IG_S009	100-29281-00000-00000-00000-00000	11	Mennin River	695.93425	s	s	u	37	LSA	1	11	10	550164.01	5486465.148	550196.193	5486983.71
IG_S010	100-29281-00000-00000-00000-00000	12	Mennin River	134.35465	s	s	u	36	LSA	1	12	11	550287.958	5486425.219	550164.01	5486465.148
IG_S011	100-29281-00000-00000-00000-00000	13	Mennin River	375.5605	s	s	u	35	LSA	1	13	12	550589.823	5486253.966	550287.958	5486425.219
IG_S012	100-29281-00000-00000-00000-00000	14	Mennin River	350.49802	s	m	u	34	LSA	1	14	13	550504.64	5485984.401	550589.823	5486253.966
IG_S013	100-29281-00000-00000-00000-00000	16	Mennin River	798.02416	n	s	u	33	LSA	1	16	15	551578.382	5485835.271	550960.224	5485897.339
IG_S014	100-29281-00000-00000-00000-00000	18	Mennin River	568.70737	s	s	u	32	LSA	1	18	17	552226.73	5485963.084	551701.559	5485919.95
IG_S015	100-29281-00000-00000-00000-00000	20	Mennin River	523.16566	s	m	u	31	LSA	1	20	19	552903.529	5486058.411	552490.428	5486091.097
IG_S016	100-29281-00000-00000-00000-00000	21	Mennin River	619.21756	f	s	u	30	LSA	1	21	20	553456.796	5485908.996	552903.529	5486058.411
IG_S017	100-29281-00000-00000-00000-00000	23	Mennin River	883.19132	m,f	s	u	29	LSA	1	23	22	552879.887	5485171.52	553534.516	5485692.733
IG_S018	100-29281-45977-09831-00000-00000	5		944.697	s	m	u	11	AOI	1	5	4	553945.521	5484715.796	553403.709	5484224.389
IG_S019	100-29281-45977-09831-00000-00000	13		339.78586	s	s	u	16	AOI	1	13	12	555465.149	5486445.444	555220.483	5486235.374
IG_S020	100-29281-45977-09831-00351-00000	1		392.18118	s,f	s	u	8	AOI	1	1	0	553714.24	5483102.017	553371.696	5482985.092
IG_S021	100-29281-45977-09831-43207-00000	1		624.1199	f,s	s	u	13	AOI	1	1	0	554849.488	5484865.773	554460.605	5485332.632
IG_S022	100-29281-45977-36723-37879-00000	3		870.76757	f	s	u	20	LSA	1	3	2	559417.7	5484634.605	558632.896	5484803.918
IG_S023	100-29281-45977-36723-52967-00000	5		226.70731	n	s	u	23	AOI	1	5	4	557816.197	5485725.565	558015.666	5485824.352
IG_S024	100-29281-45977-36723-52967-00000	6		632.63083	f	s	u	23	AOI	1	6	5	557336.39	5485700.734	557816.197	5485725.565
IG_S025	100-29281-45977-36723-52967-00000	7		151.76018	f	s	u	22	AOI	1	7	6	557278.885	5485837.91	557336.39	5485700.734
IG_S026	100-29281-45977-36723-52967-00000	8		538.28356	f,s	s	u	22	AOI	1	8	7	557411.736	5486241.444	557278.885	5485837.91
IG_S027	100-29281-45977-36723-52967-00000	9		253.36622	s	s	u	22	AOI	1	9	8	557537.735	5486450.415	557411.736	5486241.444
IG_S028	100-39760-00000-00000-00000-00000	1	Revell River	4044.08129	s	m	u	48	LSA	1	1	0	556081.567	5490196.425	554232.564	5490843.904
IG_S029	100-39760-00000-00000-00000-00000	2	Revell River	2005.59723	s	m	u	49	LSA	1	2	1	556447.803	5489497.524	556081.567	5490196.425
IG_S030	100-39760-00000-00000-00000-00000	5	Revell River	612.2083	s	m	u	50	LSA	1	5	4	557745.278	5489254.021	557520.079	5489375.656
IG_S031	100-39760-00000-00000-00000-00000	6	Revell River	1144.86225	s	m	u	51	AOI	1	6	5	558326.145	5488921.826	557745.278	5489254.021
IG_S032	100-39760-00000-00000-00000-00000	7	Revell River	660.65494	n	s	u	52	AOI	1	7	6	558806.188	5488617.62	558326.145	5488921.826
IG_S033	100-39760-00000-00000-00000-00000	9	Revell River	401.72174	n	m	u	53	AOI	1	9	8	559101.008	5488362.792	558925.665	5488506.425
IG_S034	100-39760-00000-00000-00000-00000	11	Revell River	151.80268	n	s	u	54	AOI	1	11	10	559712.976	5488291.514	559574.451	5488272.211
IG_S035	100-39760-00000-00000-00000-00000	13	Revell River	137.58645	s	s	u	55	AOI	1	13	12	559932.17	5488370.784	559813.558	5488325.028
IG_S036	100-39760-00000-00000-00000-00000	14	Revell River	951.8101	n	m	u	56	LSA	1	14	13	560476.282	5488024.06	559932.17	5488370.784
IG_S037	100-39760-00000-00000-00000-00000	16	Revell River	1679.68652	n	m	u	57	RSA	1	16	15	561690.009	5487577.158	561659.67	5487553.398
IG_S038	100-39760-00000-00000-00000-00000	17	Revell River	1411.78184	n	m	u	58	RSA	1	17	16	562331.335	5487541.239	561734.073	5487440.785
IG_S039	100-39760-00000-00000-00000-00000	20	Revell River	641.21087	s	s	u	59	RSA	1	20	19	563823.118	5487999.997	563325.819	5487955.662
IG_S040	100-39760-00000-00000-00000-00000	21	Revell River	1231.63987	s	m	u	60	RSA	1	21	20	564349.885	5487688.415	564417.177	5487598.669
IG_S041	100-39760-00000-00000-00000-00000	23	Revell River	380.81324	n	m	u	61	RSA	1	23	22	564675.45	5487287.553	564537.96	5487505.534
IG_S042	100-39760-00000-00000-00000-00000	24	Revell River	991.88247	n	m	u	62	RSA	1	24	23	564941.013	5486650.206	564675.45	5487287.553
IG_S043	100-39760-00000-00000-00000-00000	25	Revell River	299.8589	s	s	u	63	RSA	1	25	24	565165.442	5486499.667	564941.013	5486650.206
IG_S044	100-39760-00000-00000-00000-00000	26	Revell River	678.55776	s	m	u	64	RSA	1	26	25	565642.314	5486188.833	565165.442	5486499.667
IG_S045	100-39760-00000-00000-00000-00000	27	Revell River	116.03953	s	s	u	65	RSA	1	27	26	565708.221	5486272.419	565642.314	5486188.833
IG_S046	100-39760-00000-00000-00000-00000	28	Revell River	749.08984	s	m	u	66	RSA	1	28	27	566222.34	5486133.416	565708.221	5486272.419
IG_S047	100-39760-00000-00000-00000-00000	30	Revell River	487.49265	s	m	u	67	RSA	1	30	29	566800.369	5485881.253	566605.371	5486098.7
IG_S048	100-39760-00000-00000-00000-00000	33	Revell River	1012.13282	s	m	u	70	RSA	1	33	32	566858.48	5485695.9	566869.636	5485677.469
IG_S049	100-39760-00000-00000-00000-00000	34	Revell River	176.56366	s	m	u	71	RSA	1	34	33	567207.767	5485161.284	567222.499	5485284.538
IG_S050	100-39760-00000-00000-00000-00000	36	Revell River	404.52018	s	m	u	72	RSA	1	36	35	567502.952	5484895.973	567225.249	5484964

Station_ID	Watercourse ID	Reach Number	Name	Length	Wetland	Pattern	Confinemen	Segment	Study Area	Priority	UP_NID	DOWN_NID	UP_UTM_x	UP_UTM_y	DOWN_UTM_x	DOWN_UTM_y
IG_S051	100-39760-00000-00000-00000-00000	41	Revell River	688.02738	s	m	u	74	RSA	1	41	40	567964.164	5484837.987	567592.479	5484915.892
IG_S052	100-39760-00000-00000-00000-00000	42	Revell River	1809.66854	s	m	u	75	RSA	1	42	41	568158.236	5484423.268	568211.181	5484398.712
IG_S053	100-39760-00000-00000-00000-00000	44	Revell River	239.67285	s	m	u	76	RSA	1	44	43	569048.18	5483698.493	568986.388	5483862.047
IG_S054	100-39760-00000-00000-00000-00000	47	Revell River	541.88554	s	m	u	79	RSA	1	47	46	569302.854	5483158.713	569222.752	5483513.405
IG_S055	100-39760-00000-00000-00000-00000	49	Revell River	788.5494	s,f	m	u	80	RSA	1	49	48	568847.712	5482229.361	569016.2	5482718.28
IG_S056	100-29281-00000-00000-00000-00000	2	Mennin River	1008.13281	s	m	u	40	LSA	2	2	1	549117.542	5489395.383	548822.995	5489861.022
IG_S057	100-29281-00000-00000-00000-00000	3	Mennin River	616.59291	s	m	u	40	LSA	2	3	2	548845.816	5488963.732	549117.542	5489395.383
IG_S058	100-29281-00000-00000-00000-00000	5	Mennin River	232.31726	n	m	u	40	LSA	2	5	4	549177.193	5488457.635	549013.078	5488585.059
IG_S059	100-29281-00000-00000-00000-00000	6	Mennin River	432.05046	s,f	m	u	40	LSA	2	6	5	549363.162	5488260.21	549177.193	5488457.635
IG_S060	100-29281-00000-00000-00000-00000	8	Mennin River	255.79802	s	m	u	38	LSA	2	8	7	549753.128	5487675.309	549540.389	5487615.987
IG_S061	100-29281-00000-00000-00000-00000	10	Mennin River	517.57029	n	s	u	37	LSA	2	10	9	550196.193	5486983.71	550349.884	5487377.791
IG_S062	100-29281-00000-00000-00000-00000	15	Mennin River	690.37555	f,s	m	u	33	LSA	2	15	14	550960.224	5485897.339	550504.64	5485984.401
IG_S063	100-29281-00000-00000-00000-00000	17	Mennin River	161.55827	s	s	u	33	LSA	2	17	16	551701.559	5485919.95	551578.382	5485835.271
IG_S064	100-29281-00000-00000-00000-00000	19	Mennin River	325.48267	n	s	u	32	LSA	2	19	18	552490.428	5486091.097	552226.73	5485963.084
IG_S065	100-29281-00000-00000-00000-00000	22	Mennin River	303.71624	f,s	m	u	29	LSA	2	22	21	553534.516	5485692.733	553456.796	5485908.996
IG_S066	100-29281-00000-00000-00000-00000	24	Mennin River	388.67759	s	s	u	29	LSA	2	24	23	552694.069	5484846.511	552879.887	5485171.52
IG_S067	100-29281-00000-00000-00000-00000	25	Mennin River	417.79645	m	s	u	29	LSA	2	25	24	552518.492	5484480.532	552694.069	5484846.511
IG_S068	100-29281-45977-00000-00000-00000	7		223.99663	s	s	u	9	AOI	2	7	6	555646.697	5482902.24	555469.358	5482785.18
IG_S069	100-29281-45977-00000-00000-00000	8		415.8803	s	m	u	10	AOI	2	8	7	555934.483	5483018.557	555646.697	5482902.24
IG_S070	100-29281-45977-09831-00351-00000	2		424.76468	f	s	u	8	AOI	2	2	1	554099.975	5483216.687	553714.24	5483102.017
IG_S071	100-29281-45977-09831-00351-00000	3		195.77728	s	s	u	8	AOI	2	3	2	554285.271	5483254.367	554099.975	5483216.687
IG_S072	100-29281-45977-09831-00351-00000	3		207.8204	s,f	s	u	8	AOI	2	3	2	554486.388	5483288.001	554285.271	5483254.367
IG_S073	100-29281-45977-09831-00351-00000	4		369.63775	f	s	u	8	AOI	2	4	3	554841.497	5483332.18	554486.388	5483288.001
IG_S074	100-29281-45977-09831-00351-00000	5		227.98186	n,s	s	u	8	AOI	2	5	4	555054.445	5483405.747	554841.497	5483332.18
IG_S075	100-29281-45977-36723-37879-00000	2		183.21729	f	s	u	20	LSA	2	2	1	558632.896	5484803.918	558468.323	5484871.688
IG_S076	100-29281-45977-36723-37879-00000	4		288.33675	f	s	u	20	LSA	2	4	3	559671.357	5484645.669	559417.7	5484634.605
IG_S077	100-29281-45977-36723-41379-00000	2		270.97539	s	s	u	18	AOI	2	2	1	557400.537	5485165.461	557661.297	5485200.297
IG_S078	100-29281-45977-36723-41379-00000	6		741.70211	f	s	u	17	AOI	2	6	5	556386.407	5484346.726	556921.465	5484738.088
IG_S079	100-39760-00000-00000-00000-00000	3	Revell River	1112.98745	s	m	u	50	LSA	2	3	2	557031.888	5489512.258	556447.803	5489497.524
IG_S080	100-39760-00000-00000-00000-00000	4	Revell River	1130.91553	n	m	u	50	LSA	2	4	3	557520.079	5489375.656	557031.888	5489512.258
IG_S081	100-39760-00000-00000-00000-00000	8	Revell River	340.11326	n	m	u	52	AOI	2	8	7	558925.665	5488506.425	558806.188	5488617.62
IG_S082	100-39760-00000-00000-00000-00000	10	Revell River	631.64128	n	m	u	54	AOI	2	10	9	559574.451	5488272.211	559101.008	5488362.792
IG_S083	100-39760-00000-00000-00000-00000	12	Revell River	206.38244	s	m	u	54	AOI	2	12	11	559813.558	5488325.028	559712.976	5488291.514
IG_S084	100-39760-00000-00000-00000-00000	15	Revell River	1830.43619	n,s	m	u	56	LSA	2	15	14	561366.968	5487842.206	560476.282	5488024.06
IG_S085	100-00000-00000-00000-00000-00000	20	Wabigoon River	3108.58967	n	m	u	44	LSA	3	20	19	550987.646	5490299.679	549498.3	5491168.431
IG_S086	100-00000-00000-00000-00000-00000	21	Wabigoon River	478.38382	n	m	u	44	LSA	3	21	20	551217.766	5490427.108	550987.646	5490299.679
IG_S087	100-00000-00000-00000-00000-00000	22	Wabigoon River	207.49083	n	m	u	44	LSA	3	22	21	551345.681	5490315.782	551217.766	5490427.108
IG_S088	100-00000-00000-00000-00000-00000	23	Wabigoon River	1034.259	n	m	u	45	LSA	3	23	22	552262.094	5490369.701	551345.681	5490315.782
IG_S089	100-00000-00000-00000-00000-00000	24	Wabigoon River	1953.31818	n	m	u	46	LSA	3	24	23	552946.201	5491209.222	552262.094	5490369.701
IG_S090	100-00000-00000-00000-00000-00000	25	Wabigoon River	447.67899	u	m	u	46	LSA	3	25	24	553171.712	5491104.389	552946.201	5491209.222
IG_S091	100-00000-00000-00000-00000-00000	26	Wabigoon River	818.52633	n	m	u	46	LSA	3	26	25	553589.08	5490980.02	553171.712	5491104.389
IG_S092	100-00000-00000-00000-00000-00000	27	Wabigoon River	688.58126	u	m	u	46	LSA	3	27	26	553843.559	5491029.446	553589.08	5490980.02
IG_S093	100-29281-00000-00000-00000-00000	29	Mennin River	136.35593	f	m	u	6	RSA	3	29	28	554452.34	5480124.016	554380.778	5480047.297
IG_S094	100-29281-00000-00000-00000-00000	30	Mennin River	451.399	n	m	u	5	RSA	3	30	29	554827.836	5480059.743	554452.34	5480124.016
IG_S095	100-29281-00000-00000-00000-00000	31	Mennin River	120.8122	f	m	u	5	RSA	3	31	30	554924.623	5480021.041	554827.836	5480059.743
IG_S096	100-29281-00000-00000-00000-00000	32	Mennin River	245.36306	f	m	u	4	RSA	3	32	31	555122.889	5479916.93	554924.623	5480021.041
IG_S097	100-29281-00000-00000-00000-00000	33	Mennin River	603.75026	n	s	u	4	RSA	3	33	32	555428.805	5479487.427	555122.889	5479916.93
IG_S098	100-29281-00000-00000-00000-00000	34	Mennin River	830.8077	f	s	u	4	RSA	3	34	33	555957.999	5478927.312	555428.805	5479487.427
IG_S099	100-29281-00000-00000-00000-00000	35	Mennin River	508.82332	n	s	u	4	RSA	3	35	34	556320.567	5478624.159	555957.999	5478927.312
IG_S100	100-29281-00000-00000-00000-00000	37	Mennin River	215.299	n	s	u	3	RSA	3	37	36	558028.559	5475695.106	557824.447	5475697.804

Station_ID	Watercourse ID	Reach Number	Name	Length	Wetland	Pattern	Confinemen	Segment	Study Area	Priority	UP_NID	DOWN_NID	UP_UTM_x	UP_UTM_y	DOWN_UTM_x	DOWN_UTM_y
IG_S101	100-29281-00000-00000-00000-00000	39	Mennin River	67.92005	s	s	u	2	RSA	3	39	38	559811.881	5474891.128	559791.058	5474952.331
IG_S102	100-29281-00000-00000-00000-00000	40	Mennin River	290.92524	s	n,s	u	1	RSA	3	40	39	560074.579	5474927.851	559811.881	5474891.128
IG_S103	100-39760-00000-00000-00000-00000	18	Revell River	424.62606	n	m	u	59	RSA	3	18	17	562457.791	5487522.958	562331.335	5487541.239
IG_S104	100-39760-00000-00000-00000-00000	19	Revell River	1968.88803	s	m	u	59	RSA	3	19	18	562607.096	5487527.967	562647.521	5487549.658
IG_S105	100-39760-00000-00000-00000-00000	22	Revell River	85.11061	s	s	u	61	RSA	3	22	21	564537.96	5487505.534	564463.467	5487533.182
IG_S106	100-39760-00000-00000-00000-00000	29	Revell River	681.35069	s	m	u	66	RSA	3	29	28	566605.371	5486098.7	566222.34	5486133.416
IG_S107	100-39760-00000-00000-00000-00000	31	Revell River	185.14219	s	m	u	68	RSA	3	31	30	566854.092	5485786.889	566800.369	5485881.253
IG_S108	100-39760-00000-00000-00000-00000	32	Revell River	93.08873	s	m	u	69	RSA	3	32	31	566870.229	5485709.387	566854.092	5485786.889
IG_S109	100-39760-00000-00000-00000-00000	35	Revell River	312.44476	s	m	u	71	RSA	3	35	34	567225.249	5484964	567207.767	5485161.284
IG_S110	100-39760-00000-00000-00000-00000	37	Revell River	102.82401	s	s	u	72	RSA	3	37	36	567592.479	5484915.892	567502.952	5484895.973
IG_S111	100-39760-00000-00000-00000-00000	38	Revell River	90.03377	s	s	u	73	RSA	3	38	37	567307.473	5485266.377	567222.499	5485284.538
IG_S112	100-39760-00000-00000-00000-00000	39	Revell River	424.72046	s	s	u	73	RSA	3	39	38	567483.039	5484993.113	567307.473	5485266.377
IG_S113	100-39760-00000-00000-00000-00000	40	Revell River	140.64101	s	s	u	73	RSA	3	40	39	567592.479	5484915.892	567483.039	5484993.113
IG_S114	100-39760-00000-00000-00000-00000	43	Revell River	857.81891	s	m	u	76	RSA	3	43	42	568986.388	5483862.047	568543.978	5484058.095
IG_S115	100-39760-00000-00000-00000-00000	45	Revell River	140.10496	s	m	u	77	RSA	3	45	44	569152.367	5483634.744	569048.18	5483698.493
IG_S116	100-39760-00000-00000-00000-00000	46	Revell River	237.25243	s	m	u	78	RSA	3	46	45	569222.752	5483513.405	569152.367	5483634.744
IG_S117	100-39760-00000-00000-00000-00000	48	Revell River	749.14958	s	m	u	80	RSA	3	48	47	569016.2	5482718.28	569302.854	5483158.713
IG_S118	100-39760-00000-00000-00000-00000	55	Revell River	863.63958	f	s	u	83	RSA	3	55	54	568954.252	5480801.604	568490.999	5481337.178
IG_S119	100-29281-00000-00000-00000-00000	26	Mennin River	1270.21899	f,m	s	u	29	LSA	Lake	26	25	551900.648	5483438.721	552518.492	5484480.532
IG_S120	100-29281-00000-00000-00000-00000	28	Mennin River	1874.38251	f	m	u	7	RSA	Lake	28	27	554380.778	5480047.297	552896.958	5480223.432
IG_S121	100-29281-45977-00000-00000-00000	9		322.48843	n	s	u	10	AOI	Lake	9	8	556187.245	5483196.651	555934.483	5483018.557
IG_S122	100-29281-45977-09831-00000-00000	4		211.12843	f	m	u	11	AOI	Lake	4	3	553403.709	5484224.389	553302.215	5484105.172
IG_S123	100-29281-45977-09831-00000-00000	6		191.41656	s	m	u	12	AOI	Lake	6	5	553974.584	5484857.354	553945.521	5484715.796
IG_S124	100-29281-45977-09831-00000-00000	9		184.40267	f,s	s	u	14	AOI	Lake	9	8	554759.511	5485675.797	554663.1	5485572.383
IG_S125	100-29281-45977-09831-00000-00000	10		222.45759	s	s	u	15	AOI	Lake	10	9	554890.261	5485842.077	554759.511	5485675.797
IG_S126	100-29281-45977-09831-00000-00000	12		199.04517	f	s	u	16	AOI	Lake	12	11	555220.483	5486235.374	555098.874	5486102.865
IG_S127	100-29281-45977-09831-00000-00000	14		429.68502	s	s	u	16	AOI	Lake	14	13	555738.682	5486758.76	555465.149	5486445.444
IG_S128	100-29281-45977-36723-00000-00000	1		452.12009	m	m	u	25	AOI	Lake	1	0	558686.973	5485908.287	558381.028	5485870.477
IG_S129	100-29281-45977-36723-00000-00000	2		127.17931	m,f	s	u	25	AOI	Lake	2	1	558787.893	5485971.816	558686.973	5485908.287
IG_S130	100-29281-45977-36723-00000-00000	4		173.13545	f	s	u	26	AOI	Lake	4	3	559028.824	5486057.768	558876.5	5486006.842
IG_S131	100-29281-45977-36723-00000-00000	6		189.10439	m	s	u	27	AOI	Lake	6	5	559292.236	5486177.309	559141.2	5486090.243
IG_S132	100-29281-45977-36723-00000-00000	7		373.33095	m	s	u	27	AOI	Lake	7	6	559448.178	5486419.385	559292.236	5486177.309
IG_S133	100-29281-45977-36723-00000-00000	9		180.67878	f	s	u	28	AOI	Lake	9	8	559963.577	5486601.389	559828.681	5486685.035
IG_S134	100-29281-45977-36723-37879-00000	1		210.29881	m	s	u	19	AOI	Lake	1	0	558468.323	5484871.688	558296.461	5484876.197
IG_S135	100-29281-45977-36723-37879-00000	5		247.4448	m,f	s	u	21	LSA	Lake	5	4	559830.892	5484519.752	559671.357	5484645.669
IG_S136	100-29281-45977-36723-41379-00000	1		192.98837	m	s	u	18	AOI	Lake	1	0	557661.297	5485200.297	557798.277	5485092.832
IG_S137	100-29281-45977-36723-41379-00000	3		350.40436	f,s	s	u	18	AOI	Lake	3	2	557115.454	5484982.812	557400.537	5485165.461
IG_S138	100-29281-45977-36723-41379-00000	5		177.3622	s,f	s	u	17	AOI	Lake	5	4	556921.465	5484738.088	557012.089	5484885.465
IG_S139	100-29281-45977-36723-52967-00000	2		60.84317	f	s	u	24	AOI	Lake	2	1	558235.989	5485976.784	558291.043	5485957.003
IG_S140	100-29281-45977-36723-52967-00000	4		209.25298	s,f	s	u	23	AOI	Lake	4	3	558015.666	5485824.352	558163.542	5485954.596
IG_S141	100-39760-00000-00000-00000-00000	50	Revell River	138.37088	s,f	m	u	81	RSA	Lake	50	49	568756.296	5482154.89	568847.712	5482229.361
IG_S142	100-39760-00000-00000-00000-00000	54	Revell River	414.91305	f	m	u	82	RSA	Lake	54	53	568490.999	5481337.178	568305.882	5481631.741
IG_S143	100-39760-00000-00000-00000-00000	56	Revell River	307.19802	n	s	u	84	RSA	Lake	56	55	568953.968	5480501.621	568954.252	5480801.604



NWMO Biodiversity Impact Studies

Aquatic Habitat Mapping Fieldwork Locations

Area of Interest (AOI)
Local Study Area (LSA_{AQU})

Watercourses
- Priority 1 for Survey
- Priority 2 for Survey
- Priority 3 for Survey
- Surveyed During Lake Procedure
- Other Watercourses

Fieldwork Locations
- Priority 1 Lake/Pond
- Priority 2 Lake/Pond
- Priority 1 Wetland

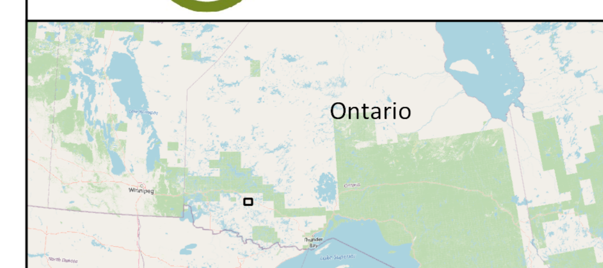
Ecosite Groups
- Marsh
- Fen
- Bog
- Swamp
- Hardwood
- Conifer
- Shrub
- Vertical or Active Mineral
- Water
- Cleared
- Compact Gravelled Surface
- Pavement/Concrete

Roads
- Local Road
- Highway or Arterial Road
- Resource/Recreation Road

1:80,000

0 1 2 km

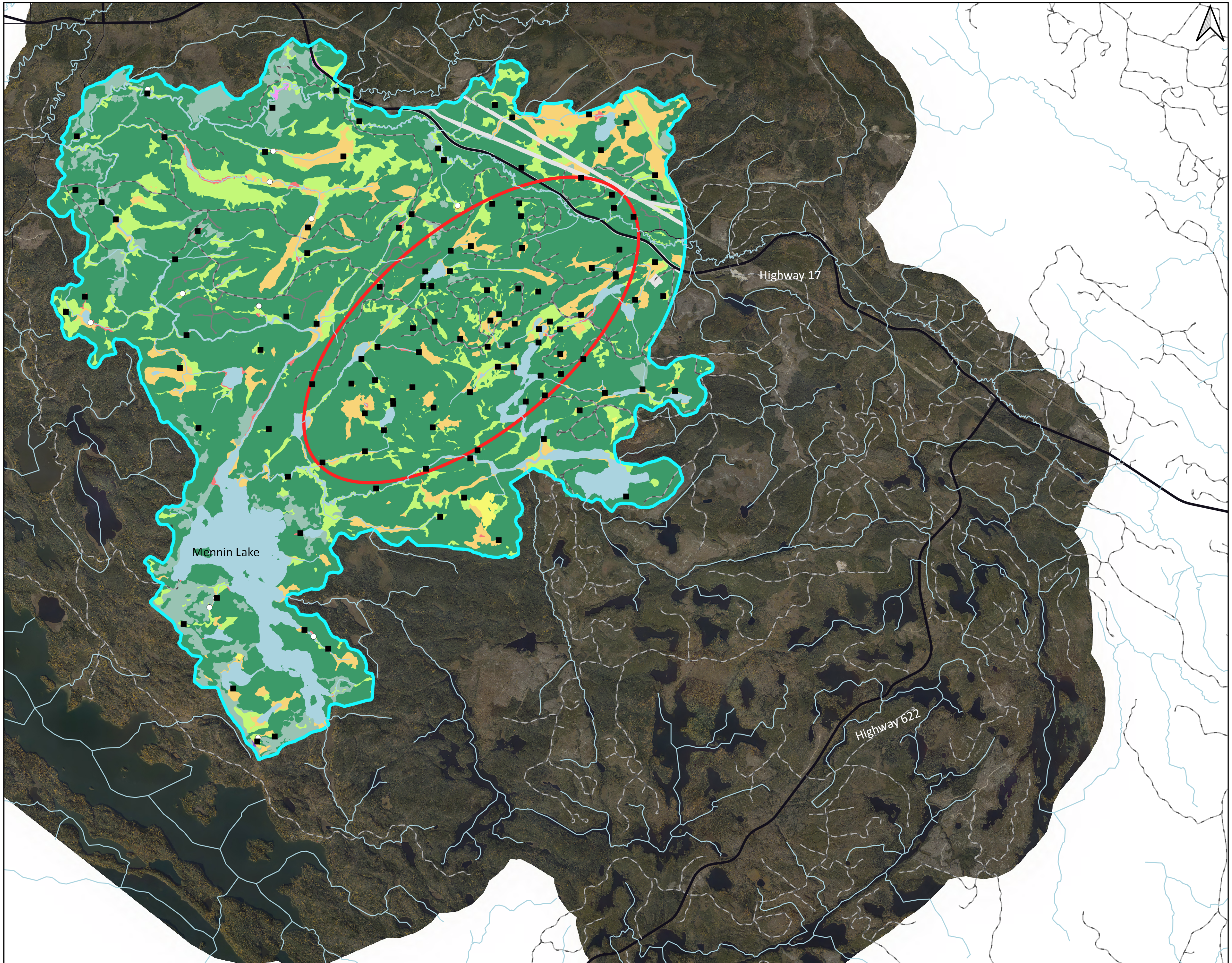
ZOETICA



Inset Basemap © OpenStreetMap contributors

Data received from:
Ontario GeoHub — OHN Watercourse (MNRF); MNRF Road Segments (MNRF)
NWMO — AOI; Basemap Imagery

Project CRS: NAD83 / UTM zone 15N	
Author: DM	Verified by: CC
June 22, 2021	Map ID: NWMO_BIS_069



NWMO Biodiversity Impact Studies

Aquatic Habitat Mapping
Oversample Fieldwork Locations

Area of Interest (AOI)
Local Study Area (LSA_{AQU})
Watercourses

Oversample Fieldwork Locations
Oversample Priority 2 Lake/Pond
Oversample Priority 2 Wetland

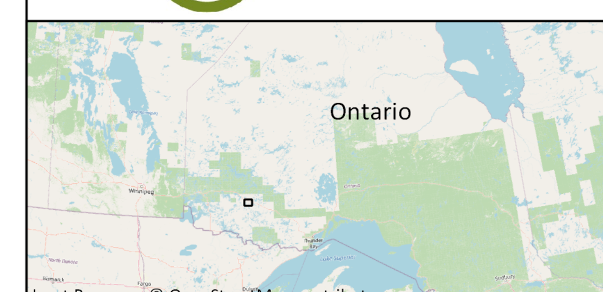
Ecosite Groups
Marsh
Fen
Bog
Swamp
Hardwood
Conifer
Shrub
Vertical or Active Mineral
Water
Cleared
Compact Gravelled Surface
Pavement/Concrete

Roads
Local Road
Highway or Arterial Road
Resource/Recreation Road

Oversample points are to be used to replace planned points if they are found inaccessible in the field.

