Appendix B.8.1

Fish and Fish Habitat Baseline Supplemental Report

Crawford Nickel Project: Fish and Fish Habitat Supplemental Baseline Report

September 30, 2024

Prepared for:
Canada Nickel Company

Prepared by:
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Project Number:
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Limitations and Sign-off

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Acronyms and Abbreviations

CALA	Canadian Association for Laboratory Accreditation
CCME	Canadian Council of Ministers of the Environment
cm	Centimetre
COSSARO	Committee on the Status of Species at Risk in Ontario
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPOM	coarse particulate organic matter
CPUE	catch per unit effort
CSQG	Canadian Sediment Quality Guidelines
dB	decibels
DFO	Fisheries and Oceans Canada
DO	dissolved oxygen
dwt	dry weight
ECCC	Environment and Climate Change Canada
eDNA	environmental DNA
EPT	Ephemeroptera, Plecotera, and Trichoptera
FEQG	Federal Environmental Quality Guidelines
FPOM	fine particulate organic matter
g	gram

GIS	Geographical Information System
GS	generating station
HEP	Habitat Evaluation Procedures
HSI	Habitat Suitability Index
HU	Habitat Unit
Hz	Hertz
IAAC	Impact Assessment Agency of Canada
ID	Identification
ISQG	interim sediment quality guidelines
kHz	Kilohertz
LEL	lowest effect level
LIO	Land Information Ontario
LSA	Local Study Area
m	Metre
ml	Millilitre
m/sec	Metres per second
Masl	metre(s) above sea level
MECP	Ontario Ministry of Environment, Conservation and Parks
mg/kg dwt	milligrams per kilogram dry weight
mg/kg wwt	milligrams per kilogram wet weight

mg/L	Milligram per litre
mm/s	millimetre/second
MNR	Ministry of Natural Resources
MNRF	Ministry of Natural Resources and Forestry
MECP	Ministry of the Environment, Conservation and Parks (formerly Ministry of Environment and Climate Change [MOE/MOECC])
MTO	Ministry of Transportation
NHIC	Natural Heritage Information Centre
OSAP	Ontario Stream Assessment Protocol
OWIT	Ontario Watershed Information Tool
PA	Project Area
PEL	probable effect level
PPV	peak particle velocity
P/R	production to respiration ratio
PSQG	Provincial Sediment Quality Guidelines
PTS	permanent threshold shift
qPCR	quantitative polymerase chain reaction
RSA	Regional Study Area
SARA	*Species at Risk Act*
SC	Special Concern

SD	standard deviation
SDI	Simpson's diversity index
SEI	Simpson's evenness index
SEL	severe effect level
TIS	Tailored Impact Statement
TTS	temporary threshold shift
µm	Micrometre
VC	Valued Component
wwt	wet weight

1 Introduction

Canada Nickel Company (Canada Nickel) proposes to develop, operate, and progressively reclaim the Crawford Nickel Project ('the Project"), a new open pit nickel mine and processing facility located approximately 42 kilometres (km) north of Timmins, Ontario. The Project is being assessed in accordance with the *Impact Assessment Act,* 2019.

Stantec Consulting Ltd. (Stantec) has been retained by Canada Nickel to assess the potential effects of the Project on various biophysical and socio-economic Valued Components (VCs), including fish and fish habitat. This Fish and Fish Habitat Supplemental Baseline Report has been completed to inform the Impact Statement. It has been prepared pursuant to the *Impact Assessment Act,* 2019 and to comply with the Tailored Impact Statement (TIS) Guidelines developed for the Crawford Nickel Project (Appendix A.1 of the Impact Statement).

The information presented in this report summarizes the existing condition of fish habitat, fish community, lower trophic community, and fish tissue contaminant burdens near the Project. The report summarizes information obtained from published literature, government databases and websites, and previous consultant reports, including results of fish and fish habitat surveys conducted for the Project by Canada Nickel (2021-2023 Fish and Fish Habitat Baseline, Appendix B.8.2 of the Impact Statement). Results of surveys conducted by Stantec in spring of 2024 are included in Appendix C of this report to supplement existing information.

1.1 Objectives

The purpose of this Fish and Fish Habitat Supplemental Baseline Report is to summarize existing information about the baseline (i.e., pre-mine) condition of fish habitat, fish community, lower trophic community, and fish tissue contamination burdens in waterbodies and watercourses near the Project so potential effects of Project components and activities on fish and fish habitat can be identified, mitigated, and assessed in accordance with the TIS Guidelines. The objectives of this Fish and Fish Habitat Supplemental Baseline Report are to:

1. Summarize publicly information regarding fish and fish habitat in streams, lakes, ponds, and rivers near the Project
2. Summarize fish and fish habitat data collected between 2021 and 2023 for the Project (2021-2023 Fish and Fish Habitat Baseline, Appendix B.8.2 of the Impact Statement)
3. Provide the information specified in Section 8.8.1 (Baseline Conditions) of the TIS Guidelines

1.2 Concordance with TIS Guidelines Requirements

To facilitate comparison of the information requirements identified in the TIS Guidelines and the information provided in this report, a concordance table has been developed (Table 1.1).

Table 1.1 Concordance Table for Fish and Fish Habitat Baseline Information Identified in the Tailored Impact Statement Guidelines for the Crawford Nickel Project

TIS Guidelines Information Requested	Section of Report that Information is Provided
Prepare a list of all waterbodies and watercourses (permanent and intermittent) that may be directly or indirectly affected by the Project and provide: • Type of waterbody or watercourse • Size and depth of the waterbody or watercourse • Streamflow types, Strahler stream order and streamflow characteristics • Substrate type, emergent and submerged aquatic vegetation type and presence of barriers to fish	Section 4.2, Appendix A and Appendix B of this report Appendix B.8.2 of the Impact Statement
For each potentially affected waterbody or watercourse that has the potential to be frequented by fish, provide the location and area of potential and confirmed fish habitat and a detailed assessment of physical and biological habitat characteristics. Present information as maps using recent satellite imagery overlaid with relevant information and text description, with associated summary tables. Relevant physical and biological habitat characteristics for fish habitat include: • Surface and groundwater characteristics in Section 8.6.1 of TIS Guidelines • Baseline extent of habitat disturbance (e.g., fragmentation) • Habitat use or suitability for fish and aquatic species present, including lake sturgeon and species identified by Indigenous Peoples • Habitat function (e.g., spawning, nursery, growth, prey, invertebrate population, food availability, foraging, migration, cover habitat, thermal and overwintering habitat) and sensitive times for these activities • Description of any proposed in-water work; and • For all crossings, describe the anticipated construction method of crossing; • Substrate type, aquatic vegetation, riparian vegetation, bank stability, light penetration, presence of woody debris, presence of beaver dams, stream segment type (riffle, run, pool) and Strahler stream order, natural or anthropogenic barriers to fish passage, and geomorphological features and processes.	Section 4.2, Appendix A and Appendix B of this report Appendix B.8.2 of the Impact Statement

TIS Guidelines Information Requested	Section of Report that Information is Provided
For each potentially affected waterbody or watercourse, provide a detailed description of potentially affected fish species and populations (as defined in subsection 2(1) of the Fisheries Act) within the freshwater environment. Where data is used to generate biodiversity metrics (e.g., abundance, richness, diversity, density), provide rationale on the choice of metrics based on their applicability for use in the effects assessment and associated follow-up, if applicable	Sections 4.1, 4.2.5, 4.6, 4.7 Appendix B.8.2 of the Impact Statement
Describe parameters and ecological processes relevant to predict effects on fish and aquatic species present. For example, it may be necessary to establish a broader ecological baseline if the Project affects a spawning area for a migratory species but does not affect the larger area they depend on for life processes. Relevant parameters and ecological processes may include: migratory patterns, food webs, and trophic levels, structural and functional linkages (e.g., predator-prey interactions), life history and population dynamics, sensitive habitat and periods, behavior or other relevant ecological processes that fish depend on to carry out their life history. Use either a qualitative or quantitative approach to characterize ecological processes, as appropriate, and include a rationale to support the selected approach	Section 4.10
Provide a list of aquatic species at risk likely to be present, and provide the location and description of suitable or potential habitat for these species in or near the Project area, including lake sturgeon in both the Mattagami River watershed and North Driftwood River	Section 4.4.1 - 4.4.3, Appendix C of this report
Provide current and historical distribution for lake sturgeon in the Mattagami River and North Driftwood River including: • Confirming presence or absence in any lower stretches of the North Driftwood River that may be affected by the project • Taking into account annual variation in the location of potential suitable sturgeon spawning habitat in the Mattagami River, as influenced by flow management at Lower Sturgeon Dam upstream and headpond management at Yellow Falls Dam downstream	Section 4.4.4
Identify and describe the data sources used, including information on data collection (e.g., gear and catch methods, location of sampling sites, date of catches, date of surveys, species surveyed, size and life cycle stage, catch-per-unit-effort). It is recommended that the information be presented in the form of maps and tables	Sections 3, Appendix A of this report Appendix B.8.2 of the Impact Statement
Provide baseline measurements of contaminants in fish and aquatic species	Section 4.8, Appendix B.8.2 of the Impact Statement

TIS Guidelines Information Requested	Section of Report that Information is Provided
Describe the use of fish as country foods or for other traditional purposes, including a description of the particular species of importance including lake sturgeon, and species identified as important by Indigenous Peoples and whether its consumption has cultural importance for Indigenous Peoples, including medicinal use. All sites used in the LSA or historically important sites for the collection of country foods must be identified and mapped	Section 4.9, Appendix A of this report
Provide a summary of existing studies and research on potential effects of noise and vibrations resulting from blasting (above ground and underground) and seismic activity on potentially affected aquatic species including lake sturgeon and behavior impacts in the freshwater environment from all species at different life stages	Section 4.11
Describe any existing, designated, or proposed freshwater areas, such as species at risk critical habitat or ecological reserves, within or in proximity to the Project location or that could be affected by routine project operations	Section 4.3.2
Identify and describe sensitive habitat areas within the LSA and RSA and include maps that demonstrate proximity of these areas to the Project	Appendix A, Figure A.7 of this report

2 Study Areas

Fish and fish habitat information for assessment of potential effects of the Project has been collected from three different study areas: **Project Area (PA)**, **Local Study Area (LSA)**, and **Regional Study Area (RSA)**. Each of these areas are described below.

2.1 Project Area

The PA encompasses the Project footprint and is the anticipated area of physical disturbance associated with construction, operations, and decommissioning and closure of the Project. The PA includes the open pit, stockpiles, ore processing plants, and other mine related infrastructure, as well as a new rail spur line and the relocation of Highway 655 and existing 500 kilovolt (kV) transmission line. The PA is shown on Figure A.1, Appendix A of this report. The PA includes headwater ponds, lakes, and streams in the North Driftwood River watershed, West Buskegau River watershed, and the Jocko Creek watershed (Figure A.2, Appendix A of this report). Jocko Creek is a tributary of the Mattagami River.

2.2 Local Study Area

The LSA encompasses the area in which Project-related effects (direct or indirect) are predicted or can be measured with a level of confidence appropriate for the assessment and in which there is a reasonable expectation that the potential effects in the LSA are of public interest. The LSA for the Fish and Fish Habitat VC is shown in Figure A.1 (Appendix A of this report) and includes:

- The North Driftwood River watershed upstream of its confluence with Nesbitt Creek
- The West Buskegau River watershed upstream of its confluence with the Buskegau River
- The Jocko Creek watershed upstream of its confluence with Kidd Creek

The areas of these watershed within the LSA are shown in Figure A.2 (Appendix A of this report). The watercourses and waterbodies within the LSA are shown in Figure A.3 (Appendix A or this report).

2.3 Regional Study Area

The RSA includes the area within which potential cumulative effects on fish and fish habitat may occur due to the interaction of Project-related effects with residual effects from other past, present, or reasonably foreseeable future projects or activities. The RSA also encompasses an area used to provide regional context for the potential Project-specific effects on fish and fish habitat. The RSA for the Fish and Fish Habitat VC is show in Figure A.1 (Appendix A of this report) and includes:

- The North Driftwood River watershed upstream from its confluence with the Abitibi River
- The Buskegau River watershed upstream from its confluence with the Frederick House River
- The Jocko Creek watershed upstream from its confluence with the Mattagami River

- The Mattagami River mainstem from Lower Sturgeon Dam to Yellow Falls Dam

The areas of these watershed within the RSA are shown in Figure A.2 (Appendix A of this report).

3 Methods

3.1 Desktop Review of Historical Information

3.1.1 Fish and Fish Habitat Information

A desktop review of existing online Land Information Ontario (LIO) geospatial data layers using information accessed from Ontario GeoHub (Ministry of Natural Resources [MNR], formerly the Ministry of Natural Resources and Forestry [MNRF]). Layers reviewed included:

- Fish Activity Sites/Areas
- Thermal Regime
- Fish Species List: Aquatic Resource Area Polygon and Line data
- Constructed Drainage
- Federal Protected Areas
- Natural Heritage Information Centre (NHIC)1 km Grid
- Fish Survey Point

3.1.2 Aquatic Species at Risk Information

The following websites and published reports were reviewed as they relate to aquatic species at risk near the Project:

- Species at Risk in Ontario website (MECP 2024)
- Federal Species at Risk Public Registry website (ECCC 2024)
- Fisheries and Oceans Canada's (DFO) Aquatic Species at Risk map website (DFO 2024)
- Lake Sturgeon Distribution in the Upper Mattagami River Summer 2007 (Golder 2008)
- Island Falls Hydroelectric Project Aquatic Assessment (Stantec 2009)
- An Assessment of Adult Lake Sturgeon (*Acipenser fulvescens*) Translocation Reintroduction Effort in a Fragmented River System (Boothroyd 2018)

3.1.3 Ecological Processes Information

One of the requirements of the TIS Guidelines is to "*describe parameters and ecological processes relevant to predicted effects on the fish and aquatic species present. Relevant parameters and ecological processes may include migratory patterns, food webs and trophic levels, structural and functional linkages, life history and population dynamics, sensitive habitats and periods, behaviour, or other relevant ecological processes that fish depend on to carry out their life history.*"

The following sources of information were used to describe the parameters and ecological processes relevant to understanding potential effects of the Project on fish and aquatic species within and downstream of the PA:

- Allan, J.D., M.M. Castillo, and K.A. Capps. 2021. Stream Ecology: Structure and Function of Running Waters. 3rd edition. Springer Publishing.
- Bradford, M.J., R.G. Randall, K.S. Smokorowski, B.E. Keatley, and K.D. Clarke. 2014. A framework for assessing fisheries productivity for the Fisheries Protection Program. Can. Sci. Advis. Sec. Res. Doc. 2013/067. Ottawa, ON.
- Smokorowski, K.E., and T.C. Pratt. 2007. Effect of a change in physical structure and cover on fish and fish habitat in freshwater ecosystems – a review and meta-analysis. Environ. Rev. 15:15-41.
- Vannote, R.L., G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Can. J. Fish. Aquat. Sci. 37: 130-137.
- Larsen, A.N., J.R. Larsen, and S.N. Lane. 2021. Dam builders and their works: beaver influences on the structure and function of river corridor hydrology, geomorphology, biogeochemistry, and ecosystems. Earth-Science Reviews 218(2021) 46 p.

3.2 Field Surveys

WSP conducted field surveys in in 2021, 2022, and 2023 in the PA and LSA to supplement existing fish and fish habitat data (2021-2023 Fish and Fish Habitat Baseline, Appendix B.8.2 of the Impact Statement). Surveys were conducted during the following seasons:

- 2021: summer (August 5 to 11) and fall (October 19 to 28)
- 2022: spring (May 28 to June 9), summer (August 16 and 17), late summer (August 29 to September 2 and September 14 to 18), and fall (October 11 to 26)
- 2023: spring (May 30 to June 14) and summer (July 11 to 16).

Field surveys included an assessment of fish habitat, fish community, benthic invertebrate community, fish tissue, and sediment quality. A description of the methods used for each of these surveys is provided below. A detailed description of the survey timing, locations, and methods is provided in 2021-2023 Fish and Fish Habitat Baseline (Appendix B.8.2 of the Impact Statement), included in this report as Appendix B.8.2 of the Impact Statement.

3.2.1 Fish Habitat

Fish habitat assessments were conducted at 38 riverine (lotic) sites and in six lentic sites between 2021 and 2023. Lotic sites included two sites in the Mattagami River, two sites in Jocko Creek, 17 sites in the upper North Driftwood River watershed, 11 sites in the West Buskegau River watershed, and six sites along the proposed highway realignment. Lentic sites included Gerry Lake, Martin Lake, Jack Lake, Sutherland Lake, Mel Lake, and Davis Lake, which are headwater lakes in the North Driftwood River watershed. Locations for fish habitat assessments are shown in Figure A.5 (Appendix A of this report) as well as Table 2-1 of Appendix B.8.2 of the Impact Statement.

Fish habitat assessments identified the fish habitat types present, determined whether the waterbody or watercourse was permanent or ephemeral, and characterized the instream and riparian habitat using the Ontario Ministry of Transportation (MTO 2020) protocol, where appropriate. Additional habitat features were collected from sites using a modified Ontario Stream Assessment Protocol (OSAP), where appropriate. Measured instream habitat variables included wetted width, channel depth, substrate type, and cover type. Measured riparian habitat variables included dominant and subdominant vegetation types (e.g., trees, shrubs, grasses) and identification of vegetation species, where possible.

Bathymetric surveys were conducted in the six headwater lakes in the North Driftwood River watershed and in Zed Lake and an unnamed lake south of Zed Lake in the Jocko Creek watershed, and an unnamed lake west of the proposed west stockpile. Bathymetry data was collected using a combined GPS/sonar transducer. Surveys were conducted following methods in the Manual of Instructions for Bathymetric Surveys published by the MNRF (Levec and Skinner 2004). Vertical and horizontal resolutions were approximately +/- 0.1 (metre) m and +/- 4.0 m respectively. Lake perimeters from base mapping were digitized into a geographic information system (GIS) to calculate surface area and perimeter length. Bathymetric data were used to determine maximum and mean depth and digitized to estimate lake volume.

In-field surface water quality measurements were recorded at each sample location using handheld portable water quality meters. Vertical physio-chemical profiles were conducted in Martin, Gerry, Jack, Sutherland, Mel, and Davis lakes. The following physio-chemical parameters were measured at 1 m intervals during these profiles:

- Temperature
- pH
- Conductivity
- Dissolved oxygen (DO) concentration

Because the Project is located primarily in the headwaters of the North Driftwood River, West Buskegau River, and Jocko Creek watersheds, a GIS analysis was conducted to identify first and second order watercourses and waterbodies not otherwise identified on the 1:50,000 LIO database. This analysis was conducted using satellite imagery and a LiDAR-based flow model to delineate potential flows paths for unmapped first and second order streams. The resulting model was ground-truthed by Stantec in October 2023 to confirm model fit. Once the modeled watercourses were added to the GIS, the watercourse segments, ponds and lakes in the Project area were assigned unique identification codes consisting of two letters designating the watershed (e.g. ND=North Driftwood River), one letter designating the feature type (e.g. W=watercourse) and a unique three-digit numerical identifier.

Pond and lake habitats were identified from the 1:50,000 LIO database and a desktop analysis using recent (September 29, 2023) air photos.

3.2.2 Fish Community Conventional Methods

Fish community surveys were conducted during spring, summer and fall as per the conditions of the "Licenses to Collect Fish for Scientific Purposes" issued by MNRF. The following gear types were utilized:

- Baited gee-style minnow traps
- Minnow (small-mesh) fyke nets
- Dip nets
- Seine nets
- Backpack electrofishing
- Gillnets (various stretched mesh sizes)

A summary of the fish sampling gear utilized at each sampling location and by field program is presented in Table 2-2 in Appendix B.8.2 of the Impact Statement. Captured fish were identified to species, measured for length (total and fork, depending on species) and fresh weight, scrutinized for visible malformation, parasites, or evidence of disease, and sexed (when possible) from external examinations. Aging structures were collected from individual fish sacrificed for tissue analysis during the fall assessments.

3.2.3 Environmental DNA

Environmental DNA (eDNA) sampling was conducted as a complement to conventional sampling to help corroborate historical records and available Indigenous knowledge. The study design included collection of triplicate samples for quantitative polymerase chain reaction [qPCR] or metabarcoding analyses. Each sample was collected using a Kemmerer bottle and was comprised a filtered, two litre composite water sample collected from near-bottom, mid-depth, and near-surface, as well as nearshore and offshore grabs as appropriate. This provided a higher likelihood of collecting genetic material from the fish species present during the time of sampling. Sampling equipment was decontaminated between sample locations and negative control samples were collected during each sampling event to reduce the likelihood of false positive and false negative results.

The objectives of the eDNA sampling were to identify lake sturgeon presence using qPCR (species/taxa-specific) and metabarcoding analysis. The qPCR analysis provided quantitative results, amplifying the target lake sturgeon eDNA and providing a score for the number of positive lake sturgeon replicates out of 12. Metabarcoding provided qualitative results that provided an indication of the different species present within the samples based comparison of the genetic material collected to known gene sequence primers in the lab. eDNA sampling within the Mattagami River utilized both eDNA methods paired with conventional visual surveys. eDNA sampling conducted in the North Driftwood River relied on qPCR and metabarcoding analysis with no accompanying visual surveys.

Additional eDNA sampling was conducted in spring 2024 by Stantec. A full summary of the methods of this survey as well as the locations sampled is provided in Appendix C.

3.2.4 Species at Risk

Sampling for lake sturgeon within the LSA and RSA was conducted in spring 2023 using the following methods (2021-2023 Fish and Fish Habitat Baseline, Appendix B.8.2 of the Impact Statement):

- Deployment of artificial substrates to capture lake sturgeon eggs downstream of the Lower Sturgeon generating station (GS) in the Mattagami River
- Visual surveys for spawning lake sturgeon in the nearshore area of the Mattagami River downstream of the Lower Sturgeon GS
- Triplicate eDNA sampling using qPCR analysis of water samples collected in the Mattagami River downstream of the Lower Sturgeon GS and in two locations in the North Driftwood River mainstem: immediately downstream of the PA and upstream of the confluence with Nesbitt Creek.

Artificial substrate traps were deployed, visual observations were conducted, and eDNA samples were collected for lake sturgeon in the Mattagami River on May 14, 2023. Water temperature in the river at this time was 12ºC, which is within the temperature range suitable for lake sturgeon spawning (2021-2023 Fish and Fish Habitat Baseline, Appendix B.8.2 of the Impact Statement).

3.2.5 Sediment Quality and Benthic Invertebrate Community

Sediment samples were collected concurrently with benthic invertebrate community samples using a Petite Ponar grab sampler during the falls of 2021 and 2022. Sediment and benthic invertebrate samples were collected from the same location in each waterbody to allow for correlation of physical and biological characteristics. Each grab sampled a surface area of 0.023 m^2. Three sediment and three benthic invertebrate replicate samples were collected at each sample location within similar depths. Each sample was comprised of three grabs that were homogenized into one composite sample to account for localized habitat heterogeneity.

Sediment samples were analyzed by a CALA certified laboratory for particle size distribution and metal and nutrient concentrations. The lab followed protocols set by the CALA *Guide to Current Sampling Practices* (Fowlie 2014) and Environment Canada's *Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2012).

3.2.6 Plankton Communities

Phytoplankton and zooplankton samples were collected in Gerry Lake and Martin Lake in 2021, in Gerry Lake, Martin Lake, Davis Lake, Sutherland Lake, Mel Lake, and Jack Lake in 2022, and in Gerry Lake, Martin Lake, Davis Lake, and Sutherland Lake in 2023.

Phytoplankton samples were collected from the euphotic zone (i.e., upper zone of light penetration) of each lake with a Kemmerer water sampler. At sampling stations with euphotic zones deeper than 2 m, water was collected at 2 m intervals and combined to make composite samples. A sub-sample of the water was poured into a pre-labelled 50 millilitre (mL) opaque plastic bottle and preserved with 2 mL of Lugol's solution. Samples were analyzed in the lab for taxonomic composition, abundance, and biomass (i.e., chlorophyll a concentration).

Zooplankton samples were collected from the water column with a 0.13 m diameter Wisconsin plankton net with a 63 micrometre (µm) mesh net. The net was lowered to the bottom, approximately 30 centimetre (cm) above the bottom and pulled vertically to the surface at a rate of approximately 0.5 metres per second (m/s) to collect the samples. Samples were preserved using half an Alka-Seltzer tablet and 10% buffered formalin. Samples were sent to Salki Consultants, Winnipeg, Manitoba and analyzed for taxonomic composition, density, and biomass.

3.2.7 Fish Tissue Contamination Burdens

Fish tissue samples were collected for analysis of contaminant burden concentrations in 2021 and 2022. One large-bodied fish species (northern pike [*Esox lucius*]) and various small-bodied fish species were collected from streams, lakes, and ponds in the North Driftwood River, West Buskegau River, and Jocko Creek watersheds. The small-bodied species retained for analysis were based on presence and abundance in each watershed and included northern pearl dace (*Margariscus nachtriebi*), northern redbelly dace (*Chrosomus eos*), finescale dace (*Chrosomus neogaeus*), lake chub (*Couesius plumbeus*), brook stickleback (*Culaea inconstans*), and fathead minnow (*Pimephales promelas*).

Tissue samples from northern pike were comprised of skinless, boneless muscle tissues taken from the left side of the fish. Tissue samples from small-bodied fish species were comprised of composites of enough whole-body samples for a minimum of 20 grams (g) wet weight (wwt). Each small-bodied tissue sample was comprised of individuals of the same species.

Tissue samples were frozen and shipped to ALS Canada Limited in Waterloo, Ontario for analysis, a Canadian Association for Laboratory Accreditation (CALA) accredited laboratory. Tissue samples were analyzed for the 35 metals and metalloids identified in Table 3.1. The analysis included methylmercury and selenium, two parameters known to bioaccumulate in fish tissues.

Table 3.1 Parameters and Laboratory Detection Limits Used for Fish Tissue Contaminant Burden Analysis

Parameter	Detection Limit (mg/kg wwt)	Detection Limit (mg/kg dwt)
Aluminum	0.40	2.0
Antimony	0.0020	0.010
Arsenic	0.0040	0.020
Barium	0.010	0.050
Beryllium	0.0020	0.010
Bismuth	0.0020	0.010
Boron	0.20	1.0
Cadmium	0.0010	0.0050
Calcium	4.0	20
Cesium	0.0010	0.0050
Chromium	0.010	0.050
Cobalt	0.0040	0.020
Copper	0.020	0.10
Iron	0.60	3.0
Lead	0.0040	0.020
Lithium	0.10	0.50
Magnesium	0.40	2.0
Manganese	0.010	0.050
Mercury	0.0010 to 0.0025	0.0050 to 0.135
Methylmercury[1]	1.0 to 4.0	5.0 to 200
Molybdenum	0.0040	0.020
Nickel	0.040	0.20
Phosphorus	2.0	10.0
Potassium	4.0	20.0
Rubidium	0.010	0.050
Selenium	0.010	0.050
Sodium	4.0	20.0
Strontium	0.010	0.050
Tellurium	0.0040	0.020
Thallium	0.00040	0.0020
Tin	0.020	0.10
Uranium	0.00040	0.0020
Vanadium	0.020	0.10
Zinc	0.10	0.50

Parameter	Detection Limit (mg/kg wwt)	Detection Limit (mg/kg dwt)
Zirconium	0.040	0.20

Notes: mg/kg wwt = milligrams per kilogram wet weight; mg/kg dwt = milligrams per kilogram dry weight.
Parameters with detection limit ranges indicated two or more detection limits.
1 - Methylmercury reported in units of µg/kg.

3.3 Data Analysis

3.3.1 Fish Habitat

Fish habitat data was entered into Microsoft Excel spreadsheets. The modified OSAP protocol field data (diagnostic indicators of channel stability) was used to determine bank full and active channel widths. Average active channel width in metres was calculated from sampled streams of a given order within each watershed. This value was then multiplied by the length (in metres) of stream segments of a given order within each watershed to generate an estimate of fish habitat spatial area in square metres.

Average wetted channel width measured from the air photos and ground-truthed in the field was used to calculate habitat areas for stream orders that were underrepresented by the LIO dataset. Habitat area estimates for pond and lake habitats were generated using a GIS. To simplify the characterization of fish habitats, a fish habitat characterization matrix was developed based on the similarities in fish habitat within the PA. Existing habitat types were grouped into five categories based on the following quantitative and qualitative descriptors:

- Morphological characteristics such as depth, width, degree of entrenchment and frequency of riffles, flats, and pools
- Cover and substrate composition
- Strahler stream order
- Relative degree of beaver influence
- Average species richness

A Habitat Evaluation Procedures (HEP) approach (US Fish and Wildlife Service 1980,1981) was used to generate species-specific habitat maps. In the HEP approach, fish habitat quality was defined by habitat suitability indices (HSIs) which ranked the importance of each habitat category for spawning, rearing, adult foraging, migration and overwintering for the focal fish species used in the effects assessment: northern pike, walleye, white sucker and the forage fish guild. HSI models for these species were developed using:

- published data on the distribution and abundance of the fish species of interest
- published data on the habitat requirements, preferences and tolerances of the focal fish species
- baseline fish data regarding the distribution and abundance of the focal fish species in the PA and LSA

- baseline data regarding the habitat characteristics of each habitat categories defined in the PA and LSA from the where focal fish species were captured in the PA and LSA

The main habitat characteristics used in the HSI models included depth, substrate for cover and feeding, substrate for spawning, water temperature, percent cover, channel unit type, and DO concentrations. These characteristics were selected based on professional knowledge of habitat characteristics typically associated with habitat used by the focal fish species and a review of literature on these aquatic habitat characteristics (Gormann and Karr 1978; Matthews 1987; Newbury and Gaboury 1993; Hauer and Lamberti 1996; Stauffer and Goldstein 1997; United States Department of Agriculture Federal Interagency Stream Restoration Working Group 1998; Lammert and Allan 1999; Wetzel 2001). The published species-specific HSI models were then used to assign ordinal ranks from 1 to 5 to each habitat category in the PA: 1 = excellent, 2 = above average, 3 = average, 4 = below average, and 5 = unsuitable. These rankings corresponded to a HSI scores of 1, 0.75, 0.5, 0.25, and 0, respectively. Multiplication of the assigned habitat quality scores by habitat quantity (surface area expressed in units of ha) provided Habitat Units (HUs) for each life stage, of each focal fish species, present in the PA. The HUs are dimensionless units that represents the overall value of the habitat for fish species that are present or that could reasonably be expected to be present in the PA.

Additional fish habitat studies that were primarily focussed on lake sturgeon were conducted in spring 2024 by Stantec and are summarized in Appendix C.

3.3.2 Fish Community

Fish community data was entered into Microsoft Excel spreadsheets and organized by sampling gear type, year, season, and sample station identification. Abundance and catch per unit effort (CPUE) were calculated for each species and sampling event.

3.3.3 Sediment Quality

Sediment concentrations were compared to the lowest effect level (LEL) and severe effect level (SEL) concentrations identified in the Provincial Sediment Quality Guidelines (PSQG) for the protection and management of aquatic sediment quality in Ontario (MOE 2008) for: arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc. Sediment concentrations were also compared to the interim sediment quality guidelines (ISQG) and probable effect level (PEL) concentrations identified in the Canadian Sediment Quality Guidelines (CSQG) for the protection of aquatic life (CCME 2002) for: arsenic, cadmium, chromium, copper, lead, mercury, and zinc.

3.3.4 Benthic Invertebrate Community

In the lab, benthic invertebrate samples were identified to the lowest taxa possible (typically genus) and enumerated. Benthic invertebrate data from each site was used to calculate total density, Simpson's diversity index (SDI), Simpson's evenness index (SEI), taxa richness, percentage of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (i.e., EPT%), and percentage of chironomid larvae (midges).

3.3.5 Plankton Communities

Phytoplankton and zooplankton results were analyzed for total biomass and community composition. Phytoplankton data were analyzed at the genus-level. Biomass data was used to interpret ecological significance and food web linkages and community composition. Calculations were completed using Microsoft Excel and plots were created using RStudio 3.6.2.

3.3.6 Fish Tissue Contaminant Burdens

Concentrations of each metal and metalloid in fish tissue samples were reported in milligrams per kilogram wet weight (mg/kg wwt) and milligrams per kilogram dry weight (mg/kg dwt). Dry weight concentrations were calculated from wet weight concentrations using the percent moisture content of each sample.

Total mercury concentrations in fish tissues were compared to the Ontario consumption guidelines (MOE 2015) and the Canadian food and nutrition standard of 0.5 mg/kg wwt (Health Canada 2020). Methylmercury concentrations were compared to the Canadian Tissue Residue Guideline for the Protection of Wildlife Consumers of Aquatic Biota - methylmercury of 0.033 µg/g wwt (CCME 2000). Selenium concentrations in whole-body small-bodied fish samples were compared to the Federal Environmental Quality Guidelines (FEQG) of 6.7 µg/g dwt (ECCC 2022).

4 Results

4.1 Desktop Review

A spatial summary of information collected during the desktop review is provided in Figure A.4 (Appendix A of this report).

The Project is located within the Abitibi Ecoregion (Ecoregion 3E) in northeastern Ontario within the Shield Ecozone (MNR 2009). The northern portion of the Ecoregion is part of the Clay Belt and is underlain by deep, fine-textured, glaciolacustrine sediments from post-glacial Lake Barlow-Ojibway resulting in an area of low relief with poor drainage and large areas of wetlands overlain by deep organic deposits (Appendix B.8.2 of the Impact Statement [2021-2023 Fish and Fish Habitat Baseline]). The southern portion of the ecoregion has more varied terrain with poorly developed, thinner soils, and large areas of exposed bedrock.

The PA is drained by the North Driftwood River, West Buskegau River, and Jocko Creek. The North Driftwood River drains into the Abitibi River while the West Buskegua River drains into the Buskegau River and then the Frederick House River, a tributary of the Abitibi River. Jocko Creek drains into the Mattagami River. The Abitibi and Mattagami rivers flow north and are tributaries of the Moose River which drains into James Bay.

Two provincial parks (North Driftwood River Provincial Park and Greenwater Provincial Park) are located within the RSA however neither park has any restrictions on fishing over and above the provincial regulations. One provincially designated fish sanctuary is located within the LSA wherein fishing is prohibited from April 1-June 14 annually in a section of the Mattagami River from the Lower Sturgeon hydro dam and downstream to the northern border of Mahaffy Township (OMNRF 2024) This designation is presumably to protect spawning habitat for lake sturgeon and walleye in this area.

Twenty three- fish species have been previously observed or captured in the North Driftwood River, West Buskegau River, Jocko Creek, and Mattagami River (Table 4.1). Lake sturgeon are the only species listed as species at risk and are designated as special concern under the *Species at Risk Act* (SARA) and the Committee on the Status of Endangered Wildlife Species in Canada (COSEWIC). Lake sturgeon have only been previously observed or captured in the Mattagami River. There is no identified critical habitat for any freshwater fish species in the LSA or RSA (DFO 2024).

Table 4.1 Fish Species Previously Captured or Observed in the North Driftwood River, West Buskegau River, Jocko Creek, and Mattagami River

Family	Common Name	Scientific Name	SARA	COSEWIC	North Driftwood River	West Buskegau River	Jocko Creek	Mattagami River
Acipenseridae	Lake sturgeon	*Acipenser fulvescens*	SC	SC	–	–	–	✓
Catostomidae	Longnose sucker	*Catostomus catostomus*	No status	Not assessed	–	–	–	✓
	White sucker	*Catostomus commersonii*	No status	Not assessed	–	✓	✓	✓
Centrarchidae	Rock bass	*Ambloplites rupestris*	No status	Not assessed	–	–	–	✓
	Smallmouth bass	*Micropterus dolomieu*	No status	Not assessed	–	–	–	✓
Cyprinidae	Blacknose shiner	*Notropis heterolepis*	No status	Not assessed	✓	–	–	–
	Brassy minnow	*Hybognathus hankinsoni*	No status	Not assessed	✓	–	✓	✓
	Common shiner	*Luxilus cornutus*	No status	Not assessed	✓	✓	–	–
	Creek chub	*Semotilus atromaculatus*	No status	Not assessed	–	–	✓	–
	Finescale dace	*Chrosomus neogaeus*	No status	Not assessed	✓	✓	–	–
	Lake chub	*Couesius plumbeus*	No status	Not assessed	✓	–	✓	–
	Longnose dace	*Rhinichthys cataractae*	No status	Not assessed	–	–	✓	–
	Spottail shiner	*Notropis hudsonius*	No status	Not assessed	✓	–	–	✓
Cottidae	Mottled sculpin	*Cottus bairdii*	No status	Not assessed	–	–	✓	✓
Esocidae	Northern pike	*Esox Lucius*	No status	Not assessed	–	✓	–	✓
Gasterosteidae	Brook stickleback	*Culaea inconstans*	No status	Not assessed	✓	✓	✓	–
Ictaluridae	Brow bullhead	*Ameiurus nebulosus*	No status	Not assessed	–	–	–	✓
Lotidae	Burbot	*Lota lota*	No status	Not assessed	–	–	✓	✓
Percidae	Iowa darter	*Etheostoma exile*	No status	Not assessed	✓	–	–	–
	Johnny darter	*Etheostoma nigrum*	No status	Not assessed	✓	–	–	–
	Logperch	*Percina caprodes*	No status	Not assessed	✓	–	✓	✓
	Walleye	*Sander vitreus*	No status	Not assessed	–	–	–	✓
	Yellow perch	*Perca flavescens*	No status	Not assessed	–	–	–	✓

Notes: SARA = *Species at Risk Act*; COSEWIC = Committee on the Status of Endangered Wildlife Species in Canada; SC = Special Concern.

4.2 Fish Habitat

4.2.1 Watershed Characteristics

The Jocko Creek, North Driftwood River and West Buskegau River watersheds are relatively flat, with an overall topographic average slope of 1.7% (Surface Water Resources Assessment*;* Appendix C.5 of the Impact Statement). Elevations within the Jocko Creek watershed range from 258.9 metres above sea level (masl) to 322.3 masl, with an average slope of 1.8%. The North Driftwood River watershed ranges from 248.2 masl to 303.1 masl with an average slope of 1.8%. The West Buskegau River watershed ranges from 260.9 masl to 356.1 masl with an average slope of 1.6%. Channel slopes vary from 0.05% within the West Buskegau River watershed, 0.08% within the North Driftwood River watershed, and 0.11% in the Jocko Creek watershed according to Ontario Watershed Information Tool (OWIT). The majority of aquatic habitats in the Project Area in the Jocko Creek, North Driftwood River and West Buskegau River watersheds are relatively undisturbed or greenfield in nature. The moderate anthropogenic disturbances that do exist are primarily related to recreational vehicle and logging access roads.

Land cover within the PA is composed of upland treed habitat (approximately 19.1%), wetland (approximately 77.1%), water (0.1%), and sparsely vegetated or anthropogenic areas (approximately 3.7%) (*Vegetation, Riparian and Wetland Environments Supplemental Baseline Report*, Appendix B.7.1 of the Impact Statement). Typical boreal vegetation includes black spruce (*Picea mariana*), white spruce (*Picea glauca*), tamarack (*Larix laricina*), jack pine (*Pinus banksiana*), trembling aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*).

4.2.2 Watercourses

Mainstem channels of the North Driftwood River, West Buskegau Creek, and Jocko Creek within the PA are relatively shallow, low gradient, and wide (6 m to 20 m) with broad floodplains and fine depositional substrates. Streams and channels draining to the mainstem channels are generally shallow, low gradient, low energy depositional environments with fine-grained organic substrates. Beaver dams and ponds are frequent in these smaller, headwater tributaries. Beaver ponds are typically shallow (<2 m) with fen mats, sedges, grasses, as well as sparse shrubs providing overhead cover nearshore. Upland vegetation in headwater areas is mostly coniferous species, including black spruce, eastern white cedar (*Thuja occidentalis*), and tamarack.

Further descriptions of fish habitat conditions at each sampled sites are summarized in Section 3.0 of 2021-2023 Fish and Fish Habitat Baseline (Appendix B.8.2 of the Impact Statement). MTO protocol and modified OSAP fish habitat survey data for streams, lakes and pond are summarized in Appendix B of this report.

In situ water quality measurements collected during the field investigations indicate that DO concentrations and pH play a role in determining habitat suitability for fish species. Approximately 24% of sites (25/105) sampled from 2021-2023 had low DO concentrations (<5.5 mg/L). Approximately 27% of sites (28/105) had low pH (<6). *In situ* water quality data is presented in Appendix A of 2021-2023 Fish and Fish Habitat Baseline (Appendix B.8.2 of the Impact Statement).

4.2.3 Lakes

Maximum depths in the headwater lakes in the North Driftwood River Watershed range between 11 m (Unnamed Lake Stockpile West) and 22 m (Sutherland Lake). These lakes were likely created by gravel excavations required for the concrete used in the Lower Sturgeon GS which was built in the 1920's' they are due east of the dam, located in a gravel esker area, and are the only small, named lakes in the area. Riparian habitat in these lakes is comprised of floating fen mats, sedges, grasses, as well as sparse shrubs providing overhead cover nearshore. The upland vegetation is mostly coniferous species, including black spruce, eastern white cedar, and tamarack. Bathymetric results are presented in Table 4.2 and Appendix A, Figure A.6 of this report

Table 4.2 Bathymetry Results of Select Study Area Lakes

Watershed	Name	Water level Elevation (masl)	Mean Depth (m)	Maximum Depth (m)	Surface Area (ha)
North Driftwood	Unnamed Lake – Stockpile West	270.19	2.5	11.0	5.02
	Martin Lake	268.29	3.4	11.0	19.98
	Gerry Lake	268.28	6.2	21.0	14.29
	Jack Lake	274.07	4.5	18.0	5.34
	Sutherland Lake	274.68	4.1	22.0	7.95
	Mel Lake	274.86	7.3	21.0	2.73
Jocko Creek	Zed Lake	282.53	4.0	13.0	4.56
	Unnamed Lake – South of Zed Lake	278.58	7.9	13.0	4.10

These bathymetry data are relative to water levels at the time of the survey and are not tied to benchmarks. Additional bathymetry data is presented in the 2021-2023 Fish and Fish Habitat Baseline, Appendix B.8.2 of the Impact Statement.

DO concentrations and temperature profiles for the headwater lakes showed near anoxic levels (< 3 mg/L) below the thermocline during summer stratification period. Vertical profiles are presented in Figures A3-1 to A3-6 of the 2021-2023 Fish and Fish Habitat Baseline (Appendix B.8.2 of the Impact Statement).

4.2.4 Spatial Fish Habitat Area Calculations

Appendix A, Figure A.7 of this report shows the spatial extent of fish habitat in the North Driftwood River, West Buskegau River, and Jocko Creek watersheds that may be affected by the Project footprint. The total estimated area of fish habitat that will be directly affected by the Project footprint is 147 ha (Table 4.3). Most (70%) of this affected habitat will be in the North Driftwood River watershed with smaller areas of affected habitat in the West Buskegau River watershed (30%) and Jocko Creek watershed (<1%). In the North Driftwood River watershed, potentially affected fish habitat includes approximately 8 km of the North Driftwood River mainstem channel and smaller, unnamed tributaries and headwater ponds in 14 subwatersheds.

Most (92%) of the fish habitat potentially affected by the Project footprint in the North Driftwood River watershed is headwater tributary habitat and headwater pond habitat. None of the habitat in the headwater lakes in the North Driftwood River watershed (i.e., Martin, Jerry, Jack, Sutherland, Mel, and Davis Lakes) will be affected by the Project.

In the West Buskegau River watershed, 99% of potentially affected fish habitat is in unnamed tributaries and headwater ponds in six subwatersheds that drain into the West Buskegau River mainstem. Habitat in the West Buskegau River mainstem will only be affected by the proposed effluent discharge pipes; this habitat comprises <1% of the total affected habitat in the West Buskegau River watershed.

In the Jocko Creek watershed, potentially affected fish habitat is limited to small, headwater tributaries; 0.15 ha of headwater tributary habitat in the Jocko Creek watershed will be potentially affected by water management infrastructure.

Table 4.3 Summary of Fish Habitat Potentially Affected by the Project Area

Watershed	Habitat Type	Total Spatial Area (ha)
North Driftwood River	Mainstem[1]	14.96
	Headwater tributary[2]	21.42
	Headwater pond[3]	66.32
West Buskegau River	Mainstem[1]	0.36
	Headwater tributary[2]	10.08
	Headwater pond[3]	34.02
Jocko Creek	Headwater tributary[2]	0.15
Total		147.29

Notes:
1 - includes segments with stream orders ≥4
2 - includes tributaries with stream orders 1 to 3
3 - includes ponds and beaver dam impoundments

4.2.5 Rare or Sensitive Habitat Areas

The only sensitive habitat area identified in the Project Area, LSA or RSA is the provincially designated fish sanctuary located in a section of the Mattagami River from the Lower Sturgeon hydro dam and downstream to the northern border of Mahaffy Township (OMNRF 2024) This designation is presumably to protect spawning habitat for lake sturgeon and walleye in this area. Field surveys specifically focussed on locating rare or sensitive habitat particularly related to lake sturgeon were conducted by Stantec in spring 2024 and the results are presented in Appendix C.

4.3 Fish Community

4.3.1 Species Abundance and Distribution

The fish communities in the North Driftwood River, West Buskegau River, Jocko Creek and Mattagami River watersheds are represented by a mix of cool and cold-water fish species typical of northeastern Ontario. They include a variety of small-bodied (e.g., minnows) and large-bodied (e.g., northern pike) species.

Fish species captured, by location, are summarized in Table 4.4. A total of 28 fish species were identified during the surveys conducted in 2021, 2022, and 2023. Fourteen fish species were captured in the headwater lakes of the North Driftwood River. The most common small-bodied fish species in these lakes were brook stickleback, finescale dace, Iowa darter (*Etheostoma exile*) and golden shiner (*Notemigonus crysoleucas*). Less common small-bodied fish species in the lakes included bluntnose shiner (*Notropis simus*), bluntnose minnow (*Pimephales notatus*), northern pearl dace, northern redbelly dace, and trout perch (*Percopsis omiscomaycus*). Yellow perch (*Perca flavescens*) were captured in all six lakes and were the most common large-bodied fish species; northern pike were captured in three of the six lakes.

Fifteen fish species were captured in the Mattagami River. Small-bodied fish species in the Mattagami River included emerald shiner (*Notropis atherinoides*), finescale dace, Iowa darter, lake chub, northern peal dace, spottail shiner (*Notropis hudsonius*), and trout perch. Large-bodied fish species in the Mattagami River included burbot (*Lota lota*), lake sturgeon, longnose sucker (*Catostomus catostomus*), northern pike, rock bass (*Ambloplites rupestris*), walleye (*Sander vitreus*), white sucker (*Catostomus commersonii*), and yellow perch.

White sucker were the only large-bodied fish species captured in Jocko Creek. Brook stickleback, finescale dace, northern redbelly dace, northern pearl dace, and lake chub were the most common small-bodied species in Jocko Creek.

Nineteen fish species were captured in the North Driftwood River watershed; 16 small-bodied species and three large-bodied species. The most common small-bodied fish species were finescale dace, fathead minnow, brook stickleback, northern redbelly dace, northern pearl dace, and golden shiner. Northern pike, white sucker, and yellow perch were the large-bodied fish species captured in the North Driftwood River watershed; no walleyes were captured in the North Driftwood River watershed in 2021, 2022, or 2023.

Seventeen fish species were captured in the West Buskegau River watershed; 14 small-bodied species and three large-bodied species. The most common small-bodied fish species were finescale dace, northern pearl dace, brook stickleback, fathead minnow and northern redbelly dace. Burbot, northern pike, and white suckers were the large-bodied fish species captured in the West Buskegau River watershed. Longnose dace and mottled sculpin (*Cottus bairdii*) were captured in the West Buskegau River watershed but not in the North Driftwood River or Jocko Creek watersheds. These two species are present only in swift-flowing habitats with clean, rocky substrates. Their presence suggests that the West Buskegau River watershed provides more of diverse habitats than the other two watersheds.

Total catch and CPUE are presented in the 2021-2023 Fish and Fish Habitat Baseline, Appendix B.8.2 of the Impact Statement.

Table 4.4 Fish Species Presence by Location

Waterbody / Watercourse	Location ID	Species Richness	Blacknose Dace	Blacknose Shiner	Bluntnose Minnow	Brook Stickleback	Burbot	Common Shiner	Creek Chub	Emerald Shiner	Fathead Minnow	Finescale Dace	Golden Shiner	Iowa Darter	Johnny Darter	Lake Chub	Lake Sturgeon	Logperch	Longnose Dace	Longnose Sucker	Mottled Sculpin	Northern Pearl Dace	Northern Pike	Northern Redbelly Dace	Rock Bass	Spottail Shiner	Trout Perch	Walleye	White Sucker	Yellow Perch
Gerry Lake	NDR-GERLK	4											X	X								X								X
Martin Lake	NDR-MARLK	2																					X							X
Jack Lake	NDR-JACLK	11		X		X		X			X	X	X	X									X	X			X			X
Sutherland Lake	NDR-SUTLK	11		X	X	X		X			X	X	X	X									X	X						X
Mel Lake	NDR-MELLK	9				X		X			X	X	X	X								X		X						X
Davis Lake	NDR-DAVLK	8				X		X			X	X	X	X								X								X
Jocko Creek (tributary)	JC-S-01	7				X					X	X				X						X		X					X	
	JC-S-03	7				Xi					Xi	Xi				Xi						Xi		Xi					Xi	
Mattagami River	MAT-R-01	15 (21)					Xx			Xx		Xx		Xx		Xx	Xx			Xx		Xx	Xx		Xx	Xx	Xx	Xx	Xx	Xx
	MAT-R-02	15					Xi			Xi		Xi		Xi		Xi	Xi			Xi		Xi	Xi		Xi	Xi	Xi	Xi	Xi	Xi
North Driftwood River	NDR-P-01	8			X	X		X			X	X				X						X							X	
	NDR-P-02	0																												
	NDR-P-02B	0																												
	NDR-P-02C	0																												
	NDR-P-03	5				X					X			X								X		X						
	NDR-P-04	4				X					X	X										X								
	NDR-P-05	5				X					X	X										X								
	NDR-P-06	4				X					X	X												X						
	NDR-P-07	6				X						X										X		X					X	
	NDR-S-01	11		X		X					X	X	X									X	X	X					X	X
	NDR-S-02	7				X				X		X	X		X							X	X							
	NDR-S-04	16		X	X	X		X		X	X		X		X			X				X	X	X		X	X		X	X
	NDR-S-05	5				X					X	X												X						
	NDR-S-06	10 (14)							Xx		Xx	Xx		Xx	Xx								Xx			Xx	Xx		Xx	Xx
	NDR-S-06B	6				X					X	X										X		X					X	
	NDR-TRIB-01	3				X																	X							X
	NDR-TRIB-02	3										X										X								
	NDR-US-TC	8 (12)										Xx		Xx	Xx								Xx	Xx		Xx	Xx		Xx	

Waterbody / Watercourse	Location ID	Species Richness	Blacknose Dace	Blacknose Shiner	Bluntnose Minnow	Brook Stickleback	Burbot	Common Shiner	Creek Chub	Emerald Shiner	Fathead Minnow	Finescale Dace	Golden Shiner	Iowa Darter	Johnny Darter	Lake Chub	Lake Sturgeon	Logperch	Longnose Dace	Longnose Sucker	Mottled Sculpin	Northern Pearl Dace	Northern Pike	Northern Redbelly Dace	Rock Bass	Spottail Shiner	Trout Perch	Walleye	White Sucker	Yellow Perch
West Buskegau River	WBR-P-01	7				X					X	X										X		X					X	
	WBR-P-02	4				X						X										X		X						
	WBR-P-03	5				X					X	X										X		X						
	WBR-P-04	6				X					X	X										X	X	X						
	WBR-S-01	4				X	X														X						X			
	WBR-S-02	4				Xi	Xi														Xi						Xi			
	WBR-S-03	7					X	X		X					X						X	X					X			
	WBR-S-04	15	X			X	X	X		X	X	X			X			X	X		X	X	X				X		X	
	WBR-S-05	5				Xi					Xi	Xi										Xi		Xi						
	WBR-S-06	7					Xi	Xi		Xi					Xi						Xi	Xi					Xi			
	WBR-S-07	15	Xi			Xi	Xi	Xi		Xi	Xi	Xi			Xi			Xi	Xi		Xi	Xi	Xi				Xi		Xi	

Notes:

Species caught during the conventional fish community surveys within the sample locations are denoted with an X.