1:80,000
0 1 2 km

ZOETICA



Data received from:
Ontario GeoHub — OHN Watercourse (MNRF); MNRF Road Segments (MNRF)
NWMO — AOI; Basemap Imagery

Project CRS: NAD83 / UTM zone 15N

Author: DM	Verified by: CC
June 22, 2021	Map ID: NWMO_BIS_069

Appendix B: Waterbody (Lake/Pond/Wetland) Reach Table and Map

(see next page)

Station ID	Polygon ID	Sample Order	Waterbody Type	Panel	Point UTM x	Point UTM y	Name	Tertiary Watershed	Lake Reach	Num Inlets	Num Outlet	IN NID	OUT NID	IN x	IN y	OUT x	OUT y	Priority
IG_W001	555482107	AOI.Lake-001	Pond	Census	553741.5997	5483135.761		Wabigoon River	2	1	1	2	1	553767.3063	5483127.63	553714.2401	5483102.017	1
IG_W002	555480429	AOI.Lake-002	Lake	Census	553309.176	5483834.458		Wabigoon River	3	1	1	3	2	553302.2153	5484105.172	553180.5021	5483580.528	1
IG_W003	555480440	AOI.Lake-003	Lake	Census	555113.5844	5484169.022		Wabigoon River	11	1	1	11	10	555159.4364	5484269.969	554957.2864	5483852.41	1
IG_W004	555480451	AOI.Lake-004	Pond	Census	554612.4417	5484335.167		Wabigoon River	1	0	0	-	-					1
IG_W005	555480539	AOI.Lake-005	Lake	Census	557126.6372	5484960.04		Wabigoon River	4	1	1	4	3	557012.0893	5484885.465	557115.4544	5484982.812	1
IG_W006	555480684	AOI.Lake-007	Pond	Census	558817.2539	5486014.385		Wabigoon River	3	1	1	3	2	558876.4996	5486006.842	558787.8933	5485971.816	1
IG_W007	555480695	AOI.Lake-008	Lake	Census	558311.421	5485857.717		Wabigoon River	1	2	1	1	0	558291.0425	5485957.003	558288.6473	5485647.362	1
IG_W008	555480703	AOI.Lake-009	Pond	Census	559100.6803	5486072.969		Wabigoon River	5	1	1	5	4	559141.1996	5486090.243	559028.8244	5486057.768	1
IG_W009	555480706	AOI.Lake-010	Lake	Census	555027.8295	5486016.559		Wabigoon River	11	1	1	11	10	555098.8743	5486102.865	554890.2609	5485842.077	1
IG_W010	555480726	AOI.Lake-011	Lake	Census	558180.6838	5485956.306		Wabigoon River	3	1	1	3	2	558163.5416	5485954.596	558235.9887	5485976.784	1
IG_W011	555480837	AOI.Lake-012	Lake	Census	559774.9198	5486668.843		Wabigoon River	8	1	1	8	7	559828.681	5486685.035	559448.1776	5486419.385	1
IG_W012	555480919	AOI.Lake-013	Lake	Census	560447.08	5487303.477		Wabigoon River	12	0	1	-	11			560506.2686	5487320.383	1
IG_W013	555480931	AOI.Lake-014	Lake	Census	555933.5742	5487134.655		Wabigoon River	15	1	1	15	14	556276.101	5487200.021	555738.6821	5486758.76	1
IG_W014	555480622	AOI.Lake-016	Lake	Census	558105.038	5485329.859		Wabigoon River	10	16	1	10	9	558288.6473	5485647.362	558336.5572	5483214.494	1
IG_W015	555480626	AOI.Lake-017	Lake	Census	554307.7842	5485327.527		Wabigoon River	8	2	1	8	7	554663.0996	5485572.383	554119.6518	5485101.041	1
IG_W016	WS-303	AOI.Wetland-001	Swamp Wetland	PanelOne	558825.8557	5486321.195		Wabigoon River										1
IG_W017	WS-300	AOI.Wetland-002	Swamp Wetland	PanelOne	557864.0365	5486331.961		Wabigoon River										1
IG_W018	WS-289	AOI.Wetland-003	Swamp Wetland	PanelOne	556545.7695	5483375.042		Wabigoon River										1
IG_W019	WS-480	AOI.Wetland-004	Swamp Wetland	PanelOne	555995.9386	5486731.166		Wabigoon River										1
IG_W020	WS-316	AOI.Wetland-005	Swamp Wetland	PanelOne	558800.0041	5485198.991		Wabigoon River										1
IG_W021	WS-339	AOI.Wetland-006	Swamp Wetland	PanelOne	557089.8621	5485675.464		Wabigoon River										1
IG_W022	WS-304	AOI.Wetland-007	Swamp Wetland	PanelOne	556253.105	5486481.763		Wabigoon River										1
IG_W023	WS-366	AOI.Wetland-008	Swamp Wetland	PanelOne	559495.9306	5489012.92		Wabigoon River										1
IG_W024	WP-053	AOI.Wetland-009	Fen Wetland	PanelOne	557896.1118	5484330.04		Wabigoon River										1
IG_W025	WP-048	AOI.Wetland-010	Fen Wetland	PanelOne	553400.9121	5484236.375		Wabigoon River										1
IG_W026	WS-328	AOI.Wetland-011	Swamp Wetland	PanelOne	554681.5973	5485137.922		Wabigoon River										1
IG_W027	WS-347	AOI.Wetland-012	Swamp Wetland	PanelOne	557412.5156	5487738.868		Wabigoon River										1
IG_W028	WS-312	AOI.Wetland-013	Swamp Wetland	PanelOne	557164.5792	5485826.585		Wabigoon River										1
IG_W029	WM-164	AOI.Wetland-014	Marsh Wetland	PanelOne	554573.5048	5484272.535		Wabigoon River										1
IG_W030	WP-111	AOI.Wetland-015	Fen Wetland	PanelOne	555572.434	5486972.354		Wabigoon River										1
IG_W031	WS-463	AOI.Wetland-016	Swamp Wetland	PanelOne	558236.6699	5488100.273		Wabigoon River										1
IG_W032	WP-149	AOI.Wetland-017	Fen Wetland	PanelOne	558856.8372	5486026.668		Wabigoon River										1
IG_W033	WP-145	AOI.Wetland-018	Fen Wetland	PanelOne	558138.5822	5485815.264		Wabigoon River										1
IG_W034	WP-084	AOI.Wetland-019	Fen Wetland	PanelOne	556384.3019	5483197.142		Wabigoon River										1
IG_W035	WS-502	AOI.Wetland-020	Swamp Wetland	PanelOne	556533.8064	5487362.76		Wabigoon River										1
IG_W036	WS-340	AOI.Wetland-021	Swamp Wetland	PanelOne	558790.5145	5485574.171		Wabigoon River										1
IG_W037	WP-046	AOI.Wetland-022	Fen Wetland	PanelOne	556959.4766	5485423.77		Wabigoon River										1
IG_W038	WP-144	AOI.Wetland-023	Fen Wetland	PanelOne	556752.6555	5485605.739		Wabigoon River										1
IG_W039	WS-364	AOI.Wetland-024	Swamp Wetland	PanelOne	559717.3744	5488769.779		Wabigoon River										1
IG_W040	WS-270	AOI.Wetland-025	Swamp Wetland	PanelOne	556964.3327	5484313.792		Wabigoon River										1
IG_W041	WS-324	AOI.Wetland-026	Swamp Wetland	PanelOne	553633.3209	5484462.426		Wabigoon River										1
IG_W042	WP-141	AOI.Wetland-027	Fen Wetland	PanelOne	554371.2245	5485585.724		Wabigoon River										1
IG_W043	WS-483	AOI.Wetland-028	Swamp Wetland	PanelOne	557692.9017	5486785.449		Wabigoon River										1
IG_W044	WS-296	AOI.Wetland-029	Swamp Wetland	PanelOne	557765.2797	5486180.551		Wabigoon River										1
IG_W045	WS-318	AOI.Wetland-030	Swamp Wetland	PanelOne	556471.5299	5484807.336		Wabigoon River										1
IG_W046	WP-112	AOI.Wetland-031	Fen Wetland	PanelOne	555798.6982	5487045.387		Wabigoon River										1
IG_W047	WS-461	AOI.Wetland-032	Swamp Wetland	PanelOne	559974.9356	5488345.682		Wabigoon River										1
IG_W048	WM-181	AOI.Wetland-033	Marsh Wetland	PanelOne	559401.4363	5486261.906		Wabigoon River										1
IG_W049	WP-039	AOI.Wetland-034	Fen Wetland	PanelOne	556998.1297	5484946.68		Wabigoon River										1
IG_W050	WS-259	AOI.Wetland-035	Swamp Wetland	PanelOne	555507.4376	5483663.139		Wabigoon River										1

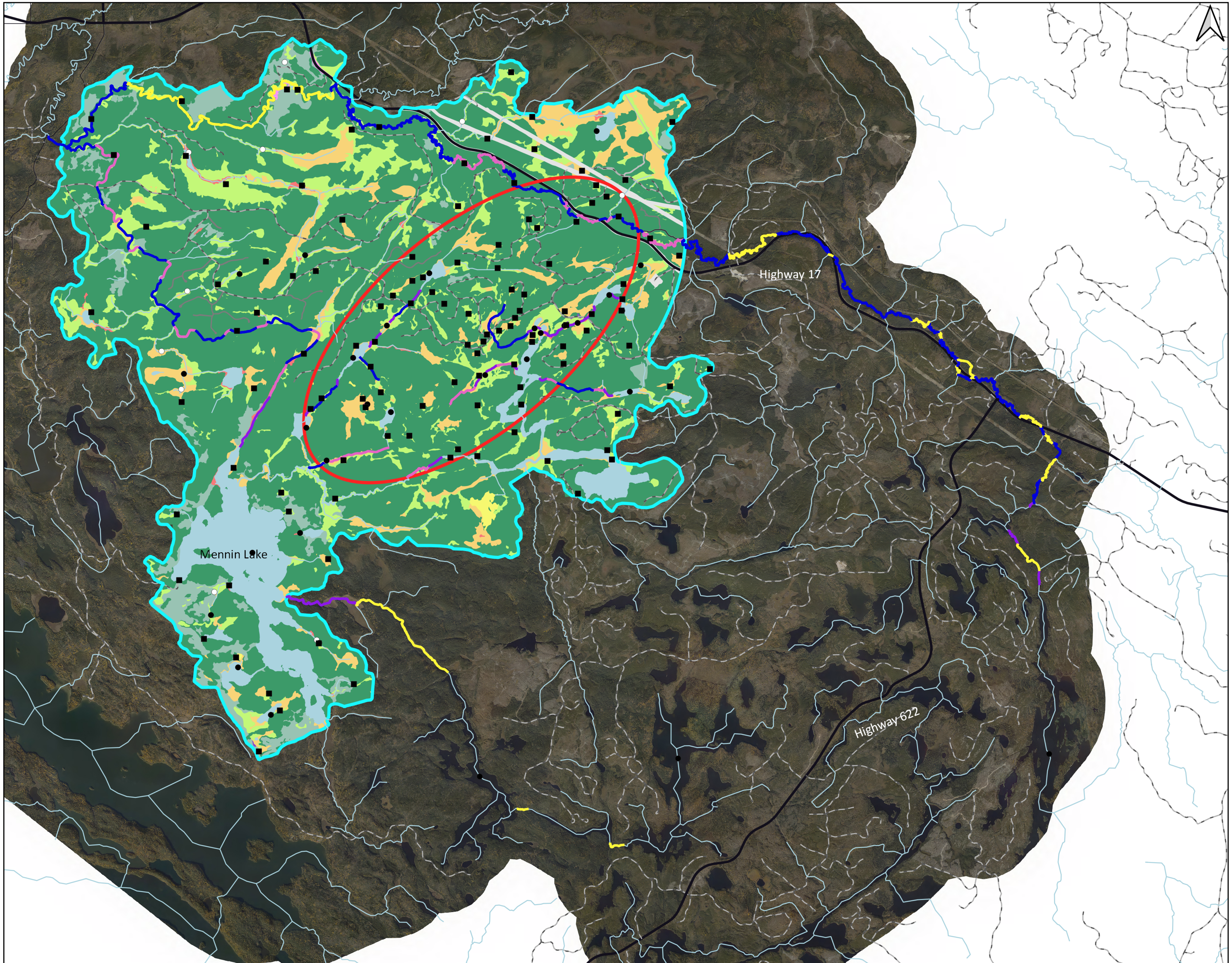
Station ID	Polygon ID	Sample Order	Waterbody Type	Panel	Point UTM x	Point UTM y	Name	Tertiary Watershed	Lake Reach	Num Inlets	Num Outlet	IN NID	OUT NID	IN x	IN y	OUT x	OUT y	Priority
IG_W051	WS-368	AOI.Wetland-036	Swamp Wetland	PanelOne	557747.4667	5489061.844		Wabigoon River										1
IG_W052	WP-106	AOI.Wetland-037	Fen Wetland	PanelOne	560054.8296	5486579.94		Wabigoon River										1
IG_W053	WS-290	AOI.Wetland-038	Swamp Wetland	PanelOne	555047.7037	5483659.982		Wabigoon River										1
IG_W054	WS-481	AOI.Wetland-039	Swamp Wetland	PanelOne	555539.4791	5486491.578		Wabigoon River										1
IG_W055	WS-342	AOI.Wetland-040	Swamp Wetland	PanelOne	558493.6549	5487332.531		Wabigoon River										1
IG_W056	WP-152	AOI.Wetland-041	Fen Wetland	PanelOne	557667.2499	5486005.865		Wabigoon River										1
IG_W057	WP-059	AOI.Wetland-042	Fen Wetland	PanelOne	554899.0054	5484591.268		Wabigoon River										1
IG_W058	WS-297	AOI.Wetland-043	Swamp Wetland	PanelOne	554899.0762	5486429.381		Wabigoon River										1
IG_W059	WS-503	AOI.Wetland-044	Swamp Wetland	PanelOne	557392.4949	5487244.063		Wabigoon River										1
IG_W060	WS-331	AOI.Wetland-045	Swamp Wetland	PanelOne	558128.4598	5485668.344		Wabigoon River										1
IG_W061	WP-055	AOI.Wetland-046	Fen Wetland	PanelOne	555791.702	5484301.655		Wabigoon River										1
IG_W062	WS-497	AOI.Wetland-047	Swamp Wetland	PanelOne	555156.692	5486655.645		Wabigoon River										1
IG_W063	WS-462	AOI.Wetland-048	Swamp Wetland	PanelOne	559073.7985	5488231.661		Wabigoon River										1
IG_W064	WS-307	AOI.Wetland-049	Swamp Wetland	PanelOne	559291.7255	5485909.12		Wabigoon River										1
IG_W065	WP-041	AOI.Wetland-050	Fen Wetland	PanelOne	557744.7265	5485186.355		Wabigoon River										1
IG_W066	WS-476	AOI.Wetland-051	Swamp Wetland	PanelOne	556771.9048	5486268.272		Wabigoon River										1
IG_W067	WS-360	AOI.Wetland-052	Swamp Wetland	PanelOne	559410.659	5488636.681		Wabigoon River										1
IG_W068	WS-266	AOI.Wetland-053	Swamp Wetland	PanelOne	557877.9555	5484700.272		Wabigoon River										1
IG_W069	WS-284	AOI.Wetland-054	Swamp Wetland	PanelOne	554102.6054	5483140.368		Wabigoon River										1
IG_W070	WS-336	AOI.Wetland-055	Swamp Wetland	PanelOne	554771.8069	5485669.593		Wabigoon River										1
IG_W071	WS-474	AOI.Wetland-056	Swamp Wetland	PanelOne	557960.1094	5486680.184		Wabigoon River										1
IG_W072	WS-311	AOI.Wetland-057	Swamp Wetland	PanelOne	557422.9071	5485907.015		Wabigoon River										1
IG_W073	WP-056	AOI.Wetland-058	Fen Wetland	PanelOne	554513.4638	5484453.114		Wabigoon River										1
IG_W074	WS-345	AOI.Wetland-059	Swamp Wetland	PanelOne	555571.6029	5487482.153		Wabigoon River										1
IG_W075	WS-466	AOI.Wetland-060	Swamp Wetland	PanelOne	558060.625	5488285.091		Wabigoon River										1
IG_W076	555480543	XAOI.Lake-002	Pond	PanelOne	550696.1983	5484986.046		Wabigoon River	1	3	1	1	0	550669.611	5484953.803	550757.9123	5484995.117	1
IG_W077	555480210	XAOI.Lake-004	Lake	PanelOne	553175.3077	5481588.292		Wabigoon River	2	0	1	-	1			552736.463	5481441.078	1
IG_W078	555480071	XAOI.Lake-008	Lake	PanelOne	551851.6562	5478718.608		Wabigoon River	2	1	1	2	1	551926.0554	5478849.669	552200.8023	5478589.74	1
IG_W079	555482065	XAOI.Lake-009	Pond	PanelOne	553282.8806	5487519.799		Wabigoon River	16	1	1	16	15	553290.8073	5487517.425	553273.9029	5487507.368	1
IG_W080	555480490	XAOI.Lake-013	Lake	PanelOne	560214.4198	5484605.206		Wabigoon River	6	2	1	6	5	560420.7771	5484604.754	559830.8918	5484519.752	1
IG_W081	555480867	XAOI.Lake-014	Pond	PanelOne	551884.0848	5487118.172		Wabigoon River	13	1	1	13	12	551905.3294	5487097.369	551869.4132	5487114.282	1
IG_W082	555480114	XAOI.Lake-016	Pond	PanelOne	551272.8092	5479835.831		Wabigoon River	9	1	1	9	8	551295.3963	5479835.874	551263.2736	5479887.034	1
IG_W083	555480027	XAOI.Lake-018	Lake	OverSamp	552552.3829	5477704.262		Wabigoon River	3	0	1	-	2			552796.0287	5477900.632	1
IG_W084	555481483	XAOI.Lake-029	Lake	OverSamp	559505.1516	5490169.914	Pyatt Lake	Wabigoon River	4	1	1	4	3	559900.8281	5490551.129	559543.8692	5490507.129	1
IG_W085	555480085	XAOI.Lake-030	Pond	OverSamp	553584.1024	5479241.448		Wabigoon River	8	1	1	8	7	553584.6767	5479238.823	553574.5835	5479252.585	1
IG_W086	555480796	XAOI.Lake-031	Lake	OverSamp	560050.8005	5486334.188		Wabigoon River	10	2	1	10	9	560257.8589	5486447.337	559963.5771	5486601.389	1
IG_W087	555481183	XAOI.Lake-034	Lake	PanelOne	552157.5615	5481166.38	Mennin Lake	Wabigoon River	27	13	1	27	26	552896.9578	5480223.432	551721.003	5482596.376	1
IG_W088	555471234	XAOI.Lake-035	Lake	Census	561244.3983	5476774.154	Spruce Lake	Wabigoon River	41	6	1	41	40	561851.0581	5477016.098	560074.5786	5474927.851	1
IG_W089	555471236	XAOI.Lake-036	Lake	Census	557010.4196	5476388.56	Cox Lake	Wabigoon River	36	7	1	36	35	557824.447	5475697.804	556320.5671	5478624.159	1
IG_W090	555471235	XAOI.Lake-037	Lake	Census	569165.9512	5476870.918	Revell Lake	Wabigoon River	58	2	1	58	57	570653.2054	5476751.672	568947.5571	5478939.103	1
IG_W091	WS-263	XAOI.Wetland-001	Swamp Wetland	PanelOne	561923.5025	5485088.076		Wabigoon River										1
IG_W092	WS-313	XAOI.Wetland-002	Swamp Wetland	PanelOne	551829.439	5485903.187		Wabigoon River										1
IG_W093	WS-283	XAOI.Wetland-003	Swamp Wetland	PanelOne	553924.4017	5482320.944		Wabigoon River										1
IG_W094	WS-374	XAOI.Wetland-004	Swamp Wetland	PanelOne	557172.8446	5490007.065		Wabigoon River										1
IG_W095	WS-448	XAOI.Wetland-005	Swamp Wetland	PanelOne	560647.4925	5487878.451		Wabigoon River										1
IG_W096	WS-456	XAOI.Wetland-006	Swamp Wetland	PanelOne	549890.9547	5488127.032		Wabigoon River										1
IG_W097	WP-120	XAOI.Wetland-007	Fen Wetland	PanelOne	559193.4248	5489322.474		Wabigoon River										1
IG_W098	WS-214	XAOI.Wetland-008	Swamp Wetland	PanelOne	554322.9979	5478360.301		Wabigoon River										1
IG_W099	WP-079	XAOI.Wetland-009	Fen Wetland	PanelOne	559832.239	5483157.217		Wabigoon River										1
IG_W100	WS-237	XAOI.Wetland-010	Swamp Wetland	PanelOne	552772.6096	5482450.227		Wabigoon River										1

Station ID	Polygon ID	Sample Order	Waterbody Type	Panel	Point UTM x	Point UTM y	Name	Tertiary Watershed	Lake Reach	Num Inlets	Num Outlet	IN NID	OUT NID	IN x	IN y	OUT x	OUT y	Priority
IG_W101	WM-196	XAOI.Wetland-011	Marsh Wetland	PanelOne	552895.7593	5491057.778		Wabigoon River										1
IG_W102	WS-212	XAOI.Wetland-012	Swamp Wetland	PanelOne	552512.6355	5478160.254		Wabigoon River										1
IG_W103	WS-282	XAOI.Wetland-013	Swamp Wetland	PanelOne	558456.7617	5483125.234		Wabigoon River										1
IG_W104	WP-057	XAOI.Wetland-014	Fen Wetland	PanelOne	552193.0004	5484676.255		Wabigoon River										1
IG_W105	WM-199	XAOI.Wetland-015	Marsh Wetland	PanelOne	550736.3794	5489639.201		Wabigoon River										1
IG_W106	WS-384	XAOI.Wetland-016	Swamp Wetland	PanelOne	548719.626	5490426.468		Wabigoon River										1
IG_W107	WP-091	XAOI.Wetland-017	Fen Wetland	PanelOne	560037.1685	5486336.329		Wabigoon River										1
IG_W108	WM-179	XAOI.Wetland-018	Marsh Wetland	PanelOne	552254.8197	5486291.565		Wabigoon River										1
IG_W109	WP-022	XAOI.Wetland-019	Fen Wetland	PanelOne	553774.5182	5481031.332		Wabigoon River										1
IG_W110	WS-426	XAOI.Wetland-020	Swamp Wetland	PanelOne	554277.9096	5490200.882		Wabigoon River										1
IG_W111	WS-341	XAOI.Wetland-021	Swamp Wetland	PanelOne	561267.9263	5487509.353		Wabigoon River										1
IG_W112	WP-099	XAOI.Wetland-022	Fen Wetland	PanelOne	556547.4026	5488565.937		Wabigoon River										1
IG_W113	WS-406	XAOI.Wetland-023	Swamp Wetland	PanelOne	557681.1741	5491427.318		Wabigoon River										1
IG_W114	WM-161	XAOI.Wetland-024	Marsh Wetland	PanelOne	551124.4951	5479326.601		Wabigoon River										1
IG_W115	WS-285	XAOI.Wetland-025	Swamp Wetland	PanelOne	559732.7646	5483356.241		Wabigoon River										1
IG_W116	WS-250	XAOI.Wetland-026	Swamp Wetland	PanelOne	552935.0594	5482046.624		Wabigoon River										1
IG_W117	WS-411	XAOI.Wetland-027	Swamp Wetland	PanelOne	553119.74	5491051.168		Wabigoon River										1
IG_W118	WS-220	XAOI.Wetland-028	Swamp Wetland	PanelOne	552744.4188	5477797.215		Wabigoon River										1
IG_W119	WS-501	XAOI.Wetland-029	Swamp Wetland	PanelOne	553022.1493	5487075.798		Wabigoon River										1
IG_W120	WS-262	XAOI.Wetland-030	Swamp Wetland	PanelOne	550646.939	5484384.707		Wabigoon River										1
IG_W121	WS-395	XAOI.Wetland-031	Swamp Wetland	PanelOne	550652.8718	5490807.228		Wabigoon River										1
IG_W122	WS-414	XAOI.Wetland-032	Swamp Wetland	PanelOne	549199.3083	5489658.862		Wabigoon River										1
IG_W123	WS-329	XAOI.Wetland-033	Swamp Wetland	PanelOne	560202.004	5485588.365		Wabigoon River										1
IG_W124	WM-175	XAOI.Wetland-034	Marsh Wetland	PanelOne	553255.9408	5485414.909		Wabigoon River										1
IG_W125	WS-439	XAOI.Wetland-035	Swamp Wetland	PanelOne	558177.7828	5489783.221		Wabigoon River										1
IG_W126	WS-379	XAOI.Wetland-036	Swamp Wetland	PanelOne	554865.2355	5490256.178		Wabigoon River										1
IG_W127	WS-236	XAOI.Wetland-037	Swamp Wetland	PanelOne	559106.3391	5482427.94		Wabigoon River										1
IG_W128	WP-097	XAOI.Wetland-038	Fen Wetland	PanelOne	554077.7744	5488275.329		Wabigoon River										1
IG_W129	WS-357	XAOI.Wetland-039	Swamp Wetland	PanelOne	560119.4692	5489125.053		Wabigoon River										1
IG_W130	WM-160	XAOI.Wetland-040	Marsh Wetland	PanelOne	550595.2228	5480579.931		Wabigoon River										1
IG_W131	WS-267	XAOI.Wetland-041	Swamp Wetland	PanelOne	561072.8173	5484718.647		Wabigoon River										1
IG_W132	WS-249	XAOI.Wetland-042	Swamp Wetland	PanelOne	550544.1367	5481983.879		Wabigoon River										1
IG_W133	WS-470	XAOI.Wetland-043	Swamp Wetland	PanelOne	553215.7081	5489005.46		Wabigoon River										1
IG_W134	WS-224	XAOI.Wetland-044	Swamp Wetland	PanelOne	551660.9333	5480468.893		Wabigoon River										1
IG_W135	WS-344	XAOI.Wetland-045	Swamp Wetland	PanelOne	552445.9237	5487383.96		Wabigoon River										1
IG_W136	WP-082	XAOI.Wetland-046	Fen Wetland	PanelOne	556959.4051	5483230.271		Wabigoon River										1
IG_W137	WS-421	XAOI.Wetland-047	Swamp Wetland	PanelOne	556681.1196	5489482.394		Wabigoon River										1
IG_W138	WP-090	XAOI.Wetland-048	Fen Wetland	PanelOne	548719.1069	5486302.057		Wabigoon River										1
IG_W139	WS-495	XAOI.Wetland-049	Swamp Wetland	PanelOne	560079.0804	5486903.111		Wabigoon River										1
IG_W140	WM-184	XAOI.Wetland-050	Marsh Wetland	PanelOne	551422.6607	5486895.919		Wabigoon River										1
IG_W141	WM-197	XAOI.Wetland-051	Marsh Wetland	PanelOne	558130.0873	5490471.655		Wabigoon River										1
IG_W142	WS-234	XAOI.Wetland-052	Swamp Wetland	PanelOne	553575.3047	5479231.079		Wabigoon River										1
IG_W143	WS-273	XAOI.Wetland-053	Swamp Wetland	PanelOne	559958.3976	5484132.74		Wabigoon River										1
IG_W144	WS-500	XAOI.Wetland-054	Swamp Wetland	PanelOne	553511.5507	5487181.301		Wabigoon River										1
IG_W145	WP-125	XAOI.Wetland-055	Fen Wetland	PanelOne	561122.6642	5490363.821		Wabigoon River										1
IG_W146	WP-001	XAOI.Wetland-056	Fen Wetland	PanelOne	552296.0449	5476923.251		Wabigoon River										1
IG_W147	WS-292	XAOI.Wetland-057	Swamp Wetland	PanelOne	557752.9508	5483738.985		Wabigoon River										1
IG_W148	WP-088	XAOI.Wetland-058	Fen Wetland	PanelOne	551756.7218	5482978.014		Wabigoon River										1
IG_W149	WS-427	XAOI.Wetland-059	Swamp Wetland	PanelOne	551592.2382	5489035.645		Wabigoon River										1
IG_W150	WP-010	XAOI.Wetland-060	Bog Wetland	PanelOne	551808.6616	5478931.57		Wabigoon River										1

Station ID	Polygon ID	Sample Order	Waterbody Type	Panel	Point UTM x	Point UTM y	Name	Tertiary Watershed	Lake Reach	Num Inlets	Num Outlet	IN NID	OUT NID	IN x	IN y	OUT x	OUT y	Priority
IG_W151	555482098	AOI.Lake-006	Pond	Census	557149.9143	5485818.024		Wabigoon River	1	0	0	-	-					2
IG_W152	555481161	AOI.Lake-015	Pond	Census	560049.7172	5488797.042		Wabigoon River	2	1	1	2	1	560177.746	5488901.499	559982.7024	5488637.801	2
IG_W153	WP-150	AOI.Wetland-061	Fen Wetland	OverSamp	558272.8033	5485940.602		Wabigoon River										2
IG_W154	WP-054	AOI.Wetland-062	Fen Wetland	OverSamp	555156.0297	5484404.656		Wabigoon River										2
IG_W155	WS-348	AOI.Wetland-063	Swamp Wetland	OverSamp	556390.0418	5487614.438		Wabigoon River										2
IG_W156	WS-490	AOI.Wetland-064	Swamp Wetland	OverSamp	559915.6995	5487062.588		Wabigoon River										2
IG_W157	WM-172	AOI.Wetland-065	Marsh Wetland	OverSamp	558723.743	5485934.627		Wabigoon River										2
IG_W158	WP-142	AOI.Wetland-066	Fen Wetland	OverSamp	557600.9756	5485594.622		Wabigoon River										2
IG_W159	WS-258	AOI.Wetland-067	Swamp Wetland	OverSamp	556006.1628	5483843.899		Wabigoon River										2
IG_W160	WS-468	AOI.Wetland-068	Swamp Wetland	OverSamp	557855.014	5488626.2		Wabigoon River										2
IG_W161	WS-288	AOI.Wetland-069	Swamp Wetland	OverSamp	556964.0847	5483353.611		Wabigoon River										2
IG_W162	WP-206	AOI.Wetland-070	Bog Wetland	OverSamp	553434.1179	5484764.782		Wabigoon River										2
IG_W163	WP-045	AOI.Wetland-071	Fen Wetland	OverSamp	554484.9338	5485302.495		Wabigoon River										2
IG_W164	WP-107	AOI.Wetland-072	Fen Wetland	OverSamp	557165.9503	5486771.9		Wabigoon River										2
IG_W165	WP-110	AOI.Wetland-073	Fen Wetland	OverSamp	559172.5794	5486246.775		Wabigoon River										2
IG_W166	WM-178	AOI.Wetland-074	Marsh Wetland	OverSamp	557740.4653	5485124.714		Wabigoon River										2
IG_W167	WP-047	AOI.Wetland-075	Fen Wetland	OverSamp	555711.5797	5485449.655		Wabigoon River										2
IG_W168	WS-471	AOI.Wetland-076	Swamp Wetland	OverSamp	557276.505	5488616.023		Wabigoon River										2
IG_W169	WP-153	AOI.Wetland-077	Fen Wetland	OverSamp	557757.3397	5486057.538		Wabigoon River										2
IG_W170	WP-205	AOI.Wetland-078	Bog Wetland	OverSamp	554270.4757	5484777.97		Wabigoon River										2
IG_W171	WS-488	AOI.Wetland-079	Swamp Wetland	OverSamp	554874.4108	5486846.02		Wabigoon River										2
IG_W172	WS-464	AOI.Wetland-080	Swamp Wetland	OverSamp	557889.2384	5488349.606		Wabigoon River										2
IG_W173	WS-320	AOI.Wetland-081	Swamp Wetland	OverSamp	558745.0401	5484983.885		Wabigoon River										2
IG_W174	WP-040	AOI.Wetland-082	Fen Wetland	OverSamp	557395.745	5485139.594		Wabigoon River										2
IG_W175	WP-146	AOI.Wetland-083	Fen Wetland	OverSamp	556593.1691	5485734.373		Wabigoon River										2
IG_W176	WP-119	AOI.Wetland-084	Fen Wetland	OverSamp	559175.1542	5489171.612		Wabigoon River										2
IG_W177	WP-151	AOI.Wetland-085	Fen Wetland	OverSamp	557237.2711	5486124.515		Wabigoon River										2
IG_W178	WS-271	AOI.Wetland-086	Swamp Wetland	OverSamp	554556.52	5484142.482		Wabigoon River										2
IG_W179	WS-499	AOI.Wetland-087	Swamp Wetland	OverSamp	555847.1113	5487172.905		Wabigoon River										2
IG_W180	WP-093	AOI.Wetland-088	Fen Wetland	OverSamp	557913.7177	5487673.828		Wabigoon River										2
IG_W181	WP-044	AOI.Wetland-089	Fen Wetland	OverSamp	558729.4606	5485410.654		Wabigoon River										2
IG_W182	WS-335	AOI.Wetland-090	Swamp Wetland	OverSamp	557177.853	5485564.588		Wabigoon River										2
IG_W183	WS-314	AOI.Wetland-091	Swamp Wetland	OverSamp	556045.0664	5486101.466		Wabigoon River										2
IG_W184	WS-469	AOI.Wetland-092	Swamp Wetland	OverSamp	559873.6167	5488530.423		Wabigoon River										2
IG_W185	WS-485	AOI.Wetland-093	Swamp Wetland	OverSamp	557425.1602	5486260.402		Wabigoon River										2
IG_W186	WS-269	AOI.Wetland-094	Swamp Wetland	OverSamp	556024.0167	5484264.918		Wabigoon River										2
IG_W187	WM-183	AOI.Wetland-095	Marsh Wetland	OverSamp	555800.958	5486860.685		Wabigoon River										2
IG_W188	WS-350	AOI.Wetland-096	Swamp Wetland	OverSamp	559991.7533	5487637.996		Wabigoon River										2
IG_W189	WS-327	AOI.Wetland-097	Swamp Wetland	OverSamp	559219.4652	5485301.018		Wabigoon River										2
IG_W190	WP-036	AOI.Wetland-098	Fen Wetland	OverSamp	554963.9557	5483781.997		Wabigoon River										2
IG_W191	WS-315	AOI.Wetland-099	Swamp Wetland	OverSamp	555585.409	5485961.114		Wabigoon River										2
IG_W192	WP-137	AOI.Wetland-100	Fen Wetland	OverSamp	559831.8048	5488808.786		Wabigoon River										2
IG_W193	WM-171	AOI.Wetland-101	Marsh Wetland	OverSamp	558264.6127	5485655.821		Wabigoon River										2
IG_W194	WP-063	AOI.Wetland-102	Fen Wetland	OverSamp	556802.3846	5484593.236		Wabigoon River										2
IG_W195	WS-487	AOI.Wetland-103	Swamp Wetland	OverSamp	555976.8404	5486860.102		Wabigoon River										2
IG_W196	WP-095	AOI.Wetland-104	Fen Wetland	OverSamp	559402.7879	5487246.615		Wabigoon River										2
IG_W197	WS-265	AOI.Wetland-105	Swamp Wetland	OverSamp	558400.0499	5484526.708		Wabigoon River										2
IG_W198	WP-033	AOI.Wetland-106	Fen Wetland	OverSamp	554559.3951	5483331.346		Wabigoon River										2
IG_W199	WM-174	AOI.Wetland-107	Marsh Wetland	OverSamp	554827.5985	5485561.336		Wabigoon River										2
IG_W200	WP-108	AOI.Wetland-108	Fen Wetland	OverSamp	557834.7681	5486806.588		Wabigoon River										2