Species inferred to be present within a sample location due to connectivity and proximity to sampled locations are denoted with an Xi.

Species detected by eDNA sample analysis are denoted with an Xx, these results do not include high-level taxa detections (e.g., genus or family-level) which are discussed within the text; however, the total number of taxa are shown within brackets in the richness column.

Sample locations NDR-P-02, NDR-P-02B and NDR-P-02C did not contain fish

4.3.2 Habitat Utilization

Habitat uses for spawning, rearing, adult foraging and overwintering life stages were assessed for the five focal fish species: lake sturgeon, walleye, northern pike, white sucker, and the forage fish guild.

Walleye is a large-bodied, piscivorous species that is found in the West Buskegau River and Mattagami River. Walleye is an important recreational fish species and is harvested as country food by all potentially affected Indigenous nations. Walleye spawn in spring after ice break-up in shallow shoreline areas and shoals in lakes and riffles with rocky substrate and good water circulation in rivers. A walleye spawning area was identified by provincial data sets near the Lower Sturgeon GS in the Mattagami River. The distribution of walleye spawning, rearing, adult foraging and overwintering habitat in the PA are presented in Appendix A, Figure A.8-10 of this report.

Northern pike is a large-bodied, piscivorous species that is widespread in the streams and lakes in the LSA and is the top predatory fish species in the LSA. Northern pike are an important recreational fish species and are harvested as country food by all potentially affected Indigenous nations. Northern pike spawn in the spring in still or slow-moving water with aquatic vegetation or submerged terrestrial vegetation. The distribution of northern pike spawning, rearing, adult foraging, and overwintering habitat in the PA are presented in Appendix A, Figure A.11-13 of this report.

White sucker is a large-bodied, benthivorous species that is found in the mainstem and headwater lakes of the North Driftwood River and in the mainstem of the West Buskegau River and Jocko Creek. White suckers are an important recreational fish species and are harvested as country food by most of the potentially affected Indigenous nations. White suckers spawn in spring, typically in swift-flowing riffles with clean cobble and gravel, habitat that is vulnerable to changes in flow, but also along gravel shorelines in lakes. The distribution of white sucker adult, spawning/rearing, and overwintering habitat in the PA are presented in Appendix A, Figure A.14-16.

The forage species guild is a group of five ecologically similar small-bodied species (brook stickleback, northern pearl dace, northern redbelly dace, fathead minnow and finescale dace), which is found in headwater ponds and streams with stagnant water or slow flow throughout the PA and LSA. These fishes are common prey for large-bodied, piscivorous fish such as walleye, yellow perch, and northern pike. This guild of fishes typically spawns in late spring and generally feed on benthic invertebrates, plankton, or algae. Forage fish are actively harvested by the commercial bait fishery. The distribution of forage fish species adult, spawning/rearing, and overwintering habitat in the PA are presented in Appendix A, Figure A.17-19 of this report).

4.4 Species at Risk

4.4.1 Lake Sturgeon

Lake sturgeon is the only aquatic species at risk in the vicinity of the Project. The Southern Hudson Bay-James Bay population, which includes populations known to inhabit the Mattagami River, Abitibi River, and Frederick House River within the RSA, are listed as Special Concern on Schedule 1 of SARA.

The Southern Hudson Bay-James Bay population is also listed as Special Concern by the Province of Ontario (COSSARO 2017). However, this population appears to be more robust and less at risk compared to other provincial populations due to its large distance from industrial development and active commercial fisheries (COSSARO 2017). Threats to lake sturgeon in the Southern Hudson Bay-James Bay management unit include habitat and population disruption due to present, past, and future hydroelectric power development on many of the northern rivers in Ontario.

4.4.2 Field Survey Results

No lake sturgeon eggs were captured, and no adult lake sturgeon were observed spawning, in the Mattagami River downstream of the Lower Sturgeon GS in May 2023. However, fast-flows and turbid conditions precluded effective sampling (2021-2023 Fish and Fish Habitat Baseline, Appendix B.8.2 of the Impact Statement).

Positive detections were observed in 35 out of 36 lake sturgeon eDNA replicates in the Mattagami River downstream of the Lower Sturgeon GS in May 2023. However, it was unclear if this eDNA was from lake sturgeon residing above or below the GS (2021-2023 Fish and Fish Habitat Baseline, Appendix B.8.2 of the Impact Statement).

None of the replicate samples collected for qPCR analysis detected any lake sturgeon eDNA in the North Driftwood River. An aerial survey was completed in May 2024 to identify suitable lake sturgeon habitat within the LSA. A summary report of this survey is included in Appendix C of this baseline report.

4.4.3 Lake Sturgeon Habitat

Lake sturgeon populations occur in large rivers and lakes and require specific habitats to fulfill their life history (Scott and Crossman 1973; Auer 1996). During their lives, lake sturgeons typically exploit upstream to downstream (i.e., fast to slow-moving water) and substrate (i.e., coarse to fine) gradients (Gosselin et al. 2015; McDougall et al. 2017) related to fluvial erosion and transport processes (COSEWIC 2017).

Lake sturgeon require diverse habitat to complete their life cycle and can migrate extensive distances to fill these requirements, making them particularly sensitive to habitat fragmentation (Auer 1996; Haxton & Findlay 2008; Haxton et al. 2015). While long sections (>100 km) of interrupted river are thought to be necessary to provide lake sturgeon to the variety of habitats necessary to complete their life history, the persistence of lake sturgeon in impounded river systems and their genetic structuring in these interrupted rivers suggests that lake sturgeon can sustain populations in shorter sections (e.g., 10 km) if the section provides “spawn-drift-settle-establish” habitat sequences (McDougall et al. 2017).

4.4.3.1 Spawning Habitat

Lake sturgeon spawn in mainstem rivers and larger tributaries that support populations year-round. Lake sturgeon spawning typically occurs at the upstream extent of a given habitat unit, where high water velocities and coarse aggregate and gravel substrates predominate (COSEWIC 2017). These are typically rapids, below waterfalls, river constrictions, or below hydroelectric generating stations. Spawning

occurs in water with velocities up to 2 m/s, depths up to 20 m, over substrates including gravel, cobble, boulders, and bedrock. Water velocities >0.3 m/s are required for successful egg development (Hrenchuk 2011). Lake sturgeon will shift spawning locations from year to year depending on habitat conditions and availability (COSEWIC 2017).

4.4.3.2 Juvenile Rearing Habitat

Following yolk sac absorption, larval lake sturgeons emerge from the substrates and drift passively downstream (La Haye et al. 1992; Auer and Baker 2002; McAdam and Jonsson 2011; Hastings et al. 2013), settling in deep, slow-flowing pools. These rearing habitats are typically the first deep pool downstream of the spawning area (McDougall et al. 2017).

4.4.3.3 Overwintering Habitat

Juvenile and adult lake sturgeon require overwintering habitat that offers refuge from flow. This includes off-current refugia, lakes downstream of spawning areas and deep pools in rivers (Barth et al. 2011; McDougall et al. 2013; Pollack et al. 2015).

4.4.3.4 Critical Habitat

Critical habitat is defined under section 2 of SARA as “habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species’ critical habitat in the recovery strategy or in an action plan for the species”. Section 49(1)(a) of SARA requires that a species Recovery Strategy/Action Plan include identification of the species’ critical habitat to the extent possible, based on the best available information, including information provided by COSEWIC.

Critical habitat for the Southern Hudson Bay- James Bay population unit has not been identified and a recovery plan for this population has not been developed. This is because the Southern Hudson Bay-James Bay population unit is not listed as Threatened or Endangered.

4.4.4 Current and Historical Distribution of Lake Sturgeon in the Mattagami and North Driftwood Rivers

4.4.4.1 Mattagami River

Commercial and subsistence harvest of lake sturgeon in the Mattagami River started in the 1920s but the fisheries were closed in the 1980s due to declining populations (MNR 2008; MacRitchie 1983). The size of the commercial harvest ranged from 5,500 kg in 1948 to 190 kg in 1967 with a mean annual harvest of 2,350 kg (Seyler 1997).

The upper Mattagami River is fragmented by three hydroelectric generating stations: from upstream to downstream, these are Wawaitin GS, Sandy Falls GS, and Lower Sturgeon Falls GS. Lake sturgeons were believed to have been extirpated from the 35 km reach between the Wawaitin GS and the Sandy Falls GS, and consequently, 52 adult lake sturgeon from Little Long Reservoir were translocated into the reach in 2002 (Barth et al. 2017). The success of the translocation effort was determined when 10 adult

and 103 juvenile lake sturgeon were captured between the Wawaitin GS and Sandy Falls GS in 2011, 2013, and 2015 (Boothroyd 2018). Genetic analysis revealed that the juveniles were related to the translocated fish, indicating that some of the translocated fish had successfully spawned (Boothroyd 2018; Boothroyd et al. 2018). This population has now grown to between 300 to 400 individuals (D. Gibson, Ontario Power Generation, pers. comm.). The Mattagami River between Sandy Falls GS and Lower Sturgeon GS was designated as a Fish Sanctuary by the Ontario MNR in 2007 (MRET 2007).

The current size of the lake sturgeon population between the Lower Sturgeon GS and Cypress Falls is unknown. Cypress Falls is a suspected spawning area located upstream of the Missinabi River confluence and is an impassible barrier to upstream migrants. In 1985, the MNR conducted a gill netting program on the Mattagami River between the Lower Sturgeon GS and Lower Rapids (approximately 34 km downstream of the Lower Sturgeon GS). Lake sturgeons were not captured in 40 gill nets set within 7 km of the Lower Sturgeon GS. Based on mark-recapture data, it was estimated that about 114 lake sturgeon were resident in this river section (Payne 1987). The estimated lake sturgeon biomass in this section of the Mattagami River was 2.0 kg/ha which is lower than the estimated 7.1 kg/ha for the Abitibi River and 13 to 22 kg/ha for the Frederick House River (Payne 1987). No young-of-year lake sturgeon were captured downstream of the Lower Sturgeon GS in 2005 (MRET 2007).

The lake sturgeon population in the Mattagami River between Cypress Falls and the Little Long GS has been estimated to include up to 12,000 individuals (Sheehan and McKinley 1992). A more recent survey estimated nearly 10,000 individuals (Hatch 2014). This population includes the Groundhog River from the LaDuke Rapids barrier to the confluence with the Mattagami River, the lower Kaspuskasing River, and the Little Long Reservoir.

4.4.4.2 North Driftwood River

The North Driftwood River is a tributary of the Abitibi River with its confluence more than 60 km downstream from the PA. The Abitibi River is known to support a lake sturgeon population. A survey of potential barriers to upstream migration of lake sturgeon into the North Driftwood River and a survey of the current distribution of lake sturgeon in the North Driftwood River has not been conducted. However, no lake sturgeon eDNA was detected in any of the samples collected in the North Driftwood River in spring 2023 (2021-2023 Fish and Fish Habitat Baseline, Appendix B.8.2 of the Impact Statement).

The aerial survey undertaken in May 2024 identified five barriers to upstream migration in the North Driftwood River. One of these barriers (a series of bedrock waterfalls) was identified as being ‘impassable without reservation’, meaning that lake sturgeon would not be able to pass upstream beyond this point, regardless of the flow conditions in the river. This barrier is 21.8km upstream of the NDR’s confluence with the Abitibi River and 63.3km downstream of the Project Area. The NDR can therefore be excluded as a possible avenue for lake sturgeon to enter the project area from downstream.

4.4.4.3 West Buskegau River

The West Beskegau River flows into the Buskegau River approximately 19km downstream of the Project. The Buskegau River flows for a distance of approximately 42.6km before joining the Frederick House River. The Frederick House River is known to support a lake sturgeon population. The spring 2024 survey found that there are no barriers to upstream passage of Lake Sturgeon in the West Buskegau River or Buskegau River that would prevent Lake Sturgeon in the Frederick House River from migrating upstream into habitat near the Project area. There are three impediments to passage in the WBR, which at high or moderate flow may allow lake sturgeon access to upstream. Seven riffles in the WBR and Buskegau River between the Frederick House River confluence and the Project area were identified as having high potential for Lake Sturgeon spawning. All were in the Buskegau River within 16 km of the confluence with the Frederick House River (between 45.21 and 61.65 km downstream of the Project area).

Even though there are no barriers to upstream passage via the WBR, the likelihood of sturgeon using the habitat in the project area is considered low. This is because the habitat conditions in the Project area are not considered attractive to lake sturgeon, being relatively shallow, slow moving, and depositional in nature.

4.5 Sediment Quality

A total of 64 sediment samples were collected in 2021 and 2022: 46 sediment samples from the North Driftwood River watershed and 18 sediment samples from the West Buskegau River watershed. Mean metal concentrations (± standard deviation) in sediment samples collected in the North Driftwood River and West Buskegau River watersheds are presented in Table 4.5. A summary of sediment metal concentrations that exceeded provincial and/or federal sediment quality guidelines for the protection of aquatic biota is presented in Table 4.6.

4.5.1 North Driftwood River Watershed

Laboratory analysis of the 46 sediment samples collected from the lakes, streams, and ponds in the North Driftwood River watershed showed that:

- Lake and pond sediment samples were primarily comprised of silt and fine clay and stream sediment samples were primarily comprised of silt, clay, and fine sand.
- Arsenic concentrations ranged from 1.46 to 9.05 mg/kg and were above the PSQG for the protection and management of aquatic sediment quality in Ontario LEL and CSQG ISQG for the protection of aquatic life (CCME 2002) in five of the 46 samples (8%).
- Cadmium concentrations ranged from 0.08 to 1.9 mg/kg and were above the PSQG LEL and CSQG ISQG in 26 of the 46 samples (57%).
- Chromium concentrations ranged from 16.7 to 59.1 mg/kg and were above the PSQG LEL in 24 of 46 samples (52%) and above the CCME ISQG in nine of 46 samples (20%).

- Copper concentrations ranged from 5.17 to 47.6 mg/kg and were above the PSQG LEL in 21 of 46 samples (46%) and the above the CCME ISQG in one of 46 samples (2%).
- Iron concentrations ranged from 6,020 to 38,100 mg/kg and were above the PSQG LEL in seven of 46 samples (15%).
- Lead concentrations ranged from 4.91 to 71.7 mg/kg and were above the PSQG LEL in eight of 46 samples (17%) and CSQG ISQG in six of 46 samples (13%).
- Manganese concentrations ranged from 135 to 1660 mg/kg and were above the PSQG LEL in 26 of 46 samples (57%) and the above the PSQG SEL in four of 46 samples (9%).
- Mercury concentrations ranged from 0.0267 to 0.138 mg/kg and were below the provincial and federal sediment quality guidelines for the protection of aquatic biota.
- Nickel concentrations ranged from 8.95 to 34.9 mg/kg and were above the PSQG LEL in 24 of 46 samples (52%).
- Zinc concentrations ranged from 35.6 to 171 mg/kg and were above the PSQG LEL and CSQG ISQG in 14 of 46 samples (30%).

4.5.2 West Buskegau River Watershed

Laboratory analysis of the 18 sediment samples collected from lake, stream, and pond stations in the West Buskegau River showed that:

- Lake and pond sediment samples were primarily comprised of silt and fine clay and stream sediment samples were primarily comprised of silt, clay, and fine sand.
- Arsenic concentrations ranged from 1.51 to 4.02 mg/kg and were below the provincial and federal sediment quality guidelines for the protection of aquatic biota.
- Cadmium concentrations ranged from 0.141 to 1.66 mg/kg and were above the PSQG LEL and CSQG ISQG in four of 18 samples (22%).
- Chromium concentrations ranged from 13.8 to 47 and were above the PSQG LEL in nine of 18 samples (50%) and above the CSQG ISQG in three of 18 samples (17%).
- Copper concentrations ranged from 3.48 to 17.4 mg/kg and were above the PSQG LEL in one of the 18 samples (6%).
- Iron concentrations ranged from 7,360 to 21,900 and were above the PSQG LEL in two of 18 samples (11%).
- Lead concentrations ranged from 3.17 to 33.3 mg/kg and were above the PSQG LEL in one of 18 samples (6%).
- Manganese concentrations ranged from 333 to 2,050 mg/kg and were above the PSQG LEL in 12 of 18 samples (67%) and PSQG SEL in two of 18 samples (11%).
- Mercury concentrations ranged from 0.0129 to 0.133 mg/kg and were below the provincial and federal sediment quality guidelines for the protection of aquatic biota.

- Nickel concentrations ranged from 7.7 to 24.4 mg/kg and were above the PSQG LEL in six of 18 samples (33%).
- Zinc concentrations ranged from 30.9 to 134 mg/kg and were above the PSQG LEL and CSQG ISQG in two of 18 samples (11%).

Table 4.5 Summary Statistics for Sediment Quality Samples Collected in the North Driftwood River and West Buskegau River watershed in 2021 and 2022

Parameter (mg/kg)	North Driftwood River												West Buskegau River			
	Martin Lake (n=6)		Gerry Lake (n=6)		Jack Lake (n=3)		Sutherland Lake (n=3)		Unnamed Watercourses (n=21)		Unnamed Ponds (n=7)		Unnamed Watercourses (n=9)		Unnamed Ponds (n=9)	
Aluminum (Al)	16250	± 6367	15153	± 5984	11920	± 2131	8890	± 650	9269	± 1964	9673	± 987	7942	± 3044	12380	± 4009
Antimony (Sb)	0.18	± 0.05	0.18	± 0.05	0.46	± 0.31	0.41	± 0.13	0.11	± 0.01	0.26	± 0.19	0.10	± 0.01	0.12	± 0.02
Arsenic (As)	4.17	± 1.09	4.67	± 1.26	6.30	± 3.58	6.08	± 0.73	2.29	± 0.48	3.45	± 1.41	2.56	± 0.87	2.61	± 0.67
Barium (Ba)	108.5	± 36.4	141.6	± 51.1	77.7	± 17.4	49.2	± 11.7	59.5	± 12.5	68.6	± 11.0	45.0	± 19.0	76.4	± 8.6
Beryllium (Be)	0.54	± 0.18	0.53	± 0.19	0.45	± 0.16	0.33	± 0.06	0.28	± 0.07	0.37	± 0.02	0.28	± 0.12	0.39	± 0.18
Bismuth (Bi)	0.25	± 0.06	0.25	± 0.06	0.42	± 0.23	0.39	± 0.04	<0.20	± -	0.24	±	<0.20	± -	0.20	± 0.01
Boron (B)	8.9	± 3.1	10.5	± 2.8	11.4	± 3.3	18.1	± 1.5	5.4	± 0.7	7.6	± 1.7	5.9	± 1.2	6.4	± 1.7
Cadmium (Cd)	0.72	± 0.14	0.73	± 0.27	1.16	± 0.96	1.39	± 0.09	0.57	± 0.26	0.79	± 0.27	0.25	± 0.10	0.80	± 0.50
Calcium (Ca)	11233	± 2629	25317	± 6545	26933	± 26733	16800	± 3100	8200	± 3887	15000	± 2662	12390	± 11755	10967	± 4204
Chromium (Cr)	40.3	± 14.6	39.1	± 13.5	35.5	± 3.9	24.3	± 3.1	25.5	± 7.4	24.0	± 2.8	24.6	± 9.1	28.7	± 10.9
Cobalt (Co)	10.1	± 3.31	10.4	± 2.41	8.8	± 1.52	5.6	± 0.73	6.7	± 1.67	6.3	± 1.26	6.9	± 2.27	8.8	± 2.09
Copper (Cu)	19.1	± 7.6	20.9	± 6.6	35.9	± 10.8	27.1	± 5.9	11.0	± 5.2	18.5	± 4.4	7.8	± 3.2	12.5	± 2.9
Iron (Fe)	21100	± 8227	27367	± 11701	18967	± 666	12433	± 751	11108	± 2842	11417	± 1267	12503	± 4271	13700	± 5328
Lead (Pb)	17.5	± 6.4	17.4	± 7.0	40.9	± 33.1	46.4	± 3.3	9.1	± 2.4	22.2	± 11.7	5.6	± 2.1	18.3	± 7.7
Lithium (Li)	23.9	± 8.3	21.7	± 8.6	16.9	± 1.6	12.1	± 1.3	12.5	± 3.0	12.6	± 2.2	12.3	± 4.8	15.2	± 6.5
Magnesium (Mg)	7495	± 3379	12565	± 4916	10020	± 7091	6123	± 2086	4139	± 1311	5329	± 1934	5813	± 3331	4987	± 2412
Manganese (Mn)	799	± 307	899	± 404	276	± 27	240	± 75	662	± 388	301	± 149	676	± 295	807	± 551
Mercury (Hg)[1]	0.099	± 0.014	0.084	± 0.024	-	± -	-	± -	0.069	± 0.036	0.106	± 0.007	0.023	± 0.010	0.122	± 0.012
Molybdenum (Mo)	0.41	± 0.12	0.55	± 0.16	1.24	± 0.65	1.91	± 0.34	0.45	± 0.61	0.63	± 0.40	0.22	± 0.21	0.53	± 0.28
Nickel (Ni)	24.5	± 8.6	25.1	± 7.8	25.9	± 1.9	19.0	± 1.2	13.5	± 4.2	16.4	± 2.2	13.8	± 5.2	15.2	± 5.5
Phosphorus (P)	663	± 140	722	± 273	988	± 550	1190	± 149	607	± 151	761	± 212	397	± 91	716	± 168
Potassium (K)	2247	± 976	2158	± 947	1643	± 211	1490	± 132	1003	± 253	1203	± 148	1041	± 504	1512	± 533
Selenium (Se)	0.47	± 0.14	0.50	± 0.16	1.25	± 0.96	1.64	± 0.18	0.33	± 0.17	0.89	± 0.45	<0.20	± -	0.49	± 0.17
Silver (Ag)	0.11	± 0.01	0.12	± 0.02	0.17	± 0.08	0.15	± 0.03	<0.10	± -	0.11	± 0.01	<0.10	± -	<0.10	± -
Sodium (Na)	211	± 96	242	± 105	289	± 88	413	± 90	129	± 37	141	± 19	109	± 44	160	± 50
Strontium (Sr)	29.1	± 5.2	38.6	± 7.1	29.3	± 11.7	22.0	± 3.6	22.0	± 7.3	34.7	± 6.6	19.1	± 9.7	32.3	± 9.4
Sulfur (S)	1567	± 416	2283	± 943	7433	± 5284	11467	± 1553	1160	± 345	3057	± 2309	<1000	± -	1433	± 458
Thallium (Tl)	0.176	± 0.054	0.165	± 0.027	0.218	± 0.006	0.169	± 0.031	0.110	± 0.021	0.120	± 0.021	0.084	± 0.032	0.147	± 0.030
Tin (Sn)	1.5	± 0.5	1.6	± 0.5	3.0	± 0.8	4.2	± 1.4	1.4	± 0.5	1.3	± 0.4	<1.0	± -	1.7	± 0.5
Titanium (Ti)	722	± 237	629	± 200	503	± 185	337	± 45	434	± 118	357	± 117	483	± 148	446	± 284
Tungsten (W)	<0.50	± -	<0.50	± -	0.51	± 0.02	0.54	± 0.03	<0.50	± -	<0.50	± -	<0.50	± -	<0.50	± -
Uranium (U)	0.945	± 0.121	0.634	± 0.107	0.927	± 0.372	2.727	± 0.920	1.119	± 1.057	1.092	± 0.230	0.522	± 0.197	1.170	± 0.541
Vanadium (V)	35.6	± 13.1	34.0	± 12.2	31.3	± 0.1	19.4	± 3.6	20.8	± 3.7	21.5	± 2.2	22.3	± 7.7	25.0	± 7.8

Parameter (mg/kg)	North Driftwood River												West Buskegau River					
	Martin Lake (n=6)			Gerry Lake (n=6)			Jack Lake (n=3)			Sutherland Lake (n=3)			Unnamed Watercourses (n=21)			Unnamed Ponds (n=7)			Unnamed Watercourses (n=9)			Unnamed Ponds (n=9)		
Zinc (Zn)	136.4	±	38.2	116.6	±	37.0	113.9	±	70.1	135.3	±	16.3	80.7	±	29.1	93.8	±	25.2	48.5	±	15.3	87.1	±	30.5
Zirconium (Zr)	8.2	±	2.7	10.0	±	4.4	6.3	±	0.7	6.5	±	1.6	3.0	±	1.1	6.4	±	0.7	3.6	±	2.0	4.3	±	2.5

Notes:

n = the total number of sediment samples collected for each waterbody

Data in this table was extracted from Appendix E of the *2021-2023 Fish and Fish Habitat Baseline* (Appendix B.8.2 in the Impact Statement).

1 - Mercury was not sampled for all sediment samples, sample sizes for mercury was three for Martin Lake and Gerry Lake, zero for Jack Lake and Sutherland Lake, 12 and six for unnamed watercourses and unnamed ponds from North Driftwood River, respectively, and three from unnamed ponds from West Buskegau River.