Station ID	Polygon ID	Sample Order	Waterbody Type	Panel	Point UTM x	Point UTM y	Name	Tertiary Watershed	Lake Reach	Num Inlets	Num Outlet	IN NID	OUT NID	IN x	IN y	OUT x	OUT y	Priority
IG_W201	WM-166	AOI.Wetland-109	Marsh Wetland	OverSamp	558311.1677	5484948.174		Wabigoon River										2
IG_W202	WS-323	AOI.Wetland-110	Swamp Wetland	OverSamp	555165.5788	5484346.397		Wabigoon River										2
IG_W203	WP-102	AOI.Wetland-111	Fen Wetland	OverSamp	556819.1304	5487712.99		Wabigoon River										2
IG_W204	WS-504	AOI.Wetland-112	Swamp Wetland	OverSamp	559909.7329	5487111.955		Wabigoon River										2
IG_W205	WS-277	AOI.Wetland-113	Swamp Wetland	OverSamp	557993.7301	5484393.849		Wabigoon River										2
IG_W206	WP-080	AOI.Wetland-114	Fen Wetland	OverSamp	553653.2649	5483092.993		Wabigoon River										2
IG_W207	WP-066	AOI.Wetland-115	Fen Wetland	OverSamp	554774.2217	5484850.459		Wabigoon River										2
IG_W208	WS-482	AOI.Wetland-116	Swamp Wetland	OverSamp	558261.0197	5486742.334		Wabigoon River										2
IG_W209	WS-308	AOI.Wetland-117	Swamp Wetland	OverSamp	558509.6148	5486102.51		Wabigoon River										2
IG_W210	WP-060	AOI.Wetland-118	Fen Wetland	OverSamp	555573.3953	5484699.759		Wabigoon River										2
IG_W211	WP-094	AOI.Wetland-119	Fen Wetland	OverSamp	556373.5993	5487177.582		Wabigoon River										2
IG_W212	WS-281	AOI.Wetland-120	Swamp Wetland	OverSamp	555863.0307	5482960.151		Wabigoon River										2
IG_W213	555482030	XAOI.Lake-001	Pond	PanelOne	556638.0295	5490375.869		Wabigoon River	2	1	1	2	1	556660.001	5490384.918	556626.1656	5490352.301	2
IG_W214	555481343	XAOI.Lake-003	Lake	PanelOne	552376.4186	5489779.194		Wabigoon River	2	1	1	2	1	552464.3526	5489781.507	552282.707	5489803.923	2
IG_W215	555481198	XAOI.Lake-005	Pond	PanelOne	553225.33	5488999.466		Wabigoon River	5	1	1	5	4	553322.5635	5488931.39	553179.3813	5488961.863	2
IG_W216	555480596	XAOI.Lake-006	Pond	PanelOne	550219.2557	5485469.351		Wabigoon River	3	1	1	3	2	550307.8414	5485473.831	550227.6974	5485419.087	2
IG_W217	555481334	XAOI.Lake-007	Lake	PanelOne	550798.6695	5489715.029		Wabigoon River	2	1	1	2	1	550999.5115	5489258.038	550743.1675	5489783.218	2
IG_W218	555480826	XAOI.Lake-010	Pond	PanelOne	550768.3704	5486752.809		Wabigoon River	6	1	1	6	5	550833.1839	5486767.107	550760.1351	5486737.077	2
IG_W219	555481652	XAOI.Lake-011	Pond	PanelOne	552847.1764	5491640.255		Wabigoon River	1	0	0	-	-					2
IG_W220	555480133	XAOI.Lake-012	Pond	PanelOne	551344.9519	5480328.311		Wabigoon River	1	0	0	-	-					2
IG_W221	555480092	XAOI.Lake-015	Pond	PanelOne	553531.5539	5479302.768		Wabigoon River	6	1	1	6	5	553564.5471	5479263.99	553495.8983	5479324.926	2
IG_W222	555480496	XAOI.Lake-017	Lake	PanelOne	550640.8888	5484656.435		Wabigoon River	2	1	1	2	1	550496.6323	5484638.003	550728.4996	5484720.703	2
IG_W223	555480810	XAOI.Lake-019	Pond	OverSamp	550669.2991	5486701.09		Wabigoon River	4	1	1	4	3	550745.975	5486715.875	550670.0544	5486692.194	2
IG_W224	555480005	XAOI.Lake-020	Pond	OverSamp	552278.4584	5477215.934		Wabigoon River	1	0	0	-	-					2
IG_W225	555482021	XAOI.Lake-021	Pond	OverSamp	552296.0439	5486434.277		Wabigoon River	2	1	1	2	1	552278.8146	5486438.905	552281.5321	5486417.417	2
IG_W226	555480128	XAOI.Lake-022	Pond	OverSamp	551377.5409	5480201.794		Wabigoon River	1	0	0	-	-					2
IG_W227	555480753	XAOI.Lake-023	Lake	OverSamp	548704.9765	5486080.745		Wabigoon River	5	3	1	5	4	548564.0625	5486336.083	548748.5374	5486085.796	2
IG_W228	555480117	XAOI.Lake-024	Pond	OverSamp	551241.2868	5480002.175		Wabigoon River	7	1	1	7	6	551257.2245	5479904.049	551295.6821	5480039.869	2
IG_W229	555482048	XAOI.Lake-025	Pond	OverSamp	556540.1732	5488577.122		Wabigoon River	3	0	1	-	2			556520.9803	5488588.857	2
IG_W230	555482101	XAOI.Lake-026	Pond	OverSamp	549924.3886	5491058.708		Wabigoon River	1	0	0	-	-					2
IG_W231	555481064	XAOI.Lake-027	Pond	OverSamp	553416.5355	5488297.942		Wabigoon River	9	1	1	9	8	553474.8864	5488296.706	553459.5455	5488322.457	2
IG_W232	555481810	XAOI.Lake-028	Pond	OverSamp	552527.369	5489084.241		Wabigoon River	5	1	1	5	4	552567.8736	5489087.212	552520.7229	5489059.226	2
IG_W233	555480095	XAOI.Lake-032	Pond	OverSamp	553463.7865	5479375.734		Wabigoon River	4	1	1	4	3	553480.6198	5479345.835	553447.5846	5479383.992	2
IG_W234	555481338	XAOI.Lake-033	Pond	OverSamp	552600.4414	5489739.685		Wabigoon River	4	1	1	4	3	552632.9625	5489741.718	552578.4112	5489759.216	2
IG_W235	WS-321	XAOI.Wetland-061	Swamp Wetland	OverSamp	550610.6671	5485112.267		Wabigoon River										2
IG_W236	WS-254	XAOI.Wetland-062	Swamp Wetland	OverSamp	556677.5389	5482344.522		Wabigoon River										2
IG_W237	WS-441	XAOI.Wetland-063	Swamp Wetland	OverSamp	556121.8915	5489797.318		Wabigoon River										2
IG_W238	WS-355	XAOI.Wetland-064	Swamp Wetland	OverSamp	548939.2903	5488649.348		Wabigoon River										2
IG_W239	WP-105	XAOI.Wetland-065	Fen Wetland	OverSamp	560327.0288	5486567.951		Wabigoon River										2
IG_W240	WS-302	XAOI.Wetland-066	Swamp Wetland	OverSamp	552881.1739	5486208.551		Wabigoon River										2
IG_W241	WS-240	XAOI.Wetland-067	Swamp Wetland	OverSamp	554798.945	5482537.741		Wabigoon River										2
IG_W242	WS-381	XAOI.Wetland-068	Swamp Wetland	OverSamp	554441.0934	5490378.923		Wabigoon River										2
IG_W243	WP-051	XAOI.Wetland-069	Fen Wetland	OverSamp	561178.2055	5484619.517		Wabigoon River										2
IG_W244	WM-170	XAOI.Wetland-070	Marsh Wetland	OverSamp	553181.881	5481584.187		Wabigoon River										2
IG_W245	WS-408	XAOI.Wetland-071	Swamp Wetland	OverSamp	549912.8081	5490972.05		Wabigoon River										2
IG_W246	WS-211	XAOI.Wetland-072	Swamp Wetland	OverSamp	552633.4145	5477242.537		Wabigoon River										2
IG_W247	WS-473	XAOI.Wetland-073	Swamp Wetland	OverSamp	560926.0446	5486647.253		Wabigoon River										2
IG_W248	WS-334	XAOI.Wetland-074	Swamp Wetland	OverSamp	552330.9082	5485499.561		Wabigoon River										2
IG_W249	WS-417	XAOI.Wetland-075	Swamp Wetland	OverSamp	557899.7657	5489383.566		Wabigoon River										2
IG_W250	WP-130	XAOI.Wetland-076	Fen Wetland	OverSamp	554099.4389	5489627.825		Wabigoon River										2

Station ID	Polygon ID	Sample Order	Waterbody Type	Panel	Point UTM x	Point UTM y	Name	Tertiary Watershed	Lake Reach	Num Inlets	Num Outlet	IN NID	OUT NID	IN x	IN y	OUT x	OUT y	Priority
IG_W251	WP-028	XAOI.Wetland-077	Fen Wetland	OverSamp	560133.9296	5482366.817		Wabigoon River										2
IG_W252	WS-256	XAOI.Wetland-078	Swamp Wetland	OverSamp	552507.8266	5483806.854		Wabigoon River										2
IG_W253	WS-418	XAOI.Wetland-079	Swamp Wetland	OverSamp	552427.5696	5489722.606		Wabigoon River										2
IG_W254	WP-015	XAOI.Wetland-080	Fen Wetland	OverSamp	553269.3826	5479517.373		Wabigoon River										2
IG_W255	WS-361	XAOI.Wetland-081	Swamp Wetland	OverSamp	560723.1314	5488749.39		Wabigoon River										2
IG_W256	WS-343	XAOI.Wetland-082	Swamp Wetland	OverSamp	550508.2162	5487430.492		Wabigoon River										2
IG_W257	WS-399	XAOI.Wetland-083	Swamp Wetland	OverSamp	557706.4675	5490461.441		Wabigoon River										2
IG_W258	WM-158	XAOI.Wetland-084	Marsh Wetland	OverSamp	553774.2093	5479116.665		Wabigoon River										2
IG_W259	WS-291	XAOI.Wetland-085	Swamp Wetland	OverSamp	558377.0921	5483595.611		Wabigoon River										2
IG_W260	WS-243	XAOI.Wetland-086	Swamp Wetland	OverSamp	552915.5725	5482790.859		Wabigoon River										2
IG_W261	WS-396	XAOI.Wetland-087	Swamp Wetland	OverSamp	552585.5627	5490667.273		Wabigoon River										2
IG_W262	WS-353	XAOI.Wetland-088	Swamp Wetland	OverSamp	548380.6089	5488913.289		Wabigoon River										2
IG_W263	WS-493	XAOI.Wetland-089	Swamp Wetland	OverSamp	560752.9217	5487369.719		Wabigoon River										2
IG_W264	WM-186	XAOI.Wetland-090	Marsh Wetland	OverSamp	550988.2812	5488034.316		Wabigoon River										2
IG_W265	WP-127	XAOI.Wetland-091	Fen Wetland	OverSamp	559342.8403	5490525.696		Wabigoon River										2
IG_W266	WS-221	XAOI.Wetland-092	Swamp Wetland	OverSamp	550689.9555	5479643.422		Wabigoon River										2
IG_W267	WS-272	XAOI.Wetland-093	Swamp Wetland	OverSamp	559142.4646	5484204.725		Wabigoon River										2
IG_W268	WS-255	XAOI.Wetland-094	Swamp Wetland	OverSamp	551005.7699	5483829.728		Wabigoon River										2
IG_W269	WS-372	XAOI.Wetland-095	Swamp Wetland	OverSamp	550281.0304	5490037.687		Wabigoon River										2
IG_W270	WS-375	XAOI.Wetland-096	Swamp Wetland	OverSamp	548407.9349	5490056.554		Wabigoon River										2
IG_W271	WS-460	XAOI.Wetland-097	Swamp Wetland	OverSamp	560293.337	5488338.67		Wabigoon River										2
IG_W272	WP-135	XAOI.Wetland-098	Fen Wetland	OverSamp	555556.5528	5488394.685		Wabigoon River										2
IG_W273	WS-437	XAOI.Wetland-099	Swamp Wetland	OverSamp	559597.6321	5489761.924		Wabigoon River										2
IG_W274	WP-013	XAOI.Wetland-100	Fen Wetland	OverSamp	551400.8909	5480201.336		Wabigoon River										2
IG_W275	WM-192	XAOI.Wetland-101	Marsh Wetland	OverSamp	553328.8107	5487563.592		Wabigoon River										2
IG_W276	WP-083	XAOI.Wetland-102	Fen Wetland	OverSamp	556807.3046	5483181.471		Wabigoon River										2
IG_W277	WS-407	XAOI.Wetland-103	Swamp Wetland	OverSamp	553950.5753	5491030.652		Wabigoon River										2
IG_W278	WM-182	XAOI.Wetland-104	Marsh Wetland	OverSamp	548581.0941	5486633.437		Wabigoon River										2
IG_W279	WS-264	XAOI.Wetland-105	Swamp Wetland	OverSamp	560485.4852	5484655.167		Wabigoon River										2
IG_W280	WS-454	XAOI.Wetland-106	Swamp Wetland	OverSamp	555284.4715	5488102.252		Wabigoon River										2
IG_W281	WP-129	XAOI.Wetland-107	Fen Wetland	OverSamp	560141.088	5490345.109		Wabigoon River										2
IG_W282	WP-002	XAOI.Wetland-108	Fen Wetland	OverSamp	552261.8211	5477136.517		Wabigoon River										2
IG_W283	WP-136	XAOI.Wetland-109	Fen Wetland	OverSamp	553342.8948	5488111.272		Wabigoon River										2
IG_W284	WP-025	XAOI.Wetland-110	Fen Wetland	OverSamp	557413.9403	5481435.88		Wabigoon River										2
IG_W285	WS-422	XAOI.Wetland-111	Swamp Wetland	OverSamp	556243.8875	5489549.776		Wabigoon River										2
IG_W286	WS-475	XAOI.Wetland-112	Swamp Wetland	OverSamp	548175.8335	5486307.209		Wabigoon River										2
IG_W287	WM-165	XAOI.Wetland-113	Marsh Wetland	OverSamp	559681.497	5484578.31		Wabigoon River										2
IG_W288	WS-295	XAOI.Wetland-114	Swamp Wetland	OverSamp	553526.8471	5486055.145		Wabigoon River										2
IG_W289	WP-128	XAOI.Wetland-115	Fen Wetland	OverSamp	560753.9385	5489227.494		Wabigoon River										2
IG_W290	WP-017	XAOI.Wetland-116	Fen Wetland	OverSamp	551747.7882	5478268.231		Wabigoon River										2
IG_W291	WP-148	XAOI.Wetland-117	Fen Wetland	OverSamp	550751.7896	5485811.38		Wabigoon River										2
IG_W292	WS-251	XAOI.Wetland-118	Swamp Wetland	OverSamp	556166.5033	5481931.659		Wabigoon River										2
IG_W293	WS-402	XAOI.Wetland-119	Swamp Wetland	OverSamp	557334.0341	5490727.356		Wabigoon River										2
IG_W294	WS-452	XAOI.Wetland-120	Swamp Wetland	OverSamp	549240.7554	5488283.804		Wabigoon River										2



NWMO Biodiversity Impact Studies

Aquatic Habitat Mapping Fieldwork Locations

Area of Interest (AOI)
Local Study Area (LSA_{AQU})

Watercourses
- Priority 1 for Survey
- Priority 2 for Survey
- Priority 3 for Survey
- Surveyed During Lake Procedure
- Other Watercourses

Fieldwork Locations
- Priority 1 Lake/Pond
- Priority 2 Lake/Pond
- Priority 1 Wetland

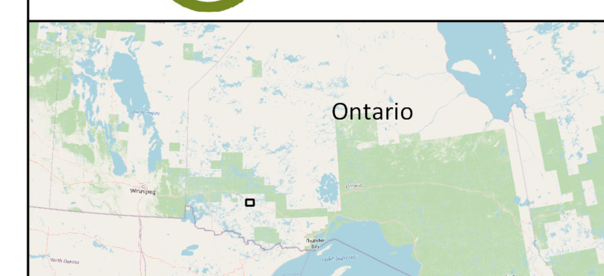
Ecosite Groups
- Marsh
- Fen
- Bog
- Swamp
- Hardwood
- Conifer
- Shrub
- Vertical or Active Mineral
- Water
- Cleared
- Compact Gravelled Surface
- Pavement/Concrete

Roads
- Local Road
- Highway or Arterial Road
- Resource/Recreation Road

1:80,000

0 1 2 km

ZOETICA

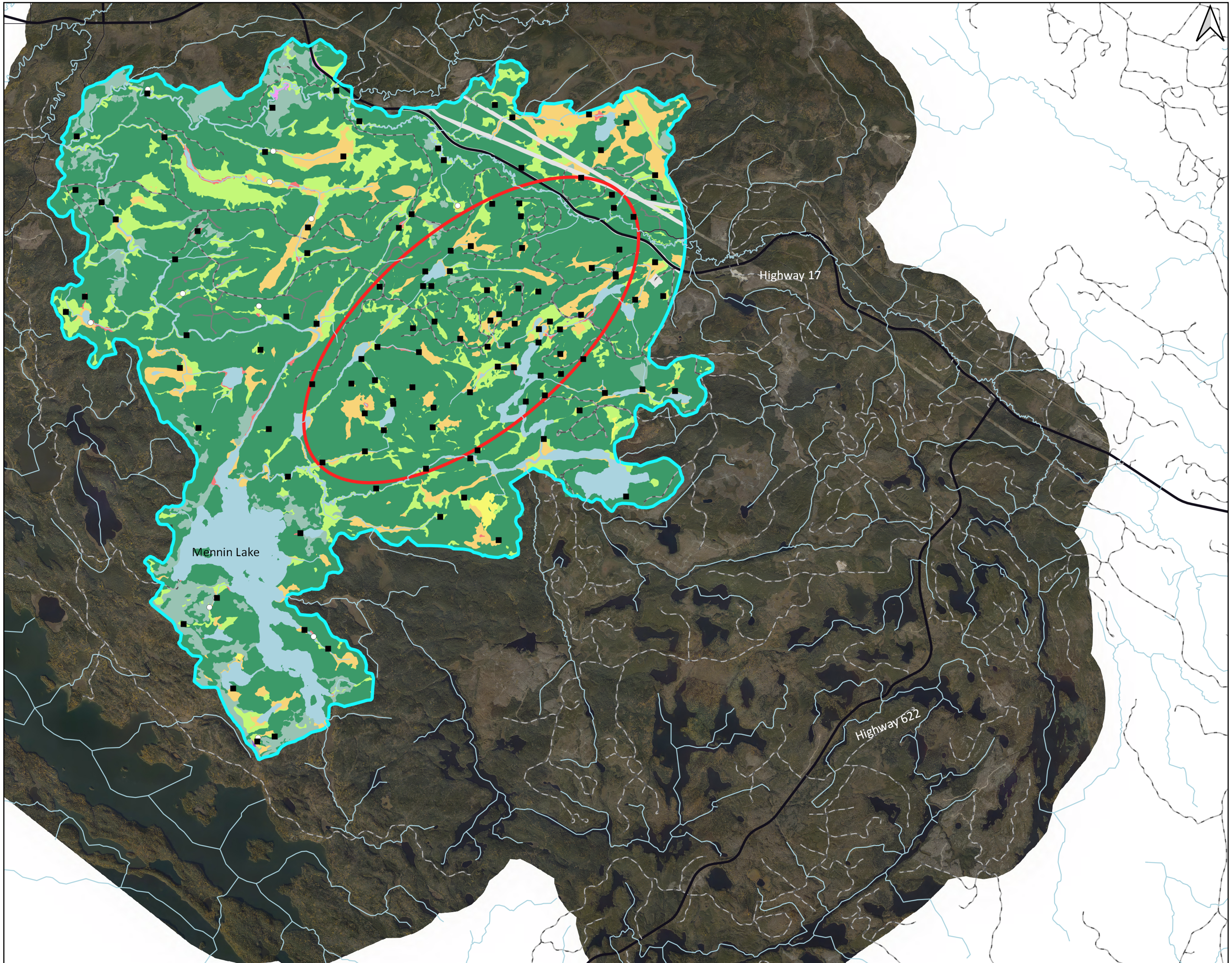


Inset Basemap © OpenStreetMap contributors

Data received from:
Ontario GeoHub — OHN Watercourse (MNRF); MNRF Road Segments (MNRF)
NWMO — AOI; Basemap Imagery

Project CRS: NAD83 / UTM zone 15N

Author: DM	Verified by: CC
June 22, 2021	Map ID: NWMO_BIS_069



NWMO Biodiversity Impact Studies

Aquatic Habitat Mapping Oversample Fieldwork Locations

Area of Interest (AOI)
Local Study Area (LSA_{AQU})
Watercourses

Oversample Fieldwork Locations
- Oversample Priority 2 Lake/Pond
- Oversample Priority 2 Wetland

Ecosite Groups
- Marsh
- Fen
- Bog
- Swamp
- Hardwood
- Conifer
- Shrub
- Vertical or Active Mineral
- Water
- Cleared
- Compact Gravelled Surface
- Pavement/Concrete

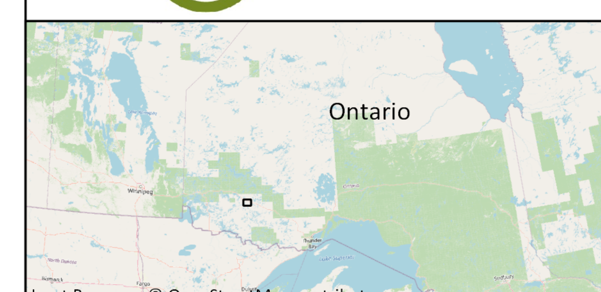
Roads
- Local Road
- Highway or Arterial Road
- Resource/Recreation Road

Oversample points are to be used to replace planned points if they are found inaccessible in the field.

1:80,000

0 1 2 km

ZOETICA



Inset Basemap © OpenStreetMap contributors

Data received from:
Ontario GeoHub — OHN Watercourse (MNRF); MNRF Road Segments (MNRF)
NWMO — AOI; Basemap Imagery

Project CRS: NAD83 / UTM zone 15N

Author: DM	Verified by: CC
June 22, 2021	Map ID: NWMO_BIS_069

Appendix C: Site Identifier Form

(see next page)

Site Identifier Form

Location:			
Station ID	WATERCOURSE/WATERBODY ID	WATERCOURSE/WATERBODY NAME	DATE (mm-dd-yyyy)

REACH #	Crew ID	SITE #	SAMPLE #	SITE LENGTH (m)

	Zone	Easting	Northing	or		
Uncorr.					Lat	
	Zone	Easting	Northing		Long	
Corrected						

Source of Uncorrected UTM Coord.		Source of Corrected UTM Coord.		Name of Layer Used for correction
☐ GPS/DGPS	☐ Other (specify)	☐ FWIS	☐ Other (specify)	
☐ GIS		☐ Ortho-photos		
☐ OBM		☐ GIS		

Weather Conditions:						
Sky Conditions:	Wind Direction:	Wind Speed km/hr:	Temperature (°C)	Time (24hr)	Rain last 24hr (mm):	Snow last 24hr (cm):

Access and Site
ACCESS ROUTE
SITE DESCRIPTION
☐ Site was unsampleable - add reason on reverse
SKETCHES

PHOTO #	PHOTO NAME	PHOTO DESCRIPTION

Crew Information					
Crew Leader (init. & Last Name)	Crew Initials	Recorder	Entered	Verified	Corrected

Site Identifier Form

SITE MARKER DESCRIPTION					
UPSTREAM MARKER				Photo No.	Photo Name
(measure from stake to site)	Bearing (D)	Distance (m)	Upstream		
			Downstream		

UPSTREAM DESCRIPTION

DOWNSTREAM MARKER				Photo No.	Photo Name
	Bearing (D)	Distance (m)	Upstream		
(measure from stake to site)			Downstream		

DOWNSTREAM DESCRIPTION

SITE IS UNSAMPLEABLE/UNSURVEYABLE

- ☐ Stream dry
- ☐ Insufficient water to sample effectively
- ☐ Stream is no longer present at location (tiled or relocated, etc.)
- ☐ Naturally unwadeable (i.e., > 1.5 m deep)
- ☐ Unwadeable due to ponding from a permanent barrier
- ☐ Unwadeable due to ponding from temporary barrier (e.g. beaver dam)
- ☐ Landowner coud not be contacted
- ☐ Landowner refused access
- ☐ Inaccessible for safety reasons (add details in comments below)
- ☐ Stream is wadeable but not appropriate for the intended sampling

What is the permanent barrier?

What is the temporary barrier?

COMMENTS

Appendix D: Guidelines for Filling out Site Identifier Form

Data Required	Instructions
Location	
Station ID	Record from reach table (**Appendix A** for watercourses (streams) or **Appendix B** for waterbodies (lakes/ponds/wetlands with no defined channel). Station ID is a unique identifier for each unique reach to be surveyed.
Watercourse/Waterbody ID	Desk-based unique ID provided by Zoetica in the *Watercourse (Stream) Survey Reach Table* (**Appendix A**) or the *Waterbody (Lake/Pond/Wetland) Reach Table* (**Appendix B**) and used to describe the characteristics of each watercourse/waterbody.
Watercourse/Waterbody Name	Record as per the Reach Table (**Appendix A** for streams and **Appendix B** for wetlands, ponds and lakes).
Date	Record as MM-DD-YYYY format
Reach Number	Derived by Zoetica using desk-based GIS mapping and provided in the *Watercourse (Stream) Survey Reach Table* (**Appendix A**) and in the Polygon ID column in the *Waterbody (Lake/Pond/Wetland) Reach Table* (**Appendix B**)
Crew ID	Unique crew identifier for each field crew team
Site Number	Sequential number to identify each unique site in a reach. Thus, in any given reach the first site number assigned will be 1 and will increase sequentially.
Sample Number	Sample number is 1 for the first time a site is visited in any given year, and increased sequentially for every subsequent visit in a year
Site Length	Record (to the nearest metre) the longitudinal length of the site as measured down the centre of the stream.
Uncorrected UTM Coordinates	For uncorrected UTM coordinates, record at least the following number of digits for the UTM coordinates: grid (two), easting (six), northing (seven)
Corrected UTM Coordinates	Once corrected, record at least the following number of digits for the UTM coordinates: grid (two), easting (six), northing (seven) in the 'Uncorrected UTM coordinates' boxes. Note decimal places can be added for eastings and northings
Latitude and Longitude	As an alternative to the UTM coordinates, record the latitude and longitude of the site to the nearest decimal second (at minimum)
Source of Uncorrected UTM Coordinates	Record which method was used to obtain the uncorrected geocoordinates (i.e., GPS unit, GIS, OBM or topographical map.
Source of Corrected UTM Coordinates	Record the source of corrected UTM coordinates (i.e., FWIS, Ortho-photos, GIS). If a GIS layer was used, please provide the name of the layer used for the correction.
Name of Layer Used for Correction	The name of the GIS layer and its origin should be recorded to enable users to address drift issues during applications.
Weather Conditions	
Sky Conditions	Provide a brief description of the weather conditions, including any precipitation. Examples include: sunny, overcast, cloudy, light rain, foggy.
Wind Direction	Record general wind direction using cardinal/ordinal directions (i.e., N, NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW, NNW), the word “calm” for no wind, or the word “variable” for frequently changing wind direction.
Wind Speed	Record the wind speed in km/h.
Temperature	Record air temperature in °C
Time	Record time air temperature was taken (24 hr clock)
Rain last 24 hr (mm)	Record the rainfall from the past 24 hours in mm.
Snow last 24 hr (mm)	Record the snowfall from the past 24 hours in cm.
Access Route	Describe the route taken to the site, beginning at a major interchange or reference point. Include distances between turns in rural areas. Remember that the data will also be used to verify the location of the site on a GIS, so record distances, not just 911 addresses.
Site Description	Describe the walking route from the parking location to the site and provide a detailed description of landmarks for locating the site

Unsampleable	If the site is found to be unsampleable, check the box on page one and identify reasons on page two by selecting applicable option(s) and comment field.
Sketches	Draw a sketch of the site include site identifier details. If access route is tricky, split sketch block to draw a sketch of the access route.
Photo No.	Record the number of any photographs taken.
Photo Name	Record the file name of the photo if it is downloaded from a digital camera.
Photograph description	Describe the photograph taken so it can be accurately labelled when downloaded.
Crew Leader	First initial and last name of the crew leader.
Crew	Record the initials of all crew members.
Recorder	Initials of the person entering the information on the sheet.
Entered	This field is for filling out when data has been entered to database. Enter date and initials of personnel that entered data.
Verified	This field is for filling out when data has been verified after being entered to database. Enter date and initials of personnel that verified data.
Corrected	This field is for filling out after verification of data in database. Enter date and initials of personnel that corrected data.
Site Marker Description	
Site Marker Description	Record the type(s) of markers used, locations, compass bearings, and distances (to the nearest 0.1 m) from the top and bottom of the site (for upstream and downstream markers). Include a description of each of upstream and downstream markers for the site and provide photo numbers and photo names for site.
Site is Unsampleable	If site was deemed to be unsampleable and checked off on first page of the form, check off the reason why the stream was unsampleable on the second page. Include a description of the permanent or temporary barriers if any exist.
Comments	Record any other relevant information here, such as the landowner's name and phone number, special requests (i.e., wants to be contacted with results, etc.)

Appendix E: Site Features Form

(see next page)

Site Features Form

Station ID	WATERCOURSE/WATERBODY ID	WATERCOURSE/WATERBODY NAME	DATE (mm-dd-yyyy)

Reach #	Crew ID	Site #	Sample #

For each landuse, check box that applies. Be sure to include comments explaining the particulars, including names and numbers of contacts.

Site Features	Ongoing & Active	Historical Evidence	No Evidence but Reported	No Evidence	Unknown	Comments
Potential Point or Non-point Source of Contaminants	☐	☐	☐	☐	☐	
Major Nutrient Sources Upstream	☐	☐	☐	☐	☐	
Channel Hardening or Straightening	☐	☐	☐	☐	☐	
Adjacent Landuses that Destabilize Banks	☐	☐	☐	☐	☐	
Sediment Loading or Deprivation	☐	☐	☐	☐	☐	
Instream Habitat Modifications	☐	☐	☐	☐	☐	
Barriers and/or Dams in the Vicinity of the Site	☐	☐	☐	☐	☐	
High Fishing Pressure	☐	☐	☐	☐	☐	
Log Jam Deflectors	☐	☐	☐	☐	☐	
Springs or Seeps at the Site	☐	☐	☐	☐	☐	
Impervious Substrate Limiting Burrowing Depth of Fish	☐	☐	☐	☐	☐	
Fish Stocked Near Sampling Site	☐	☐	☐	☐	☐	
Other Activities that Could Influence Biota or Habitat	☐	☐	☐	☐	☐	
Intensive Logging in the Riparian Zone	☐	☐	☐	☐	☐	

Sources of Information				**Temperatures**	
☐ Visual Immediate	☐ Visual Extended	☐ Interview	☐ Maps/Photos	Time (24 hr) :	Water Temp (°C)

Riparian Vegetation Community (Only check one box for each bank and zone)

	Dominant Vegetation Type													
	Left Bank							Right Bank						
Riparian Zone	None	Lawn	Cropland	Meadow	Scrubland	Forest	Wetlands	None	Lawn	Cropland	Meadow	Scrubland	Forest	Wetlands
1.5 - 10 m	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
11 - 30 m	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
31 - 100 m	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Crew Leader (init. & Last Name)	Crew Initials	Recorder	Entered	Verified	Corrected

Appendix F: Guidelines for Filling out Site Features Form

Data Required	**Instructions/Definitions**
Station ID	Record from reach table (**Appendix A** for watercourses (streams) or **Appendix B** for waterbodies (lakes/ponds/wetlands with no defined channel). Station ID is a unique identifier for each unique reach to be surveyed.
Watercourse/Waterbody ID	Desk-based unique ID provided by Zoetica in the *Watercourse (Stream) Survey Reach Table* (**Appendix A**) or the *Waterbody (Lake/Pond/Wetland) Reach Table* (**Appendix B**) and used to describe the characteristics of each watercourse/waterbody.
Watercourse/Waterbody Name	Record as per the Reach Table (**Appendix A** for streams and **Appendix B** for wetlands, ponds and lakes)
Date	Record as MM-DD-YYYY format
Reach Number	Derived by Zoetica using desk-based GIS mapping and provided in the *Watercourse (Stream) Survey Reach Table* (**Appendix A**) and in the Polygon ID column in the *Waterbody (Lake/Pond/Wetland) Reach Table* (**Appendix B**)
Crew ID	Unique crew identifier for each field crew team.
Site Number	Sequential number to identify each unique site in a reach. Thus, in any given reach the first site number assigned will be 1 and will increase sequentially.
Sample Number	Sample number is 1 for the first time a site is visited in any given year, and increased sequentially for every subsequent visit in a year
Evidence Categories for Site Features	
Ongoing and Active	There is evidence of the feature at the time of the site visit
Historical Evidence	There are signs that the activity has occurred in the past
No Evidence but Reported	It has been historically reported, but no obvious physical signs exist
No Evidence	There is no current or historical evidence of this activity
Unknown	The feature has not been sufficiently evaluated
Site Feature Attributes	
Potential Point or Non-point Contaminants	Look for outlets from storm sewers, tile drains, or industrial discharge pipes. Note any obvious signs of discharge at the site (odour, staining, sheen, etc.)
Major Nutrient Sources Upstream	Algal blooms or dense growth of aquatic macrophytes are indicators of upstream nutrient sources. If present, look for potential sources such as sewage treatment plants, processing plants, intensive agricultural operations (e.g., chicken ranches, livestock, feed lots) upstream of the site.
Channel Hardening or Straightening	Hardening is indicated by rip-rap or gabion baskets. Straightened channels will often have dredged material piled adjacent to the stream, or will be atypically straight relative to the valley gradient.
Adjacent Land uses that Destabilize Banks	Refers to unrestricted access (cattle horses, humans, etc.) to banks, cutting or trampling of riparian vegetation.
Sediment Loading or Deprivation	Evidence of sediment loading: mid channel bars; extended point bars around bends; pools filled with fines; sand dunes in shallow areas. Sediment deprivation can result in either hardening of the streambed (e.g., in high calcium areas), or boulders stacked like dominoes, (imbrication) where there are not enough cementing materials to hold larger particles in place.
Instream Habitat Modifications	Debris or material removal, dam construction, habitat enhancement (lunker, structures, etc.)
Barriers and Dams in the Vicinity of the Site	Often visible from roads or air photos; historical evidence includes elevated floodplains with an atypically flat gradient throughout the reach. There may also be evidence along the banks (e.g., elevated culverts, fallen timbers or old bridges that have been buried.
High Fishing Pressure	Heavily packed trails, fishing debris, garbage, etc.
Log Jam Deflectors	Fallen trees and/or woodpiles large enough to force water against the bank and cause lateral erosion. Record the number of occurrences within the site.

Springs or Seeps at the Site	Abundant watercress in the stream; differences in stream temperature between sections (record temperatures in comments); a rust-coloured deposit on sediments surrounding the groundwater discharge zones in areas with high mineral content
Impervious Substrate Limiting Burrowing Depth of Fish	Exposed bedrock or hardpan (clay) within the site boundaries.
Fish Stocked Near Site	Personal knowledge or anecdotal evidence such as the capture of fish with hatchery markings. Information is available from MNRF.
Other Activities	Any other features not already covered that could Influence biota or habitat
Logging Activities	Intensive logging activities such as road construction, vegetation removal, clear cutting, ruts and other damage from machinery use that cause permanent ruts.
Sources of Information for Data collected on Site Features	
Visual Immediate	Observed within 50 m of the site
Visual Extended	Observed beyond 50 m of the site
Interview	Discussion with someone familiar with the land use history of the site (e.g., landowner)
Maps/Photos	Air photos or maps of the area (current and historical)
Temperatures	
Time (24 hr)	Record the time at which water temperature is taken (on a 24-hour clock)
Water Temp (°C)	Determine water temperature (in °C) using either a thermometer or a digital recording thermometer. Place the thermometer in the main flow of the stream (e.g., a run or scour pool), avoiding deep pools as they may be sources of groundwater upwellings. After 30 seconds have elapsed, record the water temperature to the nearest degree.
Types of Vegetation Communities	
None	Over 75% of the soil has no vegetation
Lawn	Grasses that are not allowed to reach a mature state due to mowing.
Cropped Land	Planted in agricultural crops in most years; plants typically arranged in rows (due to machine-planting); may be subject to periodic tillage.
Meadow	< 25% tree/shrub cover; characterized by grasses and forbs
Scrubland	> 25% and < 60% trees and shrubs interspersed with grasses and sedges (a transitional area between meadow and forest, with trees generally less than 10 cm in diameter at breast height).
Forest	> 60% of the canopy is covered by the crowns of trees.
Wetland	Areas that are seasonally or permanently flooded and support vegetation adapted to wet conditions

Appendix G: Watercourse (Stream) Survey Form

(see next page)

Watercourse (Stream) Survey Form

GENERAL INFORMATION				
PROJECT #:	PROJECT DESCRIPTION:		SURVEY DATE (MM-DD-YYYY)	
CREW ID:	ALL SURVEYORS:		TIME STARTED:	TIME FINISHED:
AIR TEMP: °C	WATER TEMP: °C	pH:	CONDUCTIVITY: µS/cm	TURBIDITY:
PHOTO NUMBERS & DESCRIPTIONS:				

LOCATION				
INLET/OUTLET Yes ○ No ○	STATION ID	WATERCOURSE ID: - - - - - -	WATERCOURSE NAME:	REACH #

GPS COORDINATES (upstream end of reach):			REACH SUB-DIVIDERS: ○ Yes ○ No
UTM ZONE	Easting/Lat.	Northing/Long.	Sub-divider IDs:

REACH SECTION TYPE AND MORPHOLOGY				
REACH OR SUB-REACH #:	SITE #:	Field Site UTM (downstream end of the site):		
		UTM Zone	Easting/Lat.	Northing/Long.

TYPE:	Stream/River ○	Channelized ○	Permanent ○	Intermittent ○	Ephemeral ○	ASSOCIATED WETLAND:

TOTAL SITE LENGTH (m):	GRADIENT %:	GRADIENT CODE:	STREAM DISCHARGE: L ○ M ○ H ○

SUBSECTIONS:	Run ○		Pool ○		Riffle ○		Flats ○		Inside culvert ○		Other ○	
Percentage of area	%		%		%		%		%		%	
	Individual	Mean	Individual	Mean	Individual	Mean	Individual	Mean	Individual	Mean	Individual	Mean
Mean depth wetted	m		m		m		m		m		m	
	m		m		m		m		m		m	
	m	m	m	m	m	m	m	m	m	m	m	m
	m		m		m		m		m		m	
	m		m		m		m		m		m	
	m		m		m		m		m		m	
Mean width wetted	m		m		m		m		m		m	
	m		m		m		m		m		m	
	m	m	m	m	m	m	m	m	m	m	m	m
	m		m		m		m		m		m	
	m		m		m		m		m		m	
	m		m		m		m		m		m	
Mean bankfull width	m		m		m		m		m		m	
	m		m		m		m		m		m	
	m	m	m	m	m	m	m	m	m	m	m	m
	m		m		m		m		m		m	
	m		m		m		m		m		m	
	m		m		m		m		m		m	
Mean bankfull depth	m		m		m		m		m		m	
	m		m		m		m		m		m	
	m	m	m	m	m	m	m	m	m	m	m	m
	m		m		m		m		m		m	
	m		m		m		m		m		m	
	m		m		m		m		m		m	

SUBSTRATE %:								
Bedrock	Boulder	Cobble	Gravel	Sand	Silt	Clay	Muck	Detritus
%	%	%	%	%	%	%	%	%

BANK STABILITY:	Depositional	Protected	Vulnerable	Erosional
Left Upstream Bank:	○	○	○	○
Right Upstream	○	○	○	○

Watercourse (Stream) Survey Form

COVER & HABITAT							
IN-STREAM COVER (% surface area):	Undercut banks %	Boulders %	Cobble %	Woody Debris Instream: % Overhanging: %	Vascular Instream: % Overhanging: %	Other %	None %
SHORE COVER (% stream shaded):	100 – 90% ◯	90 – 60% ◯	60 – 30% ◯	30 – 1% ◯			
VEGETATION TYPE (%):	Submergent %	Floating %	Emergent %	None			
PREDOMINANT SPECIES:							
RIPARIAN VEGETATION TYPE:	Grass ◯	Shrub ◯	Coniferous Forest ◯	Deciduous Forest ◯	Mixed Forest ◯	Wetland ◯	None ◯
RIPARIAN STAGE:	Initial (< 5 % Total Cover) LUB ◯ RUB ◯	< 10 % Total Cover LUB ◯ RUB ◯	Pole Sapling LUB ◯ RUB ◯	Young Forest LUB ◯ RUB ◯	Mature Forest LUB ◯ RUB ◯		

ADDITIONAL INFORMATION			
MIGRATORY OBSTRUCTIONS:	None ◯	Seasonal ◯	Permanent ◯
OBSTRUCTION DETAILS:			
POTENTIAL CRITICAL HABITAT / LIMITING HABITAT:	Spawning	Evidence of Groundwater	Other

POTENTIAL ENHANCEMENT OPPORTUNITIES:

COMMENTS:

Additional Notes Appended? ◯ No ◯ Yes Number of pages _______

Date entered into spreadsheet: Entered by: QA/QC by:

Appendix H: Watercourse Reference Guide: Stream Reaches

Information	Purpose/Description/Directions
General Information – some information can be obtained before entering the field	
Project Number	To identify the APM Project. Project Number: **NWMO-BIS-AQH1**
Project Description	A concise description of the project. Insert: **Biodiversity Baseline Data Collection**
Survey Date	Date in MM-DD-YYYY format
Crew ID	Unique ID for each field crew team
All Surveyors	Identify all members of the field crew and identify the crew leader. Identify the person or people doing the fieldwork. Example: ABC Consultants: CG AM crew, AC leader
Time Started/Finished	It is essential to record the time of day the surveying is done as well as the date. When the information is reviewed, it may be important to know if water temperatures were taken early in the morning or early afternoon (typically the warmest time of the day). Local or regional weather conditions could be reviewed and related to the water levels.
Air Temp (°C)	Record in °C
Water Temp (°C)	Record in °C from YSI or HydroLab while measuring Conductivity
pH	Record water pH from YSI or HydroLab
Conductivity (µS/cm)	Make conductivity measurements from mid-stream and mid-depth if possible. Electrical conductivity (EC) is dependent on the total dissolved salt concentration (TDS) in the water; the higher the conductivity, the higher the salt (e.g., sodium, calcium, sulphate) concentration. Measure EC in the field using a portable conductivity meter (e.g., YSI, HydroLab). Most conductivity meters automatically convert conductivity measurements to 25°C. If your meter does not automatically standardize to 25°C, record the water temperature at the same time as conductivity and use a conductivity nomograph to convert the reading to 25°C.
Turbidity	Using a turbidity meter, record turbidity at the same survey locations for conductivity measurements.
Photo Numbers and Descriptions	Record photograph numbers (from the camera), direction (Upstream (US)/Downstream (DS)/Cross Stream (X)/ Streambed (Sb)/ Left Upstream bank (LUB)/ Right Upstream Bank (RUB)and a description of what each photo shows (e.g., Photo 004 – US Beaver Dam).
Location – some information can be obtained before entering the field	
Inlet/Outlet	Identify whether the reach is an Inlet/Outlet survey as part of the Waterbody Protocol. For inlets and outlets of pond, lakes, see waterbody reference guide (**Appendix M**) for direction on filling out the Station ID, Watercourse ID and Reach number fields.
Station ID	Record from reach table (**Appendix A**). Station ID is a unique identifier for each reach to be surveyed.
Watercourse ID	Desk-based unique ID provided by Zoetica in the *Watercourse (Stream) Survey Reach Table* (**Appendix A**) and used to describe the characteristics of each watercourse.
Watercourse Name	Many watercourses have had an official name gazetted, and this will be published in the Ontario edition of the “Gazetteer of Canada.” If the name does not appear in the Gazetteer, then the name used on a published map should be used. If there is a commonly used local name, it should be included with the official name and flagged as a local name.
Reach Number	Derived by Zoetica using desk-based GIS mapping and provided in the *Watercourse (Stream) Survey Reach Table* (**Appendix A**)
Reach Sub-dividers	Identify if the reach was subdivided into smaller reaches and record new sub-divider reach IDs
GPS Coordinates	Record the GPS coordinates (UTM) and GPS accuracy (e.g., +/-5 m) of the station. Try to get within 3m accuracy or less.
REACH SECTION TYPE AND MORPHOLOGY	
Reach or Sub-reach #	Unique Identifier name for the reach. Note: if the Reach Number identified in the Location Block is sub-divided further in the field, record Sub-Reach Number here
Site #	Sequential number to identify each unique site in a reach. Thus, in any given reach the first site number assigned will be 1 and will increase sequentially.

Field Site UTM	Record the UTM at the downstream end of the site to be surveyed using NAD 83. Record UTM Coordinates (Zone/Easting/Northing) to the meter level (uncertainty).
Type	*Check the appropriate type (natural/altered and flow regime)*
Stream / River	'Natural' watercourse containing flowing water at least part of the year.
Channelized	Constructed or altered/straightened channel, drain, ditch, canal or aqueduct that is straight and uniform in structure.
AND check either	
Permanent	A stream that flows for 9 or more consecutive months per year under average annual precipitation conditions. It has a channel with a defined bed and banks of a permanent nature.
Intermittent	A stream that flows for less than 9 consecutive months per year under average annual precipitation conditions and usually is dry in May/June. It has a poorly defined channel.
Ephemeral	A stream that flows for short periods in the spring or in response to runoff events, and usually or insufficient duration to create a defined channel (e.g., field swale, or gully).
Associated Wetland	Name and describe any wetland that appears to be hydrologically connected to the stream reach. Write N/A if no wetland present. Wetland types include Wetland Marsh (Wm), Wetland Swamp (Ws), Wetland bog (Wb), Wetland fen (Wf), and Wetland unknown (Wu). Please see **Appendix J** for descriptions or the Ontario Wetland Evaluation System - Northern Manual for full details.
Total Site Length (m)	Record length of the reach/site surveyed in m. Minimum length of 100 m.
Gradient % and Code	Measure at a minimum of two locations along the survey site over as long a distance as possible. Measure in upstream and downstream directions to maximize the distance. Measurements are sighted from similar habitat units (e.g., riffle crest to riffle crest). Record method used to assess gradient as follows: Ground Estimate (GE); Clinometer (C); Abney type level (AL); Survey equipment (S)
Stream Discharge	Record the amount of water passing through the channel at the time of the survey in relation to the bankfull depth as follows: Low (L) = 0 – 30% of bankfull; Moderate (M) = 31 – 90% of bankfull; High (H) = >90% bankfull
Subsections	*Check the appropriate types present and channel dimensions*
Run	Areas typically found at the head of a pool with rapidly flowing water and a similar hydraulic head (≥ 8 mm) and velocity (0.25-0 – 40 m/s) as a riffle but greater depth. The water's surface is typically not agitated by bed material but may be turbulent.
Pool	Areas of a stream that are deep with a relatively low velocity and a smooth unagitated surface. Pools have a hydraulic head of 0 to 3 mm and a velocity less than 0.05 – 0.15 m/s.
Riffle	Areas of relatively shallow fast, turbulent flow where the water's surface is typically broken. Riffles have a hydraulic head of 8 mm or greater and fast velocities ranging from 0.25 – 0.40 m/s.
Flats	Low flowing water with a smooth unagitated surface (not as deep as a pool). Flats have a hydraulic head of 4-7 mm and velocity between 0.15 – 0.30+ m/s.
Channel Dimensions	
Mean depth wetted (m)	Maximum within the specific morphological feature (e.g., pool). Provide average and range if several features (e.g., pools) within a section. For larger crossings, measure at least five locations spread equally across a transect. It should be the same transect used to measure the wetted width of the waterbody. Measurements can be made easily using a meter stick, ensuring it is not sinking into the substrate. The mean should be calculated using the formula: Mean depth = (D1 + D2 + ... Dn)/n Where D = depth measurement, and n = total number of measurements
Mean width wetted (m)	The distance from high water mark on one stream bank to the opposite stream bank. It is a transect taken perpendicular to the direction of flow. High water marks are either visibly stained on the stream bank or taken at the beginning of rooted vegetation on the stream bank/lakeshore or top of the bank. When measuring the wetted width of the stream, subtract the width of islands and include undercuts to the nearest tenth of a metre.

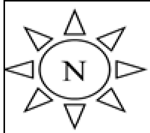
Mean bankfull width (m)	The width at the elevation point of incipient flooding, indicated by deposits of sand or silt at the active scour mark, break in stream bank slope, perennial vegetation limit, rock discoloration, and root hair exposure.
Mean bankfull depth (m)	The average depth measured at the elevation point of incipient flooding and should be measured at the same transect used to measure the bankfull width and calculated as per *mean wetted depth*.
Substrate (%)	An estimate of the percent cover of the substrate type can be made visually. The substrate should be classified according to the categories described below:
Bedrock	Exposed rock with no overburden.
Boulder	Particles with an intermediate width (median axis) of 256 to >1024 mm.
Cobble	Particles with an intermediate width (median axis) between 64 and 256 mm.
Gravel	Particles with an intermediate width (median axis) between 2 to 64 mm.
Finer textures	Particles with an intermediate width (median axis) of less than 2 mm. For the fine-textured material, place about ½ to 1 tablespoon of sediment in the palm. Feel the mass by rubbing between fingers.
Sand	Loose and single grained. The individual grains can readily be seen or felt. If squeezed in the hand, it will form a cast but will crumble when touched.
Silt	Single grains are not identifiable. Silky smooth feel to it when rubbed between fingers.
Clay	The finest of the substrate types. It is quite plastic and usually sticky when wet. When the moist soil is pinched out between the thumb and fingers, it will form a long flexible ribbon.
Muck	A mixture of decomposing organic matter, silt and/or clay. It tends to be dark in colour and greasy to the touch.
Detritus	Organic material with large pieces of sticks and leaves accounting for at least 85% of the mass.
Bank Stability	Stable banks are characterized by the presence of boulders, rocks, or rooted vegetation that reduces the bank's susceptibility to erosion. Unstable banks are characterized by the presence of exposed raw dirt, lack of rooted vegetation, steep-sloped banks, undercuts, and often slumping banks. Determine the category of bank stability for the left upstream bank and right upstream bank separately.
Deposition Zone	Gentle, <45-degree slope. Generally, materials that have been deposited by the river during its flood condition.
Protected Bank	Steep, >45-degree non-erodible materials (e.g., rock, boulders or hardened clay). Vegetation may or may not be present and includes banks armoured by humans.
Vulnerable Bank	Steep, >45-degree erodible materials which show no recent signs of erosion (i.e., undercuts or slumping) and protected by a mat of live vegetation.
Eroding Bank	Steep, >45-degree erodible materials undercut (by at least 5 cm) or shows signs of recent slumping (i.e., no or little vegetation present).
Cover and Habitat	
In-Stream Cover (% Surface Area)	The in-stream cover provides an area for resting, shelter and predator avoidance for fish. Different types of cover are important in different habitat types, so it is essential to note in which part of the waterbody the features occur. A cover particle is any object that touches the water within the survey area, is **at least 100 mm wide** along the median axis and of sufficient density to block >75% of sunlight from reaching the stream bottom.
Undercut banks	A bank that has had its base eroded away and now overhangs the water. These often occur under tree root systems. The undercut area should be probed with a meter stick to determine its size and depth.
Boulders	In-stream rocks larger than 25 cm in diameter are considered suitable cover for many larger fish. They create back eddies for fish to rest out of the current and are also large enough to hide fish from predators.
Cobble	In-stream rocks 8 to 25 cm in diameter provide interstitial spaces (gaps between rocks) that can be used as cover by small or juvenile fish. These interstitial spaces are important overwintering and/or spawning areas for many fish.
Woody Debris	Living or dead woody materials (includes fallen trees, stumps, logs, mats of twigs, shrubs).
Vascular Macrophytes	Living aquatic and terrestrial non-woody plants in-stream or overhanging (< 1 m above the water surface) vegetation can provide shelter, protection and an attachment surface for food items.
Other	Other type of cover not identified in the list above

None	No cover
Shore Cover (% Stream Shaded)	A visual estimate of the percent of the watercourse that is shaded by overhanging trees or shrubs that are more than 1 m above the water surface.
Vegetation Type (%)	In-stream vegetation is an important component of fish habitat. It provides cover for fish to seek shelter from predators and provides shade from the sun. Food production is usually excellent in areas with a variety of vegetation. Visual estimation of the percent of the stream bed covered by each vegetation type should be made, and plant species (at least predominant species) identified.
Submergent	Group of plants that remains under the water surface at most times. Both vascular and non-vascular plants are included. Examples of these plants include pondweeds and milfoil. Algae often form an extensive mat covering the stream bed. However, the value in terms of fish cover is limited, so it should not be included in that category.
Floating	Vascular plants, usually with broad leaves floating on the water surface. Common in calm, still waters (e.g., water lilies).
Emergent	Vascular plants which root to the stream or lake bottom while their stems extend above the water surface (e.g., cattails, bulrushes, and sedges). Insects with aquatic life stages are often abundant in areas with emergent vegetation. These insects are an essential food source for many fish.
Riparian Vegetation Type	Check the dominant types of vegetation present at the stream section assessed (grass, shrub, coniferous forest, deciduous forest, mixed forest, wetland, none)
Riparian Stage	Check the dominant riparian stage (initial, shrub/herb, pole-sapling, young forest, mature forest) for each bank (Left upstream bank (LUB) and right upstream bank (RUB)).
Migratory Obstructions	Natural or constructed obstructions (e.g., dams, weirs, perched culverts) that block the movement of fish. Barriers may also result from insufficient water depth, for example, through a culvert with no low flow channel, or due to high slope and/or velocity. A description of the obstruction should be provided.
None	
Seasonal	The barrier is only present during lower water levels (i.e., is low enough that fish can move over it during higher flow periods/water levels; insufficient depth during low flow period may develop in a culvert with no low flow channel) or high flow periods (i.e., extreme velocities).
Permanent	The barrier is present under all flow conditions and during all times of the year.
Potential Critical Habitat	
Spawning	All evidence of spawning fish should be recorded in relation to the specific habitat. Potential spawning habitats should be identified in relation to the fish community. Known spawning areas (from background data) should be inspected.
Groundwater	The locations of all evidence of potential groundwater discharge such as springs, watercress, iron 'floc' or staining, and bank seepage should be recorded.
Other	Other types of habitat that may provide critical habitat functions should be identified, such as nursery habitat, seasonal refugia, deep holding or staging pools, should be recorded. Concentrations of fish may evidence these areas.
Potential Enhancement Opportunities	
	Opportunities to improve existing habitat conditions, such as removal of barriers to movement, rehabilitation of degraded conditions (e.g., bank failure, debris clean-up), diversification of homogeneous habitats or addition of features that may be limiting productivity (e.g., pools, gravels).
Comments	Additional comments. Include observations of wildlife, and any additional pertinent information.

Appendix I: Aquatic Habitat Mapping Form

(see next page)

Station ID:	Watercourse/Waterbody ID:	Site length (m):	Scale (cm / m)



Project #

Mapper:

Name of waterbody:

Reach #:

Site # (if >1 per reach):

Survey Date: MM – DD – YYYY

Legend

10d	Depth (cm)
6w	Width
⟶	Riffle
⟶	Run/Glide
⬭	Pool
▓	Island/Bar
░	Fine Substrate
###	Gravel Substrate
oOooO	Cobble/Boulder
* * *	Debris
CT	Cattail
SV/FV	Submerg/Float Veg
EV	Emergent Vegetation
W	Watercress
Fe	Iron Staining
///////	Eroded Bank
XXX	Riprap / Other
$	Stabilization
▯	Instream Log/Tree
^^^	Dam/Weir/Obstruction
®	Riparian Tree
|	Seep/Spring
– – –	Undercut Bank
▬	Barrier to Fish Movement
-S-	Seasonal Barrier
-x--x-	Fence Line
U	Culvert

Profile:	Horz. Scale	Vert. Scale

Appendix J: Wetland Type Reference Guide

According to the Ontario Wetland Evaluation System Manual (from MNRF, 2014), wetlands are classified into the following four classes/types:

- ***Marsh (Wm)***: Marshes are wet areas periodically inundated with standing or slowly moving water, and/or permanently inundated areas characterized by robust emergent, and to a lesser extent, anchored floating plants and submergents. Marsh wetlands have mineral and sometimes well-decomposed peat soils. When peat soils are present, they are often enriched with mineral materials. Waters are nutrient-rich with near neutral to basic pH. Surface water levels typically fluctuate seasonally with declining levels exposing matted vegetation or mudflats. Emergent vegetation includes grasses, cattails, sedges, rushes, and reeds, which cover more than 25% of the wetland surface.

- ***Swamp (Ws)***: Swamp wetlands are wooded wetlands with 25% cover or more trees or tall shrubs. In swamps standing or gently flowing water occurs seasonally or may persist for long periods and have an abundance of pools and channels. Many are typically flooded in spring and dry with relict pools later in the season. Swamps include forest swamps (having mature trees) and thicket swamps (having shrub-carrs characterized by thick growths of tall shrubs such as willow, red-osier dogwood, buttonbush and speckled alder.). There is pronounced internal water movement from adjacent mineral areas, making the water nutrient-rich. If peat is present, it is mainly well-decomposed wood and occasional sedges. The vegetation is typically dominated by coniferous or deciduous trees or dense shrubs and herbaceous species.

- ***Fen (Wf)***: Fens are peatlands characterized by surface layers of poorly to moderately decomposed peat, often with well-decomposed peat near the base and less than 25% live tree cover. Fen peats usually consist of mosses and sedges. Two main types of fens exist nutrient-rich fens, fed by groundwater and have a high pH and can be dominated by sedges and grasses; and nutrient-poor fens, with less groundwater and lower pH and may consist of low shrubs or ericaceous species. Fens have a higher diversity of plants compared to bogs. Fen wetlands have organic soils and a water table at or above the surface. Soils are primarily moderate to well-decomposed sedge and non-sphagnum moss peats. Waters are mainly nutrient-rich with a near neutral to slightly acidic pH. The vegetation consists primarily of sedges, grasses, reeds, mosses, and some shrubs. Scattered trees may be present.

- ***Bog (Wb)***: Bogs are peat covered areas or peat-filled depressions with a high water table and a surface carpet of mosses, primarily Sphagnum. Raised peat hummocks are present in bogs, and the wetland is ombrotrophic (i.e., dependent on atmospheric moisture for its nutrients). Bogs have low plant diversity with less than 14 species and few to no fen indicator plant species and few or no tamaracks or eastern white cedar. Bog wetlands have organic soils with a water table at or near the surface. Soils are predominantly composed of poorly to moderately decomposed sphagnum moss peats. The bog surface is usually unaffected by groundwaters, and thus waters are generally acidic and low in nutrients. Bogs are usually covered with sphagnum mosses and ericaceous (belonging to or similar to heath family, genus Erica) shrubs, and may be treed or treeless but with less than 25% tree cover.

Appendix K: Waterbody (Lake/Pond/Wetland) Checklist Form

Field Requirements Checklist

Field Lake Survey	**Lake Inlets and Outlets**
☐ Waterbody location and referencing ☐ Survey information ☐ Access ☐ Terrain characteristics ☐ Shoreline characteristics	☐ Identify tributaries, outlet locations ☐ Survey first reach of each tributary/ outlet (on Watercourse (Stream) Survey Form)
Bathymetry	**Photographic Documentation**
☐ Conduct a full bathymetric survey ☐ Benchmark ☐ Maximum depth (from bathymetry) ☐ High water level ☐ % littoral area (from bathymetry)	☐ Panoramic view of the surrounding area ☐ Shoreline and riparian conditions ☐ Inlet and outlet streams ☐ Aquatic Plant Communities ☐ Benchmark ☐ Any important/relevant features ☐ Record location/direction on outline map
Limnological Sampling	**Wildlife and Aquatic Flora**
☐ Establish limnological station ☐ Location on map and UTM ☐ Station Number ☐ Date and Time ☐ EMS number ***Record field measurements:*** ☐ Dissolved oxygen profile ☐ Temperature profile ☐ Secchi depth ☐ Water colour ☐ pH (surface and bottom) ☐ Conductivity (surface and bottom) ☐ Hydrogen sulphide detection	In the comments section record observations specific to: ☐ Rare and endangered species (non-fish) ☐ Aquatic species (non-fish) ☐ Comment on wildlife activities ☐ Identify and record dominant aquatic flora to species level

Appendix L: Waterbody (Lake/Pond/Wetland) Survey Form

(see next page)

Waterbody (Lake/Pond/Wetland) Survey Form

GENERAL INFORMATION					
PROJECT #:		PROJECT DESCRIPTION:	SURVEY DATE (MM-DD-YYYY):		
CREW ID:	ALL SURVEYORS:		TIME STARTED:		TIME FINISHED:
AIR TEMP (°C):		SURFACE WATER TEMP (°C):	SURFACE CONDITIONS: Calm ◯	Rippled ◯	Wavy ◯ Rough ◯
PHOTO NUMBERS AND DESCRIPTIONS:					

LOCATION			
STATION ID	WATERBODY ID/ Polygon ID:	Waterbody Name	Site #

GPS COORDINATES (from Reach Table):			**Field Site UTM** (approx. center of site)):		
UTM Zone	Easting/Lat.	Northing/Long.	UTM Zone	Easting/Lat.	Northing/Long.