Table 4.6 Summary of Frequency of Exceedance of Provincial and/or Federal Sediment Quality Guidelines for Sediment Samples Collected in the North Driftwood River and West Buskegau River watersheds in 2021 and 2022

Parameter	North Driftwood River						West Buskegau River	
	Martin Lake (n=6)	Gerry Lake (n=6)	Jack Lake (n=3)	Sutherland Lake (n=3)	Unnamed watercourses (n=21)	Unnamed ponds (n=7)	Unnamed watercourses (n=9)	Unnamed ponds (n=9)
Percent (%) of Samples Exceeding Guidelines								
Arsenic (As)		17 (PSQG LEL)	67 (PSQG LEL)	67 (PSQG LEL)				
		17 (CSQG ISQG)	67 (CSQG ISQG)	67 (CSQG ISQG)				
Cadmium (Cd)	67 (PSQG LEL)	67 (PSQG LEL)	67 (PSQG LEL)	100 (PSQG LEL)	33 (PSQG LEL)	86 (PSQG LEL)		44 (PSQG LEL)
	67 (CSQG ISQG)	67 (CSQG ISQG)	67 (CSQG ISQG)	100 (CSQG ISQG)	33 (CSQG ISQG)	86 (CSQG ISQG)		44 (CSQG ISQG)
Chromium (Cr)	100 (PSQG LEL)	67 (PSQG LEL)	100 (PSQG LEL)	33 (PSQG LEL)	33 (PSQG LEL)	43 (PSQG LEL)	56 (PSQG LEL)	44 (PSQG LEL)
	50 (CSQG ISQG)	67 (CSQG ISQG)	33 (CSQG ISQG)		5 (CSQG ISQG)		11 (CSQG ISQG)	22 (CSQG ISQG)
Copper (Cu)	50 (PSQG LEL)	67 (PSQG LEL)	67 (PSQG LEL)	100 (PSQG LEL)	19 (PSQG LEL)	57 (PSQG LEL)		11 (PSQG LEL)
			33 (CSQG ISQG)					
Iron (Fe)	50 (PSQG LEL)	67 (PSQG LEL)						22 (PSQG LEL)
Lead (Pb)			67 (PSQG LEL)	100 (PSQG LEL)		43 (PSQG LEL)		11 (PSQG LEL)
			67 (CSQG ISQG)	100 (CSQG ISQG)		14 (CSQG ISQG)		
Manganese (Mn)	100 (PSQG LEL)	100 (PSQG LEL)			62 (PSQG LEL)	14 (PSQG LEL)	67 (PSQG LEL)	67 (PSQG LEL)
	17 (PSQG SEL)	17 (PSQG SEL)			10 (PSQG SEL)			22 (PSQG SEL)
Nickel (Ni)	100 (PSQG LEL)	67 (PSQG LEL)	100 (PSQG LEL)	100 (PSQG LEL)	14 (PSQG LEL)	71 (PSQG LEL)	33 (PSQG LEL)	33 (PSQG LEL)
Zinc (Zn)	50 (PSQG LEL)	67 (PSQG LEL)	67 (PSQG LEL)	100 (PSQG LEL)	5 (PSQG LEL)	14 (PSQG LEL)		22 (PSQG LEL)
	50 (CSQG ISQG)	67 (CSQG ISQG)	67 (CSQG ISQG)	100 (CSQG ISQG)	5 (CSQG ISQG)	14 (CSQG ISQG)		22 (CSQG ISQG)

Notes:
PSQG: Provincial Sediment Quality Guidelines for the protection and management of aquatic sediment quality in Ontario; LEL = lowest effect level; SEL = severe effect level; CSQG: Canadian Sediment Quality Guidelines for the protection of aquatic life; ISQG = interim sediment quality guideline.
Light green highlighted text indicates an exceedance of the PSQG LEL.
Dark green highlighted text indicates an exceedance of the PSQG SEL.
Light blue highlighted text indicates an exceedance of the CSQG ISQG.
Dark blue highlighted text indicates an exceedance of the CSQG PEL.
n = the total number of sediment samples collected for each waterbody.
Data in this table was extracted from Appendix E in *2021-2023 Fish and Fish Habitat Baseline* (Appendix B.8.2 of the Impact Statement).

4.6 Benthic Invertebrate Community

A total of 27 benthic invertebrate samples were collected in 2021 and 2022: 20 benthic invertebrate samples from the North Driftwood River watershed; six benthic invertebrate samples from the West Buskegau River watershed; and one benthic invertebrate sample from the Jocko Creek watershed. A summary of the mean benthic invertebrate community indices in the North Driftwood River, West Buskegau River, and Jocko Creek watersheds is presented in Table 4.7.

4.6.1 North Driftwood River Watershed

Laboratory analysis of the 20 benthic invertebrate samples collected from lake, stream, and pond stations in the North Driftwood River showed that:

- Total density of benthic invertebrates ranged from 498 to 33,469 individuals per m^2 with an average density of 7,800 individuals per m^2.
- Taxa richness ranged from two to 27 taxa per sample. The average taxa richness for all samples collected was 8.5 taxa per sample.
- The SDI ranged from 0.25 to 0.79 and SEI were low at all sites (<0.50) indicating that one taxonomic group dominated the benthic invertebrate community. The SEI ranged from 0.11 to 0.5 and the average SEI for all sites was 0.23.
- The EPT% ranged from 0 to 29% with an average of 6.85% EPT in all sites. EPT% was generally low (<15%), which indicates a low abundance of swift flowing habitat with clean, course substrates, habitat preferred by these taxa.
- The % chironomid larvae ranged from 27 to 85% with an average of 52.8% chironomid larvae in all samples collected. In general, one or two species of chironomids (i.e. midge larvae) dominated the samples collected.

4.6.2 West Buskegau River Watershed

Laboratory analysis of the six benthic invertebrate samples collected from lakes, streams, and ponds in the West Buskegau River showed that:

- Total density of benthic invertebrates ranged from 4,415 to 16,213 individuals per m^2 with an average density of 8,917 individuals per m^2. Taxa richness ranged from five of 14 taxa per sample. The average taxa richness was 10.7 for all samples.
- The SDI ranged from 0.12 to 0.83 with an average SDI of 0.58.
- The SEI were generally low (<0.50) at all sites indicating that one taxonomic group dominated the benthic invertebrate community. SEI ranged from a 0.9 to 0.32 with an average SEI of 0.20.
- The EPT% ranged from 1 to 33%, with an average of 11.5% EPT. The EPT% was generally low (<15%), which indicates that most sites had a low abundance of swift flowing habitat with clean, course substrates, habitat preferred by these taxa.

- The % chironomid larvae ranged from 25% to 97% with an average % chironomid larvae of 50%. In general, one or two species of chironomids (i.e. midge larvae) dominated all samples collected in the West Buskegau River watershed.

4.6.3 Jocko Creek Watershed

Laboratory analysis of the benthic invertebrate community samples collected from the one stream site in the Jocko Creek watershed showed that:

- Total density of benthic invertebrates was 34,638 individuals per m^2, which was the highest density of individuals in all samples collected in 2021 and 2022 from the three watersheds.
- Taxa richness was nine taxa per sample, SDI was 0.15, and SEI was low (0.06) indicating that one taxonomic group dominated the benthic invertebrate community.
- The EPT% was 1% and the % chironomid larvae was 92%. These data suggest a paucity of the swift flowing habitat with clean, course substrates that is preferred by EPT taxa and that the habitat at the sample site was more representative of the slow-flowing deposition habitat preferred by chironomid larvae.

Table 4.7 Summary of Benthic Invertebrate Community Indices for Samples Collected in the North Driftwood River, West Buskegau River, and Jocko Creek Watersheds in 2021 and 2022

Watershed	Waterbody	Station ID	Sample Year	Mean Density (#/m^2)	Mean Richness	Mean Diversity	Mean Evenness	Mean % EPT	Mean % Chiron.
North Driftwood River	Gerry Lake	NDR-GER-LK	2021	12456	12	0.76	0.25	29	38
	Martin Lake	NDR-MAR-LK	2021	16623	11	0.70	0.17	21	50
	Unnamed Pond	NDR-P-01	2021	2369	6	0.64	0.24	0	66
	Unnamed Pond	NDR-P-03	2021	4758	7	0.55	0.15	3	63
	Unnamed Watercourse	NDR-S-01	2021	4483	3	0.25	0.15	0	85
	Unnamed Watercourse	NDR-S-02	2021	9754	13	0.70	0.15	13	51
	Unnamed Watercourse	NDR-S-04	2021	3903	13	0.77	0.29	18	43
	Unnamed Watercourse	NDR-TRIB-01	2021	11522	7	0.56	0.16	0	62
West Buskegau River	Unnamed Pond	WBR-P-01	2021	9043	5	0.45	0.13	3	71
	Unnamed Watercourse	WBR-S-02	2021	4923	14	0.82	0.23	33	31
	Unnamed Watercourse	WBR-S-03	2021	12454	14	0.75	0.17	9	25
	Unnamed Watercourse	WBR-S-04	2021	4415	14	0.83	0.24	18	30
North Driftwood River	Gerry Lake	NDR-GER-LK	2022	1314	4	0.42	0.34	0	29
	Martin Lake	NDR-MAR-LK	2022	1271	6	0.48	0.34	3	36
	Jack Lake	NDR-JAC-LK	2022	1899	8	0.46	0.20	10	68
	Sutherland Lake	NDR-SUT-LK	2022	498	4	0.60	0.50	0	35
	Unnamed Pond	NDR-P-01	2022	3715	2	0.25	0.30	0	61
	Unnamed Pond	NDR-P-03	2022	1217	3	0.30	0.27	0	80
	Unnamed Pond	NDR-P-07	2022	9662	3	0.53	0.24	0	60
	Unnamed Watercourse	NDR-S-01	2022	3169	4	0.45	0.27	0	67
	Unnamed Watercourse	NDR-S-02	2022	6493	15	0.73	0.13	25	43
	Unnamed Watercourse	NDR-S-04	2022	9319	27	0.79	0.15	14	34

Watershed	Waterbody	Station ID	Sample Year	Mean Density (#/m^2)	Mean Richness	Mean Diversity	Mean Evenness	Mean % EPT	Mean % Chiron.
	Unnamed Watercourse	NDR-S-05	2022	33469	6	0.43	0.16	0	27
	Unnamed Watercourse	NDR-TRIB-01	2022	18097	16	0.62	0.11	1	58
West Buskegau River	Unnamed Pond	WBR-P-03	2022	16213	11	0.12	0.09	1	94
	Unnamed Pond	WBR-P-04	2022	6454	6	0.49	0.32	5	49
Jocko Creek	Unnamed Watercourse	JC-S-01	2022	34638	9	0.15	0.06	1	92

4.7 Plankton Communities

4.7.1 Phytoplankton

Results of phytoplankton sampling showed seasonal variability in the community assemblage and biomass, typical of northeastern Ontario environments. A total of seven classes of phytoplankton were identified, including Bacillariophyceae, Chlorophyceae, Chrysophyceae, Cryptophyceae, Cyanophyceae, Dinophyceae, and Euglenophyceae. The total number of classes per lake, as well as the dominant class, based on relative biovolume and relative density, are presented in Table 4.8.

Gerry Lake had the highest phytoplankton density and Davis Lake had the lowest phytoplankton density of all sample locations. Martin Lake had the highest phytoplankton biovolume and Davis Lake had the lowest phytoplankton biovolume of the locations sampled. Sutherland Lake had the greatest class diversity of all locations sampled (n=7), whereas Gerry and Martin Lake had the lowest species diversity with only four classes each.

Table 4.8 Summary of Phytoplankton Diversity, Relative Biovolume and Relative Density in Headwater Lakes near the Project

Waterbody	No. of Classes	Dominant Phytoplankton Classes Based on Relative Biovolume	Dominant Phytoplankton Classes Based on Relative Density
Gerry Lake	4	• Cyanophyceae (blue-green algae) • Bacillariophyceae (diatoms)	• Chrysophyceae (golden algae) • Bacillariophyceae (diatoms)
Martin Lake	4	• Bacillariophyceae (diatoms)	• Bacillariophyceae (diatoms)
Jack Lake	5	• Chrysophyceae (golden algae) • Cyanophyceae (blue-green algae)	• Cryptophyceae (cryptophyte algae) • Chrysophyceae (golden algae) • Cyanophyceae (blue-green algae)
Sutherland Lake	7	• Bacillariophyceae (diatoms) • Dinophyceae (dinoflagellates)	• Bacillariophyceae (diatoms) • Chlorophyceae (green algae) • Chrysophyceae (golden algae)
Mel Lake	5	• Chlorophyceae (green algae) • Cyanophycae (blue-green algae)	• Chrysophyceae (golden algae) • Chlorophyceae (green algae) • Cyanophyceae (golden algae)
Davis Lake	5	• Chlorophyceae (green algae) • Cyanophycae (blue-green algae)	• Chrysophyceae (golden algae) • Chlorophyceae (green algae) • Cyanophyceae (golden algae)

4.7.2 Zooplankton

Nine orders of zooplankton were found in the lakes sampled during baseline sampling activities in 2021 and 2022. Daphniidae, Calanoida, Cyclopoida, and Bosminidae were the most common orders of zooplankton in the sampled lakes (Table 4.9). These four orders accounted for over 90% of zooplankton density. Relative species composition was seasonally variable, and biomass ranged from 28 to 1,200 mg/m^3.

Table 4.9 Summary of Zooplankton Diversity, Relative Biomass and Relative Density in Headwater Lakes near the Project

Waterbody	Year	No. Zooplankton Orders (Diversity)	Dominant Zooplankton Orders Based on Biomass	Dominant Zooplankton Orders Based on Relative Density
Gerry Lake	2021	5	• Daphniidae • Calanoida • Bosminidae	• Cyclopoida • Calanoida • Daphniidae
	2022	7	• Bosminidae • Calanoida • Cyclopoida	• Bosminidae • Calanoida • Ploima
Martin Lake	2021	5	• Daphniidae • Calanoida • Bosminidae	• Cyclopoida • Calanoida • Daphniidae
	2022	7	• Ploima • Cyclopoida	• Bosminidae • Calanoida • Ploima
Jack Lake	2022	7	• Daphniidae	• Cyclopoida • Daphniidae • Flosculariaceae • Ploima
Sutherland Lake	2022	7	• Daphniidae	• Bosminidae • Cyclopoida • Daphniidae • Ploima
Mel Lake	2022	7	• Daphniidae • Cyclopoida	• Bosminidae • Cyclopoida • Daphniidae
Davis Lake	2022	7	• Calanoida • Daphniidae • Cyclopoida	• Flosculariaceae • Cyclopoida

4.8 Fish Tissue Contaminant Burdens

Sixteen northern pike muscle tissue samples and 33 small-bodied fish samples were collected and analyzed from North Driftwood River watershed (Table 4.10). Northern pike samples were collected only from the headwater lakes in the North Driftwood River watershed (i.e., Martin, Gerry, Sutherland, and Jack lakes). Northern redbelly dace, northern pearl dace, finescale dace, fathead minnow, and brook stickleback were collected from headwater ponds and tributaries in the North Driftwood River watershed. Brook sticklebacks were also collected in Jack Lake.

Thirteen composite forage fish tissue samples were collected and analyzed from the West Buskegau River watershed (Table 4.10). They included nine composite finescale dace samples and four brook stickleback samples. All samples were collected in headwater ponds within the PA. No northern pike samples were collected in the West Buskegau River watershed in 2021 or 2022.

Seven composite forage fish tissue samples were collected and analyzed from the Jocko Creek watershed (Table 4.10). They included five lake chub samples and two brook stickleback samples. No northern pike were collected from the Jocko Creek watershed in 2021 or 2022.

Table 4.10 Summary of fish tissue samples collected from the North Driftwood River, West Buskegau River, and Jocko Creek watersheds in 2021 and 2022

Watershed	Fish Species	Waterbody Name & Sample ID	Habitat type	Sample Year	Number of Samples
North Driftwood River	Northern Pike	Gerry Lake	Lake	2021	8
	Northern Pike	Martin Lake	Lake	2021	4
	Northern Pike	Martin Lake	Lake	2022	1
	Northern Pike	Sutherland Lake	Lake	2022	2
	Northern Pike	Jack Lake	Lake	2022	1
	Northern Pearl Dace	NDR-S-01	Mainstem river	2021	3
	Northern Redbelly Dace	NDR-P-03	Headwater pond	2021	3
	Northern Redbelly Dace	NDR-P-03	Headwater pond	2022	5
	Fathead Minnow	NDR-P-03	Headwater pond	2022	2
	Finescale Dace	NDR-P-01	Headwater pond	2022	5
	Finescale Dace	NDR-P-06	Headwater pond	2022	5
	Brook Stickleback	NDR-S-05	Headwater tributary	2022	2
	Finescale Dace	NDR-S-05	Headwater tributary	2022	2
	Northern Redbelly Dace	NDR-S-05	Headwater tributary	2022	2
	Brook Stickleback	NDR-Trib-02	Headwater Tributary	2022	1
	Northern Pearl Dace	NDR-Trib-02	Headwater tributary	2022	1
	Brook Stickleback	Jack Lake	Lake	2022	1

Watershed	Fish Species	Waterbody Name & Sample ID	Habitat type	Sample Year	Number of Samples
	Brook Stickleback	NDR-S-01	Mainstem river	2022	1
West Buskegau River	Finescale Dace	WBR-P-04	Headwater pond	2022	5
	Finescale Dace	WBR-P-03	Headwater pond	2022	4
	Brook Stickleback	WBR-P-04	Headwater pond	2022	2
	Brook Stickleback	WBR-P-03	Headwater pond	2022	2
Jocko Creek	Lake Chub	JC-S-01	Headwater tributary	2022	5
	Brook Stickleback	JC-S-01	Headwater tributary	2022	2

Laboratory results for the fish tissue samples with summary statistics are presented in Appendix D of this report and are summarized in Table 4.11. Results for mercury and selenium, two parameters known to bioaccumulate in fish tissues, are discussed below.

4.8.1 Mercury

Total mercury concentrations in northern pike muscle tissue samples from the North Driftwood River watershed ranged from 0.20 to 6.03 mg/kg wwt, with an average concentration of 1.03 mg/kg wwt (Table 4.11). Eight of the 16 northern pike muscle tissue samples exceeded the Ontario sensitive population (0.5 mg/kg wwt) and Health Canada (0.5 mg/kg wwt) guidelines for total mercury for human consumption. Three of these eight samples also exceeded the Ontario consumption guideline developed for the general human population (1.8 mg/kg wwt) for total mercury. Elevated mercury levels in large-bodied fish such as northern pike is commonly observed in samples from northern Ontario and inland waterbodies (MOE 2015; Pirkle et al. 2016; Fimreite and Reynolds 1973) and is not unique to the site.

Total mercury concentrations in forage fish composite samples ranged from 0.009 to 0.131 mg/kg wwt (Table 4.11). Mean mercury concentrations were greater in forage fish from the Jocko Creek watershed (0.082 mg/kg wwt) than from the North Driftwood River watershed (0.040 mg/kg wwt) and West Buskegau River watershed (0.027 mg/kg wwt).

Methylmercury concentrations in northern pike muscle tissue samples ranged from 135 to 6,230 µg/kg wwt, with an average concentration of 1,100 µg/kg wwt (Table 4.11). All northern pike tissue samples exceeded the CCME guideline for the protection of wildlife consumers of aquatic biota for methylmercury (33 µg/kg wwt). Methylmercury in forage fish composite samples ranged from 6.20 to 152 µg/kg wwt. Mean methylmercury concentrations were greater in forage fish from the Jocko Creek watershed (81.6 µg/kg wwt) than from the North Driftwood River watershed (38.2 µg/kg wwt) and the West Buskegau River watershed (23.6 µg/kg wwt). Forage fish composite samples from all three watersheds exceeded the CCME guideline for the protection of wildlife consumers of aquatic biota for methylmercury (33 µg/kg wwt): 16 of 33 samples from North Driftwood River, one of 13 samples from West Buskegau River, and all seven samples from Jocko Creek watershed.

4.8.2 Selenium

Selenium concentrations in northern pike tissue samples ranged from 0.400 to 0.697 mg/kg dwt, with an average concentration of 0.544 mg/kg dwt (Table 4.11). Selenium in forage fish composite samples ranged from 0.634 to 2.010 mg/kg dwt. All northern pike and forage fish samples from the North Driftwood River, West Buskegau River, and Jocko Creek watersheds had selenium concentrations below the federal selenium tissue guideline (6.7 mg/kg dwt).

Table 4.11 Contaminant Burdens in Northern Pike and Forage Fish Tissue Samples Collected from the North Driftwood River, West Buskegau River, and Jocko Creek watersheds, 2021-2022

		North Driftwood River Watershed										West Buskegau River Watershed					Jocko River Watershed				
		Northern Pike[1]					Forage Fish[2]					Forage Fish[3]					Forage Fish[4]				
Parameter	Units	n	Min	Max	Mean	SD	n	Min	Max	Mean	SD	n	Min	Max	Mean	SD	n	Min	Max	Mean	SD
Aluminum	mg/kg wwt	16	<0.40	1.86	0.81	0.39	33	0.70	12.8	3.39	2.80	13	1.27	21.2	6.18	5.96	7	1.52	3.47	2.13	0.65
Antimony	mg/kg wwt	16	<0.0020	0.0022	0.0020	0.0001	33	<0.0020	<0.0020	<0.0020	-	13	<0.0020	0.0027	0.0021	0.0002	7	<0.0020	<0.0020	<0.0020	-
Arsenic	mg/kg wwt	16	0.0071	0.1670	0.0532	0.0422	33	0.0095	0.0353	0.0221	0.0069	13	0.0213	0.0484	0.0341	0.0084	7	0.0112	0.0222	0.0162	0.0040
Barium	mg/kg wwt	16	0.012	0.073	0.039	0.018	33	0.500	12.8	3.09	2.38	13	1.34	7.54	3.92	2.05	7	0.872	2.19	1.29	0.53
Beryllium	mg/kg wwt	16	<0.0020	<0.0020	<0.0020	-	33	<0.0020	<0.0020	<0.0020	-	13	<0.0020	<0.0020	<0.0020	-	7	<0.0020	<0.0020	<0.0020	-
Bismuth	mg/kg wwt	16	<0.0020	<0.0034	<0.0021	<0.0004	33	<0.0020	<0.0020	<0.0020	-	13	<0.0020	<0.0020	<0.0020	-	7	<0.0020	<0.0020	<0.0020	-
Boron	mg/kg wwt	16	<0.20	<0.20	<0.20	-	33	<0.20	<0.20	<0.20	-	13	<0.20	<0.20	<0.20	-	7	<0.20	<0.20	<0.20	-
Cadmium	mg/kg wwt	16	<0.0010	<0.0011	<0.0010	<0.0000	33	0.0068	0.0415	0.0151	0.0091	13	0.0064	0.0246	0.0139	0.0056	7	0.0226	0.0531	0.0308	0.0110
Calcium	mg/kg wwt	16	136	1270	658	319	33	3900	13000	8293	1825	13	5850	11900	8291	1947	7	6560	10600	7947	1761
Cesium	mg/kg wwt	16	0.0068	0.0317	0.0185	0.0071	33	0.0042	0.0425	0.0148	0.0102	13	0.0027	0.0062	0.0036	0.0009	7	0.0237	0.0486	0.0365	0.0096
Chromium	mg/kg wwt	16	<0.010	<0.036	<0.014	<0.008	33	<0.010	0.160	0.027	0.028	13	<0.010	0.064	0.029	0.018	7	<0.010	<0.010	<0.010	-
Cobalt	mg/kg wwt	16	<0.0040	<0.0040	<0.0040	-	33	0.0065	0.0435	0.0152	0.0085	13	0.0137	0.0436	0.0244	0.0092	7	0.0072	0.0135	0.0098	0.0024
Copper	mg/kg wwt	16	0.103	0.207	0.147	0.027	33	0.61	5.81	1.59	1.17	13	0.644	1.52	0.985	0.322	7	0.853	1.59	1.17	0.235
Iron	mg/kg wwt	16	1.16	4.55	2.52	0.98	33	19.6	51.0	37.0	8.23	13	33.9	66.0	43.9	10.2	7	18.6	26.0	22.0	2.61
Lead	mg/kg wwt	16	<0.0040	<0.0091	<0.0046	<0.0016	33	0.0122	0.0782	0.0271	0.0143	13	0.0297	0.0933	0.0566	0.0226	7	0.069	0.163	0.098	0.037
Lithium	mg/kg wwt	16	<0.10	<0.10	<0.10	-	33	<0.10	<0.10	<0.10	-	13	<0.10	<0.10	<0.10	-	7	<0.10	<0.10	<0.10	-
Magnesium	mg/kg wwt	16	283	350	320	16	33	286	444	349	37	13	214	299	259	29	7	304	390	335	30
Manganese	mg/kg wwt	16	0.092	0.866	0.507	0.208	33	2.21	23.6	6.83	4.36	13	5.36	35.5	12.2	9.32	7	7.24	11.5	8.81	1.63
Mercury	mg/kg wwt	16	0.204	6.03	1.03	1.4	33	0.0086	0.128	0.040	0.025	13	0.0164	0.0643	0.0270	0.0124	7	0.0559	0.131	0.082	0.028
Methylmercury	µg/kg wwt	16	135	6230	1100	1600	33	6.20	132	38.2	27.2	13	12.5	50.6	23.6	10.7	7	49.5	152	81.6	38.7
Molybdenum	mg/kg wwt	16	<0.0040	<0.0040	<0.0040	-	33	0.0179	0.0443	0.0316	0.0057	13	0.0229	0.0655	0.0354	0.0105	7	0.0178	0.0258	0.0222	0.0030
Nickel	mg/kg wwt	16	<0.040	<0.040	<0.040	-	33	<0.040	<0.040	<0.040	-	13	<0.040	0.075	0.044	0.011	7	<0.040	<0.040	<0.040	-
Phosphorus	mg/kg wwt	16	2240	2900	2485	205	33	3930	8620	6255	957	13	3990	7040	5252	1012	7	5400	7960	6439	972
Potassium	mg/kg wwt	16	3290	4620	3900	330	33	2310	3200	2815	216	13	394	1040	663	185	7	2510	3100	2721	182
Rubidium	mg/kg wwt	16	4.78	8.86	7.02	1.34	33	3.03	11.3	6.39	2.26	13	1.36	3.28	1.93	0.50	7	4.65	6.37	5.76	0.71
Selenium	mg/kg dwt	16	0.400	0.697	0.544	0.084	33	0.634	2.01	1.05	0.37	13	0.644	1.05	0.842	0.141	7	0.794	1.030	0.913	0.080
Selenium	mg/kg wwt	16	0.083	0.148	0.109	0.017	33	0.130	0.408	0.233	0.075	13	0.128	0.225	0.167	0.031	7	0.176	0.253	0.201	0.029
Sodium	mg/kg wwt	16	188	461	338	67	33	335	1130	793	196	13	194	350	250	46	7	771	828	801	20
Strontium	mg/kg wwt	16	0.024	0.326	0.172	0.086	33	3.09	13.8	8.15	2.74	13	6.59	15.2	9.25	2.29	7	4.59	6.88	5.82	1.06
Tellurium	mg/kg wwt	16	<0.0040	<0.0040	<0.0040	-	33	<0.0040	<0.0040	<0.0040	-	13	<0.0040	<0.0040	<0.0040	-	7	<0.0040	<0.0040	<0.0040	-
Thallium	mg/kg wwt	16	0.00084	0.00586	0.00328	0.00140	33	0.00125	0.0105	0.0039	0.0023	13	0.00245	0.00816	0.00473	0.00169	7	0.00438	0.0106	0.00623	0.00230
Tin	mg/kg wwt	16	<0.020	0.234	0.042	0.054	33	<0.020	0.397	0.118	0.072	13	0.050	0.142	0.112	0.028	7	0.064	0.186	0.122	0.045
Uranium	mg/kg wwt	16	<0.00040	<0.00040	<0.00040	-	30	0.00055	0.00609	0.00180	0.00167	13	0.00040	0.00227	0.00092	0.00065	7	<0.00040	0.00066	0.00049	0.00010

Parameter	Units	North Driftwood River Watershed										West Buskegau River Watershed					Jocko River Watershed				
		Northern Pike[1]					Forage Fish[2]					Forage Fish[3]					Forage Fish[4]				
		n	Min	Max	Mean	SD	n	Min	Max	Mean	SD	n	Min	Max	Mean	SD	n	Min	Max	Mean	SD
Vanadium	mg/kg wwt	16	<0.020	<0.020	<0.020	-	33	<0.020	0.067	0.023	0.010	13	<0.020	0.078	0.030	0.019	7	<0.020	<0.020	<0.020	-
Zinc	mg/kg wwt	16	3.22	6.51	4.47	0.934	33	25.4	76.8	42.4	14.5	13	38.5	58.3	48.4	6.5	7	29.2	45.1	37.5	5.27
Zirconium	mg/kg wwt	16	<0.040	0.042	0.040	0.001	33	<0.040	<0.040	<0.040	-	13	<0.040	<0.040	<0.040	-	7	<0.040	<0.040	<0.040	-

Notes:

DL = detection limit; n = sample size; SD = standard deviation; SE = standard error; "-" not applicable; mg/kg wwt = milligram per kilogram wet weight; mg/kg dwt = milligram per kilogram dry weight.