REACH TYPE AND MORPHOLOGY						
TYPE:	Large Lake ◯	Small Lake ◯	Pond ◯	Wetland ◯	Reservoir ◯	Dug-out ◯
SOURCE:	Intermittent ◯	Runoff ◯	Spring Fed ◯	Not Connected ◯	By-pass ◯	In-stream ◯
ASSOCIATED WETLAND:		WATERBODY DIMENSIONS:	Length: m		Average Width: m	

MAIN INLET STREAM SURVEYED Yes ◯ No ◯	MAIN OUTLET STREAM SURVEYED Yes ◯ No ◯
MAIN INLET REACH #	MAIN OUTLET REACH #

LIMNOLOGY, BATHYMETRY, AND WATER CHEMISTRY			
LIMNOLOGY CONDUCTED? Yes ◯ No ◯	BATHYMETRY CONDUCTED? Yes ◯ No ◯	WATER CHEMISTRY CONDUCTED? Yes ◯ No ◯	Max Depth (m):

Waterbody (Lake/Pond/Wetland) Survey Form

COVER AND HABITAT											
BANK HABITAT											
IN-WATER COVER (% Surface Area):	Undercut Banks %	Boulders %	Cobble %	Woody Debris In-water: Overhanging:	Vascular Macrophytes In-water: % Overhanging: %	None %	NEARSHORE SLOPE %				
SHORELINE SUBSTRATE (add to 100%):	Bedrock %	Boulder %	Cobble %	Gravel %	Sand %	Silt %	Clay %	Muck %	Marl %	Detritus %	Other %
SHORELINE TYPE:	Sand/Gravel Beach %	Low, Rocky Shore %	Cliff or Bluff Shore %	Wetland Shore %	Vegetated Shore %	Other %					
SHORELINE VEGETATION COVER (% cover):	Abundant (>20%) ◯	Moderate (5 - 20%) ◯	Sparse (< 5%) ◯	None ◯							
Predominant Species:											
IN-WATER HABITAT											
VEGETATION TYPE:	Submergent (%)	Floating (%)	Emergent (%)	None ◯							
PREDOMINANT SPECIES:											
UNDERWATER COVER (% Surface Area):	Undercut Banks %	Boulders %	Cobble %	Woody Debris %	Organic Debris %	Macrophytes %	None ◯				
BOTTOM SUBSTRATE:	Bedrock %	Boulder %	Cobble %	Gravel %	Sand %	Silt %	Clay %	Muck %	Marl %	Detritus %	Other %
ADDITONAL INFORMATION											
MIGRATORY OBSTRUCTIONS:	None ◯	Seasonal ◯	Permanent ◯								
OBSTRUCTION DETAILS:											
POTENTIAL ENHANCEMENT OPPORTUNITIES:											
COMMENTS:											
Additional Notes Appended? ◯ No ◯ Yes Number of pages _______											
Date entered into spreadsheet:	Entered by:	QA/QC by:									

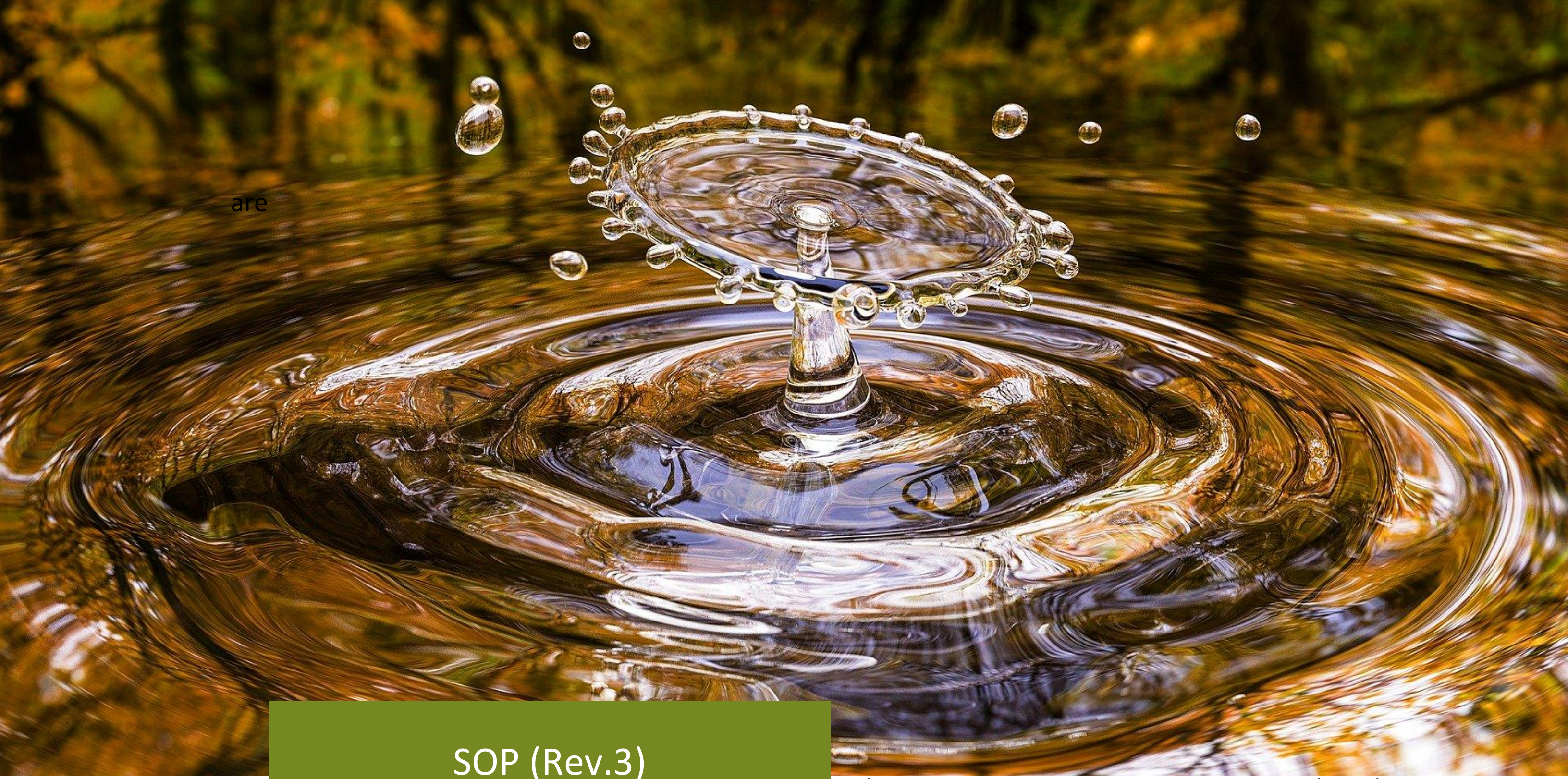
Appendix M: Waterbody Reference Guide: Lakes, Ponds, and Wetlands

Information	Purpose/Description/Directions
General Information – some information is obtained before entering the field	
Project Number	To identify the APM Project.
Project Description	A concise description of the project.
Survey Date	Date in MM-DD-YYYY format
Crew ID	Unique crew identifier for each field crew team
All Surveyors	Identify all members of the field crew and identify the crew leader. Identify the person or people doing the fieldwork, e.g., ABC Consultants: CG AM crew, AC leader
Time Started/Finished	It is essential to record the time of day the surveying is done as well as the date. When the information is reviewed, it may be important to know if water temperatures were taken early in the morning or early afternoon (typically the warmest time of the day). Local or regional weather conditions could be reviewed and related to the water levels.
Air Temp (°C)	Record in °C
Surface Water Temp (°C)	Record surface water temperature in °C
Surface Conditions:	Waterbody surface conditions
Calm	Nearly or completely motionless
Rippled	Small waves
Wavy	Large waves
Rough	Choppy wave conditions
Photo Numbers and Descriptions	Record photograph numbers (from the camera), direction (North/East/South/West) and a description of what each photo shows (e.g., Photo 004 – N bank Beaver Dam).
Location – some information is filled in before entering the field	
Station ID	Record from reach table (**Appendix B**). Station ID is a unique identifier for each unique reach to be surveyed.
Waterbody ID (Polygon ID)	Desk-based unique ID provided by Zoetica in the *Waterbody (Lake/Pond/Wetland) Survey Reach Table* (**Appendix B**) and used to describe the characteristics of each waterbody or wetland.
Waterbody Name	Record as per the Reach Table (**Appendix B**).
Site Number	Sequential number to identify each unique site in a reach. Thus, in any given reach the first site number assigned will be 1 and will increase sequentially.
GPS Coordinates	Record the GPS coordinates (UTM) from reach table into the form.
Field Site UTM	Record the UTM at the approximate centre of the waterbody (where limnology measurements are to be taken) using NAD 83. Record UTM Coordinates (Zone/Easting/Northing) to the meter level (uncertainty).
Reach Type and Morphology	
Type	*Check the waterbody type.*
Large Lake	A natural body of deep standing freshwater larger than a small pond >5 ha.
Small Lake	A natural body of deep standing freshwater larger than a pond.
Pond	A shallow body of standing water. It may dry seasonally, typically smaller than 0.5 ha.
Reservoir	A human-made lake with a dam controlling discharge flows.
Dug-out	A excavated “pond” usually for water collection for agricultural purposes.
Source	*Check waterbody source type*
Intermittent	A waterbody that is seasonally dry.
Runoff	The waterbody is supplied primarily by surface runoff (e.g., a shallow pond).
Spring-fed	The waterbody is supplied primarily by groundwater. The ground surface is permeable (e.g., kettle lake).
Not Connected	The waterbody is not connected to a watercourse.
By-pass	Water by-pass.
In-stream	The waterbody is behind an impoundment in a watercourse.
Associated Wetland	Name and describe any wetland that appears to be hydrologically connected to the stream reach. Write N/A if no wetland present. Wetland types include Wetland marsh (Wm), Wetland Swamp (Ws), Wetland bog (Wb), Wetland fen (Wf), and Wetland unknown (Wu). Please see **Appendix J** for descriptions or the Ontario Wetland Evaluation System – Northern Manual for full details.

Lake/Pond Dimensions:	
Length (m)	Estimated length.
Average Width (m)	Estimated width.
Inlet and Outlet Surveys	Check if the main inlet and outlets to the waterbody have been surveyed. Record the reach numbers for the main inlet and outlet reaches. Main inlet and outlet reaches should be named following the convention "Waterbody ID (Polygon ID in reach table) – Inlet" or "Waterbody ID (Polygon ID in reach table) – Outlet". A separate Watercourse Survey form should be filled out for the main inlet and for the main outlet. The Reach Number on the Watercourse form will be the name affiliated with the Waterbody (Polygon) ID. Enter the Waterbody polygon ID as the watercourse ID in the Watercourse Survey form for the inlet and the outlet.
Limnology, Bathymetry, and Water Chemistry **NOTE: Information in this section to be recorded on the Water Chemistry LSA Form provided in the EMBP Design Report. Check Y/N for each Question on the Waterbody (Lake/Pond/Wetland) Survey Form (Appendix L)**	
Dissolved O2 Profile	Collect dissolved oxygen concentrations and temperature at 0.5 m intervals to bottom or a maximum of 10m. Take vertical dissolved oxygen (DO) and temperature profiles simultaneously, as your meter (e.g., YSI, HydroLab) will provide a temperature reading for every depth at which the DO is measured. Take two sets of readings at each depth interval: one during descent and the other during ascent, to minimize bias due to adjustment of the meter to the water conditions at the subsequent depths. Dissolved oxygen is a measure of the concentration of oxygen dissolved in water expressed in mg/L, or in parts per million (1 mg/L is equivalent to 1 ppm). Record information on the Limnology, Water, and Plankton Datasheet – LSA form provided in the EMBP Final Design Report (CanNorth 2020).
Max depth (m)	As measured during dissolved oxygen/temperature profile.
pH	pH is a measure of the hydrogen-ion concentration in water. It operates on a scale of 0 (highly acidic) to 14 (highly basic), with a pH of 7 being neutral. Measure pH in the field using a hand-held pH meter (a low ionic strength electrode and calibration standards may be required). These measurements are to be conducted along with dissolved O2 measures at each depth and recorded on the Limnology, Water, and Plankton Datasheet – LSA form provided in the EMBP Final Design Report (CanNorth 2020).
Conductivity (µS/cm)	Make conductivity measurements from the lake surface and bottom samples. Electrical conductivity (EC) is dependent on the total dissolved salt concentration (TDS) in the water; the higher the conductivity, the higher the salt (e.g., sodium, calcium, sulphate) concentration. Measure EC in the field using a portable conductivity meter (e.g., YSI, HydroLab). Most conductivity meters automatically convert conductivity measurements to 25°C. If your meter does not automatically standardize to 25°C, record the water temperature at the same time as conductivity and use a conductivity nomograph to convert the reading to 25°C. These measurements are to be conducted along with dissolved O2 measures at each depth and recorded on the Limnology, Water, and Plankton Datasheet – LSA form provided in the EMBP Final Design Report (CanNorth 2020).
Water Temperature	Record water temperature in °C from the depth where conductivity measurements are made. These measurements are to be conducted along with dissolved O2 measures at each depth and recorded on the Limnology, Water, and Plankton Datasheet – LSA form provided in the EMBP Final Design Report (CanNorth 2020).
Secchi Depth (m)	Determining the Secchi Depth 1. Lower the Secchi disk until it disappears. 2. Note the depth to the nearest tenth of a metre. 3. Raise the Secchi until it reappears. 4. Note the depth. 5. The Secchi depth is the midpoint between these 2 depths. NOTE: Take the reading on the shady side of the boat. Do not wear sunglasses. Take the reading as close to mid-day as possible (10 am – 2 pm). Record depths in tenths of meters. Also, conduct Secchi depth determinations after the dissolved oxygen/temperature profiles have been conducted so that the water column is not disturbed. These measurements are to be conducted along with dissolved O2 measures at each depth and recorded on the Limnology, Water, and Plankton Datasheet – LSA form provided in the EMBP Final Design Report (CanNorth 2020).
Cover and Habitat	
Bank Habitat	

In-Water Cover (% Surface Area)	In-water cover provides an area for resting, shelter and predator avoidance for fish. Different types of cover are important in different habitat types, so it is essential to note in which part of the waterbody the features occur. A cover particle is any object that touches the water within the survey area, is **at least 100 mm wide** along the median axis and of sufficient density to block >75 % of sunlight from reaching the stream bottom. A cover particle can consist of a mat of materials such as twigs, macrophytes, or the bank. The mat must still meet the median diameter size and light penetration restrictions.
Undercut banks	A bank that has had its base eroded away and now overhangs the water. These often occur under tree root systems. The undercut area should be probed with a meter stick to determine its size and depth.
Boulders	In-water rocks larger than 25 cm in diameter are considered suitable cover for many larger fish. They create back eddies for fish to rest out of the current and are also large enough to hide fish from predators.
Cobble	In-water rocks 8 to 25 cm in diameter provide interstitial spaces (gaps between rocks) that can be used as cover by small or juvenile fish. These interstitial spaces are important overwintering and/or spawning areas for many fish.
Woody Debris	Living or dead woody materials (includes fallen trees, stumps, logs, mats of twigs, shrubs).
Vascular Macrophytes	Living aquatic and terrestrial non-woody plants in-water or overhanging vegetation (<1 m above the water surface) can provide shelter, protection and an attachment surface for food items.
None	
Nearshore Slope (%)	A reasonable measurement of the slope can be obtained using a handheld clinometer. Tie a ribbon or mark up the shore at eye level. While standing on the shoreline, use the clinometer to determine the angle of slope. Record gradient in %.
Shoreline Substrate (%)	An estimate of the percent cover of the substrate type can be made visually (total 100%). The substrate should be classified according to the categories described below:
Bedrock	Exposed rock with no overburden.
Boulder	Particles with an intermediate width (median axis) of 256 - >1024 mm.
Cobble	Particles with an intermediate width (median axis) between 64 and 256 mm.
Gravel	Particles with an intermediate width (median axis) between 2 to 64 mm.
Finer Textures	Particles with an intermediate width (median axis) of less than 2 mm. For the finer textured material, place about ½ to 1 tablespoon of sediment in the palm. Feel the mass by rubbing between fingers.
Sand	Loose and single grained. The individual grains can readily be seen or felt. If squeezed in the hand, it will form a cast but will crumble when touched.
Silt	Single grains are not identifiable. Silky smooth feel to it when rubbed between fingers.
Clay	The finest of the substrate types. It is quite plastic and usually sticky when wet. When the moist soil is pinched out between the thumb and fingers, it will form a long flexible ribbon.
Muck	A mixture of decomposing organic matter, silt and/or clay. It tends to be dark in colour and greasy to the touch.
Marl	White to gray accumulation on lake bottoms caused by precipitation of calcium carbonate ($CaCO_3$) in hard water lakes. Marl may contain many snail and clamshells, which are also calcium carbonate. Marl also precipitates phosphorus, resulting in low algae populations and good water clarity.
Detritus	Organic material with large pieces of sticks and leaves accounting for at least 85% of the mass.
Other	Other type of shoreline substrate; other than textures described above
Shoreline Type	The type of immediate shoreline as defined by the 5 categories below. Includes all area affected by the lake margin from the low water mark to the average annual high-water mark, and the riparian zone around the lake
Sand or gravel beach	Often associated with low rocky shoreline areas or adjacent to inlets
Low, rocky shore	Cobble, boulder or bedrock substrate, prevalent along the base of steeper shorelines
Cliff or bluff shore	Areas adjacent to steeper slopes. Usually indicates a steep-sided lake basin or sudden drop-off.
Wetland Shore	Characteristic of lakes in lowland areas. Often associated with abundant emergent vegetation such as sedges, reeds, cattails.
Vegetated shore	Characteristic of lakes in lowland areas. Vegetation is commonly shrubs and small trees.
Shore Cover (% Shaded)	Shoreline cover refers to the debris and overhanging vegetation present at the shoreline and one metre above the water**.**
In-Water Habitat	

Vegetation Type	Vegetation type refers to the vegetation emerging and present at the shoreline and in the water. Estimate and record to the nearest 10% of the lakeshore perimeter and include the most predominant species. Record the dominant aquatic plant species, to the genus level, or the species level if possible.
Submergent	Group of plants that remains under the water surface at most times. Both vascular and non-vascular plants are included. Examples of these plants include pondweeds and milfoil. Algae often form an extensive mat covering the stream bed and should be included in this group. However, the value in terms of fish cover is limited, so it should not be included as fish cover.
Floating	Vascular plants, usually with broad leaves floating on the water surface. Common in calm, still waters (e.g., water lilies).
Emergent	Vascular plants which root to the stream or lake bottom while their stems extend above the water surface (e.g., cattails, bulrushes, and sedges). Insects with aquatic life stages are often abundant in areas with emergent vegetation. These insects are an essential food source for many fish. An estimate of the amount of water interspersion and water depths in the emergent vegetation will be important in determining the value of this vegetation type as fish cover.
None	
Underwater Cover (% Surface Area)	Underwater cover provides an area for resting and predator avoidance for fish. Different types of cover are important in different habitat types, so it is essential to note in which part of the waterbody the features occur. Most types of cover should fit into the categories provided. Any additional features should be identified. The percentage should total 100% (of the surface area).
Undercut banks	A bank that has had its base eroded away and now overhangs the water. These often occur under tree root systems. The undercut area should be probed with a meter stick to determine its size and depth.
Boulders	In-water rocks larger than 25 cm in diameter are considered suitable cover for many larger fish. They create back eddies for fish to rest out of the current and are also large enough to hide fish from predators.
Cobble	In-water rocks 8 to 25 cm in diameter provide interstitial spaces (gaps between rocks) that can be used as cover by small or juvenile fish. These interstitial spaces are important overwintering and/or spawning areas for many fish.
Woody Debris	Living or dead woody materials (includes fallen trees, stumps, logs, mats of twigs, shrubs).
Organic Debris	Branches, leaves and other material will often collect in piles in streams and lakes, creating areas of good cover.
Vascular Macrophytes	Living aquatic and terrestrial non-woody plants in-water or overhanging vegetation (<1 m above the water surface) can provide shelter, protection and an attachment surface for food items.
None	
Bottom Substrate	An estimate of the percent cover of the substrate type can be made visually (if possible). The substrate should be classified according to the categories described above (see Shoreline Substrate).
Migratory Obstructions	
None	
Seasonal	Include type in the details section of the form
Permanent	Include type in the details section of the form
Potential Enhancement Opportunities	
	Opportunities to improve existing habitat conditions, such as rehabilitation of degraded conditions (e.g., shore/bank failure, debris clean-up), diversification of homogeneous habitats or addition of features that may be limiting productivity.
Comments	
	Include observations of wildlife, and any additional pertinent information



SOP (Rev.3)

File Name: NWMO_BIS_2020_eDNA SOP_IG (R003)

THE NWMO BIODIVERSITY IMPACT STUDIES: STANDARD OPERATING PROCEDURE FOR AQUATIC ENVIRONMENTAL DNA FIELD SAMPLING – NORTHWESTERN ONTARIO SITE

July 19, 2021

PREPARED BY Zoetica Environmental Consulting Services

SUBMITTED TO Melissa Mayhew
Nuclear Waste Management Organization
22 St. Clair Avenue East
Fourth Floor, Toronto, ON
M4T 2S3, Canada

ZOETICA
ENVIRONMENTAL CONSULTING SERVICES

OFFICE 102-22351 St Anne Ave, Maple Ridge, BC, V2X 2E7
PHONE 604 467 1111
WEBSITE www.zoeticaenvironmental.com

Revision History

Project Title: NWMO Biodiversity Impact Studies

Document Title: Standard Operating Procedure for Aquatic eDNA Field Sampling – Northwestern Ontario Site

Document File Name: NWMO_BIS_2020_eDNA SOP_IG (R003)

Rev. #	Issue Date	Description	Prepared By	Reviewed By	Approved By
R000	14-Aug-2020	BIS Year 1 final submission to NWMO	C. Chui	R. Hanner	H. Bears
R001	18-Dec-2020	Revised submission for Rev.1 of NW Ontario BPD Report: - Habitat groupings changed from 7 to 6; single group for watercourses (Glossary) - Added eDNA map and list of field sampling locations (App A) - Minor copyedits, formatting (throughout)	C. Chui	H. Bears	H. Bears
R002	21-Apr-2021	Revised submission for Rev.2 of NW Ontario BPD Report: - Removed Data Entry and Management (7.0) - Updated survey crew, roles for 2 pp. (6.4) - Added pre-filters: optional equipment depending on water conditions (throughout) - Added possibility of boat sampling and water safety equipment (3.3, 5.0, 6.3) - Edited seasonal sampling windows and Year 1 changes (5.0) - Mark waypoints at suitable amphibian breeding habitats (6.3) - Minor copyedits, formatting (throughout)	C. Chui	H. Bears	H. Bears
R003	19-Jul-2021	- Added Section 6.5, Environmental Data Collection and Data Recording, with more detailed instructions. - Modified data form and instructions to add polygon ID, stream flow, pre-filter, past 24-hr ppt, sample storage, review needed fields. - Added brief explanation of points and more detailed instructions and contingency planning to Section 6.2, Daily Field Planning and Reporting. - Added a summary of field sampling sites to first page of Appendix A. - Added additional info about densiometers. - Removed mobile sampling as an option for lentic systems – health and safety concern. - Updated lab shipping address and noted chain of custody procedure. - Minor copyedits, formatting (throughout)	C. Chui	H. Bears	H. Bears

Table of Contents

GLOSSARY OF TERMS

APM	Adaptive Phased Management
eDNA	Environmental DNA
NWMO	Nuclear Waste Management Organization
PQP	Project Quality Plan
QA/QC	Quality Assurance / Quality Control
SOP	Standard Operating Procedure
Contamination	Unwanted DNA in the sample. Contamination can occur by improper cleaning of equipment that touches the sample (i.e., filter housing, tweezers) or the habitat from which a sample is to be collected (e.g., boots), careless gear or sample handling/storage (e.g., reusing gloves between sites, damp filter membranes stored together), or various laboratory processes not described in this SOP.
Duplicate	A second ***sample*** collected at the same ***location***. The collection of duplicates acts as a QA/QC check for reproducibility (i.e., how reliable the results are) and also increases the probability of eDNA detection by increasing the volume of water sampled. Also known as a 'biological replicate.'
Field negative	Sample collection at a location where target species is/are known to be absent. For the APM Project, there will be no true field negatives as we cannot be sure that a species is not present at the sampling site. Instead, field negative samples will consist of "collection" of distilled water to ensure that gear has been properly decontaminated.
Field positive	Sample collection at a location where the target species is/are known to be present. If positive controls show up negative in the results, then there are likely error(s) in the field and/or laboratory methods. Positive controls also help increase confidence in the use of eDNA methods for detecting species and biodiversity monitoring, compared to traditional surveys.
GRTS	Generalized Random Tessellation Stratified. Conducted using the 'spsurvey' package in R, GRTS is a stratified random approach to study design and site selection that is also spatially balanced. The resulting PanelOne (P1) sites should be preferentially sampled in the order specified. OverSample (OS) sites are plotted in case replacement sites are needed due to logistical difficulties in the field.
Habitat grouping	The type of watercourse, waterbody, or wetland to be sampled. There are six habitat groupings proposed for initial eDNA studies: - Watercourses: 1) rivers/streams - Waterbodies: 2) lakes/ponds ≤ 1 ha, 3) lakes/ponds > 1 ha - Wetlands: 4) marshes, 5) swamps, and 6) peatlands (bogs and fens) Habitat groupings were determined through desk-based analysis of Ontario ecosite data; however, these classifications should be verified by the field contractor on the ground.
Lentic / Lotic habitat	A lentic ecosystem or habitat refers to standing or relatively still water, such as lakes, ponds, and wetlands. A lotic ecosystem or habitat refers to flowing water, such as rivers and streams.

Microhabitat	A consideration for selecting appropriate ***sampling locations*** on the ground. Microhabitats that are generally more suitable for wildlife and fish species include areas with emergent or submergent vegetation, large woody debris or rocks for cover, undercut banks, shade, gravel or cobble substrates for spawning fish, muddy substrates for turtles, etc.
Replicate	Typically, one of three ***samples*** to be collected at each ***site***. Replicates are collected at different ***sampling locations*** at a site by moving along the shoreline. The collection of replicates is meant to cover more area, which may increase the probability of species detection by sampling different microhabitats within the site.
Sample	Collection and filtration of water (ideally, 2 L) at a single ***sampling location***. One sample = one filter membrane that is labelled, stored, and analyzed separately.
(Sampling) Location	The exact location where sampling takes place, to be determined by the field contractor on the ground (geographic coordinates to be recorded on the data form = sampling location). ***Sampling site*** and sampling location may differ depending on access. GRTS site selection does not consider practicality and may select a point in the middle of a lake; however, for Year 1 eDNA studies, sampling will be conducted along the shore.
(Sampling) Site	The specific watercourse, waterbody, or wetland (i.e., ***habitat grouping***) selected for sampling through a GRTS study design. Sites are indicated as PanelOne (P1) or OverSample (OS) on the map(s) provided by Zoetica. A site corresponds to the watercourse segment, waterbody polygon, or wetland polygon, as determined through GIS analysis.
Stream reach	A section of a stream or river that is relatively homogenous, with similar hydrologic conditions such as discharge, depth, area, and slope. The ***sampling site*** for watercourses should consist of a single stream reach at least 200 m long.
Study areas (AOI, LSA, RSA)	There are three types of study areas defined for the Biodiversity Impact Studies: Area of Interest (AOI), Local Study Area (LSA), and Regional Study Area (RSA). Year 1 of eDNA studies will focus on ***sampling sites*** within the AOI and the LSA; however, ***field positives*** or other biodiversity study design control sites may be selected within the RSA.
Wetland	Several wetland classification systems can be applied in Ontario, including the *Canadian Wetland Classification System*, Ontario's Ecological Land Classification (ELC) system, and the Ontario Wetland Evaluation System (OWES). For the APM Project, we will identify four wetland types (marsh, swamp, bog, fen) according to the OWES, where shallow open water wetlands are grouped with marshes.

1.0 PURPOSE AND PRINCIPLE

The objective of this SOP is to instruct the field data collection contractor in conducting aquatic eDNA studies for the APM Project's Biodiversity Impact Studies and Environmental Media Baseline Program according to the study design developed by Zoetica and to the standards expected by the NWMO. This SOP focuses on field sampling procedures based on available best practices and guidelines for eDNA sampling. This SOP is intended to be aligned with the standard protocols of Dr. Robert Hanner's laboratory at the University of Guelph for eDNA sample collection, filtration, storage, and transport. For any minor discrepancies between this SOP and the field training provided by the Hanner laboratory, the latter should be followed. The Hanner laboratory will also conduct eDNA laboratory analyses according to their internal SOPs and QA/QC checks, and available best practices.

2.0 GENERAL PRECAUTIONS

Suggestions and precautions noted herein should not be interpreted as prescriptive or exhaustive. The field data collection contractor is responsible for their own field safety protocols, which includes the planning of field safety gear.

There are hazards inherent to eDNA sampling, including muscle strain from carrying the OSMOS eDNA sampling kit, and working in natural areas in and around water. Since work will be conducted in watercourses, waterbodies, and wetlands, there is a possibility of drowning and hypothermia. Caution should be applied around water, and the field data collection contractor should plan for safety when working around water as they see fit.

Field hazard identification and controls, safety equipment, and site emergency protocols should be outlined on the field data collection contractor's safety forms. In general, Zoetica predicts that slips, trips, and falls are likely the biggest safety risk due to uneven terrain, followed by eye-poking by sharp objects/branches in the field. However, the field data collection contractor will be responsible for conducting their own risk assessment associated with the perceived risks of this work. Zoetica recommends that the field data collection contractor, within their field safety plan, consider appropriate footwear, safety glasses, sunscreen, and appropriate clothing (e.g., bug shirt) to protect against weather conditions and biting insects. Zoetica also recommends that redundant, functional navigational gear be carried, and that protocols for helicopter safety and communications be followed.

3.0 EQUIPMENT AND MATERIALS

3.1 Sample Collection, Filtration, and Storage

Halltech OSMOS eDNA sampling kit:

- Battery-powered backpack
- 4-12' telescopic pole with tripod and pivot clamp
- 2 x 29.4 V Lithium-Ion batteries (keep extra battery as a spare)
- Smart battery charger
- Rugged field case with wheels

OSMOS reusable filter housings[1]

OSMOS pre-filters[1] and filter cloth

Cellulose nitrate filters (0.45-5 µm)[2]

Thermometer

Densiometer[3]

- Water quality instrument
- Water flow meter[4]
- Turbidity meter (or alternative)
- Disposable nitrile gloves
- Tweezers/forceps
- Small paper coin envelopes[5]
- Ziploc bags (S, M, L)
- Silica gel desiccant packs
- Sharpie markers and pencils
- Waterproof data forms in clipboard
- Distilled water
- Cooler and ice packs
- Refrigerator (optional)

[1] Reusable filter housings and pre-filters (recommended for turbid water conditions) must be decontaminated with a 50% bleach solution between uses (see Section 6.1.2). It may be feasible to carry enough filter housings and pre-filters such that decontamination can be done at the end of the day at camp. E.g., if 8 sites can be visited per day, each team would need to bring at least 30 filter housings and pre-filters (24 replicates + 4 duplicates + 2 field negatives). Alternatively, if proper decontamination can be done in the field, each team can carry fewer filter housings and pre-filters.

[2] eDNA has been successfully captured using a variety of filter materials. Cellulose nitrate filters are considered ideal; however, if there are delays or difficulties in procuring these filters, glass fibre is the next preferred filter type of the Hanner laboratory. Glass fibre filters also have the benefit of being more cost-effective. eDNA capture has been proven effective for filter pore sizes ranging from 0.45-5 µm. Pore size(s) will be selected as appropriate for the site conditions and with the guidance of Dr. Robert Hanner.

[3] Spherical densiometers are commonly used for measuring canopy cover; for eDNA sampling, canopy cover is used as a measure of UV radiation. The spherical mirror can be convex or concave shaped. Although there are no specific guidelines for eDNA sampling, a convex densiometer would reflect a wider angle/larger area and is less likely to be obscured by the user's face. Regardless, the type of densiometer selected should be consistent between field teams and campaigns to allow for valid data comparisons.

[4] Stream flow is important to document to aid with data interpretation, as water volume and velocity will affect eDNA dilution and transport. Ideally, a water flow meter capable of measuring discharge (m^3/s or L/s) would be used to quantitatively assess stream flow. A flow meter that measures velocity (m/s) will also provide some useful information. If specialized equipment is not available, a semi-qualitative assessment of stream flow (described in Section 6.5) is the minimum requirement.

[5] In humid environments, paper envelopes may not be ideal for storing dried filters (see Section 6.4.1). To protect samples from rain and humidity, and to prevent cross-contamination between samples and controls, an alternative approach is to store each filter separately in its own small plastic Ziploc bag with silica gel desiccant packs.

3.2 Decontamination

- Household bleach (5-6% sodium hypochlorite)
- Liquid dish soap
- Tap water
- Distilled or deionized water
- Tote bins (3), ideally with leak-proof or leak-resistant lids
- Pressure sprayer (with 1-2 gal tank)
- Small plastic (HDPE) containers (e.g., Nalgene bottles)
- Spray bottle

Scrub brush

Rubber gloves

Safety glasses/goggles

Paper towels

3.3 Standard Field Gear

High rubber boots and hiking boots

Binoculars, waterproof notebook, camera

Navigational equipment: GPS, compass, hard copy field maps and written coordinates, tablet or smartphone with georeferenced digital maps

General safety equipment: hi-vis clothing, safety glasses, flagging tape, long-range radio, first aid/survival kit, bear spray, field knife and/or hatchet

Water safety equipment (especially if sampling from a boat): personal flotation device, whistle, heaving line, bailer/pump

Optional or specialized safety equipment (i.e., not everyone will carry these): SPOT beacon, satellite phone, bear rifle

Transportation: helicopter, ATV, boat/canoe/kayak

4.0 QUALITY CONTROL

Quality control measures for eDNA studies include:

1. Strict decontamination procedures to avoid contamination (see Section 6.0)
2. Collection of duplicate, field negative, and field positive samples (see Section 6.4.2)
3. Data entry verification and backup management (see Data Management, Section 1.10, in the *Biodiversity Impact Studies – Northwestern Ontario Region: Baseline Program Design Report*)
4. Calibration of quantitative instruments (see Section 8.0)
5. Protocols developed by the field data collection contractor as per their PQP (not described in this SOP)
6. Laboratory QA/QC protocols; optimized and validated methods for DNA extraction, PCR amplification, library preparation, MiSeq sequencing, and bioinformatics analyses for detecting the biodiversity of the Revell Batholith Area (not described in this SOP)

5.0 GENERAL GUIDELINES FOR SAMPLING

1. **Timing** – appropriate biological windows when eDNA concentration should be higher, e.g., the breeding season of target species. For this project, Zoetica recommends seasonal sampling:
    - Spring (early-mid May)
    - Summer (early-mid July)
    - Fall (mid-late September)
    - Winter (December to March) – *winter sampling will only be conducted if species of interest are present in the fall, if the habitat could be used as an overwintering site, and if that potential overwintering site could potentially be affected by the APM Project.*

2. **Conditions** – it is not recommended to sample during or immediately after heavy rain, or during high-flow events.

3. **Locations** – suitable microhabitats where the target species is most likely to occur:
    - **Lentic systems** (waterbodies and wetlands) – can be chosen for ease of access and should represent a variety of microhabitats and as much of the spatial extent of the shoreline as possible.
    - **Lotic systems** (watercourses) – headwater streams and tributaries (rather than the main stem); stream margins, and thalweg are recommended. Always collect samples sequentially from downstream to upstream.

4. **Sampling effort** will depend on budget and time. The goal is to collect 3 replicate samples (and sometimes 1 extra duplicate sample; see Section 6.4.2) x 2 L water per sample at each site, wherever possible. (Note that each 2 L is considered a separate sample for filtering and lab analysis.) If these volumes cannot be attained (e.g., high algae/sediment levels clog the filter quickly), allow for 20 minutes of sample filtration and record the total volume filtered.

    Notes: Installing the pre-filter and/or filters with a larger pore size may also help increase the volume of water that can be collected. However, the Hanner laboratory recommends that pre-filters only be used if the first of the 3 replicates clog before pumping is complete, as the use of pre-filters may decrease the amount of eDNA captured. These methods are still preferable to turning up the pump pressure, as high filtration pressures may reduce eDNA retention (Thomas *et al*. 2018) and/or could rupture the membrane. Any modifications made to the initial (standard) parameters must be documented on the field data form (see Section 6.5).

5. Sampling recommendations when using the **OSMOS eDNA sampler** or other backpack sampling and filtration systems:
    - **Lotic systems** (watercourses) – stationary point sampling will be used, wherein the surveyor will stand in one spot while running water through the system. Always collect replicates from downstream to upstream to avoid contamination. Space replicates 100 m apart (Bedwell and Goldberg 2020) within a single stream reach.
    - **Lentic systems** (waterbodies and wetlands) – although mobile sampling (wherein the surveyor walks along the shoreline while running water through the system) may increase the area surveyed, it is logistically difficult in northwestern Ontario. Instead, stationary point sampling will also be used for lentic systems, at suitable microhabitats along the shoreline (see Section 6.3).

6. **Avoid standing in the water** while collecting samples to avoid contamination from your boots. For streams, do not enter the water upstream of the collection site.

    Notes: We prefer not to enter the water at all. The OSMOS eDNA sampler has an extendable pole that should help reduce the need to enter the water. However, northwestern Ontario is largely made up of wetlands, and avoidance may be difficult. Any gear that has entered the water (including boots) should be sprayed with bleach solution and rinsed between sites (see Section 6.1.1) to avoid the small chance of contamination of one site with DNA from another.

7. **Avoid** collecting samples in areas with **visibly disturbed sediment** in the water column, including sediment stirred up by standing in the water. Sediments will clog up your filter membrane. If the water feature has high natural turbidity, installing the pre-filter and filters with a larger pore size (up to 5 µm) can help increase the flow rate – *record whether or not a pre-filter was used and the filter pore size on the data form for each sample collected*.

8. **Sampling from boats** is generally not recommended in lentic habitats unless the boat surface can be decontaminated with 1 in 10 bleach solution between sites. However, navigation to planned sampling locations in NW Ontario may require boat access (e.g., areas of Mennin Lake). Depending on a species' habitat preference, boat sampling may increase detection. Lotic sampling is acceptable if collection occurs <u>upstream</u> from the boat (also decontaminated, ideally).

9. **Depth of sampling** – for Year 1 of this project, sample collection will occur along the shoreline at or just under the water surface to avoid stirring up sediment. The seasonal timing of surveys is planned to coincide with the periods when fish and amphibian species are closer to shore. However, sampling at depth is also possible, and the use of a boat to reach deeper areas of a watercourse or waterbody may improve the detection of deep-water species.

6.0 PROCEDURE

6.1 Decontamination Procedures

Note: if there are differences between this SOP and the field training provided by the Hanner laboratory, please refer to the field training materials and instructions.

6.1.1 <u>Decontamination Between Separate Sites</u>

1. Decontamination of field gear is not needed between replicates at the same site or between hydrologically connected sites, but must be performed before moving to a separate site (i.e., different watercourse, waterbody, or wetland that is not hydrologically connected). Daily sampling routes can be planned such that decontamination can be performed at camp instead of in the field.

2. Bleach will break down DNA and will avoid the spread of chytrid fungus, ranaviruses, and other amphibian diseases when following the *Decontamination Protocol for Field Work with Amphibians and Reptiles in Canada* (CHHWG 2017).

3. Set up a decontamination station by placing 3 tote bins on top of a tarp in a sunny location ***away from a watercourse or waterbody***. Direct sunlight will help break down residual bleach. (Note: it is assumed that there will be no impermeable surfaces within the study area on which to dispose of rinse water.)

4. Fill one tote bin with soapy water (add liquid dish soap to tap water). Scrub the soles and sides of your rubber/hiking boots with a scrub brush to remove visible organic matter, dirt, pebbles, etc. Rinse with clean tap water into the 3rd tote bin.

5. Prepare a fresh 1 in 10 dilution of household bleach, i.e., 1 part bleach, 9 parts water. Fill a 2nd tote bin and a spray bottle with this bleach solution. *Wear rubber gloves and safety glasses/goggles – bleach is corrosive!*

6. Immerse all equipment and gear that may be contaminated (including boots, extendable pole, scrub brush, etc.) in the bleach solution. Spray larger items to soak thoroughly. Let sit for at least 1 min, then using the pressure sprayer, triple rinse/spray with clean water into the 3rd tote bin.

   Notes: <u>Even trace amounts of residual bleach can adversely affect amphibians on contact.</u> If decontamination is needed in the field and it is not feasible to carry large quantities of tap water, there are two options: 1) use water from the ***next*** site for rinsing, or 2) consider bringing multiple pairs of boots and change between sites. Decontaminate all boots back at the camp.

7. Shelf life of decontamination solutions and disposal:
   a. Bleach solution in the tote bin and spray bottle can be reused for up to 7 days.
   b. Tote bin with soapy water can be reused until it becomes too dirty with visible particulate matter.
   c. Tote bin with rinse water should be disposed of daily.
   d. To dispose of old solutions, carry the bins back to camp and flush down the drain with plenty of water.

6.1.2 Daily Decontamination of eDNA Equipment

1. Any equipment or materials that directly touch eDNA samples or filters should be decontaminated with a 50% bleach solution (Goldberg and Strickler 2017, Hobbs *et al*. 2017).

2. Disposable nitrile gloves and pre-filter cloth are single use only. Dispose of nitrile gloves after handling each sample. If contamination is suspected or if you accidentally touch something before handling the sample, change gloves before proceeding.

3. By using the OSMOS backpack sampler and filtration system, only reusable filter housings, pre-filters, and tweezers should require this stronger bleach decontamination procedure (which can be performed at camp at the end of each field day).

4. To prevent contamination and for ease of cleaning, reusable filter housings and pre-filters should be stored in Ziploc bags, and used tweezers will be kept in a small, labelled Nalgene (HDPE) bottle (see Section 6.4.1).

5. Prepare a fresh 1 in 2 dilution of household bleach, i.e., 1 part bleach, 1 part water. Fill a small HDPE container with this bleach solution (HDPE is more resistant to bleach than other plastics). *Wear rubber gloves and safety glasses/goggles – bleach is corrosive!*

6. Dismantle the reusable filter housings and pre-filters so that all parts can be properly decontaminated. Let tweezers, filter housings, and pre-filters soak in the bleach solution for at least 1 min, then rinse thoroughly with distilled or deionized water.

7. Set tweezers onto clean paper towels to dry completely. Reusable filter housings and pre-filters can be dried if time allows; however, drying is not necessary before reloading with a clean filter membrane and filter cloth, respectively.

8. Be very cautious in handling the cleaned equipment to avoid possible contamination. Clean tweezers should be placed in a clearly labelled, small Ziploc bag or small Nalgene bottle (with handles facing out). Do not touch the pincer tips.

9. Reassemble reusable filter housings and pre-filters, taking care not to touch the inside that will hold the filter membrane. Place clean filter housings and pre-filters into a clean Ziploc bag.

10. The bleach solution can be stored for up to 7 days. Old bleach solution can be flushed down the sink with plenty of water.

Notes: Decontamination of OSMOS reusable filter housings and pre-filters may need to be completed in the field if not enough units are available for a full day of field work by two teams. In this case, ensure that the bleach solution and rinse water do not come into contact with the environment. <u>Even trace amounts of residual bleach can adversely affect amphibians on contact.</u>

6.2 Daily Field Planning and Reporting

1. Zoetica has developed a GRTS design for eDNA sampling. All lakes, ponds, and selected streams within the AOI were “locked in” (i.e., GRTS was forced to sample all of them), but the sampling sites were still chosen randomly – these are labelled as Census sites in the list of field sampling sites in Appendix A.

2. Certain wetlands within the AOI and watercourses, waterbodies, and wetlands outside the AOI have been pre-selected through GRTS as PanelOne (P1) sites for sampling. Census and P1 sites are shown on the first map in Appendix A and are considered higher priority for sampling.

3. OverSample (OS) sites were also selected through GRTS for wetlands within the AOI and all habitat groupings outside the AOI. OS sites are shown on the second map in Appendix A in case it is impossible to access a P1 site. However, reasonable efforts should be made to reach the P1 site.

4. For all sites (Census, P1, OS), GRTS design recommends visiting sites in the numerical *GRTSOrder* specified, wherever possible (see site details in Appendix A). i.e., if time constraints prevent completing all planned sites during the field campaign, the highest order sites should be the ones omitted.

5. Before each field day, the field data collection contractor lead should prepare a daily route plan for each survey team, considering the potential need for helicopter "hopscotching" to pick up/drop off each team as well as refueling location(s) and timing.

6. It is expected that each survey team can sample 6-10 sites per day. Plan for more in case sampling proceeds more efficiently than expected. Conversely, if fewer sites can be sampled than expected, ensure that the remaining sites are on the next day's planned routes. In the field, maintain communication with the pilot and the other survey team to coordinate site visits, if needed.

7. Travel to the sampling sites will occur via helicopter, ATV, or boat, if possible. Given the prevalence of wetlands in the area, however, it is likely that the sampling site/location will need to be reached on foot. Record access waypoints (including helicopter drop-off point or ATV/boat "parking spot"), mark with flagging tape, and enable tracking on the GPS unit to assist with navigation.

8. To balance the time available with the number of samples that need to be collected, Zoetica recommends that the survey team walk <u>no farther than 1 km</u> from the landing spot or vehicle/boat restriction point. If the distance to the sample site is greater than 1 km, consider sampling at the nearest OS site as a replacement if this location is more accessible.

9. If the exact coordinates cannot be reached, <u>but the appropriate polygon</u> (see site details in Appendix A) can be accessed within 1 km of the drop-off point, and stream reach requirements are met if applicable (see Section 6.3), sampling may be conducted at the accessible location.

10. Similarly, if a sampling site is found to be dry during the summer, but there is another location <u>within the appropriate polygon</u> where open/surface water is available for collection, sampling may be conducted at this location.

11. If OS sites are used, try to replace the P1 site with an OS site from the same habitat grouping. If this is not feasible, record the habitat grouping of the replaced P1 site and the replacement OS site, so that the planned sampling proportions in each habitat grouping within each study area are still maintained, as much as possible, by the end of the field campaign.

12. For any replacement sites needed (moved points within the same polygon as outlined in step 9, or use of OS sites as outlined in step 11), <u>replacement sites must stay within the AOI as planned, or outside the AOI as planned</u>.

13. At the end of each day, program all actual sampling site coordinates onto the tablet with the georeferenced digital map (e.g., Avenza Maps). Review the area covered and the number of sites per habitat grouping completed. Use this information to plan the next day's surveys.

14. At the end of each day, hold a team debrief meeting to discuss any questions or concerns, including hazards encountered, access and/or sampling difficulties, etc. Discuss lessons learned and any improvements that can be made.

15. Prepare a daily report (email) to the NWMO regarding progress made to date (e.g., information gathered from steps 13 and 14). Study design changes, if needed, must be approved by Zoetica and the NWMO.

6.3 Microhabitat Selection and Wetland Verification

1. Upon arrival at any pre-selected site, the experienced biologist(s) will also assess the general shoreline area to select suitable microhabitats for sampling (as these features are not discernible from remote sensing data used by Zoetica to develop the study design). Suitable microhabitats will include areas with submergent or emergent vegetation, logs or rocks for cover, and other habitat features preferred by wildlife or fish species.

   Notes: Document whether a wetland or pond may be suitable breeding habitat for amphibians (based on microhabitat characteristics and incidental wildlife observations) and mark waypoints. This information may be used to inform Tier 2 studies for herpetofauna.

2. The GRTS study design includes stratification of wetland types based on ELC data; however, wetland classification by air photo interpretation has inherent uncertainty. After arriving at a wetland site, the experienced biologist will verify the wetland type as either marsh, swamp, bog, or fen (MNRF 2014).

3. For watercourses, the sampling site should consist of a single stream reach (i.e., a relatively homogenous length of stream). The field data collection contractor should verify that the stream reach is at least 200 m long before initiating sample collection at a watercourse, i.e., Replicate 1 will be collected at 0 m, replicate 2 will be collected at 100 m, and replicate 3 will be collected at 200 m.

6.4 Collecting and Filtering eDNA Samples

6.4.1 Collecting "Unknown" Samples

Review the Halltech OSMOS eDNA Sampler video here. *Note: If there are differences between this SOP and the field training provided by the Hanner laboratory, please refer to the field training materials and instructions.*

1. Each survey team will consist of one contracted field data collection staff or NWMO staff, and one local field assistant. At each site, there will be two roles:
   a. eDNA sample collector – to handle the eDNA equipment and samples
   b. Environmental data collector and record keeper – to take environmental measurements (e.g., weather, water quality), and to record all information onto the field data form.

2. Use a GPS to record site coordinates (UTM zone 15N, NAD 83) of the starting location for all 3 replicates. Mark as waypoints on the GPS unit (e.g., unique station ID - R1, R2, R3) and record on the field data form. *Optional*: mark the physical location with flagging tape to help find the sampling site during the next seasonal campaign and subsequent years of study.

3. Record site and sample info on a waterproof field data form (see Section 6.5 and Appendix B). Weather conditions, canopy cover, incidental observations, and photographs can be taken by the environmental data collector/record keeper while eDNA samples are being collected. Measurements taken in the water should be done ***after*** eDNA sample collection has been completed to minimize the risk of contamination.

4. Prepare the OSMOS eDNA sampler. Find a suitable place to fix the tripod. Place the pivoting boom clamp on the tripod and lock it in place.

5. Attach the inlet tube to the bottom of the unit using the quick connect.

6. Turn ON the unit (inside) and close the door.

7. Hang the unit on the tripod for added stability. Ensure the tripod feet are firmly in the ground.

8. Attach the aluminum filter housing (and pre-filter, if needed) to the end of the pole. The filter housing and pre-filter should be stored in separate Ziploc bags until use. Avoid touching them with your hands while assembling the equipment.

9. Extend the pole to the required length. Adjust the pole to the required height (to sample at or just under the water surface to avoid stirring up sediment) and lock it in place.

10. Adjust the running parameters using the keypad:
    a. Volume Limit = 2.0 L
    b. Pre Filters = 0 if not used, 1 if used
    c. Pressure = -60 kPa
    d. Hose Length = 15 ft
    e. Enable Heater? NO
    f. Enable Remote Switch? NO
    g. Shutoff Automatic? Auto

11. Press ENT to start. The unit will display the key parameter values in real-time: pressure, temperature, flow, and quantity.

12. Once the target volume has been reached, the unit will beep. If 2 L of water cannot be filtered due to high water turbidity, allow the unit to run for 20 minutes, then proceed to the next steps. Note: It is recommended that the pre-filter only be used if necessary (i.e., if the 1st replicate becomes clogged). Filters with increased pore size may also be installed, if available.

13. Invert the pole and follow the onscreen prompt to continue. Let the unit run until all the water has been pumped out.

14. The final results screen will show the total volume pumped, average flow rate, and runtime. (Note: it only takes a few minutes to pump 1-2 L of water if turbidity is not an issue.)

15. Retract the pole to retrieve the filter. Invert the filter housing and lock in place.

(Steps 16-18 can be performed by the environmental data collector/record keeper while waiting for sampling to complete.)

16. Dried filter membranes will be placed in small paper coin envelopes.* Using a Sharpie marker, label envelopes with the following sample identifiers (must match the info recorded on the field data form; see Section 6.5):
    - Unique station ID
    - Initials of eDNA sample collector
    - Date and time
    - Sample/replicate number

17. Prepare a medium Ziploc bag to hold the sample envelopes once completed. Designate one bag per site for all “unknown” and control samples.*

* *If the environment is wet or humid, paper envelopes (step 16) may not be ideal for storing dried filters. To protect from rain and humidity and to prevent cross-contamination between samples and controls (step 17), store each filter separately in its own small plastic Ziploc bag with silica gel desiccant packs.*

18. Wear sterile nitrile gloves before handling desiccant packs. Place a handful (~20) of desiccant packs at the bottom of the bag, enough to line the bottom.

    Notes: Zoetica recommends pre-packing the miniature coin envelopes into the Ziploc bags with desiccants. This step will minimize the chances of a large-scale envelope contamination event (e.g., accidentally dripping sample water across all envelopes, which could lead to contamination of the filter that will go inside the envelopes).

19. Use sterilized gloves while removing the membrane from the filter housing. Gloves that will be used to handle samples should be stored in a large Ziploc bag for easy access to the wrist ends and to avoid contamination. Shake the gloves around in the bag and tip one toward the bag opening so you are able to grab the wrist part of a glove without touching any other gloves or the inside of the bag, which may transfer contamination to the remaining gloves.

20. Disassemble the filter housing components to expose the membrane.

21. Grab a pair of clean tweezers by the handle (from a Ziploc bag or bottle) using the dominant hand. Do not touch the pincers. You can place the tweezers on the palm of a gloved hand if you need to adjust positioning.

22. Use the tweezers to pick up the filter ring. Hold the edge of the ring with your free (non-dominant) hand. Use the tweezers to gently fold one side of the filter membrane toward the other. Use the untouched side of the filter ring to hold down the fold, then use the tweezers to gentle crease the membrane in half. Pick up the folded filter membrane with the tweezers. *<u>By using the filter ring and tweezers, your fingers should not need to touch the membrane at all.</u>*

23. Put the filter ring aside and pick up a labelled sample envelope using your non-dominant hand. Use a clean gloved finger to lift the flap, then gently squeeze the sides to open the envelope. Without touching the inside of the envelope, place the filter membrane deep into the envelope.

24. Seal the envelope and place it in the prepared Ziploc bag with desiccants. Store at ambient temperature in the dark (or preferably in a cooler with ice packs, if possible) while completing the rest of the day's sampling.

25. Replace the filter ring into the aluminum filter housing and place it back into the labelled Ziploc bag. The unit (and pre-filter, if used) must be decontaminated before reuse (see Section 6.1.2).

26. Remove gloves and keep in a labelled bag designated for used gloves; dispose of used gloves in the garbage back at camp. Place contaminated tweezers into the labelled Nalgene bottle designated for used tweezers. Put on a new pair of gloves and use clean tweezers for each sampling location (including replicates and duplicates) and when collecting field positive and negative samples.

27. Disconnect the pole from the unit (the quick connect at the bottom). Roll up tubing and pack up the tripod so that it can be stored safely and carried comfortably to the next sampling location.

6.4.2 Collecting Duplicate, Field Negative, and Field Positive Samples

1. A **duplicate sample** will be collected at every other site as a QA/QC check to assess the reproducibility of the results. Duplicates allow for the measurement of variability between samples and will potentially reveal lab analytical errors. Collecting a duplicate also doubles the volume of water sampled at a location and may increase the chances of eDNA detection.

2. The collection of a duplicate sample should mimic the collection of the first "unknown" sample at that location (as above, Section 6.4.1). In the 'Replicate no.' field of the data form, record the replicate number and the duplicate as "DUP".

3. A **field negative sample** of distilled (DNA-free) water is "collected" to ensure that no contamination is occurring throughout the decontamination and collection procedures. If there is no contamination, a field negative should not display any DNA markers. This QA/QC check helps confirm that samples collected are representative of the site and do not contain any extra DNA.

4. One field negative should be collected every three sites. Run 2 L of distilled water through the OSMOS system and handle the filter like an actual sample (as above, Section 6.4.1). In the 'Replicate no.' field of the data form, record as "FIELD NEG".

5. Whenever possible, collect a **field positive sample** at a site where the species of interest is/are known to occur (which can be within any study area: AOI, LSA, or RSA). This QA/QC check helps to confirm that your protocols are working, establish rates of false negatives (which should be low), and also helps to confirm traditional surveying techniques.

6. The collection of field positives should mimic the collection of actual samples (as above, Section 6.4.1). In the 'Replicate no.' field of the data form, record as "FIELD POS".

6.5 Environmental Data Collection and Data Recording

1. The environmental data collector/record keeper will record all site and sampling information on the eDNA field data form (see Appendix B).

2. Fill in the GENERAL SITE INFORMATION fields.
    a. Date and time – enter in dd-mm-yyyy format and 24-hour clock
    b. Station ID – refer to *StationID* values in the list of field sampling sites (see Appendix A)
    c. Replicate number – R1, R2, R3 for "unknown" samples; or DUP, FIELD NEG, FIELD POS for controls
    d. Polygon ID – refer to *POLYID* in the list of field sampling sites (see Appendix A)
    e. Location – coordinates in UTM zone 15N, NAD 83 read from GPS unit (or tablet if precise enough)
    f. Survey crew – enter initials (of first, middle, last names) of eDNA sample collector and environmental data collector/record keeper. Note: if any personnel share the same initials, develop and document unique naming for traceability.

3. Fill In the ENVIRONMENTAL CONDITIONS fields.
    a. Cloud cover (%) – visual estimate
    b. Air temperature (°C) – read from a thermometer
    c. Canopy cover (%) – measured using a densiometer
    d. Current precipitation – 7-point scoring system:
        i. 0 – None
        ii. 1 – Foggy (reduced visibility, like a cloud)
        iii. 2 – Misty Drizzle (no distinct raindrops but can dampen clothing)
        iv. 3 – Drizzle (fine raindrops <0.5 mm diameter, visible on ground)
        v. 4 – Light Rain (puddles not forming quickly, <2.5 mm rain per hour)
        vi. 5 – Hard Rain (puddles form quickly, >2.5 mm rain per hour)
        vii. 6 – Snow
    e. Past 24-hr rainfall (mm) – can be filled in back at camp. Record data obtained from nearest meteorological station and note the station used: "NWMO" or "AUT"[1].
    f. Water temperature (°C)
    g. Dissolved oxygen (mg/L)
    h. pH
    i. Conductivity (ms/cm)
    j. Turbidity (NTU)

Measured using a water quality meter

[1] NWMO will be installing a meteorological station at the NW Ontario site in mid-July 2021. For ECCC data, search "ATIKOKAN (AUT)" on https://climate.weather.gc.ca/historical_data/search_historic_data_e.html

k. Stream flow: discharge (m^3/s) *or* velocity (m/s) *or* — Measured using a water flow meter, if available
qualitative (L, M, H; see step 5 below)

4. Water quality and flow measurements should be done ***after*** eDNA sample collection has been completed to avoid contamination. Readings should be made just under the surface, where eDNA sampling occurs.

5. If a water flow meter is not available, qualitative stream flow (discharge) measurements following the *SOP for Aquatic Habitat Mapping – NW Ontario Site* will be used:
    a. Observe the amount of water in the channel in relation to the bankfull depth.
    b. Look for low flow indicators:
        i. The distinct sequence of riffles and pools, or steps and pools
        ii. Wetted width significantly less than the channel width
        iii. Dry, unvegetated channel bars
    c. Look for high flow indicators:
        i. The distinction between riffles and pools or steps and pools is difficult
        ii. The water level at or over bank tops
        iii. Wetted width similar to or greater than the channel width
        iv. No visible bars or banks
    d. Record the appropriate code: L – Low flow (0-30% of bankfull), M – Moderate flow (31-90% of bankfull), H – High flow (>90% of bankfull)

6. Record qualitative site/habitat characteristics of relevance for habitat selection by the target species groups. Examples:
    a. Wetland type (as verified on the ground, see Section 6.3)
    b. Presence and abundance of cover (e.g., emergent and submergent vegetation, coarse woody debris, boulders, undercut banks, riparian trees and shrubs)
    c. Substrate type (e.g., mud, sand, gravel, cobble, detritus)
    d. Water depth and other features (e.g., shallow, slow-moving, presence of deeper pools)
    e. Adjacent habitat types (e.g., woodland, wetland, shrubland, grassland, agricultural, cleared or built-up area)
    f. Habitat modifications and potential barriers to movement (e.g., beaver activity, human disturbance)

7. Record any incidental wildlife or fish observations of potential relevance to eDNA studies, including direct animal (or egg) sightings, vocalizations, tracks, or other sign. Observations of both the target species/groups (i.e., amphibians, reptiles, fish) and their potential predators should be recorded.

    Notes: Refer to the *Work Instruction for Incidental Wildlife and Plant Observations – NW Ontario Site* for the field procedure and data form and instructions for recording incidental observations for other species of interest (e.g., at-risk, rare, and culturally important species; and selected species for wildlife habitat assessment/habitat suitability modelling). The eDNA survey team should also carry this Incidental Observations Form

(Wildlife) and record relevant observations both at the eDNA sampling location/site or while travelling between sites.

8. Take geotagged photos of each collection location to document habitat characteristics, including a wide-angle photo for overall context, the microhabitat(s) where sampling occurred, and wildlife sign. Record geotagged photo numbers on the data form. These photos will also be linked to the unique station ID and replicate number when a photo of the completed data form is taken (step 12).

9. Fill in the SAMPLING CONDITIONS fields.
    a. Method – OSMOS eDNA sampler
    b. Filter type – use abbreviations for cellulose nitrate (CN) or glass fibre (GF)
    c. Filter pore size (µm)
    d. Prefilter used? If so, enter pre-filter cloth pore size (µm)
    e. Input parameters:
        i. Sample volume (L)
        ii. Pump pressure (kPa)

        Read from OSMOS digital sensor, but should be standardized to 2.0 L and -60 kPA
    f. Output parameters:
        i. Total volume pumped (L)
        ii. Average flow rate (L/min)
        iii. Runtime (min)

        Read from OSMOS final results screen
    g. Sample storage conditions:
        i. Filter preservation – silica
        ii. Time at collection (when sample bags are completed)
        iii. Time at refrigeration (back at camp)
        iv. Elapsed time between collection and refrigeration

10. Record any additional comments or modifications made to the standard sampling protocol. Take a photo of the filter membrane before it is removed from the filter housing and record the photo numbers on the data form.

11. Indicate whether the field data need to be reviewed later (e.g., wildlife or vegetation/habitat notes where species ID needs to be verified). This is intended for the field data collection contractor's use only.

12. Ensure that all fields on the data form have been filled out before leaving the sampling location. Take a photo of the completed data form.

13. When the field data are entered into the electronic spreadsheet (for ultimate transfer to the NWMO, and then to Zoetica), record the dates and persons completing the data entry and QA/QC (should not be the same person doing both).

6.6 Storage and Transport of Samples to Laboratory

1. At the end of the day, back at camp, store all samples within a larger bag, securely and in the dark in the refrigerator (but do not freeze). The longevity of desiccant storage is thought to be 6-12

months (Hobbs *et al.* 2017); however, it is best to send them to the lab for DNA extraction as soon as possible.

2. Document the sample filter storage conditions (e.g., temperature, duration) until the point when samples are shipped to the Hanner laboratory for analysis. Submission of eDNA samples should be accompanied by both hard copy and electronic data forms, and site photos.

3. Ziploc bags of samples should be packaged securely on ice packs in a cooler and shipped via courier with tracking enabled.

4. Following the appropriate chain of custody procedure, the NWMO will send sample batches to the Hanner Laboratory c/o:
   University of Guelph Laboratory Services
   Agriculture & Food Laboratory
   95 Stone Road West
   Guelph, Ontario, N1G 2Z4

7.0 EXPECTED RESULTS

The Hanner laboratory will present the eDNA metabarcoding methods and results in a summary report focused on species detected (and/or higher taxa as appropriate to the taxonomic resolution of the marker gene and reference database used to infer analysis). In addition, because existing morphologically-based taxonomy can overlook cryptic species, a summary of “molecular operational taxonomic units” (MOTUs) will also be included to further facilitate site comparisons. Raw data will be appended (e.g., as an Excel spreadsheet) and archived.

8.0 MAINTENANCE

Follow all maintenance procedures specified by Halltech Aquatic Research Inc. for the OSMOS eDNA sampling kit. Calibration of quantitative instruments (e.g., water quality meter, flow meter, GPS unit) should be conducted before use to ensure the accuracy and precision of data collected. Ensure that all electronic devices have power, recharge daily (if possible), and carry extra batteries. Tie flagging tape to all equipment to prevent losing means of communication and navigation.

9.0 REFERENCES

Bedwell, M. E., and C. S. Goldberg. 2020. Spatial and temporal patterns of environmental DNA detection to inform sampling protocols in lentic and lotic systems. Ecology and Evolution 10:1602–1612.

CHHWG. 2017. Decontamination Protocol for Field Work with Amphibians and Reptiles in Canada. Canadian Herpetofauna Health Working Group.

Goldberg, C., and K. Strickler. 2017. eDNA Protocol: Sample Collection. Washington State University.

Hobbs, J., C. S. Goldberg, C. C. Helbing, and N. Veldhoen. 2017. Environmental DNA Protocol for Freshwater Aquatic Ecosystems, Version 2.2. Prepared for BC Ministry of Environment, Ecosystems Branch.

MNRF. 2014. Ontario Wetland Evaluation System: Northern Manual. 1st edition. Ministry of Natural Resources and Forestry.

Thomas, A. C., J. Howard, P. L. Nguyen, T. A. Seimon, and C. S. Goldberg. 2018. ANDe™: A fully integrated environmental DNA sampling system. Methods in Ecology and Evolution 9:1379–1385.