Light green highlighted text indicates an exceedance of the Ontario sensitive population (0.5 mg/kg) and Health Canada (0.5 mg/kg) guidelines for total mercury for human consumption.

Dark green highlighted text indicates an exceedance of the Ontario consumption guideline for total mercury developed for the general human population (1.8 mg/kg).

Grey highlighted text indicates an exceedance of the CCME guideline for the protection of wildlife consumers of aquatic biota for methylmercury (33 µg/kg).

Bolded text indicates an exceedance of the Federal Environmental Quality Guideline (FEQG) for selenium in whole body fish tissues (6.7 mg/kg dwt)

1 Northern pike captured in the North Driftwood River watershed were captured in Jack Lake (n=2), Gerry Lake (n=8); Martin Lake (n=5) and Sutherland Lake (n=2).

2 Forage fish captured in North Driftwood River Watershed included composite samples of brook stickleback (n= 5), fathead minnow (n = 2), finescale dace (n= 12), northern pearl dace (n= 4), and northern redbelly dace (n= 10).

3 Forage fish captured in West Buskegau River Watershed included composite samples of brook stickleback (n= 4) and finescale dace (n= 9).

4 Forage fish captured in Jocko Creek Watershed included composite samples of brook stickleback (n= 2) and lake chub (n= 5)

4.9 Fish as Country Food

Apitipi Anicinapek Nation, Flying Post First Nation, Matachewan First Nation, Métis Nation of Ontario - Region 3, Mattagami First Nation, and Taykwa Tagamou Nation harvest fish species within the Indigenous interests LSA and RSA as country foods, as well as for other traditional or medicinal purposes (Apitipi Anicinapek Nation 2023, 2024; Flying Post First Nation 2023; IAAC 2023; Matachewan First Nation 2023; Mattagami First Nation 2023; Taykwa Tagamou Nation 2023). Country food fish species identified by all potentially affected Indigenous nations (as identified in Flying Post First Nation 2023; IAAC 2023; Mattagami First Nation 2023; Matachewan First Nation 2023; Taykwa Tagamou Nation 2023; Wahgoshig First Nation Odonaterra Inc. and Shared Value Solutions 2021) include: bait fish (unspecified), bass (large and smallmouth), brook trout, burbot, catfish (channel and brown bullhead), goldeye, mooneye, northern pike/jackfish, perch, pickerel/walleye, sauger, sea trout, sheepshead, splake, sturgeon, whitefish/lake whitefish

Lake trout was reported to be harvested and consumed by all Indigenous nations except for the Mattagami First Nation (Flying Post First Nation 2023; IAAC 2023; Mattagami First Nation 2023; Matachewan First Nation 2023; Taykwa Tagamou Nation 2023; Wahgoshig First Nation Odonaterra Inc. and Shared Value Solutions 2021). Suckers (white suckers and redhorse) were reported to be harvested and consumed by all Indigenous nations except for Apitipi Anicinapek Nation (Flying Post First Nation 2023; IAAC 2023; Mattagami First Nation 2023; Matachewan First Nation 2023; Taykwa Tagamou Nation 2023; Wahgoshig First Nation Odonaterra Inc. and Shared Value Solutions 2021).

In addition to the fish species listed above, three Indigenous nations identified other fish species that are consumed as country foods or that hold other traditional values specific to their community (IAAC 2023; Matachewan First Nation 2023; Wahgoshig First Nation, Odonaterra Inc. and Shared Value Solutions 2021). These include:

- rainbow trout, an introduced fish species, and smelts which are harvested and consumed by Apitipi Anicinapek Nation
- lingcod/burbot, minnow, speckled trout, and trout which are harvested and consumed by Matachewan First Nation
- northern pike/jackfish which are harvested and consumed by members of the Métis Nation of Ontario (Region 3).

Sturgeon was identified as a culturally important fish species by all Indigenous nations (Apitipi Anicinapek Nation 2024, IAAC 2023; Mattagami First Nation 2023; Matachewan First Nation 2023; Taykwa Tagamou Nation 2023; Wahgoshig First Nation Odonaterra Inc. and Shared Value Solutions 2021). Flying Post First Nation reported that sturgeon is a sacred species (Flying Post First Nation 2023). All Nations reported specific concerns relating to potential Project impacts on sturgeon (Apitipi Anicinapek Nation 2024, Flying Post First Nation 2023; IAAC 2023; Mattagami First Nation 2023; Matachewan First Nation 2023; Taykwa Tagamou Nation 2023; Wahgoshig First Nation Odonaterra Inc. and Shared Value Solutions 2021).

Other fish species that were identified as being of cultural significance and concern include northern pike/jackfish and suckers (white and redhorse) (Apitipi Anicinapek Nation 2024, Flying Post First Nation 2023; IAAC 2023; Mattagami First Nation 2023; Matachewan First Nation 2023; Taykwa Tagamou Nation 2023; Wahgoshig First Nation Odonaterra Inc. and Shared Value Solutions 2021).

Table 4.12 lists the watercourses and waterbodies identified by Indigenous nations as being important for the collection of fish as county foods and other traditional or medicinal purposes (Apitipi Anicinapek Nation 2024; Flying Post First Nation 2023; IAAC 2023; Mattagami First Nation 2023; Matachewan First Nation 2023; Taykwa Tagamou Nation 2023). In addition to the sites listed in Table 4.12, Apitipi Anicinapek Nation, Flying Post First Nation, Matachewan First Nation, Mattagami First Nation, and Taykwa Tagamou Nation reported several unspecified country foods fishing areas within the PA and the LSA (Apitipi Anicinapek Nation 2024; Flying Post First Nation 2023; Mattagami First Nation 2023; Matachewan First Nation 2023; Taykwa Tagamou Nation 2023). All locations identified are shown in the PA and LSA figures included in Appendix A of this report.

Additional information regarding Apitipi Anicinapek Nation, Flying Post First Nation, Matachewan First Nation, Mattagami First Nation, Taykwa Tagamou Nation, and Métis Nation of Ontario - Region 3 rights and interest is described in Chapters 25-28 of the Impact Statement.

Table 4.12 Fishing Sites Reported by Indigenous Nations

Fishing Sites	Location	Indigenous Nation	Source
North Driftwood River	PA	• Apitipi Anicinapek Nation • Flying Post First Nation • Matachewan First Nation • Mattagami First Nation • Métis Nation of Ontario - Region 3 • Taykwa Tagamou Nation	Apitipi Anicinapek Nation 2024; Flying Post First Nation 2023; IAAC 2023; Mattagami First Nation 2023; Matachewan First Nation 2023; Taykwa Tagamou Nation 2023
West Buskegau River	PA		
Mattagami River	4 km west of the PA within the LSA		
Bigwater Lake	4.1 km southeast of the PA within the LSA	• Matachewan First Nation • Mattagami First Nation • Taykwa Tagamou Nation	Mattagami First Nation 2023; Matachewan First Nation 2023; Taykwa Tagamou Nation 2023
Jocko Creek	LSA	• Apitipi Anicinapek Nation	Apitipi Anicinapek Nation 2024; IAAC 2023
Frederick House River	PA		
Lower Sturgeon Dam Road	PA	• Taykwa Tagamou Nation	Taykwa Tagamou Nation 2023
Unspecified snowmobile trail from Timmins to Cochrane	PA	• Matachewan First Nation	Matachewan First Nation 2023
Several unspecified lakes and areas off Highway 655	Within PA and LSA	• Apitipi Anicinapek Nation • Flying Post First Nation • Matachewan First Nation • Taykwa Tagamou Nation	Apitipi Anicinapek Nation 2024; Flying Post First Nation 2023; Matachewan First Nation 2023; Taykwa Tagamou Nation 2023

Fishing Sites	Location	Indigenous Nation	Source
Multiple natural spring sources	West of Kirkland in the PA	• Matachewan First Nation	Matachewan First Nation 2023
Notes: PA = Project Area; LSA = Local Study Area			

4.10 Ecological Parameters and Processes

The purpose of this section is to describe the parameters and ecological processes that are relevant to the understanding of how the Project may directly or indirectly affect fish and other aquatic biota by altering fish habitat, stream flows, and/or water quality. The section is focused on stream and river habitats because the Project is in the headwaters of the North Driftwood River, West Buskegau River, and Jocko Creek watersheds, where most of the potentially affected habitat is low gradient channels or beaver-impounded headwater streams.

4.10.1 Ecological Processes in Streams and Rivers

4.10.1.1 Physical Processes

Streams and rivers are the natural features in a landscape that move sediment and decaying organic material (i.e., vegetation, wood) from higher elevations to lower elevations. The power to move these materials comes from water as it moves downhill due to gravity. The greater the volume of water and the greater the drop in elevation, the greater the power that a stream or river has to move material.

The factors that control the channel morphology (i.e., channel shape, flow pattern, habitat frequency) of a river within its valley include those that are imposed on the river by the landscape (i.e., independent factors) and those that adjust to the imposed factors (i.e., dependent factors) (Hogan and Luzi 2010). The independent landscape factors controlling channel morphology are the surficial geology, climate, and human activities (e.g., forestry). The surficial geology of a watershed is determined by vulcanism, plate tectonics, and glaciation occurring over millennia. These processes control the type and distribution of bedrock and surficial inorganic material and the topography of the watershed (Montgomery 1999).

Climate of a watershed is driven by global atmospheric circulation patterns, latitude, and elevation. Climate controls the amount of precipitation falling on a watershed as snow and rain and when this precipitation run-offs the landscape to collect in the streams and rivers. In northern climates, precipitation in winter falls as snow. This water does not enter rivers until air temperatures warm up sufficiently to melt the accumulated snow and ice, resulting in a high flow, spring freshet. It is this spring freshet that has the greatest power to move material and, therefore, the greatest influence on channel morphology of a river.

Human influences on channel morphology include dams, forestry, agriculture, and urbanization. These activities can affect how water is transferred from the watershed to the river and how the river transports the water downstream, all of which can affect channel morphology in the short and long-terms.

The independent geology, climate, and human landscape variables to which a watershed is subjected determine the landscape-dependent variables of sediment supply, stream discharge, and vegetation (Montgomery and Buffington 1993; Buffington et al. 2003). Sediment supply is determined by the frequency, volume, and size of material delivered to the river channel from the watershed. Stream discharge is the timing, magnitude, and duration of flow. Vegetation is the herbs, shrubs, and trees that grow in the watershed, including the river floodplain and riparian areas.

Vegetation influences the volume of water reaching the river by affecting the rate of water entering the soil and groundwater aquifers (i.e., infiltration), the volume of water returned to the atmosphere (i.e., transpiration), the stability of soils in the watershed, and the amount of organic material (e.g. woody debris, leaves) entering the river.

Channel morphology of a river is determined by the combined influences of the dependent landscape variables; channels respond to these variables by adjustments in some, or all, of the following dependent channel variables: channel width and depth, bed slope, substrate size and distribution, bedform, channel sinuosity, and/or scour depth (Hogan and Luzi 2010). In natural systems, these variables are in a state of constant adjustment, a process termed “dynamic equilibrium” (Leopold and Maddock 1953). These variables are rarely characterized by an exact equilibrium but instead, the river and its channel tend toward a “statistical” mean condition while oscillating between extremes (Vannote et al. 1980). Any factor that affects the sediment supply, stream discharge, or vegetation in a watershed, therefore, has the potential to affect the dynamic equilibrium of a river’s channel morphology and the physical habitat it provides to fish and other aquatic biota.

4.10.1.2 Chemical Processes

The water chemistry of a stream is determined by several factors: the volume and chemistry of the precipitation (i.e., rain and snow) falling on the watershed; the chemistry of the rocks and soil in the watershed and their erodibility; groundwater inputs and its water quality; the rate at which the water moves downstream; and any man-made sources of pollution. In natural systems, the water quality constituents of a stream originate from dissolution of the earth’s rocks (Allan et al. 2017). These water quality constituents are (Berner and Berner 1987):

- Dissolved ions (e.g., calcium, sodium, chloride, potassium)
- Dissolved nutrients (e.g., nitrogen, phosphorus, dissolved organic carbon)
- Dissolved and suspended organic matter
- Dissolved gases (e.g., oxygen, carbon dioxide)
- Dissolved and suspended inorganic metals (e.g. aluminum, iron) and matter (e.g., silica)

Water chemistry of a stream is altered by the chemical and biological interactions that occur as the water flows downstream. Parameter concentrations may be diluted by additional run-off from storm events or by inflows of water from tributaries with different water quality than the mainstem channel. Conversely, parameter concentrations may become more concentrated as water evaporates from the stream to the

atmosphere; this effect is amplified in desert streams or in streams with impoundments from dams where the surface area of water-atmosphere interface is larger.

DO concentrations of water are of critical importance to freshwater aquatic biota. While some species have evolved to survive in low oxygen environments (e.g., chironomids, brook sticklebacks), all aquatic organisms require DO to survive, grow, and reproduce.

DO concentrations in streams are inversely correlated to water temperature (i.e., water can hold less DO as water temperatures increase) and gas exchange between the water and the atmosphere is maintained at an equilibrium determined by water and air temperature and atmospheric pressure (Allan et al. 2017). As a result, DO concentrations in streams vary seasonally as the air and water temperatures change in response to the seasons and in response to the presence of absence of ice cover. Summer and winter seasons are typically when DO concentrations in water are lowest, however for different reasons. In summer, DO concentrations may be lower than at other times of the year because the water temperatures are highest. In winter, DO concentrations may be lower than at other times of the year because of DO depletion under the ice by respiration from aquatic biota and biological oxygen demand from bacterial decomposition of decaying organic matter. This effect is most pronounced in slow-flowing or beaver impounded streams with high organic content. DO concentrations are highest and most stable in cold water streams with turbulent flow; turbulent flow over rocks increases gas exchange between the water and atmosphere.

Stream water contains a solution of carbon dioxide, carbonic acid, and bicarbonate and carbonate ions in an equilibrium that serves as the major determinant of the acidity/alkalinity balance of freshwaters. It is this equilibrium that provides the buffering capacity that is critical to the health of freshwater biota (Allan et al. 2017). Stream water can vary widely in acidity and alkalinity across the landscape but, in general, the diversity and abundance of aquatic biota are unaffected within relative wide ranges of acidity and alkalinity; it is only at pH values <5 or >9 (i.e., extreme conditions) that the effects on the aquatic ecosystem are readily evident. Water with low ionic concentrations support a lower diversity of taxa and the number of species typically increases with increasing water hardness. Naturally occurring or human-modified water with pH values <5 have serious biological consequences (Allan et al. 2017).

4.10.1.3 Biological Processes

The energy for the biological community of streams comes from two sources: 1) primary production of photosynthetic algae attached to rocks (i.e., periphyton) and the consumption of fine and course particulate matter (e.g., dead leaves and wood) and terrestrial invertebrates that fall into the stream from riparian vegetation. Energy inputs from these autochthonous and allochthonous energy sources are not equal along the length of a stream, mostly due to the differences in canopy cover and channel width between headwater streams and larger, downstream mainstem channels. In headwater streams, the channels are narrow, and the canopy cover provided by shrubs and trees is high. This combination of attributes reduces the amount of sunlight reaching the water through the leaves and increases the amount of leaf litter and woody falling into the water; allochthonous energy inputs tend to dominate in headwater streams as a result. In larger mainstem channels downstream, the channel is wider which

reduces the percentage of canopy cover and increases the amount of sunlight reaching the water; autochthonous energy inputs tend to dominate these larger streams.

Figure 4.1 shows a depiction of the gradual change in energy inputs (and the biological communities produced by them) from smaller headwater streams to larger mainstem channels. A low ratio of primary production to ecosystem respiration (P/R) in the headwaters indicates that most of the energy supplied to the food web derives from organic matter and microbial activity, mostly originating from allochthonous inputs from outside the stream channel. In these headwater habitats, invertebrate species belonging to the shredder, collector, and grazer functional feeding groups are most abundant because it is these species that tend to feed on and digest the coarse particulate organic matter (CPOM) provided by the leaf litter and wood (Merritt et al. 2017) and the periphyton that grows on the rocks. These activities begin to enrich the water and produce fine particulate organic matter (FPOM) that drifts downstream, an important upstream–downstream linkage between the smaller headwater streams and larger mainstem channels (Allan et al. 2017).

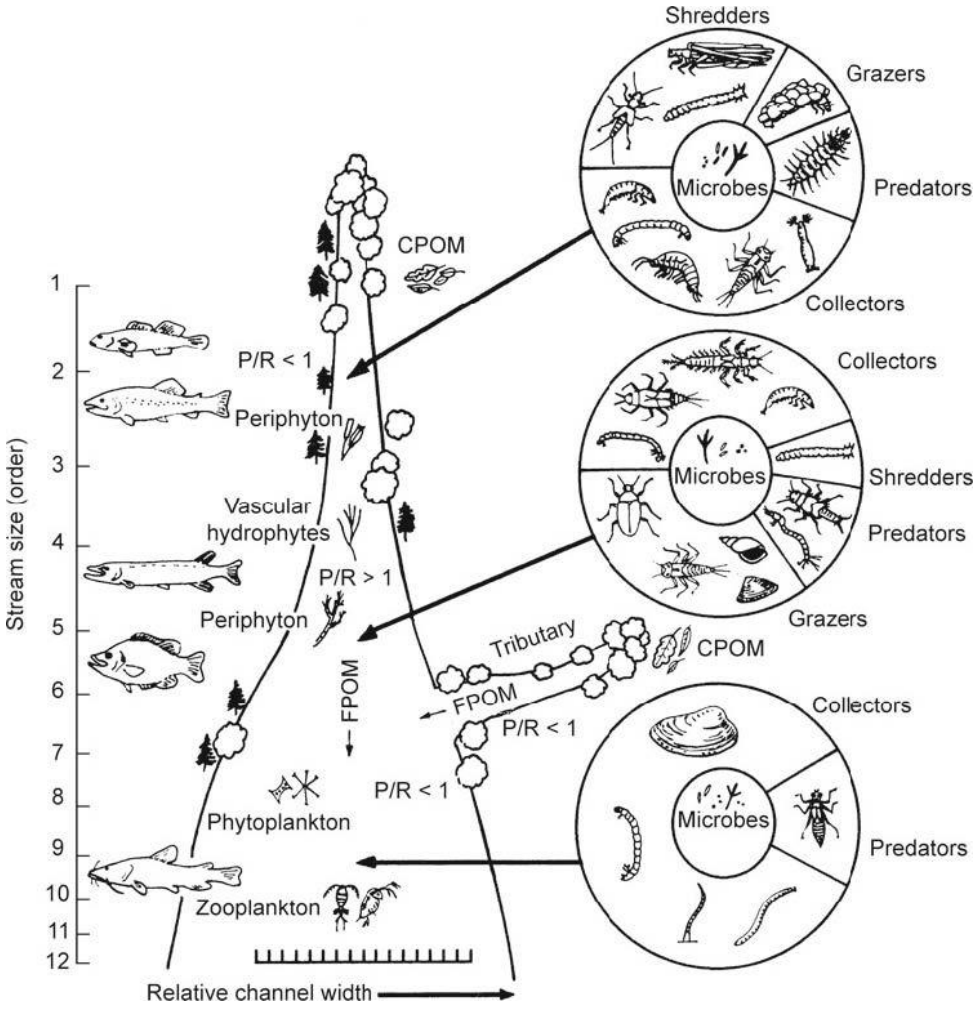
As the concentration of FPOM increases and the percentage of canopy cover decreases downstream, the P/R ratio begins to exceed one, indicating that more energy is supplied to the food web by primary production than by organic matter and microbial activity. In these medium sized streams, the proportion of the shredder functional feeding group in the benthic invertebrate community decreases and the proportions of the collector, grazer, and predator functional feeding groups increases (Figure 4.1) in response to the greater abundance of drifting FPOM in the water, the greater abundance of algae growing on the substrates, and the greater opportunity to prey on these more abundant organisms.

The P/R ratio in the largest downstream reaches of a river tend to be <1, like the headwater reaches, but for a different reason. In the headwater reaches, a P/R ratio <1 is due to the paucity of direct sunlight reaching the water through the leaves of riparian vegetation. In the larger downstream reaches, a P/R ratio <1 is due to the increasing water depth and turbidity created by the accumulation of downstream drifting sediment and FPOM. In these areas, the collector function feeding group of invertebrates (particularly the filter-feeders) dominate the benthic invertebrate community to take advantage of the drifting FPOM. Grazers and shredder functional feeding groups become rare owning to the paucity of CPOM and periphyton in the water and on the rocks.

The fish community in a watershed follows a similar upstream to downstream gradient as the benthic invertebrate community, but typically in response to a greater number of factors. Typically, habitat in headwater streams is narrower, shallower, faster, and less diverse than habitat in more downstream reaches due to higher gradient and lower flow volumes. In response, the fish community in headwater streams is typically restricted to a few species of small fish (or juveniles of larger fish) that are adapted to specific habitat conditions with narrow ranges in physical (e.g., water velocity) and chemical (i.e., water temperature and DO) attributes. Moving downstream, the fish community typically becomes more diverse in response to the greater diversity of physical habitat types (i.e., pools, riffles, runs, off-channel areas) and cover types (e.g., undercut banks, woody debris, weeds), the greater volume of habitat, the wider range of physical and chemical habitat attributes and the greater variety of prey items, either drifting downstream from above or produced from the greater variety of habitats in the same location.

Unlike algae and benthic invertebrate communities which tend to only move in a downstream direction (i.e., passive drifting), fish can migrate considerable distances upstream in streams and rivers. This requires energy and, therefore, fish will only move upstream if there is a need to do so. The principal reason for upstream migration of fish is to access spawning habitat. Other reasons for fish to move upstream in a stream include the need to access foraging areas, to find refugia from adverse temperatures or DO concentrations, to find refugia from predators, or to minimize intra-species competition caused by high densities of conspecifics. Many of these migrations are seasonal and occur every year at regular intervals. Other movements may be due to extreme, but infrequent, conditions such as drought, or landslides. Regardless of motive, the movement of fish in a river system affects the abundance, distribution, and diversity of the fish community as individual fish attempt to minimize their energy expenditure and mortality risk from predation and maximize their food intake and reproductive opportunities.

Figure 4.1 Conceptual Relationship between Stream Size and the Progressive Shift in Structural and Functional Attributes of River Ecosystems (Source: Vannote et al. 1980).



4.10.2 Site-Specific Parameters and Ecological Processes

4.10.2.1 Influence of Beavers

Because of the headwater location of the Project and the low gradient topography within the PA, beavers have a major influence on the physical, chemical, and biological processes of the streams in the North Driftwood River, West Buskegau River, and Jocko Creek watersheds that may be affected by the Project. By impounding water behind their dams, beavers alter the hydrology, geomorphology, thermal regime, nutrient cycle, and biotic communities of watersheds (Larsen et al. 2021). Beaver dams serve to increase lateral hydrologic connectivity between the stream and its floodplain and decrease longitudinal hydrologic connectivity of upstream habitat with downstream habitat (Larsen et al. 2021). These changes in hydrological connectivity are the basis for all subsequent effects of dams on a stream and its watershed.