APPENDIX A – eDNA MAPS AND LIST OF FIELD SAMPLING SITES

(see next page for maps and list – formatted for printing)

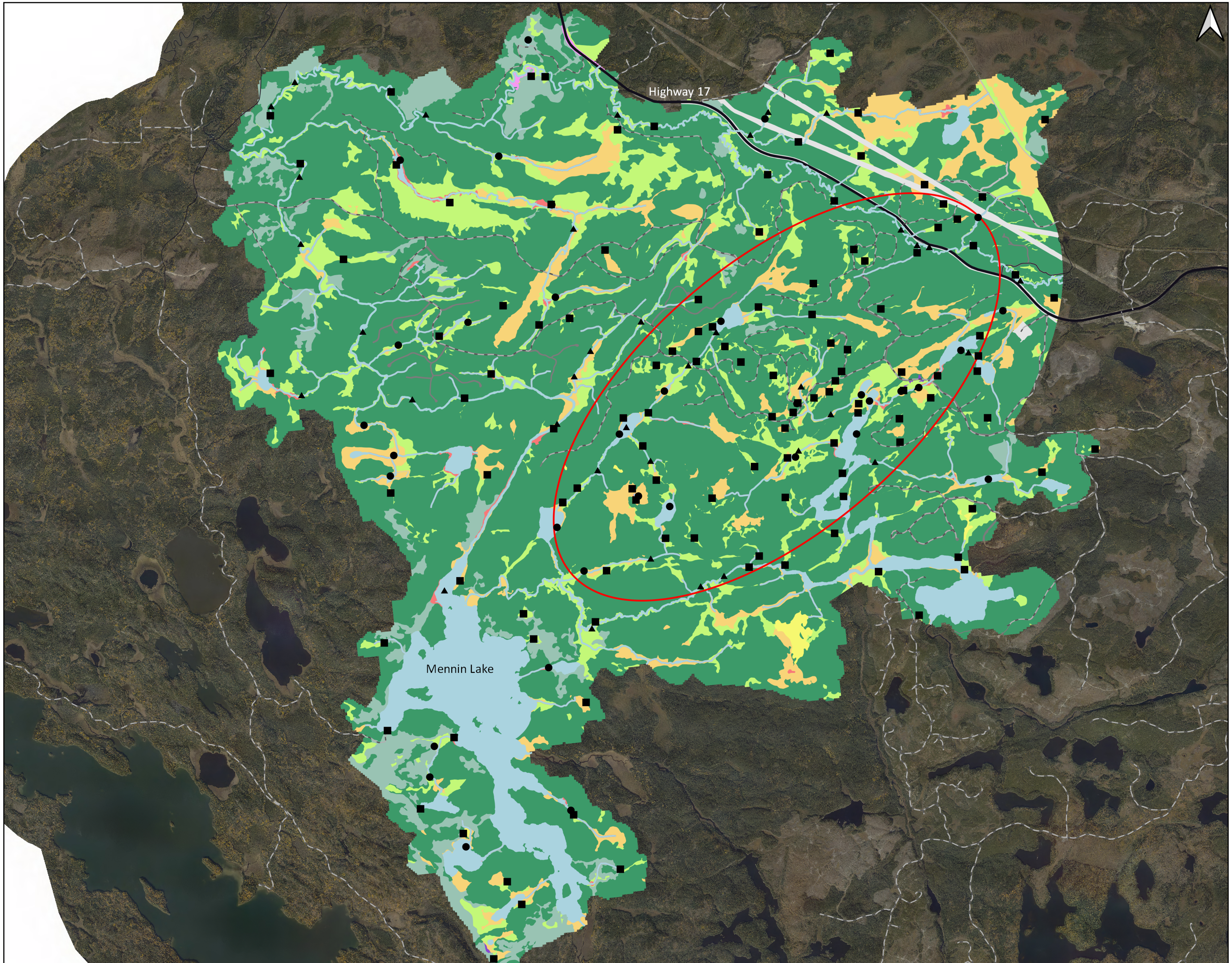
Summary of eDNA field sampling sites:

Sample.Type[1]	Census	PanelOne	OverSample	Grand Total
AOI.Lakes-0	6			6
AOI.Lakes-1	11			11
AOI.streams	19			19
AOI.Wetlands-Marsh		2	6	8
AOI.Wetlands-Peatlands		17	27	44
AOI.Wetlands-Swamp		41	27	68
XAOI.Lakes-0		11	12	23
XAOI.Lakes-1		6	5	11
XAOI.streams		20	20	40
XAOI.Wetlands-Marsh		8	6	14
XAOI.Wetlands-Peatlands		13	16	29
XAOI.Wetlands-Swamp		39	38	77
Grand Total	36	157	157	350

[1] "Lakes-0" = lakes/ponds ≤ 1 ha, "Lakes-1" = lakes/ponds > 1 ha, "AOI" = within the AOI, "XAOI" = outside the AOI but within the aquatic LSA

NWMO Biodiversity Impact Studies

eDNA Fieldwork Locations



Area of Interest (AOI)
Watercourse

Fieldwork Locations
- Stream
- Wetland
- Lake

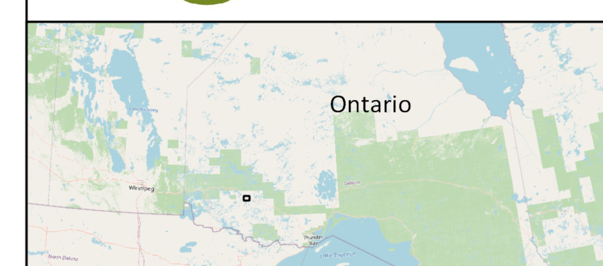
Ecosite Groups
- Marsh
- Fen
- Bog
- Swamp
- Hardwood
- Conifer
- Shrub
- Vertical or Active Mineral
- Water
- Cleared
- Compact Gravelled Surface
- Pavement/Concrete

Roads
- Local Road
- Highway or Arterial Road
- Resource/Recreation Road

1:60,000

0 1 2 km

ZOETICA

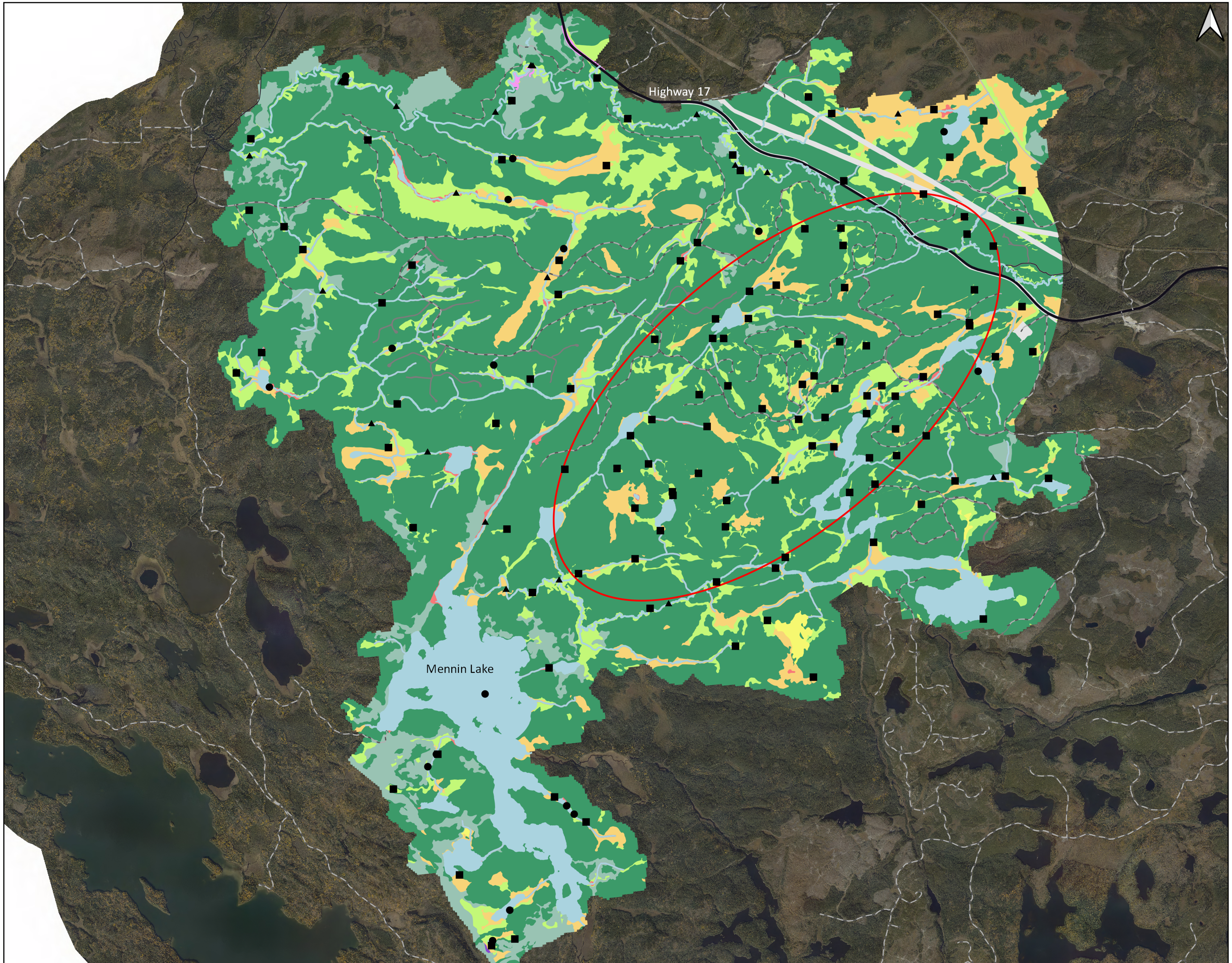


Inset Basemap © OpenStreetMap contributors

Data received from:
Ontario GeoHub — OHN Watercourse (MNRF); MNRF Road Segments (MNRF)
NWMO — AOI; Basemap Imagery

Project CRS: NAD83 / UTM zone 15N

Author: DM	Verified by: CC
July 19, 2021	Map ID: NWMO_BIS_059



NWMO Biodiversity Impact Studies

eDNA Oversample Fieldwork Locations

Area of Interest (AOI)
Watercourse

OverSample Fieldwork Locations
- Stream
- Wetland
- Lake

Ecosite Groups
- Marsh
- Fen
- Bog
- Swamp
- Hardwood
- Conifer
- Shrub
- Vertical or Active Mineral
- Water
- Cleared
- Compact Gravelled Surface
- Pavement/Concrete

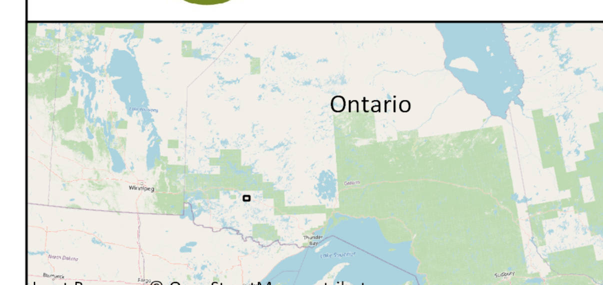
Roads
- Local Road
- Highway or Arterial Road
- Resource/Recreation Road

Oversample points are to be used to replace planned points if they are found inaccessible in the field.

1:60,000

0 1 2 km

ZOETICA



Inset Basemap © OpenStreetMap contributors

Data received from:
Ontario GeoHub — OHN Watercourse (MNRF); MNRF Road Segments (MNRF)
NWMO — AOI; Basemap Imagery

Project CRS: NAD83 / UTM zone 15N	
Author: DM	Verified by: CC
July 19, 2021	Map ID: NWMO_BIS_059

SampleType	panel	POLYID	x	y	GRTSOrder	StationID
AOI.Lakes-0	Census	555482107	553741.6	5483135.8	1	IG_AOI_L0_1
AOI.Lakes-0	Census	555480451	554612.4	5484335.2	2	IG_AOI_L0_2
AOI.Lakes-0	Census	555482098	557149.9	5485818.0	3	IG_AOI_L0_3
AOI.Lakes-0	Census	555480684	558817.3	5486014.4	4	IG_AOI_L0_4
AOI.Lakes-0	Census	555480703	559100.7	5486073.0	5	IG_AOI_L0_5
AOI.Lakes-0	Census	555481161	560049.7	5488797.0	6	IG_AOI_L0_6
AOI.Lakes-1	Census	555480429	553309.2	5483834.5	1	IG_AOI_L1_1
AOI.Lakes-1	Census	555480440	555113.6	5484169.0	2	IG_AOI_L1_2
AOI.Lakes-1	Census	555480539	557126.6	5484960.0	3	IG_AOI_L1_3
AOI.Lakes-1	Census	555480695	558311.4	5485857.7	4	IG_AOI_L1_4
AOI.Lakes-1	Census	555480706	555027.8	5486016.6	5	IG_AOI_L1_5
AOI.Lakes-1	Census	555480726	558180.7	5485956.3	6	IG_AOI_L1_6
AOI.Lakes-1	Census	555480837	559774.9	5486668.8	7	IG_AOI_L1_7
AOI.Lakes-1	Census	555480919	560447.1	5487303.5	8	IG_AOI_L1_8
AOI.Lakes-1	Census	555480931	555933.6	5487134.7	9	IG_AOI_L1_9
AOI.Lakes-1	Census	555480622	558105.0	5485329.9	10	IG_AOI_L1_10
AOI.Lakes-1	Census	555480626	554307.8	5485327.5	11	IG_AOI_L1_11
AOI.streams	Census	S2-007	557692.8	5485630.7	1	IG_AOI_ST_1
AOI.streams	Census	S2-009	557216.6	5486074.8	2	IG_AOI_ST_2
AOI.streams	Census	S4-026	555982.9	5483041.5	3	IG_AOI_ST_3
AOI.streams	Census	S4-027	555609.0	5482874.6	4	IG_AOI_ST_4
AOI.streams	Census	S4-065	559268.8	5488306.7	5	IG_AOI_ST_5
AOI.streams	Census	S4-066	557733.2	5489042.6	6	IG_AOI_ST_6
AOI.streams	Census	S4-073	559073.8	5488338.6	7	IG_AOI_ST_7
AOI.streams	Census	S4-074	558815.4	5488587.7	8	IG_AOI_ST_8
AOI.streams	Census	S2-075	555411.3	5486411.9	9	IG_AOI_ST_9
AOI.streams	Census	S2-091	558400.6	5484866.2	10	IG_AOI_ST_10
AOI.streams	Census	S2-109	559076.8	5486065.1	11	IG_AOI_ST_11
AOI.streams	Census	S2-111	559895.2	5486620.6	12	IG_AOI_ST_12
AOI.streams	Census	S2-141	555857.4	5486944.2	13	IG_AOI_ST_13
AOI.streams	Census	S3-143	553399.8	5484203.7	14	IG_AOI_ST_14
AOI.streams	Census	S2-144	554419.1	5485423.8	15	IG_AOI_ST_15
AOI.streams	Census	S3-145	553960.6	5484733.6	16	IG_AOI_ST_16
AOI.streams	Census	S2-176	554809.7	5483319.4	17	IG_AOI_ST_17
AOI.streams	Census	S2-186	554806.6	5484883.9	18	IG_AOI_ST_18
AOI.streams	Census	S2-201	557175.8	5485047.9	19	IG_AOI_ST_19
AOI.Wetlands-Marsh	PanelOne	WM-164	554573.5	5484272.5	1	IG_AOI_WM_1
AOI.Wetlands-Marsh	PanelOne	WM-181	559401.4	5486261.9	2	IG_AOI_WM_2
AOI.Wetlands-Marsh	OverSamp	WM-172	558723.7	5485934.6	3	IG_AOI_WM_3
AOI.Wetlands-Marsh	OverSamp	WM-178	557740.5	5485124.7	4	IG_AOI_WM_4
AOI.Wetlands-Marsh	OverSamp	WM-183	555801.0	5486860.7	5	IG_AOI_WM_5
AOI.Wetlands-Marsh	OverSamp	WM-171	558264.6	5485655.8	6	IG_AOI_WM_6

SampleType	panel	POLYID	x	y	GRTSOrder	StationID
AOI.Wetlands-Marsh	OverSamp	WM-174	554827.6	5485561.3	7	IG_AOI_WM_7
AOI.Wetlands-Marsh	OverSamp	WM-166	558311.2	5484948.2	8	IG_AOI_WM_8
AOI.Wetlands-Peatlands	PanelOne	WP-053	557896.1	5484330.0	1	IG_AOI_WP_1
AOI.Wetlands-Peatlands	PanelOne	WP-048	553400.9	5484236.4	2	IG_AOI_WP_2
AOI.Wetlands-Peatlands	PanelOne	WP-111	555572.4	5486972.4	3	IG_AOI_WP_3
AOI.Wetlands-Peatlands	PanelOne	WP-149	558856.8	5486026.7	4	IG_AOI_WP_4
AOI.Wetlands-Peatlands	PanelOne	WP-145	558138.6	5485815.3	5	IG_AOI_WP_5
AOI.Wetlands-Peatlands	PanelOne	WP-084	556384.3	5483197.1	6	IG_AOI_WP_6
AOI.Wetlands-Peatlands	PanelOne	WP-046	556959.5	5485423.8	7	IG_AOI_WP_7
AOI.Wetlands-Peatlands	PanelOne	WP-144	556752.7	5485605.7	8	IG_AOI_WP_8
AOI.Wetlands-Peatlands	PanelOne	WP-141	554371.2	5485585.7	9	IG_AOI_WP_9
AOI.Wetlands-Peatlands	PanelOne	WP-112	555798.7	5487045.4	10	IG_AOI_WP_10
AOI.Wetlands-Peatlands	PanelOne	WP-039	556998.1	5484946.7	11	IG_AOI_WP_11
AOI.Wetlands-Peatlands	PanelOne	WP-106	560054.8	5486579.9	12	IG_AOI_WP_12
AOI.Wetlands-Peatlands	PanelOne	WP-152	557667.2	5486005.9	13	IG_AOI_WP_13
AOI.Wetlands-Peatlands	PanelOne	WP-059	554899.0	5484591.3	14	IG_AOI_WP_14
AOI.Wetlands-Peatlands	PanelOne	WP-055	555791.7	5484301.7	15	IG_AOI_WP_15
AOI.Wetlands-Peatlands	PanelOne	WP-041	557744.7	5485186.4	16	IG_AOI_WP_16
AOI.Wetlands-Peatlands	PanelOne	WP-056	554513.5	5484453.1	17	IG_AOI_WP_17
AOI.Wetlands-Peatlands	OverSamp	WP-150	558272.8	5485940.6	18	IG_AOI_WP_18
AOI.Wetlands-Peatlands	OverSamp	WP-054	555156.0	5484404.7	19	IG_AOI_WP_19
AOI.Wetlands-Peatlands	OverSamp	WP-142	557601.0	5485594.6	20	IG_AOI_WP_20
AOI.Wetlands-Peatlands	OverSamp	WP-206	553434.1	5484764.8	21	IG_AOI_WP_21
AOI.Wetlands-Peatlands	OverSamp	WP-045	554484.9	5485302.5	22	IG_AOI_WP_22
AOI.Wetlands-Peatlands	OverSamp	WP-107	557166.0	5486771.9	23	IG_AOI_WP_23
AOI.Wetlands-Peatlands	OverSamp	WP-110	559172.6	5486246.8	24	IG_AOI_WP_24
AOI.Wetlands-Peatlands	OverSamp	WP-047	555711.6	5485449.7	25	IG_AOI_WP_25
AOI.Wetlands-Peatlands	OverSamp	WP-153	557757.3	5486057.5	26	IG_AOI_WP_26
AOI.Wetlands-Peatlands	OverSamp	WP-205	554270.5	5484778.0	27	IG_AOI_WP_27
AOI.Wetlands-Peatlands	OverSamp	WP-040	557395.7	5485139.6	28	IG_AOI_WP_28
AOI.Wetlands-Peatlands	OverSamp	WP-146	556593.2	5485734.4	29	IG_AOI_WP_29
AOI.Wetlands-Peatlands	OverSamp	WP-119	559175.2	5489171.6	30	IG_AOI_WP_30
AOI.Wetlands-Peatlands	OverSamp	WP-151	557237.3	5486124.5	31	IG_AOI_WP_31
AOI.Wetlands-Peatlands	OverSamp	WP-093	557913.7	5487673.8	32	IG_AOI_WP_32
AOI.Wetlands-Peatlands	OverSamp	WP-044	558729.5	5485410.7	33	IG_AOI_WP_33
AOI.Wetlands-Peatlands	OverSamp	WP-036	554964.0	5483782.0	34	IG_AOI_WP_34
AOI.Wetlands-Peatlands	OverSamp	WP-137	559831.8	5488808.8	35	IG_AOI_WP_35
AOI.Wetlands-Peatlands	OverSamp	WP-063	556802.4	5484593.2	36	IG_AOI_WP_36
AOI.Wetlands-Peatlands	OverSamp	WP-095	559402.8	5487246.6	37	IG_AOI_WP_37
AOI.Wetlands-Peatlands	OverSamp	WP-033	554559.4	5483331.3	38	IG_AOI_WP_38
AOI.Wetlands-Peatlands	OverSamp	WP-108	557834.8	5486806.6	39	IG_AOI_WP_39
AOI.Wetlands-Peatlands	OverSamp	WP-102	556819.1	5487713.0	40	IG_AOI_WP_40

SampleType	panel	POLYID	x	y	GRTSOrder	StationID
AOI.Wetlands-Peatlands	OverSamp	WP-080	553653.3	5483093.0	41	IG_AOI_WP_41
AOI.Wetlands-Peatlands	OverSamp	WP-066	554774.2	5484850.5	42	IG_AOI_WP_42
AOI.Wetlands-Peatlands	OverSamp	WP-060	555573.4	5484699.8	43	IG_AOI_WP_43
AOI.Wetlands-Peatlands	OverSamp	WP-094	556373.6	5487177.6	44	IG_AOI_WP_44
AOI.Wetlands-Swamp	PanelOne	WS-303	558825.9	5486321.2	1	IG_AOI_WS_1
AOI.Wetlands-Swamp	PanelOne	WS-300	557864.0	5486332.0	2	IG_AOI_WS_2
AOI.Wetlands-Swamp	PanelOne	WS-289	556545.8	5483375.0	3	IG_AOI_WS_3
AOI.Wetlands-Swamp	PanelOne	WS-480	555995.9	5486731.2	4	IG_AOI_WS_4
AOI.Wetlands-Swamp	PanelOne	WS-316	558800.0	5485199.0	5	IG_AOI_WS_5
AOI.Wetlands-Swamp	PanelOne	WS-339	557089.9	5485675.5	6	IG_AOI_WS_6
AOI.Wetlands-Swamp	PanelOne	WS-304	556253.1	5486481.8	7	IG_AOI_WS_7
AOI.Wetlands-Swamp	PanelOne	WS-366	559495.9	5489012.9	8	IG_AOI_WS_8
AOI.Wetlands-Swamp	PanelOne	WS-328	554681.6	5485137.9	9	IG_AOI_WS_9
AOI.Wetlands-Swamp	PanelOne	WS-347	557412.5	5487738.9	10	IG_AOI_WS_10
AOI.Wetlands-Swamp	PanelOne	WS-312	557164.6	5485826.6	11	IG_AOI_WS_11
AOI.Wetlands-Swamp	PanelOne	WS-463	558236.7	5488100.3	12	IG_AOI_WS_12
AOI.Wetlands-Swamp	PanelOne	WS-502	556533.8	5487362.8	13	IG_AOI_WS_13
AOI.Wetlands-Swamp	PanelOne	WS-340	558790.5	5485574.2	14	IG_AOI_WS_14
AOI.Wetlands-Swamp	PanelOne	WS-364	559717.4	5488769.8	15	IG_AOI_WS_15
AOI.Wetlands-Swamp	PanelOne	WS-270	556964.3	5484313.8	16	IG_AOI_WS_16
AOI.Wetlands-Swamp	PanelOne	WS-324	553633.3	5484462.4	17	IG_AOI_WS_17
AOI.Wetlands-Swamp	PanelOne	WS-483	557692.9	5486785.4	18	IG_AOI_WS_18
AOI.Wetlands-Swamp	PanelOne	WS-296	557765.3	5486180.6	19	IG_AOI_WS_19
AOI.Wetlands-Swamp	PanelOne	WS-318	556471.5	5484807.3	20	IG_AOI_WS_20
AOI.Wetlands-Swamp	PanelOne	WS-461	559974.9	5488345.7	21	IG_AOI_WS_21
AOI.Wetlands-Swamp	PanelOne	WS-259	555507.4	5483663.1	22	IG_AOI_WS_22
AOI.Wetlands-Swamp	PanelOne	WS-368	557747.5	5489061.8	23	IG_AOI_WS_23
AOI.Wetlands-Swamp	PanelOne	WS-290	555047.7	5483660.0	24	IG_AOI_WS_24
AOI.Wetlands-Swamp	PanelOne	WS-481	555539.5	5486491.6	25	IG_AOI_WS_25
AOI.Wetlands-Swamp	PanelOne	WS-342	558493.7	5487332.5	26	IG_AOI_WS_26
AOI.Wetlands-Swamp	PanelOne	WS-297	554899.1	5486429.4	27	IG_AOI_WS_27
AOI.Wetlands-Swamp	PanelOne	WS-503	557392.5	5487244.1	28	IG_AOI_WS_28
AOI.Wetlands-Swamp	PanelOne	WS-331	558128.5	5485668.3	29	IG_AOI_WS_29
AOI.Wetlands-Swamp	PanelOne	WS-497	555156.7	5486655.6	30	IG_AOI_WS_30
AOI.Wetlands-Swamp	PanelOne	WS-462	559073.8	5488231.7	31	IG_AOI_WS_31
AOI.Wetlands-Swamp	PanelOne	WS-307	559291.7	5485909.1	32	IG_AOI_WS_32
AOI.Wetlands-Swamp	PanelOne	WS-476	556771.9	5486268.3	33	IG_AOI_WS_33
AOI.Wetlands-Swamp	PanelOne	WS-360	559410.7	5488636.7	34	IG_AOI_WS_34
AOI.Wetlands-Swamp	PanelOne	WS-266	557878.0	5484700.3	35	IG_AOI_WS_35
AOI.Wetlands-Swamp	PanelOne	WS-284	554102.6	5483140.4	36	IG_AOI_WS_36
AOI.Wetlands-Swamp	PanelOne	WS-336	554771.8	5485669.6	37	IG_AOI_WS_37
AOI.Wetlands-Swamp	PanelOne	WS-474	557960.1	5486680.2	38	IG_AOI_WS_38

SampleType	panel	POLYID	x	y	GRTSOrder	StationID
AOI.Wetlands-Swamp	PanelOne	WS-311	557422.9	5485907.0	39	IG_AOI_WS_39
AOI.Wetlands-Swamp	PanelOne	WS-345	555571.6	5487482.2	40	IG_AOI_WS_40
AOI.Wetlands-Swamp	PanelOne	WS-466	558060.6	5488285.1	41	IG_AOI_WS_41
AOI.Wetlands-Swamp	OverSamp	WS-348	556390.0	5487614.4	42	IG_AOI_WS_42
AOI.Wetlands-Swamp	OverSamp	WS-490	559915.7	5487062.6	43	IG_AOI_WS_43
AOI.Wetlands-Swamp	OverSamp	WS-258	556006.2	5483843.9	44	IG_AOI_WS_44
AOI.Wetlands-Swamp	OverSamp	WS-468	557855.0	5488626.2	45	IG_AOI_WS_45
AOI.Wetlands-Swamp	OverSamp	WS-288	556964.1	5483353.6	46	IG_AOI_WS_46
AOI.Wetlands-Swamp	OverSamp	WS-471	557276.5	5488616.0	47	IG_AOI_WS_47
AOI.Wetlands-Swamp	OverSamp	WS-488	554874.4	5486846.0	48	IG_AOI_WS_48
AOI.Wetlands-Swamp	OverSamp	WS-464	557889.2	5488349.6	49	IG_AOI_WS_49
AOI.Wetlands-Swamp	OverSamp	WS-320	558745.0	5484983.9	50	IG_AOI_WS_50
AOI.Wetlands-Swamp	OverSamp	WS-271	554556.5	5484142.5	51	IG_AOI_WS_51
AOI.Wetlands-Swamp	OverSamp	WS-499	555847.1	5487172.9	52	IG_AOI_WS_52
AOI.Wetlands-Swamp	OverSamp	WS-335	557177.9	5485564.6	53	IG_AOI_WS_53
AOI.Wetlands-Swamp	OverSamp	WS-314	556045.1	5486101.5	54	IG_AOI_WS_54
AOI.Wetlands-Swamp	OverSamp	WS-469	559873.6	5488530.4	55	IG_AOI_WS_55
AOI.Wetlands-Swamp	OverSamp	WS-485	557425.2	5486260.4	56	IG_AOI_WS_56
AOI.Wetlands-Swamp	OverSamp	WS-269	556024.0	5484264.9	57	IG_AOI_WS_57
AOI.Wetlands-Swamp	OverSamp	WS-350	559991.8	5487638.0	58	IG_AOI_WS_58
AOI.Wetlands-Swamp	OverSamp	WS-327	559219.5	5485301.0	59	IG_AOI_WS_59
AOI.Wetlands-Swamp	OverSamp	WS-315	555585.4	5485961.1	60	IG_AOI_WS_60
AOI.Wetlands-Swamp	OverSamp	WS-487	555976.8	5486860.1	61	IG_AOI_WS_61
AOI.Wetlands-Swamp	OverSamp	WS-265	558400.0	5484526.7	62	IG_AOI_WS_62
AOI.Wetlands-Swamp	OverSamp	WS-323	555165.6	5484346.4	63	IG_AOI_WS_63
AOI.Wetlands-Swamp	OverSamp	WS-504	559909.7	5487112.0	64	IG_AOI_WS_64
AOI.Wetlands-Swamp	OverSamp	WS-277	557993.7	5484393.8	65	IG_AOI_WS_65
AOI.Wetlands-Swamp	OverSamp	WS-482	558261.0	5486742.3	66	IG_AOI_WS_66
AOI.Wetlands-Swamp	OverSamp	WS-308	558509.6	5486102.5	67	IG_AOI_WS_67
AOI.Wetlands-Swamp	OverSamp	WS-281	555863.0	5482960.2	68	IG_AOI_WS_68
XAOI.Lakes-0	PanelOne	555482030	556638.0	5490375.9	1	IG_XAOI_LK_1
XAOI.Lakes-0	PanelOne	555480543	550696.2	5484986.0	2	IG_XAOI_LK_2
XAOI.Lakes-0	PanelOne	555481198	553225.3	5488999.5	3	IG_XAOI_LK_3
XAOI.Lakes-0	PanelOne	555480596	550219.3	5485469.4	4	IG_XAOI_LK_4
XAOI.Lakes-0	PanelOne	555482065	553282.9	5487519.8	5	IG_XAOI_LK_5
XAOI.Lakes-0	PanelOne	555480826	550768.4	5486752.8	6	IG_XAOI_LK_6
XAOI.Lakes-0	PanelOne	555481652	552847.2	5491640.3	7	IG_XAOI_LK_7
XAOI.Lakes-0	PanelOne	555480133	551345.0	5480328.3	8	IG_XAOI_LK_8
XAOI.Lakes-0	PanelOne	555480867	551884.1	5487118.2	9	IG_XAOI_LK_9
XAOI.Lakes-0	PanelOne	555480092	553531.6	5479302.8	10	IG_XAOI_LK_10
XAOI.Lakes-0	PanelOne	555480114	551272.8	5479835.8	11	IG_XAOI_LK_11
XAOI.Lakes-0	OverSamp	555480810	550669.3	5486701.1	12	IG_XAOI_LK_12

SampleType	panel	POLYID	x	y	GRTSOrder	StationID
XAOI.Lakes-0	OverSamp	555480005	552278.5	5477215.9	13	IG_XAOI_LK_13
XAOI.Lakes-0	OverSamp	555482021	552296.0	5486434.3	14	IG_XAOI_LK_14
XAOI.Lakes-0	OverSamp	555480128	551377.5	5480201.8	15	IG_XAOI_LK_15
XAOI.Lakes-0	OverSamp	555480117	551241.3	5480002.2	16	IG_XAOI_LK_16
XAOI.Lakes-0	OverSamp	555482048	556540.2	5488577.1	17	IG_XAOI_LK_17
XAOI.Lakes-0	OverSamp	555482101	549924.4	5491058.7	18	IG_XAOI_LK_18
XAOI.Lakes-0	OverSamp	555481064	553416.5	5488297.9	19	IG_XAOI_LK_19
XAOI.Lakes-0	OverSamp	555481810	552527.4	5489084.2	20	IG_XAOI_LK_20
XAOI.Lakes-0	OverSamp	555480085	553584.1	5479241.4	21	IG_XAOI_LK_21
XAOI.Lakes-0	OverSamp	555480095	553463.8	5479375.7	22	IG_XAOI_LK_22
XAOI.Lakes-0	OverSamp	555481338	552600.4	5489739.7	23	IG_XAOI_LK_23
XAOI.Lakes-1	PanelOne	555481343	552376.4	5489779.2	1	IG_XAOI_LK_1
XAOI.Lakes-1	PanelOne	555480210	553175.3	5481588.3	2	IG_XAOI_LK_2
XAOI.Lakes-1	PanelOne	555481334	550798.7	5489715.0	3	IG_XAOI_LK_3
XAOI.Lakes-1	PanelOne	555480071	551851.7	5478718.6	4	IG_XAOI_LK_4
XAOI.Lakes-1	PanelOne	555480490	560214.4	5484605.2	5	IG_XAOI_LK_5
XAOI.Lakes-1	PanelOne	555480496	550640.9	5484656.4	6	IG_XAOI_LK_6
XAOI.Lakes-1	OverSamp	555480027	552552.4	5477704.3	7	IG_XAOI_LK_7
XAOI.Lakes-1	OverSamp	555480753	548705.0	5486080.7	8	IG_XAOI_LK_8
XAOI.Lakes-1	OverSamp	555481483	559505.2	5490169.9	9	IG_XAOI_LK_9
XAOI.Lakes-1	OverSamp	555480796	560050.8	5486334.2	10	IG_XAOI_LK_10
XAOI.Lakes-1	OverSamp	555481183	552157.6	5481166.4	11	IG_XAOI_LK_11
XAOI.streams	PanelOne	S5-043	549186.6	5489432.9	1	IG_XAOI_ST_1
XAOI.streams	PanelOne	S5-055	551507.4	5482809.2	2	IG_XAOI_ST_2
XAOI.streams	PanelOne	S2-199	556689.6	5490471.1	3	IG_XAOI_ST_3
XAOI.streams	PanelOne	S2-077	553845.4	5486643.5	4	IG_XAOI_ST_4
XAOI.streams	PanelOne	S5-103	548733.4	5490561.6	5	IG_XAOI_ST_5
XAOI.streams	PanelOne	S4-023	553868.1	5482200.6	6	IG_XAOI_ST_6
XAOI.streams	PanelOne	S4-070	554278.2	5490427.0	7	IG_XAOI_ST_7
XAOI.streams	PanelOne	S2-077	553584.8	5486237.7	8	IG_XAOI_ST_8
XAOI.streams	PanelOne	S2-162	549220.3	5485935.3	9	IG_XAOI_ST_9
XAOI.streams	PanelOne	S2-087	557626.1	5490456.8	10	IG_XAOI_ST_10
XAOI.streams	PanelOne	S2-006	553572.4	5488601.7	11	IG_XAOI_ST_11
XAOI.streams	PanelOne	S5-045	550992.5	5485868.1	12	IG_XAOI_ST_12
XAOI.streams	PanelOne	S5-103	549112.1	5490949.7	13	IG_XAOI_ST_13
XAOI.streams	PanelOne	S3-084	556402.7	5490103.4	14	IG_XAOI_ST_14
XAOI.streams	PanelOne	S5-102	551208.5	5490429.3	15	IG_XAOI_ST_15
XAOI.streams	PanelOne	S5-052	550200.3	5486951.7	16	IG_XAOI_ST_16
XAOI.streams	PanelOne	S5-043	549208.2	5488358.7	17	IG_XAOI_ST_17
XAOI.streams	PanelOne	S4-069	560726.6	5487772.2	18	IG_XAOI_ST_18
XAOI.streams	PanelOne	S2-166	554654.0	5487114.1	19	IG_XAOI_ST_19
XAOI.streams	PanelOne	S5-055	553310.1	5485476.9	20	IG_XAOI_ST_20

SampleType	panel	POLYID	x	y	GRTSOrder	StationID
XAOI.streams	OverSamp	S4-017	553342.8	5482984.2	21	IG_XAOI_ST_21
XAOI.streams	OverSamp	S4-072	556162.5	5489623.9	22	IG_XAOI_ST_22
XAOI.streams	OverSamp	S5-102	550736.9	5490566.5	23	IG_XAOI_ST_23
XAOI.streams	OverSamp	S5-100	552922.8	5491217.3	24	IG_XAOI_ST_24
XAOI.streams	OverSamp	S5-037	548386.6	5489774.5	25	IG_XAOI_ST_25
XAOI.streams	OverSamp	S4-023	555095.6	5482603.9	26	IG_XAOI_ST_26
XAOI.streams	OverSamp	S4-070	555547.3	5490435.2	27	IG_XAOI_ST_27
XAOI.streams	OverSamp	S2-195	551237.4	5485033.9	28	IG_XAOI_ST_28
XAOI.streams	OverSamp	S5-102	549844.9	5490960.4	29	IG_XAOI_ST_29
XAOI.streams	OverSamp	S2-093	560294.8	5484624.2	30	IG_XAOI_ST_30
XAOI.streams	OverSamp	S5-100	552323.2	5490474.0	31	IG_XAOI_ST_31
XAOI.streams	OverSamp	S3-193	550339.3	5485487.6	32	IG_XAOI_ST_32
XAOI.streams	OverSamp	S5-053	549559.4	5487610.6	33	IG_XAOI_ST_33
XAOI.streams	OverSamp	S2-086	558768.4	5490446.1	34	IG_XAOI_ST_34
XAOI.streams	OverSamp	S2-006	553154.2	5487825.8	35	IG_XAOI_ST_35
XAOI.streams	OverSamp	S5-055	552162.0	5483909.9	36	IG_XAOI_ST_36
XAOI.streams	OverSamp	S4-017	552494.0	5482834.1	37	IG_XAOI_ST_37
XAOI.streams	OverSamp	S4-071	556676.1	5489508.3	38	IG_XAOI_ST_38
XAOI.streams	OverSamp	S2-004	551695.0	5489178.1	39	IG_XAOI_ST_39
XAOI.streams	OverSamp	S5-100	552891.9	5491224.1	40	IG_XAOI_ST_40
XAOI.Wetlands-Marsh	PanelOne	WM-196	552895.8	5491057.8	1	IG_XAOI_WM_1
XAOI.Wetlands-Marsh	PanelOne	WM-199	550736.4	5489639.2	2	IG_XAOI_WM_2
XAOI.Wetlands-Marsh	PanelOne	WM-179	552254.8	5486291.6	3	IG_XAOI_WM_3
XAOI.Wetlands-Marsh	PanelOne	WM-161	551124.5	5479326.6	4	IG_XAOI_WM_4
XAOI.Wetlands-Marsh	PanelOne	WM-175	553255.9	5485414.9	5	IG_XAOI_WM_5
XAOI.Wetlands-Marsh	PanelOne	WM-160	550595.2	5480579.9	6	IG_XAOI_WM_6
XAOI.Wetlands-Marsh	PanelOne	WM-184	551422.7	5486895.9	7	IG_XAOI_WM_7
XAOI.Wetlands-Marsh	PanelOne	WM-197	558130.1	5490471.7	8	IG_XAOI_WM_8
XAOI.Wetlands-Marsh	OverSamp	WM-170	553181.9	5481584.2	9	IG_XAOI_WM_9
XAOI.Wetlands-Marsh	OverSamp	WM-158	553774.2	5479116.7	10	IG_XAOI_WM_10
XAOI.Wetlands-Marsh	OverSamp	WM-186	550988.3	5488034.3	11	IG_XAOI_WM_11
XAOI.Wetlands-Marsh	OverSamp	WM-192	553328.8	5487563.6	12	IG_XAOI_WM_12
XAOI.Wetlands-Marsh	OverSamp	WM-182	548581.1	5486633.4	13	IG_XAOI_WM_13
XAOI.Wetlands-Marsh	OverSamp	WM-165	559681.5	5484578.3	14	IG_XAOI_WM_14
XAOI.Wetlands-Peatlands	PanelOne	WP-120	559193.4	5489322.5	1	IG_XAOI_WP_1
XAOI.Wetlands-Peatlands	PanelOne	WP-079	559832.2	5483157.2	2	IG_XAOI_WP_2
XAOI.Wetlands-Peatlands	PanelOne	WP-057	552193.0	5484676.3	3	IG_XAOI_WP_3
XAOI.Wetlands-Peatlands	PanelOne	WP-091	560037.2	5486336.3	4	IG_XAOI_WP_4
XAOI.Wetlands-Peatlands	PanelOne	WP-022	553774.5	5481031.3	5	IG_XAOI_WP_5
XAOI.Wetlands-Peatlands	PanelOne	WP-099	556547.4	5488565.9	6	IG_XAOI_WP_6
XAOI.Wetlands-Peatlands	PanelOne	WP-097	554077.8	5488275.3	7	IG_XAOI_WP_7
XAOI.Wetlands-Peatlands	PanelOne	WP-082	556959.4	5483230.3	8	IG_XAOI_WP_8

SampleType	panel	POLYID	x	y	GRTSOrder	StationID
XAOI.Wetlands-Peatlands	PanelOne	WP-090	548719.1	5486302.1	9	IG_XAOI_WP_9
XAOI.Wetlands-Peatlands	PanelOne	WP-125	561122.7	5490363.8	10	IG_XAOI_WP_10
XAOI.Wetlands-Peatlands	PanelOne	WP-001	552296.0	5476923.3	11	IG_XAOI_WP_11
XAOI.Wetlands-Peatlands	PanelOne	WP-088	551756.7	5482978.0	12	IG_XAOI_WP_12
XAOI.Wetlands-Peatlands	PanelOne	WP-010	551808.7	5478931.6	13	IG_XAOI_WP_13
XAOI.Wetlands-Peatlands	OverSamp	WP-105	560327.0	5486568.0	14	IG_XAOI_WP_14
XAOI.Wetlands-Peatlands	OverSamp	WP-051	561178.2	5484619.5	15	IG_XAOI_WP_15
XAOI.Wetlands-Peatlands	OverSamp	WP-130	554099.4	5489627.8	16	IG_XAOI_WP_16
XAOI.Wetlands-Peatlands	OverSamp	WP-028	560133.9	5482366.8	17	IG_XAOI_WP_17
XAOI.Wetlands-Peatlands	OverSamp	WP-015	553269.4	5479517.4	18	IG_XAOI_WP_18
XAOI.Wetlands-Peatlands	OverSamp	WP-127	559342.8	5490525.7	19	IG_XAOI_WP_19
XAOI.Wetlands-Peatlands	OverSamp	WP-135	555556.6	5488394.7	20	IG_XAOI_WP_20
XAOI.Wetlands-Peatlands	OverSamp	WP-013	551400.9	5480201.3	21	IG_XAOI_WP_21
XAOI.Wetlands-Peatlands	OverSamp	WP-083	556807.3	5483181.5	22	IG_XAOI_WP_22
XAOI.Wetlands-Peatlands	OverSamp	WP-129	560141.1	5490345.1	23	IG_XAOI_WP_23
XAOI.Wetlands-Peatlands	OverSamp	WP-002	552261.8	5477136.5	24	IG_XAOI_WP_24
XAOI.Wetlands-Peatlands	OverSamp	WP-136	553342.9	5488111.3	25	IG_XAOI_WP_25
XAOI.Wetlands-Peatlands	OverSamp	WP-025	557413.9	5481435.9	26	IG_XAOI_WP_26
XAOI.Wetlands-Peatlands	OverSamp	WP-128	560753.9	5489227.5	27	IG_XAOI_WP_27
XAOI.Wetlands-Peatlands	OverSamp	WP-017	551747.8	5478268.2	28	IG_XAOI_WP_28
XAOI.Wetlands-Peatlands	OverSamp	WP-148	550751.8	5485811.4	29	IG_XAOI_WP_29
XAOI.Wetlands-Swamp	PanelOne	WS-263	561923.5	5485088.1	1	IG_XAOI_WS_1
XAOI.Wetlands-Swamp	PanelOne	WS-313	551829.4	5485903.2	2	IG_XAOI_WS_2
XAOI.Wetlands-Swamp	PanelOne	WS-283	553924.4	5482320.9	3	IG_XAOI_WS_3
XAOI.Wetlands-Swamp	PanelOne	WS-374	557172.8	5490007.1	4	IG_XAOI_WS_4
XAOI.Wetlands-Swamp	PanelOne	WS-448	560647.5	5487878.5	5	IG_XAOI_WS_5
XAOI.Wetlands-Swamp	PanelOne	WS-456	549891.0	5488127.0	6	IG_XAOI_WS_6
XAOI.Wetlands-Swamp	PanelOne	WS-214	554323.0	5478360.3	7	IG_XAOI_WS_7
XAOI.Wetlands-Swamp	PanelOne	WS-237	552772.6	5482450.2	8	IG_XAOI_WS_8
XAOI.Wetlands-Swamp	PanelOne	WS-212	552512.6	5478160.3	9	IG_XAOI_WS_9
XAOI.Wetlands-Swamp	PanelOne	WS-282	558456.8	5483125.2	10	IG_XAOI_WS_10
XAOI.Wetlands-Swamp	PanelOne	WS-384	548719.6	5490426.5	11	IG_XAOI_WS_11
XAOI.Wetlands-Swamp	PanelOne	WS-426	554277.9	5490200.9	12	IG_XAOI_WS_12
XAOI.Wetlands-Swamp	PanelOne	WS-341	561267.9	5487509.4	13	IG_XAOI_WS_13
XAOI.Wetlands-Swamp	PanelOne	WS-406	557681.2	5491427.3	14	IG_XAOI_WS_14
XAOI.Wetlands-Swamp	PanelOne	WS-285	559732.8	5483356.2	15	IG_XAOI_WS_15
XAOI.Wetlands-Swamp	PanelOne	WS-250	552935.1	5482046.6	16	IG_XAOI_WS_16
XAOI.Wetlands-Swamp	PanelOne	WS-411	553119.7	5491051.2	17	IG_XAOI_WS_17
XAOI.Wetlands-Swamp	PanelOne	WS-220	552744.4	5477797.2	18	IG_XAOI_WS_18
XAOI.Wetlands-Swamp	PanelOne	WS-501	553022.1	5487075.8	19	IG_XAOI_WS_19
XAOI.Wetlands-Swamp	PanelOne	WS-262	550646.9	5484384.7	20	IG_XAOI_WS_20
XAOI.Wetlands-Swamp	PanelOne	WS-395	550652.9	5490807.2	21	IG_XAOI_WS_21

SampleType	panel	POLYID	x	y	GRTSOrder	StationID
XAOI.Wetlands-Swamp	PanelOne	WS-414	549199.3	5489658.9	22	IG_XAOI_WS_22
XAOI.Wetlands-Swamp	PanelOne	WS-329	560202.0	5485588.4	23	IG_XAOI_WS_23
XAOI.Wetlands-Swamp	PanelOne	WS-439	558177.8	5489783.2	24	IG_XAOI_WS_24
XAOI.Wetlands-Swamp	PanelOne	WS-379	554865.2	5490256.2	25	IG_XAOI_WS_25
XAOI.Wetlands-Swamp	PanelOne	WS-236	559106.3	5482427.9	26	IG_XAOI_WS_26
XAOI.Wetlands-Swamp	PanelOne	WS-357	560119.5	5489125.1	27	IG_XAOI_WS_27
XAOI.Wetlands-Swamp	PanelOne	WS-267	561072.8	5484718.6	28	IG_XAOI_WS_28
XAOI.Wetlands-Swamp	PanelOne	WS-249	550544.1	5481983.9	29	IG_XAOI_WS_29
XAOI.Wetlands-Swamp	PanelOne	WS-470	553215.7	5489005.5	30	IG_XAOI_WS_30
XAOI.Wetlands-Swamp	PanelOne	WS-224	551660.9	5480468.9	31	IG_XAOI_WS_31
XAOI.Wetlands-Swamp	PanelOne	WS-344	552445.9	5487384.0	32	IG_XAOI_WS_32
XAOI.Wetlands-Swamp	PanelOne	WS-421	556681.1	5489482.4	33	IG_XAOI_WS_33
XAOI.Wetlands-Swamp	PanelOne	WS-495	560079.1	5486903.1	34	IG_XAOI_WS_34
XAOI.Wetlands-Swamp	PanelOne	WS-234	553575.3	5479231.1	35	IG_XAOI_WS_35
XAOI.Wetlands-Swamp	PanelOne	WS-273	559958.4	5484132.7	36	IG_XAOI_WS_36
XAOI.Wetlands-Swamp	PanelOne	WS-500	553511.6	5487181.3	37	IG_XAOI_WS_37
XAOI.Wetlands-Swamp	PanelOne	WS-292	557753.0	5483739.0	38	IG_XAOI_WS_38
XAOI.Wetlands-Swamp	PanelOne	WS-427	551592.2	5489035.6	39	IG_XAOI_WS_39
XAOI.Wetlands-Swamp	OverSamp	WS-321	550610.7	5485112.3	40	IG_XAOI_WS_40
XAOI.Wetlands-Swamp	OverSamp	WS-254	556677.5	5482344.5	41	IG_XAOI_WS_41
XAOI.Wetlands-Swamp	OverSamp	WS-441	556121.9	5489797.3	42	IG_XAOI_WS_42
XAOI.Wetlands-Swamp	OverSamp	WS-355	548939.3	5488649.3	43	IG_XAOI_WS_43
XAOI.Wetlands-Swamp	OverSamp	WS-302	552881.2	5486208.6	44	IG_XAOI_WS_44
XAOI.Wetlands-Swamp	OverSamp	WS-240	554798.9	5482537.7	45	IG_XAOI_WS_45
XAOI.Wetlands-Swamp	OverSamp	WS-381	554441.1	5490378.9	46	IG_XAOI_WS_46
XAOI.Wetlands-Swamp	OverSamp	WS-408	549912.8	5490972.1	47	IG_XAOI_WS_47
XAOI.Wetlands-Swamp	OverSamp	WS-211	552633.4	5477242.5	48	IG_XAOI_WS_48
XAOI.Wetlands-Swamp	OverSamp	WS-473	560926.0	5486647.3	49	IG_XAOI_WS_49
XAOI.Wetlands-Swamp	OverSamp	WS-334	552330.9	5485499.6	50	IG_XAOI_WS_50
XAOI.Wetlands-Swamp	OverSamp	WS-417	557899.8	5489383.6	51	IG_XAOI_WS_51
XAOI.Wetlands-Swamp	OverSamp	WS-256	552507.8	5483806.9	52	IG_XAOI_WS_52
XAOI.Wetlands-Swamp	OverSamp	WS-418	552427.6	5489722.6	53	IG_XAOI_WS_53
XAOI.Wetlands-Swamp	OverSamp	WS-361	560723.1	5488749.4	54	IG_XAOI_WS_54
XAOI.Wetlands-Swamp	OverSamp	WS-343	550508.2	5487430.5	55	IG_XAOI_WS_55
XAOI.Wetlands-Swamp	OverSamp	WS-399	557706.5	5490461.4	56	IG_XAOI_WS_56
XAOI.Wetlands-Swamp	OverSamp	WS-291	558377.1	5483595.6	57	IG_XAOI_WS_57
XAOI.Wetlands-Swamp	OverSamp	WS-243	552915.6	5482790.9	58	IG_XAOI_WS_58
XAOI.Wetlands-Swamp	OverSamp	WS-396	552585.6	5490667.3	59	IG_XAOI_WS_59
XAOI.Wetlands-Swamp	OverSamp	WS-353	548380.6	5488913.3	60	IG_XAOI_WS_60
XAOI.Wetlands-Swamp	OverSamp	WS-493	560752.9	5487369.7	61	IG_XAOI_WS_61
XAOI.Wetlands-Swamp	OverSamp	WS-221	550690.0	5479643.4	62	IG_XAOI_WS_62
XAOI.Wetlands-Swamp	OverSamp	WS-272	559142.5	5484204.7	63	IG_XAOI_WS_63

SampleType	panel	POLYID	x	y	GRTSOrder	StationID
XAOI.Wetlands-Swamp	OverSamp	WS-255	551005.8	5483829.7	64	IG_XAOI_WS_64
XAOI.Wetlands-Swamp	OverSamp	WS-372	550281.0	5490037.7	65	IG_XAOI_WS_65
XAOI.Wetlands-Swamp	OverSamp	WS-375	548407.9	5490056.6	66	IG_XAOI_WS_66
XAOI.Wetlands-Swamp	OverSamp	WS-460	560293.3	5488338.7	67	IG_XAOI_WS_67
XAOI.Wetlands-Swamp	OverSamp	WS-437	559597.6	5489761.9	68	IG_XAOI_WS_68
XAOI.Wetlands-Swamp	OverSamp	WS-407	553950.6	5491030.7	69	IG_XAOI_WS_69
XAOI.Wetlands-Swamp	OverSamp	WS-264	560485.5	5484655.2	70	IG_XAOI_WS_70
XAOI.Wetlands-Swamp	OverSamp	WS-454	555284.5	5488102.3	71	IG_XAOI_WS_71
XAOI.Wetlands-Swamp	OverSamp	WS-422	556243.9	5489549.8	72	IG_XAOI_WS_72
XAOI.Wetlands-Swamp	OverSamp	WS-475	548175.8	5486307.2	73	IG_XAOI_WS_73
XAOI.Wetlands-Swamp	OverSamp	WS-295	553526.8	5486055.1	74	IG_XAOI_WS_74
XAOI.Wetlands-Swamp	OverSamp	WS-251	556166.5	5481931.7	75	IG_XAOI_WS_75
XAOI.Wetlands-Swamp	OverSamp	WS-402	557334.0	5490727.4	76	IG_XAOI_WS_76
XAOI.Wetlands-Swamp	OverSamp	WS-452	549240.8	5488283.8	77	IG_XAOI_WS_77

APPENDIX B – eDNA FIELD DATA FORM

(see next page – formatted for printing)

GENERAL SITE INFORMATION					
	Date (dd-mm-yyyy) ____		Time (24-hr) ____		
Station ID ____		Replicate no. ____		Polygon ID ____	
Location:	UTM easting ____	UTM northing ____		Zone ____	
Survey crew:	eDNA collector ____	enviro data & recorder ____			
ENVIRONMENTAL CONDITIONS					
Weather:	cloud cover (%) ____	air temp. (°C) ____		canopy cover (%) ____	
	current precip. (0-6) ____	past 24-hr rain (mm) ____		*(note met. station used)*	
Water quality:	water temp. (°C) ____	dissolved O_2 (mg/L) ____		pH ____	
	conductivity (ms/cm) ____	turbidity (NTU) ____			
Stream flow:	discharge (m^3/s) / velocity (m/s) / qualitative *(circle one, enter value)* ____				
Site characteristics (wetland type, vegetation and other cover, substrate, adjacent habitats, beaver activity, human use, etc.):					
Incidental wildlife and fish observations:					
Geotagged photo no. (site/habitat, incidentals):					
SAMPLING CONDITIONS					
Method ____		Filter type ____		Filter pore size (µm) ____	
	Pre-filter used? Y / N	If used, pre-filter pore size (µm) ____			
Inputs:	sample vol. (L) ____	pump pressure (kPa) ____			
Outputs:	total vol. pumped (L) ____	avg flow rate (L/min) ____		runtime (min) ____	
Storage:	filter preservative ____	time at collection/completion (T_1) ____			
	time at refrigeration (T_2) ____	elapsed time (T_2-T_1) ____			
Comments (e.g., filtering difficulties), protocol modifications:					
Geotagged photo no. (sample filter):					
Date entered (dd-mm-yyyy):		Entered by:		Review needed?	Y / N
Date QA/QC'd (dd-mm-yyyy):		QA/QC by:			

Work Instruction (Rev.0)

File Name: NWMO_BIS_2021_Incidentals WI_IG (R000)

THE NWMO BIODIVERSITY IMPACT STUDIES: WORK INSTRUCTION FOR INCIDENTAL WILDLIFE AND PLANT OBSERVATIONS – NORTHWESTERN ONTARIO SITE

June 7, 2021

PREPARED BY Zoetica Environmental Consulting Services

SUBMITTED TO Melissa Mayhew
Nuclear Waste Management Organization
22 St. Clair Avenue East
Sixth Floor, Toronto, ON
M4T 2S3, Canada

OFFICE 102-22351 St Anne Ave, Maple Ridge, BC, V2X 2E7
PHONE 604 467 1111
WEBSITE www.zoeticaenvironmental.com

Revision History

Project Title: NWMO Biodiversity Impact Studies

Document Title: Work Instruction for Incidental Wildlife and Plant Observations – Northwestern Ontario Site

Document File Name: NWMO_BIS_2021_Incidentals WI_IG (R000)

Rev. #	Issue Date	Description	Prepared By	Reviewed By	Approved By
R000	07-Jun-2021	First submission to NWMO	C. Chui	A. Buckman	H. Bears

Table of Contents

GLOSSARY OF TERMS

BIS	Biodiversity Impact Studies
BPPA	Best Practices and Preferred Approaches (report)
CWD	Coarse Woody Debris
GPS	Global Positioning System
HSM	Habitat Suitability Modelling
NWMO	Nuclear Waste Management Organization
QA	Quality Assurance
QC	Quality Control
SOP	Standard Operating Procedure
SWH	Significant Wildlife Habitat
TEM	Terrestrial Ecosystem Mapping
UTM	Universal Transverse Mercator

1.0 INCIDENTAL BIODIVERSITY OBSERVATIONS

1.1 Field Procedure

1. Incidental observations are recorded for biodiversity species of interest (e.g., at-risk, rare, and culturally important species; selected species for the Wildlife Habitat Assessment/Habitat Suitability Modelling outside of the survey), using ***Incidental Observation Form (Wildlife)*** or ***Incidental Observation Form (Vegetation)***.
2. Incidental observations can be made anytime during the field campaign, including inside and outside the survey plot, during travel to and from the survey plot/area (by ground, air, water), and around camp. Incidental observations can be made by any member of the field crew.
3. As some of the selected species for Wildlife Habitat Assessment are fairly common in northwestern Ontario (e.g., moose, black bear, snowshoe hare), documentation for these species can focus on sign that indicates frequent or intensive use of the habitat, such as large and numerous piles of scat, well-worn trails, extensive defoliation of forage plants, etc. Carcasses or other remains should also be noted and the cause(s) of mortality described, if possible.
4. At-risk, rare, and culturally species should always be recorded when observed. These species are listed in the BPPA Report for the BIS.
5. Potential indicators of SWH (see Appendix D in the TEM/HSM/SWH SOP) and other important wildlife habitat features should be recorded. For example, record observations of nests, dens, hibernacula, seeps and springs, mineral licks, and large aggregations of animals.
6. For each observation, record the date, time, observer name, and general weather conditions.
7. Where possible, take a GPS waypoint and record the waypoint number and coordinates (UTM, NAD83) on the form. If the observation is made from a distance, UTM corrections can be noted in the Comments field (e.g., “sighted 200 m north of X,Y”).
8. Observation effort should be recorded either as time spent searching (in minutes), or “in transit” to indicate no set amount of effort. A concentrated effort to track animals or to look for plants or wildlife sign may not be possible due to time constraints; however, if an active search is conducted, use a stopwatch (or equivalent) and enable tracking on the GPS unit. This will assist with future analyses of survey effort (time and area).
9. Record the species observed. If an animal/plant or sign cannot be confidently identified to the species level, record the lowest taxonomic level possible. Photographs can be used for later review and species identification (see step 13). If the observation is a potential SWH and not a specific species, the SWH type should be indicated in the Species field and further described in the Habitat and/or Comments fields.
10. For direct wildlife observations, record the number of individuals and the sex and age of each individual, where possible. Note the animal’s activity/behaviour. If wildlife sign was observed, record the type, age, and relative amount/general prevalence of sign.
11. For vegetation observations, record the number of individuals (or general prevalence) and growth stage.
12. Record the surrounding habitat characteristics and potentially important habitat or landscape features that may support the species of interest, as well as natural or human disturbances.
13. Take georeferenced photos of the incidental observation and record photo numbers in the Comments/Associated Material field. If the species or other information could not be confidently

identified in the field, but could be distinguished through the photos, note in the Req Review box that later review/editing is needed.

14. If tissue samples are collected for later identification (e.g., not-at-risk plants, hair samples), label the sample bags with a unique identifier (e.g., with date/time, observer initials, sample ID, and "Incidental") to distinguish from any samples collected as part of the Vegetation Survey (Full Plot). Record the sample ID in the Comments/Associated Material field.

1.2 Field Form

(see next page)

Incidental Observations Form (Wildlife)												
Date/ Time	Observer	Waypoint & UTM	Weather	Obs. Effort	Species	Num Indiv. & Age/Sex	Activity/ Behav.	Type of Sign	Age & Amount of Sign	Surrounding Habitat	Comments/ Associated Material	Req Review
1	2	3	4	5	6	7a	8a	9	10	11	12	13
Review needed:			Date entered into spreadsheet:					Entered by:			QA/QC by:	14

Incidental Observations Form (Vegetation)										
Date/ Time	Observer	Waypoint & UTM	Weather	Obs. Effort	Species	Num Indiv./ Prevalence	Growth Stage	Surrounding Habitat	Comments/ Associated Material	Req Review
1	2	3	4	5	6	7b	8b	11	12	13
Review needed:			Date entered into spreadsheet:				Entered by:		QA/QC by:	14

1.3 Completing the Form

Field Label	Description and Instructions
1	Enter the **date** in DD-MM-YY format (e.g., 01-01-20 for January 1st, 2020) and **time** in 24-hr clock.
2	Enter the **observer** first initial and last name.
3	Enter the **GPS waypoint** and **UTM coordinates** and note any UTM corrections in the Comments.
4	Record general **weather** conditions at the time of observation (e.g., "sunny, calm, warm" or "overcast, light rain, windy, cool").
5	Record the **observation effort**: time (min) actively searching, or "in transit" for passive encounter.
6	Record the **species** observed (or genus or species group). If a species code is used (e.g., 4-letter alpha codes), ensure that the codes are defined on the form and transcribed properly. If applicable, enter the type of potential/candidate SWH observed.
7a	For animal observations, record the **number of individuals** and **age/sex** for each, if possible. Enter consistently in order of "Num Age Sex". Examples: • "1 Ad. M, 1 Ad. F" = one adult male + one adult female • "1 Ad. F, 2 Juv" = one adult female + two juvenile. Bird nestlings and fledglings may also be distinguished. • "4 Subad. Unk" = four subadults of unknown sex • "2 Und. M" = two males of undetermined age
7b	For plant observations, record the **number of individuals** or **prevalence** (e.g., many, few; high/med/low density) if multiple individuals in a patch are present.
8a	For animal observations, record the **activity/behaviour** observed. Examples: feeding, nesting, vocalizing, breeding, swimming, resting, travelling, rutting, burrowing, startled, etc.
8b	For plant observations, estimate the **growth** stage (e.g., seedling, vegetative, budding, flowering, fruiting, sapling, mature tree).
9	For wildlife sign observations, record the **type of sign**. Examples: scat, whitewash, track, print, hair, carcass, nest, scraping, den, burrow, bedding site, egg(s), sound, regurgitated pellet, tree cavity, feeding sign (browsing), beaver dam/lodge, communal nest, roost site, antler, fur, feather, snake shed.
10	For wildlife sign observations, record the **age** (e.g., fresh, old, unknown) and **amount** or prevalence of sign (e.g., one, a few, many; high/med/low density).
11	Record the **surrounding habitat** characteristics, such as the general ecosystem type (e.g., coniferous/deciduous/mixed woodland, wetland type, regenerating), vegetation structure preferred species (e.g., for forage or denning), site-level features such as snags and CWD, special landforms such as cliffs and eskers, proximity to waterbody/watercourse, important plant community associations, natural or human disturbance (e.g., burns, logging, roads, trails), etc.
12	Enter additional **comments** as needed, such as UTM corrections, SWH information, photo numbers, sample/specimen IDs, etc.

13 Check off the **requires review** box if species identification or other information entered is uncertain and needs to be verified later (by the observer or another qualified person). If the entire sheet of incidental observations requires review, this can be indicated at the bottom left of the form.

14 Not to be completed in the field. Data should be entered into a spreadsheet as soon as possible, ideally completed daily. Once data are entered into the spreadsheet, fill in the date entered and who entered it. Data entry should be reviewed by a second person and any discrepancies discussed with the original surveyor. Enter the name of the QA/QC reviewer once completed.

APPENDIX A: FIELD FORMS FOR PRINTING

(see next page – formatted for printing)

Incidental Observations Form (Wildlife)

Date/ Time	Observer	Waypoint & UTM	Weather	Obs. Effort	Species	Num Indiv. & Age/Sex	Activity/ Behav.	Type of Sign	Age & Amount of Sign	Surrounding Habitat	Comments/ Associated Material	Req Review

Review needed: Date entered into spreadsheet: Entered by: QA/QC by:

Incidental Observations Form (Vegetation)										
Date/ Time	Observer	Waypoint & UTM	Weather	Obs. Effort	Species	Num Indiv./ Prevalence	Growth Stage	Surrounding Habitat	Comments/ Associated Material	Req Review
Review needed:		Date entered into spreadsheet:				Entered by:			QA/QC by:	