Increased lateral connectivity results in increased water and sediment storage, more wetland and open water habitat, increased evaporation, and induces “reverse” succession in riparian vegetation community (Larsen et al. 2021). Decreased longitudinal connectivity results in increased frequency and abundance of pools and wetlands, more transitions between lentic (i.e., standing water) and lotic (i.e., flowing water) habitats, altered temperature and DO regimes, increased vertical hydraulic exchange gradients, and increased nutrient cycling because of the greater opportunity for microbial decomposition of accumulated organic matter in the beaver ponds (Larsen et al. 2021). Together, these changes in connectivity promote increase storage of water, carbon, nutrients, and sediment and increase habitat complexity and biodiversity at the reach scale.

The extent of the effects of beaver dams on stream ecosystems is dependent on the site-specific hydrogeomorphic landscape (i.e., gradient, floodplain width, valley slopes, sediment load) and the ability of beavers to sustain their dams and lodges through their generations over time. When beavers can establish in a stream and can maintain their dams for extended periods (e.g., decades), their outsized effects on river processes are fundamentally different from what occurs in their absence (Larsen et al. 2021); beavers disrupt the river continuum processes described in the section above by increasing the extent of ponded surface water behind individual dams (and collectively within beaver dam complexes) which constitute an abrupt reach-scale shift from almost exclusively lotic (i.e., flowing water) to a mix of lentic (i.e., standing water) and lotic conditions and transitions between.

4.10.2.2 Effect of Beavers on the Benthic Invertebrate Community in the Project Area

The physical and chemical changes caused by ponding of water and sediment behind beaver dams results in an increase in habitat diversity (i.e., lotic and lentic habitats) and increased littoral habitat in riparian areas and floodplain wetlands due to the promotion of macrophyte communities and grasslands at the expense of riparian woody vegetation and its canopy shading (Larsen et al. 2021). These changes should, in general, promote higher ecosystem productivity compared to unimpounded streams, including an overall increase in reach-scale diversity of the macroinvertebrate community.

The creation of lentic habitat behind beaver dams can generate a larger abundance of particulate organic matter, plant tissue, and nutrients within the ponded section, which can increase the number of shredder and collector/gatherer functional feeding group invertebrate communities. Although the new lentic habitats created by beavers may have more restricted assemblages compared to the lotic habitats, it is the capacity of beavers to facilitate and maintain a mosaic of both habitats and the transitions between them that allows reach-scale invertebrate community diversity to increase (Larsen et al. 2021). For example, chironomid (midge fly) larvae are an invertebrate group that thrives in the organically rich, oxygen-poor sediments that accumulate behind beaver dams. Conversely, mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) larvae are typically the most abundant invertebrate taxa found in well-oxygenated rocky, riffle habitats in the transition zones between beaver ponds (if there is sufficient gradient to create such habitats).

The addition of submerged woody debris created by beaver dams also provides additional habitat for many macroinvertebrate species (Benke and Wallace 2003) which can increase macroinvertebrate diversity and abundance. Similar increases in macroinvertebrate diversity and abundance can occur due to the increase in submergent and emergent vegetation that grows in the flooded wetland areas adjacent to beaver ponds. However, the magnitude of increases in macroinvertebrate community diversity and abundance caused by increased in woody debris and wetland vegetation is dependent on the local hydro-geomorphological conditions (e.g., gradient, valley confinement).

By ponding water, beaver dams may affect the downstream drift of benthic invertebrate larvae, a key process in many invertebrate species life cycle but also a key process for food delivery to downstream fish populations. However, this effect may be small and may only affect the timing of this downstream drift and not the quantity (Larsen et al. 2021).

4.10.2.3 Effects of Beavers on the Fish Community in the Project Area

The abundance of beaver dams within the PA has a major influence on the physical habitat and chemical habitat available to fish. The ponds created by the beaver dams provide spawning and rearing habitat for several of the small-bodied species present in the PA. These ponds also provide shelter and foraging habitat for these small-bodied species during low flow periods. The small-bodied species include northern pearl dace, northern redbelly dace, finescale dace, lake chub, brook stickleback, and fathead minnow. These small-bodied species make only short spawning migrations limited by the presence of the beaver dams, and generally spend their entire life cycle in the complexity of micro-habitats created by beaver activity.

Beaver dams are impediments to upstream and downstream fish passage, particularly for large-bodied adult fish. Fish can generally get past beaver dams in spring when high flows create holes in the dams or by-pass channels on the sides of dams. However, the distance that fish can migrate in a river or stream can be substantially reduced by beaver dams, particularly by older dams that have high hydraulic heads or in streams with multiple dams over short distances. Beaver dams are generally impassable during low flow conditions (summer and winter) but these are generally periods when fewer fish are moving.

Beaver dams can alter the frequency and duration of downstream benthic invertebrate drift. However, this effect generally affects sight-feeding insectivorous species (e.g. perch, bass, trout) more than piscivorous (e.g., northern pike) or benthivorous (e.g., white sucker).

4.10.3 Approach to Characterizing Ecological Processes

A qualitative approach has been taken to characterize baseline ecological processes currently occurring in the North Driftwood River, West Buskegau River, and Jocko Creek watersheds that may be affected by the Project. This is because a quantitative description of the ecological processes described above would require long-term studies to collect the kind of data needed to understand these processes (and the natural variability inherent to any biological system) and ecosystem modeling to determine which of the many inter-related processes are having the greatest influence on the biological communities that are present. In Canada Nickel's opinion, the efforts required for such quantitative approaches are beyond what is necessary to understand potential effects of a Project on fish and fish habitat and are unlikely to change the design, mitigation measures, or offsetting requirements for the Project. Nevertheless, Canada Nickel has collected water quality data and hydrology data, conducted habitat assessments, collected sediment and benthic invertebrate samples, and fish community and tissue contaminant data, all of which provide quantitative data that can be used to assess and monitor potential effects of the Project on fish and fish habitat.

4.11 Noise and Vibration Effects on Fish and Fish Eggs

4.11.1 Physiology of Fish Hearing

Fish have two sensory systems that allow them to detect sound in their environment: the inner ear and the lateral line. The inner ear consists of three otolithic organs, the saccule, lagena, and utricle, all of which are involved in hearing in all fishes through the detection of particle motion (Popper et al. 2014; Popper et al. 2019). In some species, fish can detect sound pressure through a gas-filled swim bladder. The enclosed gas is compressible and changes volume in response to sound pressure, which serves as an acoustic transformer and generates amplitudes of particle motion in the ears that stimulate the otolithic organs (Popper et al. 2014; Popper and Hawkins 2018; Popper et al. 2019). These adaptations allow fish with these organs to have increased hearing sensitivity and broadened hearing bandwidth (Popper et al. 2014; Popper et al. 2019). However, this sensitivity varies between species and distance between the swim bladder and the inner ear (i.e., having a swim bladder close to or connected to the ear enhances the hearing abilities of fishes) (Popper and Hawkins 2018).

Fish species with the greatest sensitivity to underwater sound are those that have their swim bladders mechanically linked to the inner ear (Popper and Hawkins 2018) with structures such as Weberian apparatus. The Weberian apparatus is present within otophysan fish, including minnows, carp, catfishes, and suckers. The Weberian apparatus enhances auditory sensitivity (i.e., wide frequency range and low hearing threshold) by conducting pressure changes produced by externally originating sound waves from the swim bladder to the ear.

Fish species near the Project have varying sensitivities to underwater noise (Table 4.13). Of the fish species present near the Project, cyprinids and suckers (longnose sucker, white sucker, redhorse) are the fish species with the best hearing ability and, therefore, the greatest sensitivity to sound pressures created by blasting.

Table 4.13 Summary of Hearing Abilities and Sensitivities of Fish Species Near the Project

Family	Species	Scientific Name	Hearing Abilities	Hearing Sensitivities to Anthropogenic Noise	Source
Acipenseridae	Lake Sturgeon	*Acipenser fulvescens*	• Possess a physostomous swim bladder, which may allow individuals to decrease damaging effects during exposure to impulsive sounds. • Have a basal inner ear to detect frequencies from below 100 Hz to 1,00 Hz or more and can detect direction sound. • Produce characteristic “drum” calling sound while spawning, with average frequency of 114.2 (±3.5) Hz.	• Lake sturgeon exposed to higher sound exposure level pile driving activities (cumulative sound exposure level 210 to 216 dB re 1 mPa^2s), experienced some hematomas on the swim bladder, kidney, and intestine, as well as partially deflated swim bladders. • Lake sturgeon injuries were significantly less severe than fish with physoclistous swim bladder, but more severe than fish with no swim bladders. • Lake sturgeon swim bladder is not in close proximity to internal organs, decreasing potential to cause damage. • Results from the study indicate that fish appear to be less susceptible to impulsive pile driving than is currently allowed by US injury guidelines (i.e., maximum sound exposure level 187 dB re 1 μPa^2s for sturgeon larger than 2 g and 183 dB re 1 μPa^2s for sturgeon less than 2 g). • Sturgeon hearing is most sensitive below 300 Hz, and sturgeon may be deaf to frequencies above 500 Hz.	Halvorsen et al. (2012a) Higgs and Beach (2021) Popper (2005)
Catostomidae	Longnose Sucker White Sucker	*Catostomus catostomus* *Catostomus commersonii*	• Possess a swim bladder that has Weberian ossicles connected to the inner ear and, therefore, has the most sensitive hearing and over the largest frequency range (100 Hz to 1,600 Hz).	• Longnose sucker hearing sensitivity was greatest at frequencies between 200 Hz and 800 Hz.	Mann et al. (2007)
Centrarchidae	Rock Bass	*Ambloplites rupestris*	• Possess a swim bladder that is not connected to the inner ear likely resulting in relatively lower sensitivity to underwater noise.	• Centrarchids exposed to underwater noise (160 dB re 1 µPA) were not found to exhibit avoidance or reduced foraging behavior during a recent study.	Holt and Johnston (2011) Pieniazek et al. (2020)
Cottidae	Mottled Sculpin	*Cottus bairdii*	• Sculpins do not possess a swim bladder and are likely less sensitive to underwater noise than other species as a result.	• Sculpins have been shown to be most sensitive to noise at frequencies ranging from 100 to 200 Hz.	Mann et al. (2007)
Cyprinidae	Blacknose Dace Blacknose Shiner Bluntnose Minnow Bluntnose Shiner Common Shiner Creek Chub Emerald Shiner Fathead Minnow Finescale Dace Golden Shiner Lake Chub Longnose Dace Northern Pearl Dace Northern Redbelly Dace Spottail Shiner	*Rhinichthys atratulus* *Notropis heterolepis* *Pimephales notatus* *Notropis simus* *Luxilus cornutus* *Semotilus atromaculatus* *Notropis atherinoides* *Pimephales promelas* *Chrosomus neogaeus* *Etheostoma exile* *Couesius plumbeus* *Rhinichthys cataractae* *Margariscus nachtriebi* *Chrosomus eos* *Notropis hudsonius*	• Classified as hearing specialists because the Weberian ossicles connect the swim bladder to the inner ear. • Fish in this group generally hear a wide range of noise frequencies and have a low hearing threshold.	• Adult lake chub peak noise sensitivity around 200 Hz. • Results of studies on fathead minnow noise exposure indicate a temporary, measurable loss of hearing sensitivity after only 2 hours of exposure to simulated boat engine noise and white noise (142 dB re 1 µPA at 1.0-2.0 kHz). • Wild cyprinids have been shown to exhibit avoidance and statistically significant reduced foraging behavior when exposed to underwater boat noise (160 dB re 1µPA). • Avoidance behavior is anticipated to be temporary for the duration of the noise production, as cyprinids have not shown to acclimate to underwater noise disturbance.	Pieniazek et al. (2020) Popper et al. (2005) Scholik and Yan (2001)

Family	Species	Scientific Name	Hearing Abilities	Hearing Sensitivities to Anthropogenic Noise	Source
Esocidae	Northern Pike	*Esox lucius*	• Possess a swim bladder that is not connected to ear and have intermediate hearing sensitivity compared to other freshwater species. • Ears are typical of species that do not have specializations for hearing, and the saccule is much larger than the lagena. • Northern pike can detect sounds up to 1600 Hz but had very poor hearing at 800 and 1600 Hz.	• Showed greater sensitivity at lower frequencies (100 and 200 Hz) than higher frequencies (i.e., >800 Hz). • Northern pike were 10 dB to 20 dB more sensitive than broad whitefish, which may be an adaptation for their predatory lifestyle with enhanced ability to detect prey. • Examination of northern pike following exposure to sounds from an airgun did not indicate any bleeding, overt effects to organs, and or damage to swim bladders. - Fish swam normally post-exposure and survived with no apparent adverse effects. - The greatest shift in hearing thresholds was at 400 Hz with a 20 dB shift, but within 18 hours individuals had recovered from hearing loss. - Young-of-the-year northern pike did not show any statistically significant hearing loss when exposed to the airgun. - Adult pike had more sensitive hearing than young-of-the-year, indicating possible ontogenetic shifts in hearing abilities.	Mann et al. (2007) Popper et al. (2005) Song et al. (2008)
Gasterosteidae	Brook Stickleback	*Culaea inconstans*	• Possess a swim bladder that is not connected to ear and have intermediate hearing sensitivity. • Sticklebacks are hearing generalists and are only capable of detecting low-frequency sounds at high intensities.	• Sticklebacks are most sensitive to underwater noise around 200 Hz.	Mann et al. (2007)
Lotidae	Burbot	*Lota lota*	• Possess a swim bladder that is not connected to ear and have intermediate hearing sensitivity compared to other freshwater species. • Swim bladder muscles produce sounds during reproduction that likely aid in matting cues.	• Ontogenetic shift in hearing was observed, with juvenile having more sensitive hearing than adults: - Adult hearing most sensitive between 100 and 200 Hz. - Juvenile hearing most sensitivity between 100 and 400 Hz. • Burbot hearing was most sensitive in the lower frequency range, with decreasing sensitivity as frequency increased.	Cott et al. (2013) Mann et al. (2007)
Percidae	Iowa Darter Johnny Darter Logperch Walleye Yellow Perch	*Etheostoma exile* *Etheostoma nigrum* *Percina caprodes* *Sander vitreus* *Perca flavescens*	• Yellow perch are less sensitive to underwater noise than many other species as the swim bladder is not connected to the ear in this group.	• No hearing loss or significant shift in auditory potential thresholds at 200, 400 and 600 Hz were observed between the control and exposed yellow perch directly after acoustic exposure or 24-hour post-exposure. • Yellow perch distribution and foraging behaviours were not significantly affected by boat noise exposure (i.e., foraging behaviour was similar between control and exposure groups) in a recent study.	Halvorsen et al. (2013) Pieniazek et al. (2020)
Percopsidae	Trout Perch	*Percopsis omiscomaycus*	• Trout perch possess a swim bladder which is not connected to the ear. • Relatively insensitive to underwater noise compared to species with the swim bladder-ear connection.	• Adult peak noise sensitivity around approximately 100 to 200 Hz.	Mann et al. (2007)

Notes: dB = decibels; Hz = hertz.

4.11.2 Underwater Noise Propagation

Construction activities in or near waterbodies, such as blasting, drilling, and seismic activity, have the potential to impact aquatic life. Blasting produces high-velocity spherical shock waves as well as introducing high-intensity noise into the aquatic environment through the air and vibrations in the substrate that can affect fish species and their habitats (DFO 2006; Popper et al. 2014). Injury or mortality to fish can occur due to shock waves (e.g., instantaneous pressure change) created by explosive detonations, which can rupture internal organs and damage swim bladders. Particle velocity due to the detonation of explosives can also cause injury or death of fish eggs or larval fish. In finfish, the primary site of damage is the swim bladder, but rupture or haemorrhaging to internal organs (i.e., kidney, liver, spleen, and sinus venosus) may also occur.

The water volume affected by the pressure wave produced from blasting is complex and is a function of the depth of the explosion, the size of the charge, the water depth, and substrate type (Popper et al. 2014). There are two areas within the affected water volume that pose the highest risk to fish. The first is the immediate vicinity of the explosion where the compressive forces of the shock wave produced from the blast dominate. The second is a more distant area where negative pressure from the overshoot of the gas bubble created from the blast and the reflection of the shock wave from the water surface which can cause cavitation and negative pressures low enough to cause injuries to the swim bladders and other barotraumas, including mortality (Popper et al. 2014).

4.11.3 Effects of Underwater Noise and Vibration on Fish

The effects of underwater noise from blasting on aquatic life are dependent on many factors including the life history and physiological characteristics of fish species. Fish species most susceptible to injury from blasting are species with swim bladders that function with hearing (e.g., cyprinids). There is evidence that little to no damage occurs to fish without swim bladders except at very short ranges from in-water blasting (Goertner et al. 1994; Stephenson et al. 2010; Halvorsen et al. 2012b). Goertner (1978) demonstrated that the range from a blast event where injury may occur to a non-swim bladder fish is on the order of 100 times less than swim bladder fish.

Body shape and size of fish can influence the degree of injury. Fish that have laterally compressed bodies have a greater surface area to receive shock waves than cylindrically shaped fish. Smaller fish may also be more susceptible than larger fish, making early life stages and juveniles more vulnerable (Yelverton et al. 1975).

Other factors that influence the effects of blasting are the distance and orientation of the fish to the blast and position in the water column. Fish have been observed to have a decrease in susceptibility of injury from blasts at greater depths; this decrease is a function of the decreasing differences in the hydrostatic pressure and the pressure generated by the blast as depth increases (Goertner 1978).

The range of potential effects on fish from blasting include physical injuries and mortality, temporary or permanent hearing loss, changes in behaviour, and mechanical shock to developing embryos. Barotrauma is the physical damage to tissues caused by rapid changes in ambient pressure and can result from blasting and seismic activity. The swim bladder is the organ most likely to be damaged in fish

that possess them (Yelverton et al. 1975; Goertner et al. 1994; Govoni et al. 2003; Godard et al. 2008; Carlson et al. 2011). The degree of injury to the swim bladder can vary from over inflation, ruptures, tears, and bruises. Fish species with thick-walled swim bladders have been observed to be more resistant to shock in some instances (Fitch and Young 1948; Gaspin et al. 1975). Other types of barotrauma injuries from swim bladder expansion and contraction include torn ribs, ruptured body walls, organs, peritoneum damage, stomach eversions, and vent prolapse (Kearns and Boyd 1965; Houghton and Munday 1987; Carlson et al. 2011). Barotrauma endpoints include lethal injury by immediate mortality or delayed mortality (McKinstry et al. 2007) and injuries with varying severity from which full recovery is possible (Govoni et al. 2003; Halvorsen et al. 2011; Halvorsen et al. 2012a; Halvorsen et al. 2012b; Brown et al. 2012; Casper et al. 2012; Casper et al. 2013).

Lethal and non-lethal hemorrhaging have also been observed and embolisms resulting from accumulation of gases from extreme pressure differences have been observed in gills, fins, hearts, swim bladder, and kidneys (Godard et al. 2008). Embolisms can also result in the outward displacement of eyes (Godard et al. 2008; Carlson et al. 2011).

Hearing impairment can result from underwater noise produced by the low-frequency component of blasting activities (Ocean Science Consulting 2021). This can result a permanent loss of hearing sensitivity known as permanent threshold shift (PTS) or a temporary loss in hearing sensitivity, known as temporary threshold shift (TTS). PTS is a permanent loss of hearing and may result from the death of sensory hair cells in the ear, damage to the innervating auditory nerve fibers, or damage to other tissues in the auditory pathway (e.g., swim bladder) (Popper et al. 2014).

TTS is a temporary reduction in hearing sensitivity caused by exposure to intense sound. The magnitude and duration of exposure that causes TTS is variable and is affected by factors such as the fish's hearing sensitivity, and intensity, frequency, and duration of the blast (Hastings and Popper 2005; Popper et al. 2014). Fishes where the swim bladders function with hearing or are hearing specialists have greater susceptibility to TTS. There is also evidence that with increasing depth, the gas in swim bladders become denser and stiffer, which causes a decrease in pressure-aided hearing sensitivity (Rogers and Zeddies 2008). This effect may lower the likelihood of injury to a fish's ear from high energy sound sources, even if the source is located the same depth (Popper et al. 2014). While experiencing TTS fish may exhibit decreased fitness in terms of prey or predator detection, communication, and assessing their environment. The extent and duration of TTS may continue for minutes to days after the end of exposure and depends on many factors, with time intervals between blasts playing an important role with effects to hearing (Hastings and Popper 2005; Popper et al. 2014).

4.11.4 Effects of Underwater Noise and Vibration on Fish Eggs

Ground vibrations from blasting may impose a mechanical shock to developing embryos and impulse vibrations can induce physical deformities in the embryo or potentially dislodge eggs from the substrate (U.S. Department of Transportation 2019). However, the amplitude of blast-induced vibrations that embryos can be damaged or dislodged are not well understood. Several laboratory studies have examined the sensitivity of fish eggs to physical disturbances but have not determined critical exposure levels.

Embryos sensitivity to shock varies throughout development, with greater sensitivity observed in early development and more tolerant in later stages of development (Smirnov 1955; Jensen and Alderdice 1983; Jensen and Alderdice 1989; Faulkner et al. 2008).

4.11.5 Effects of Underwater Noise of Fish Behaviour

The effects of anthropogenic sound, including blasting and seismic activity, on fish behaviour is not well understood due to the difficulty of observing behaviour in a natural setting (most studies have been conducted in a laboratory setting), as well as the difficulty of generalizing results across the hundreds of fish species potentially present in an area. A range of responses have been observed to anthropogenic underwater noise, including a change in swimming behaviour and orientation (Pearson et al.1992; Hassel et al. 2004), avoidance behaviour (Engås et al. 1996; Engås and Løkkeborg 2002), change in schooling patterns and distribution (Pearson et al. 1992), moving from preferred sites for feeding and reproduction, alteration of mitigation patterns (Popper et al. 2014), to no change in behaviour (Wardle et al. 2001; Pieniazek et al. 2020). Fish have also been observed to become habituated to underwater noise from repeated exposure to anthropogenic sound (Spiga et al., 2012a; Spiga et al., 2012b; Wale et al., 2013).

4.11.6 Guidelines for the Protection of Fish and Fish Eggs From the Effects of Underwater Noise

DFO's *Guidelines for the Use of Explosives in or Near Canadian Fisheries Water* (Wright and Hopky 1998) includes two thresholds to avoid the death of fish and fish eggs due to the use of confined or unconfined explosives: a 100 kPa peak overpressure threshold to prevent the death of fish and a 13 mm/s peak particle velocity (PPV) to prevent the death of fish eggs. However, DFO now recommends a 50 kPa overpressure threshold based on more recent data from monitoring of seismic exploration in the MacKenzie Delta in 2002 (Cott and Hanna 2005).

Although not explicitly stated, the authors of the original DFO guideline appear to have based their 100 kPa threshold on work conducted by Hubbs and Rechnitzer (1952) who found that mortalities of marine fish with air bladders occurred at negative pressures between 68 kPa and 102 kPa. Additionally, the authors of the original DFO guideline do not provide a rationale for, or the source of, the 13 mm/second PPV threshold. The scientific merits of this threshold are not clear as more recent studies have shown that peak particle velocities of 28.5 mm/s did not increase lake trout egg mortality (Faulkner et al. 2006).

Much of the literature surrounding fish species hearing abilities and sensitivity to underwater noise has been conducted in a laboratory setting and there remains large information gaps in the literature. Popper and Hawkins (2018) noted that it is difficult to reach conclusions on the levels of anthropogenic sounds that could cause change in behaviour or physical injury to fish. However, a recent review of the scientific literature by Popper et al. (2014) proposed sound pressure thresholds for different fish types based on the presence and type of swim bladder that is involved in the fish's hearing (Table 4.14). Based on these data and the knowledge that cyprinids and suckers are the fish species most sensitive to sound overpressures from blasting near the Project, sound pressures <276 kPa are unlikely to result in the death or mortal injury of any fish species present in waterbodies and watercourses near the Project.

Table 4.14 Guidelines for Protection of Fish from Underwater Explosions

Type of Animal	Mortality and Potential Mortal Injury[1]	Impairment		Behaviour[4]
		Recoverable Injury[2]	Temporary Threshold Shifts (TTS)[3]	
Fish: no swim bladder (particle motion detection)	229 – 234 dB peak or 276 – 482 kPa	(N) High (I) Low (F) Low	(N) High (I) Moderate (L) Low	(N) High (I) Moderate (F) Low
Fish where swim bladder is not involved in hearing (particle motion detection)	229 – 234 dB peak or 276 – 482 kPa	(N) High (I) High (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) High (F) Low
Fish where swim bladder is involved in hearing (primarily pressure detection)	229 – 234 dB peak or 276 – 482 kPa	(N) High (I) High (F) Low	(N) High (I) High (F) Low	(N) High (I) High (F) Low
Fish eggs and larvae	>13 mm s^{-1} peak velocity	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low

Source: Popper et al. (2014)

Notes:

peak and root mean square sound pressure levels dB re 1 µPa; sound exposure level dB re 1 μPa^2s. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N = within tens of meters from the source), intermediate (I = within the hundreds of meters from the source), and far (F = within the thousands of meters from the source).

1 Mortality and mortality injury refer to immediate or delayed death.

2 Recoverable injury refers to injuries that are not likely to result in mortality (e.g., hair cell damage, minor internal or external hematoma)

3 TTS is short- or long-term changes in hearing sensitivity that may or may not impact fitness. Defined as a change in hearing of 6 dB or greater that persists.

4 Behaviour effects are substantial changes in behaviour for a fish exposed to sound, including long-term changes in feeding, reproduction, or migration patterns. This does not include effects on a single animal or where animals become habituated to the stimulus.

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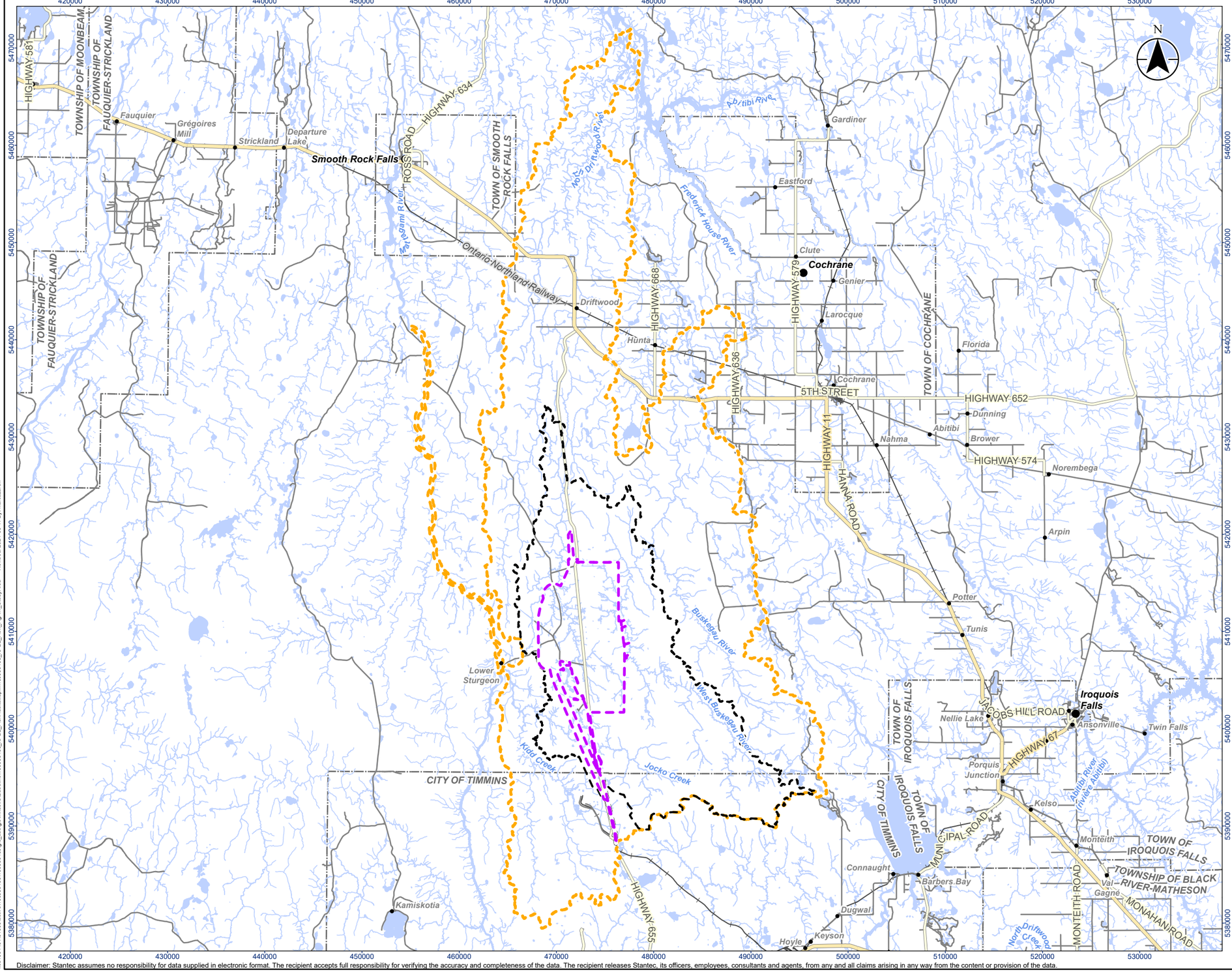
Appendices

Appendix A Study Areas and Habitat Figures



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Regional Study Area
- Expressway / Highway
- Major Road
- Minor Road
- Railway
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

0 5 10 km

1:400,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.1

Title
Study Area

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Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Regional Study Area
- Expressway / Highway
- Major Road
- Minor Road
- Railway
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Watersheds

- Jocko Creek Watershed
- North Driftwood River Watershed
- Buskegau River Watershed

0 5 10 km

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Project Location
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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.2

Title
Watershed Boundaries

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Stantec

CANADA NICKEL COMPANY

Legend

- Local Study Area
- Major Road
- Existing Transmission Line
- Watercourse
- Waterbody

0 0.5 1 km

1:30,000 (At original document size of 11x17)

Notes

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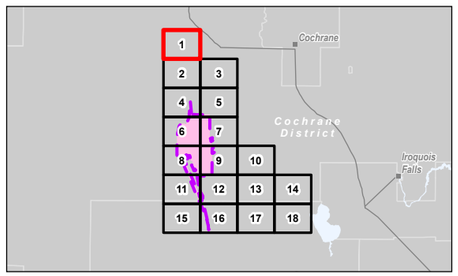

Project Location
Timmins, Ontario

160930456 REVA
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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.1

Title
Watercourses and Waterbodies LSA

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Stantec

CANADA NICKEL COMPANY

Legend

- Local Study Area
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody

0 0.5 1 km

1:30,000 (At original document size of 11x17)

Notes

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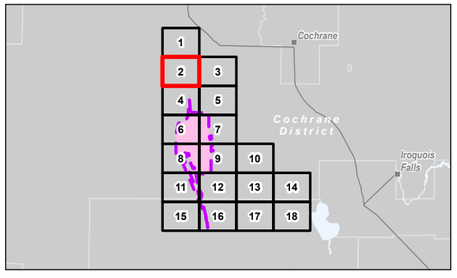

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.2

Title
Watercourses and Waterbodies LSA

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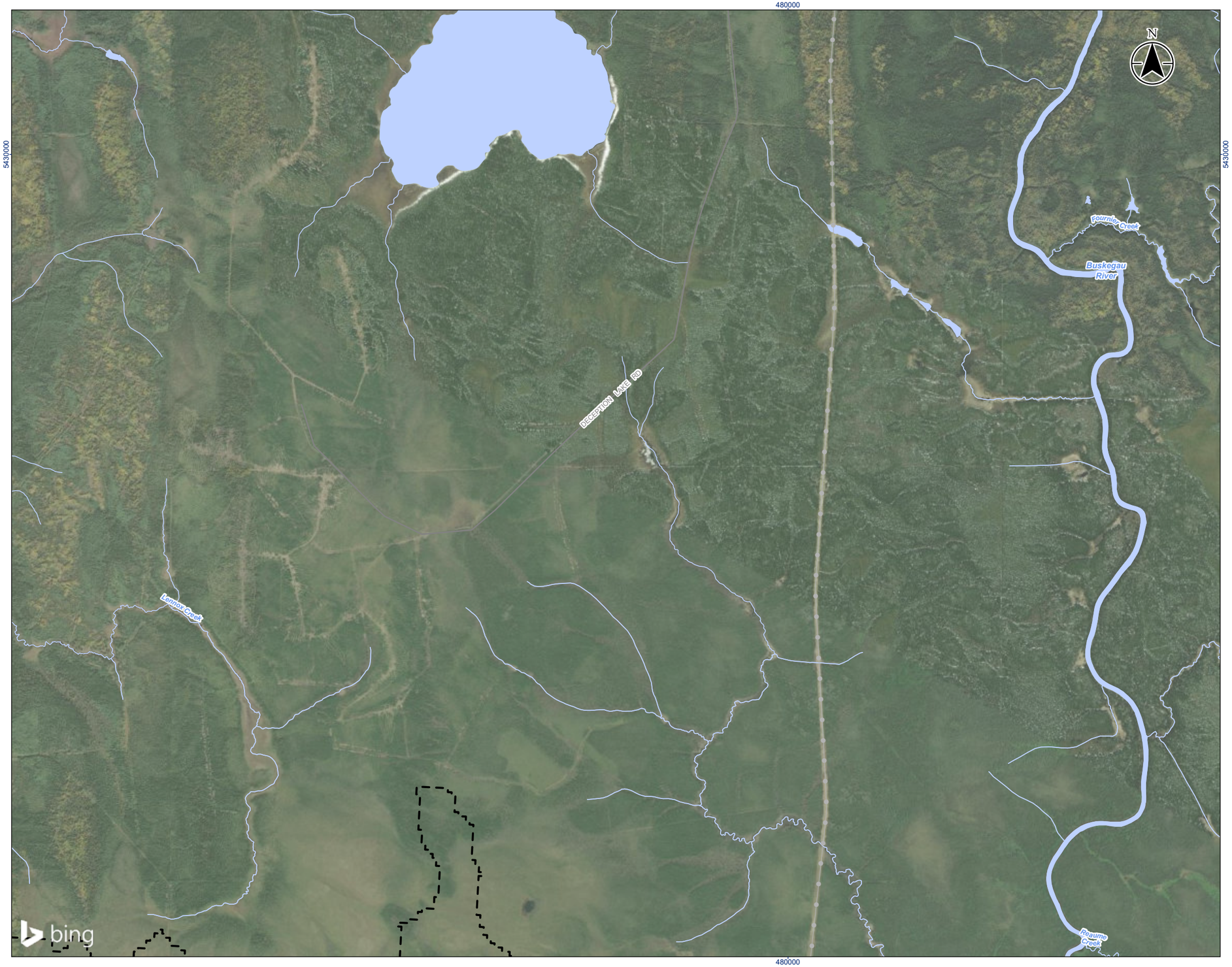

Stantec

CANADA NICKEL COMPANY

Legend

- Local Study Area
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody

0 0.5 1 km

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Notes

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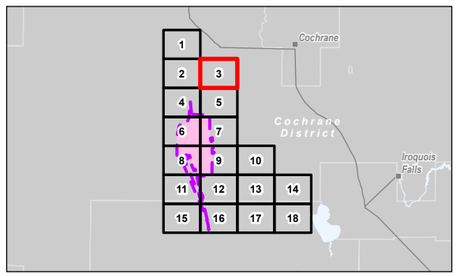

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.3

Title
Watercourses and Waterbodies LSA

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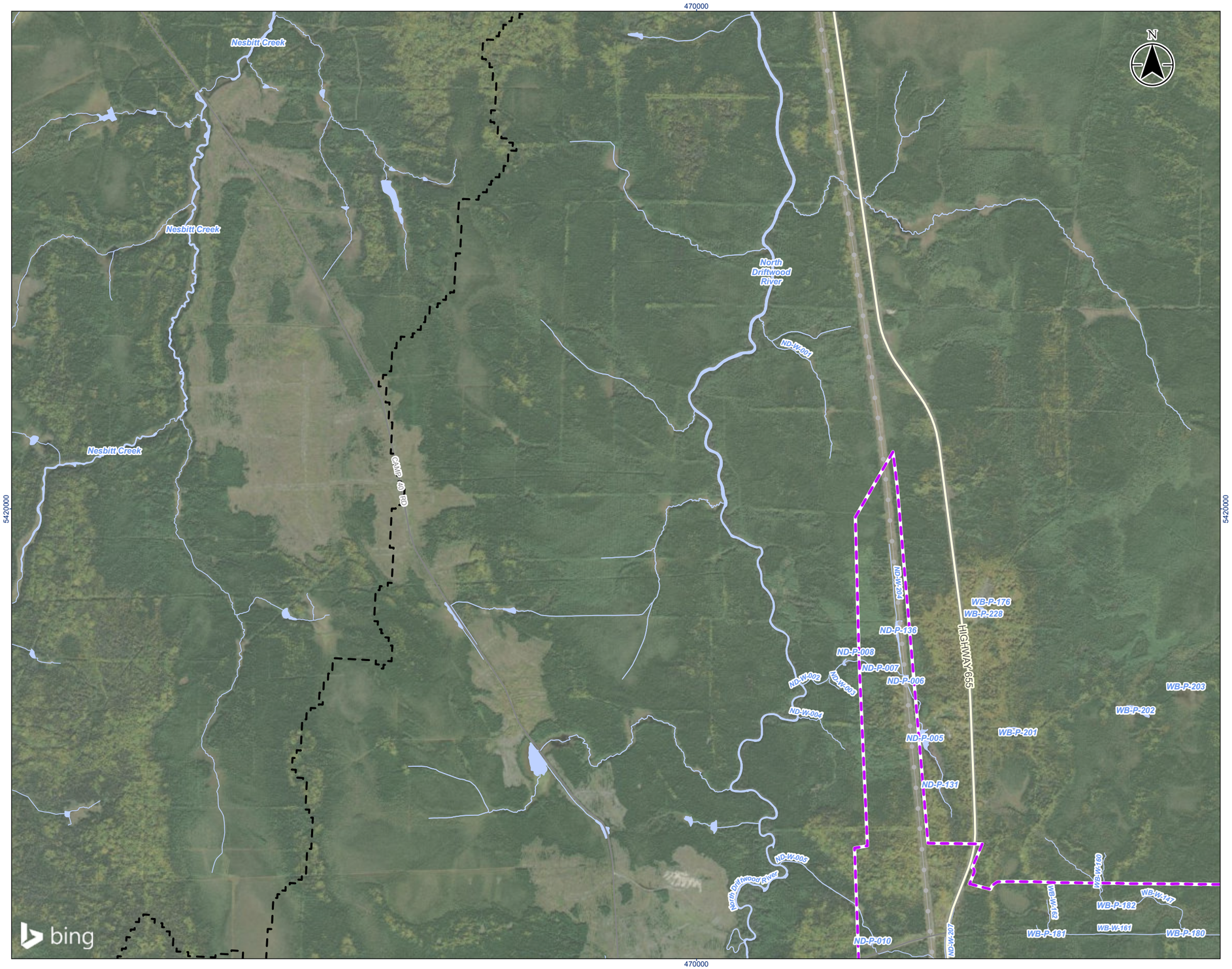

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody

0 0.5 1 km

1:30,000 (At original document size of 11x17)

Notes

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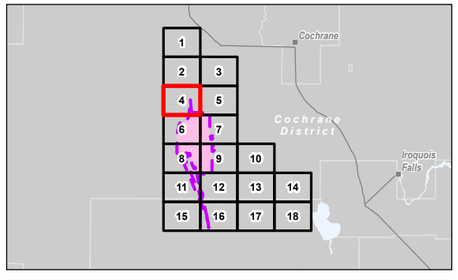

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.4

Title
Watercourses and Waterbodies LSA

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480000

5420000

WB-W-182
WB-W-181
WB-W-180
WB-W-183
WB-W-184
WB-W-185
WB-W-186
WB-W-187
WB-W-188
WB-W-189
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WB-W-191
WB-W-192
WB-W-193
WB-W-194
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WB-W-207
WB-W-208
WB-P-177
WB-P-178
WB-P-179
WB-P-180
WB-P-181
WB-P-182
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WB-P-198
WB-P-199
WB-P-200
WB-P-201
WB-P-202
WB-P-203
WB-P-204
WB-P-205
WB-P-206
WB-P-207
WB-P-208
Buskegau River
West Buskegau River
Reserve Creek

480000

5420000

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Existing Transmission Line
- Watercourse
- Waterbody

0 0.5 1 km

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Notes

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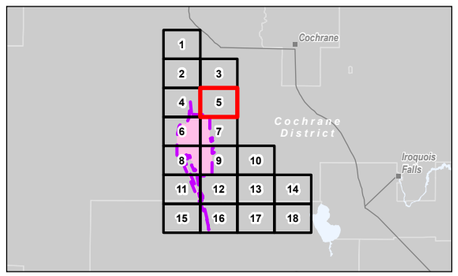

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.5

Title
Watercourses and Waterbodies LSA

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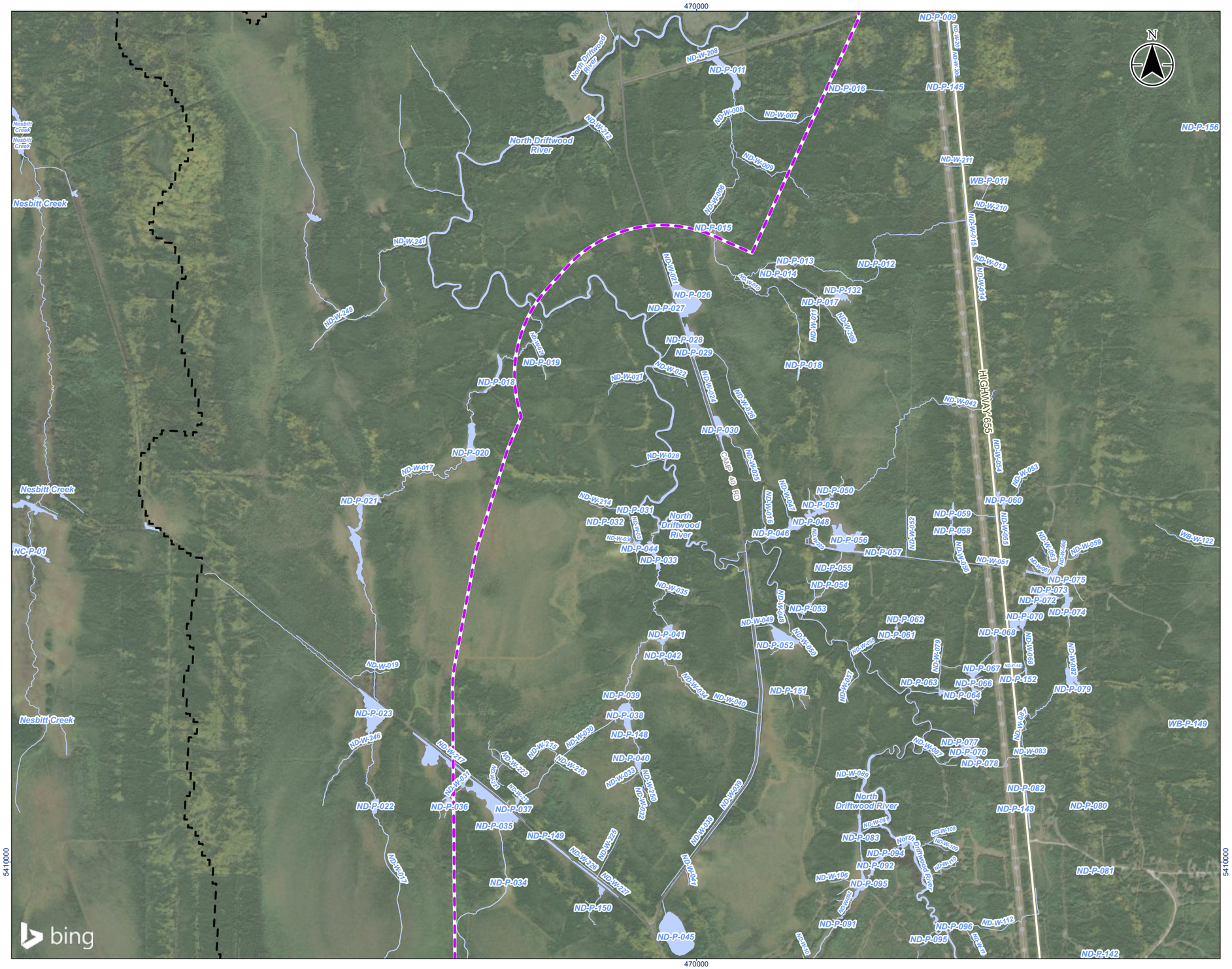

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody

0 0.5 1 km

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Notes

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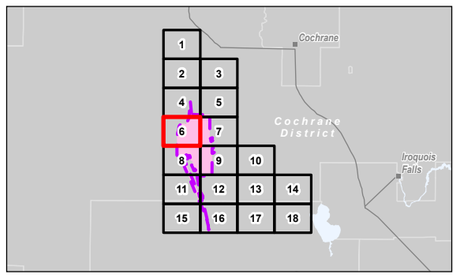

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.6

Title
Watercourses and Waterbodies LSA

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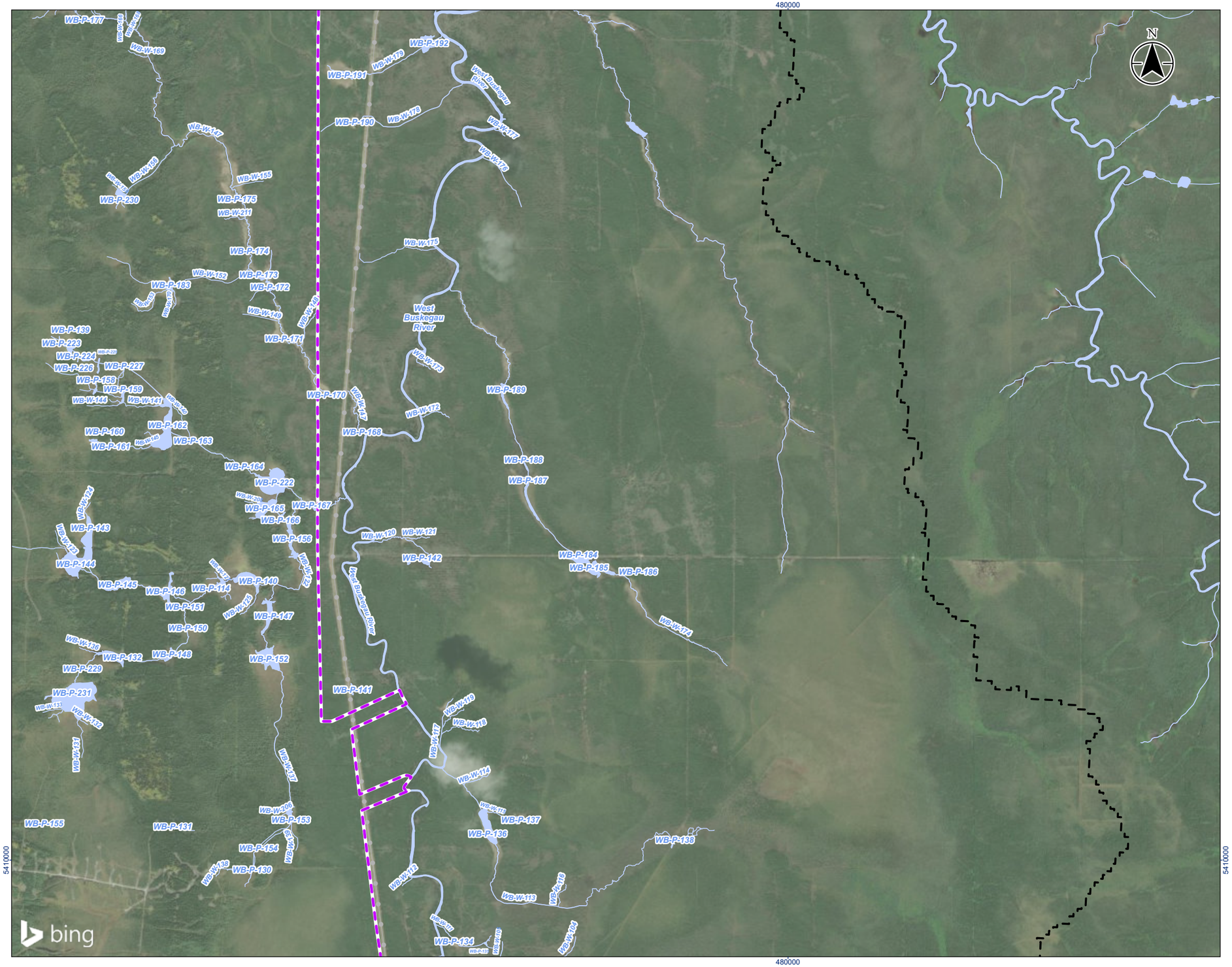

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Existing Transmission Line
- Watercourse
- Waterbody

0 0.5 1 km

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Notes

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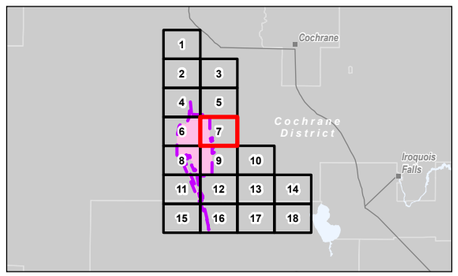

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.7

Title
Watercourses and Waterbodies LSA

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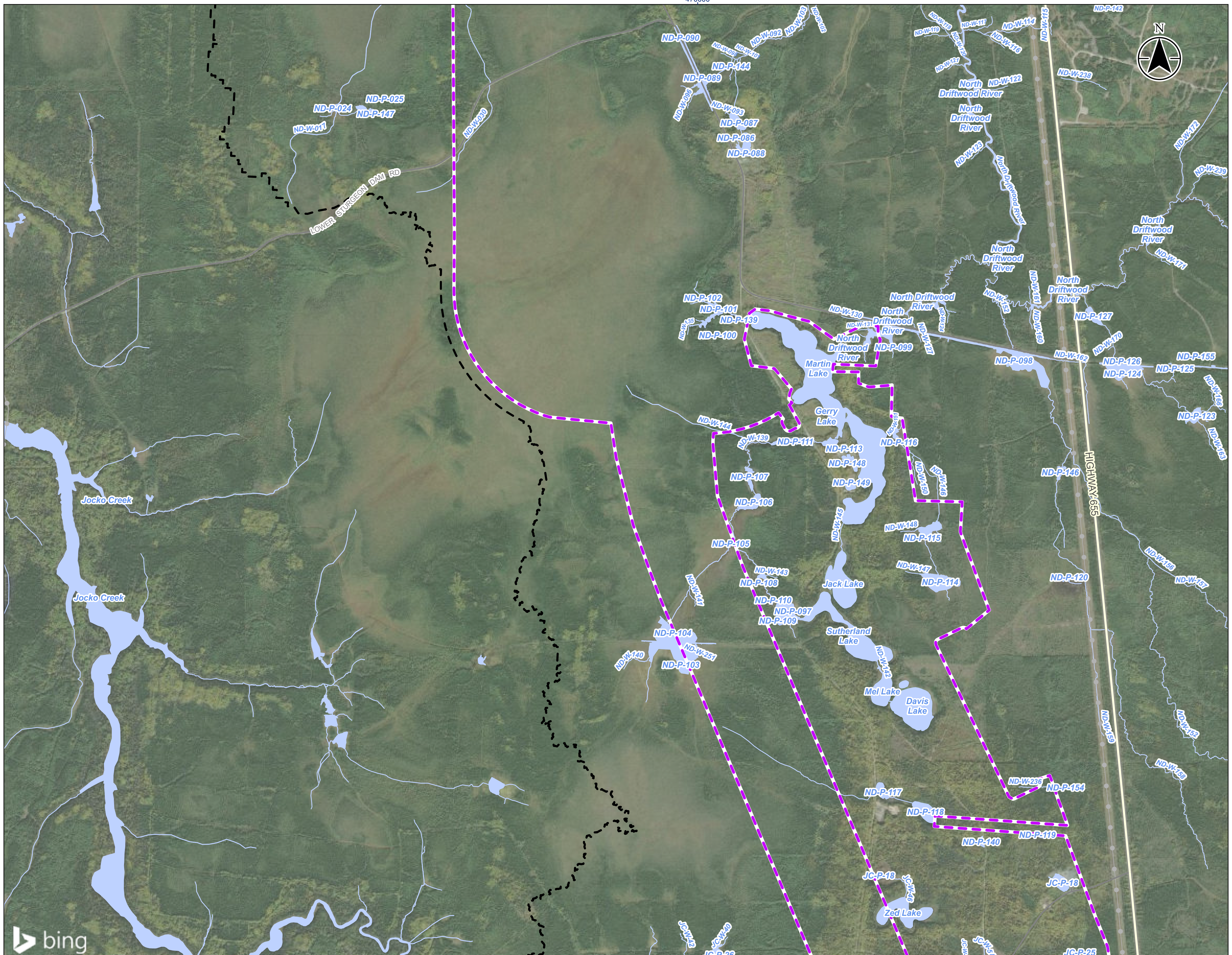

Legend
- Project Area
- Local Study Area
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody

0 0.5 1 km
1:30,000 (At original document size of 11x17)

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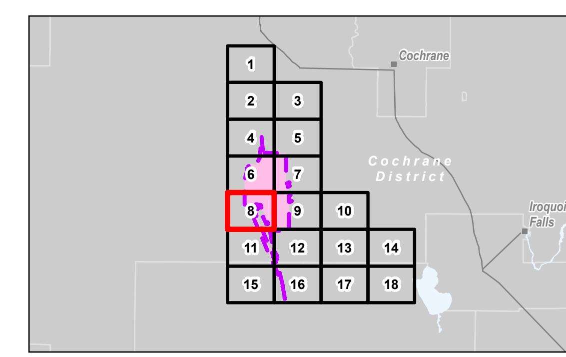

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.8

Title
Watercourses and Waterbodies LSA

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480000

WB-W-110
WB-P-133
WB-P-126
WB-W-104
WB-W-202
WB-P-221
ND-P-141
WB-P-128
WB-P-127
WB-W-103
West Buskegau River
WB-W-102
WB-W-100
WB-W-101
WB-P-121
WB-P-124
WB-P-122
WB-W-106
WB-P-125
WB-P-123
WB-W-099
WB-P-120
WB-W-098
WB-P-129
West Buskegau River
WB-W-097
ND-W-173
WB-W-096
WB-W-095
WB-W-094
WB-W-093
WB-P-119
WB-W-092
WB-W-091
ND-W-182
ND-W-174
ND-P-155
ND-W-183
ND-W-185
ND-W-187
ND-W-180
ND-W-179
ND-W-181
ND-W-184
ND-P-004
ND-W-188
ND-W-189
ND-W-190
ND-W-191
North Driftwood River
ND-W-170
ND-W-171
ND-W-193
ND-P-133
ND-P-134
ND-W-194
ND-W-192
ND-W-195
ND-W-157
ND-W-199
ND-W-172
ND-P-137
ND-P-128
ND-W-202
ND-P-135
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ND-W-198
ND-P-138
ND-P-002
ND-P-122
ND-P-121
ND-W-197
ND-P-001
ND-P-130
WB-W-089
WB-W-088
Prosser Creek
WB-W-086
WB-W-087
WB-P-116
WB-W-085
WB-W-083
WB-P-117
WB-W-084
WB-P-115
WB-W-082
Prosser Lake
Prosser Creek
WB-L-02
WB-W-077
WB-W-072
WB-P-106
WB-W-073
WB-W-051
WB-P-107
WB-P-099
WB-P-105
WB-W-050
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WB-W-075
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WB-P-216
WB-P-094
WB-P-097
WB-W-081
WB-P-093
WB-P-092
WB-W-065
WB-P-095
WB-W-062
West Buskegau River
WB-W-057
WB-P-090
WB-P-091
WB-W-056
480000

bing

N

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Existing Transmission Line
- Watercourse
- Waterbody

0 0.5 1 km

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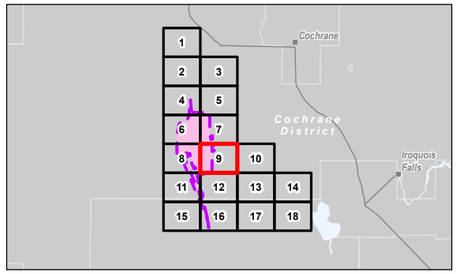

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.9

Title
Watercourses and Waterbodies LSA

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490000

N

Unnamed Lake 1

WB-W-039

WB-W-040

WB-W-041

WB-W-046

WB-W-045

WB-P-061

WB-P-062

WB-P-063

West Buckingau River

WB-W-043

WB-W-042

WB-W-044

Buckingau River

bing

490000

Stantec

CANADA NICKEL COMPANY

Legend

- Local Study Area
- Minor Road
- Watercourse
- Waterbody

0 0.5 1 km

1:30,000 (At original document size of 11x17)

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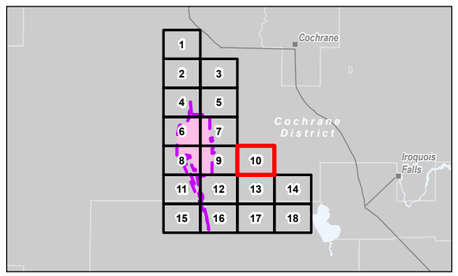

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.10

Title
Watercourses and Waterbodies LSA

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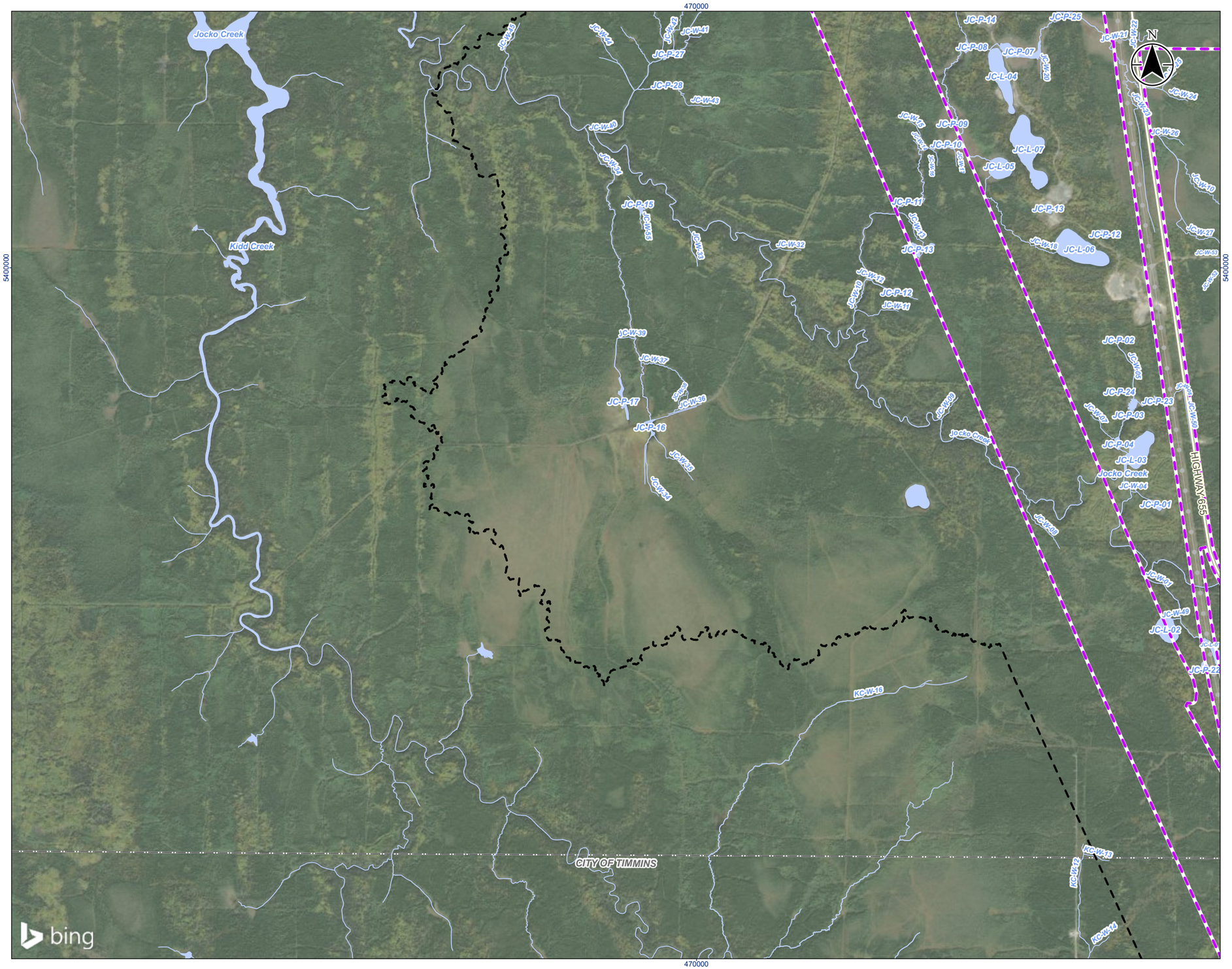

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

0 0.5 1 km

1:30,000 (At original document size of 11x17)

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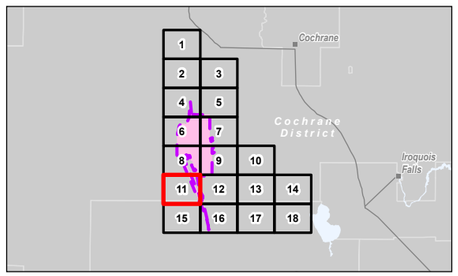

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.11

Title
Watercourses and Waterbodies LSA

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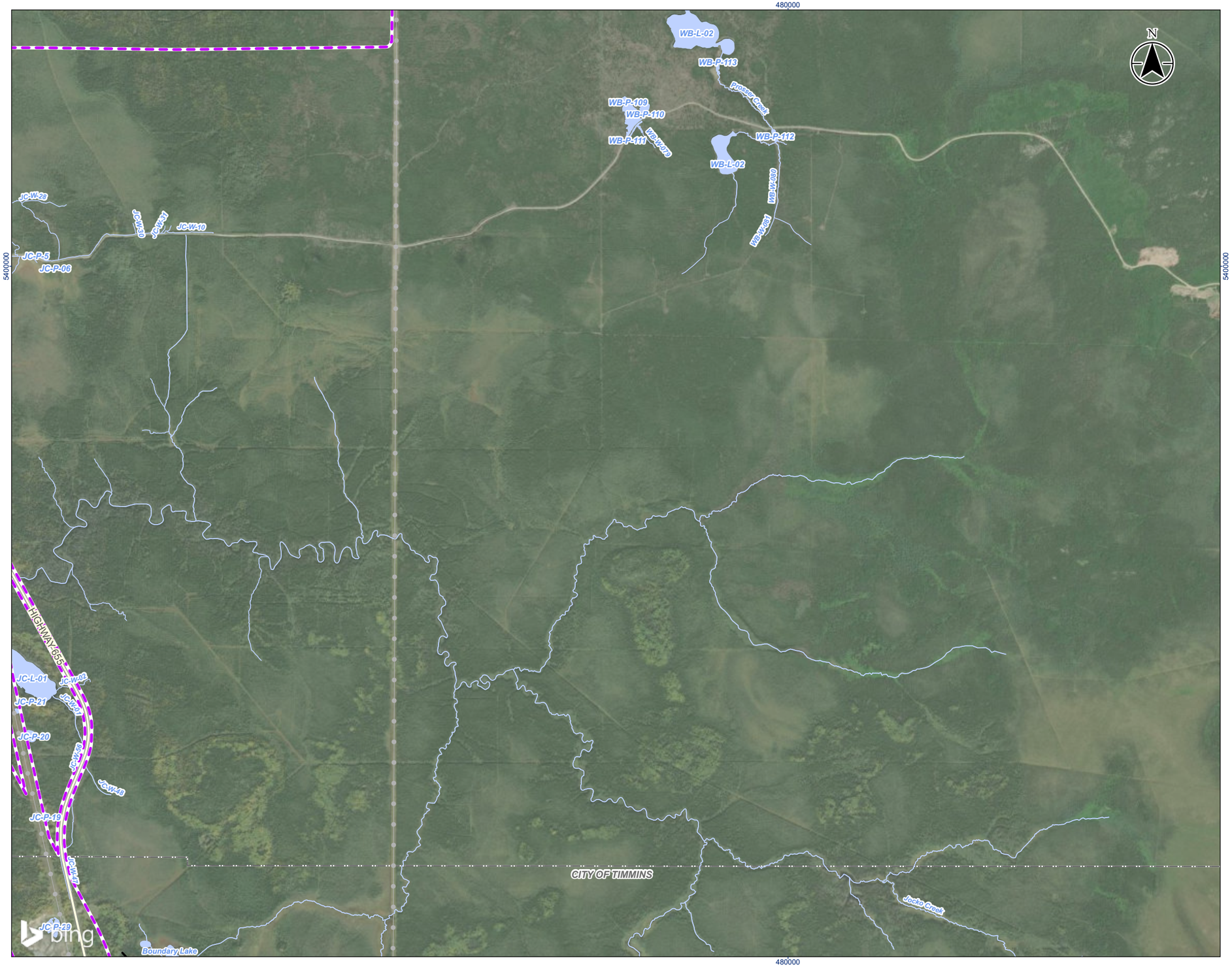

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Major Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

0 0.5 1 km

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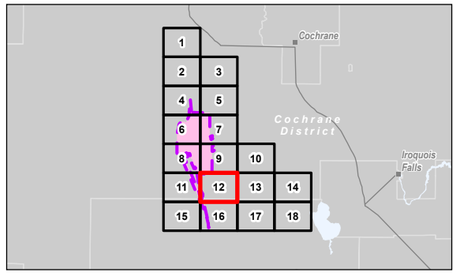

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.12

Title
Watercourses and Waterbodies LSA

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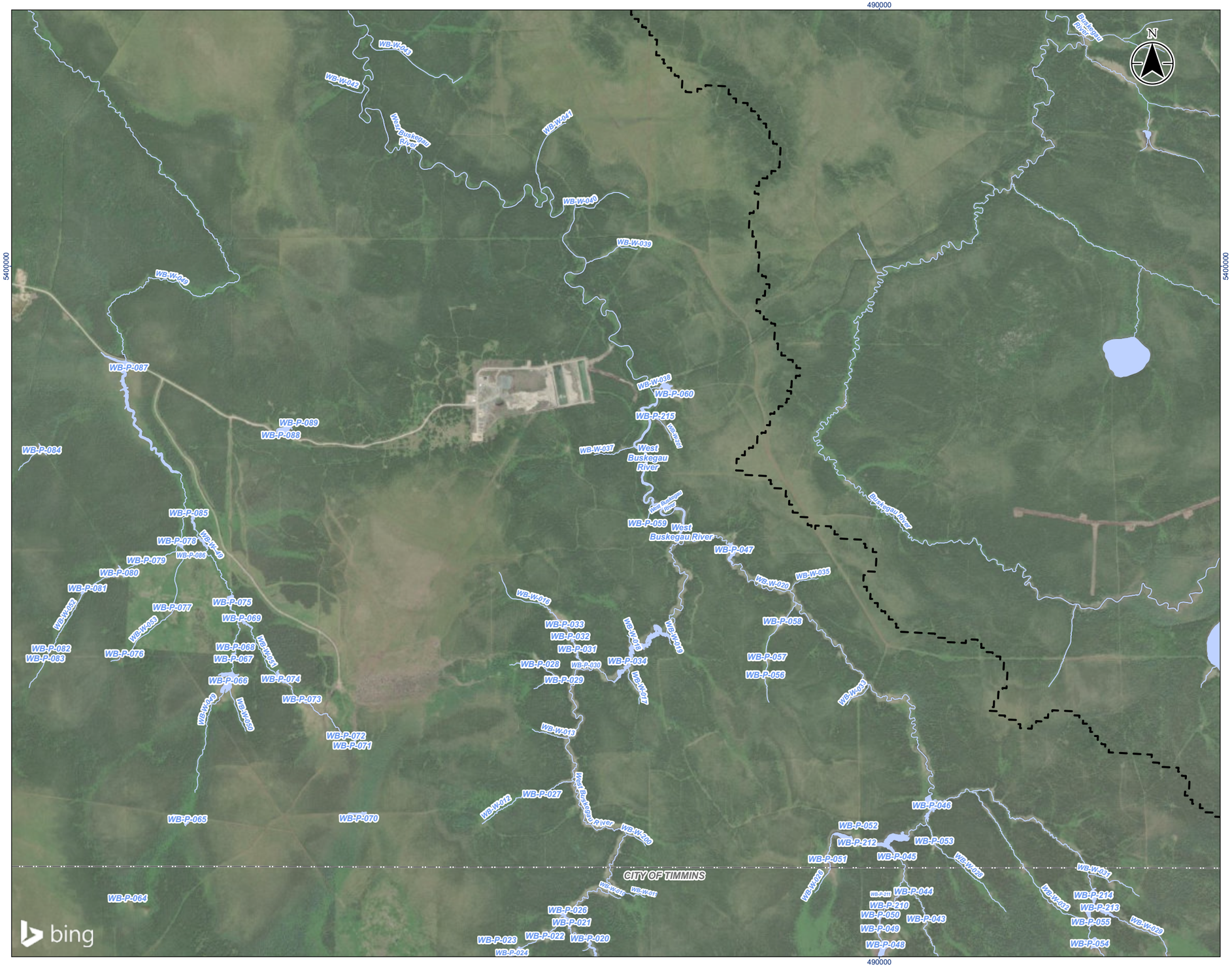

Stantec

CANADA NICKEL COMPANY

Legend

- Local Study Area
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

0 0.5 1 km

1:30,000 (At original document size of 11x17)

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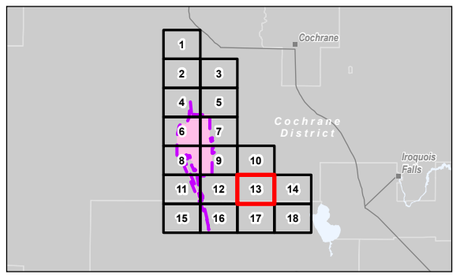

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.13

Title
Watercourses and Waterbodies LSA

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Stantec

CANADA NICKEL COMPANY

Legend

- Local Study Area
- Minor Road
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

0 0.5 1 km

1:30,000 (At original document size of 11x17)

Notes

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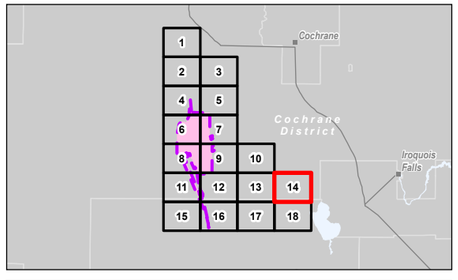

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.14

Title
Watercourses and Waterbodies LSA

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Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Minor Road
- Railway
- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

0 0.5 1 km

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Notes

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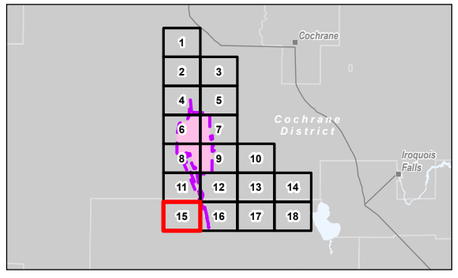

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.15

Title
Watercourses and Waterbodies LSA

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480000

Boundary Lake

Joe Jo Creek

KC-W-04

KC-W-01A

KC-W-09

KC-W-10

KC-P-01

HIGHWAY 655

KC-W-04

KC-W-03

KC-W-08

KC-W-07

KC-W-06

KC-W-01

KC-W-02

Ontario Northland Railway

Feldman Lake

5390000

480000

bing

N

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

0 0.5 1 km

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Notes

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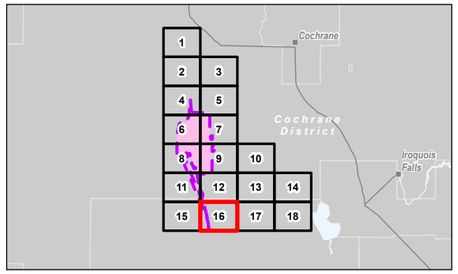

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.16

Title
Watercourses and Waterbodies LSA

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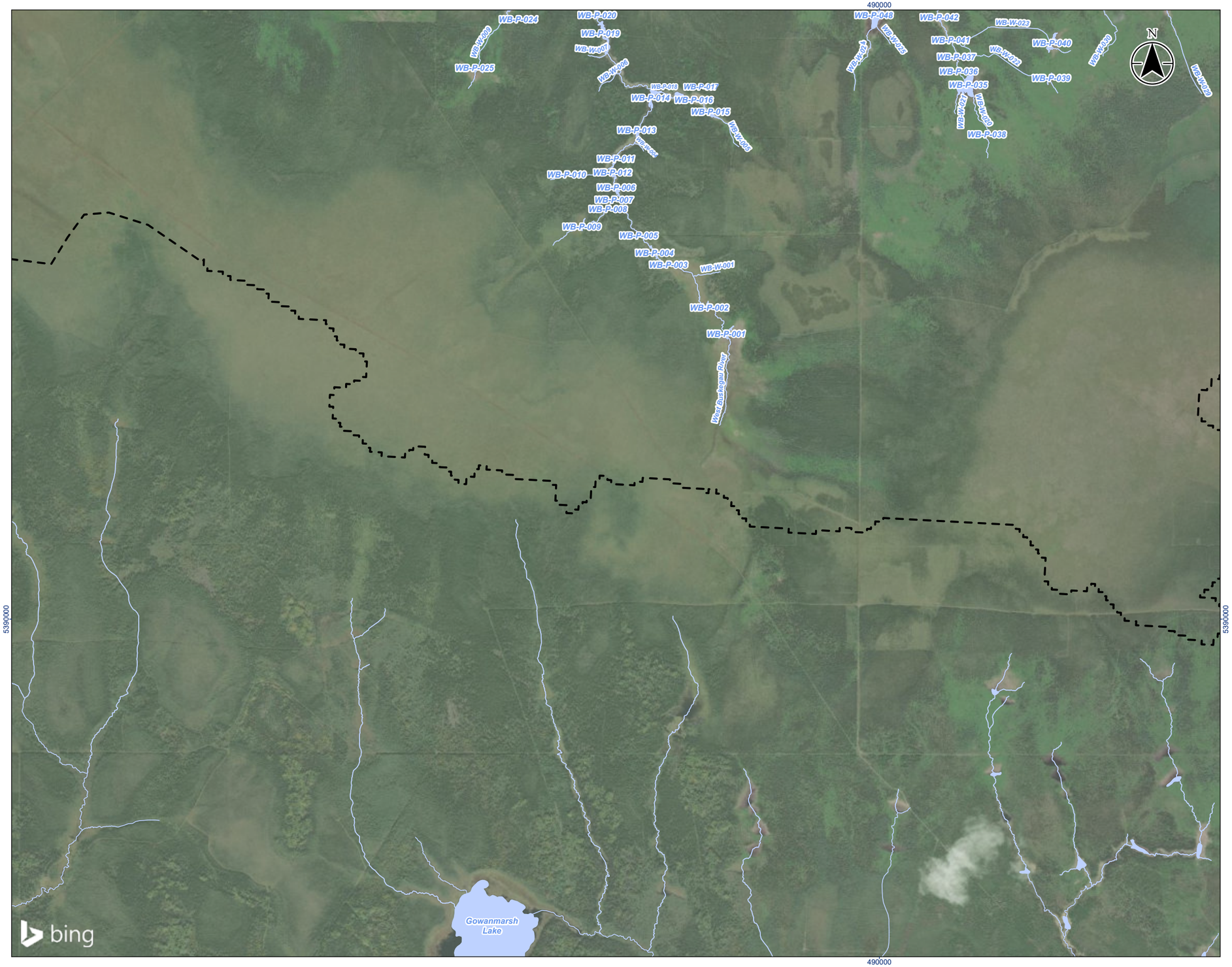

Stantec

CANADA NICKEL COMPANY

Legend

- Local Study Area
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

0 0.5 1 km

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Notes

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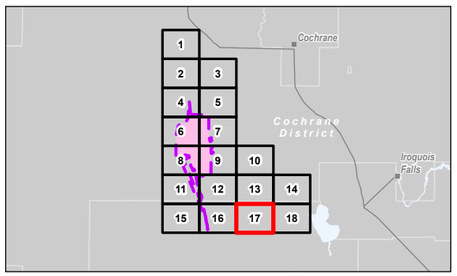

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.17

Title
Watercourses and Waterbodies LSA

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Stantec

CANADA NICKEL COMPANY

Legend

- Local Study Area
- Minor Road
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

0 0.5 1 km

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Notes

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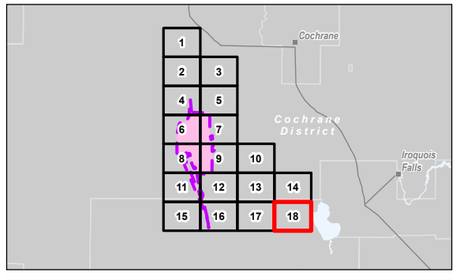

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3.18

Title
Watercourses and Waterbodies LSA

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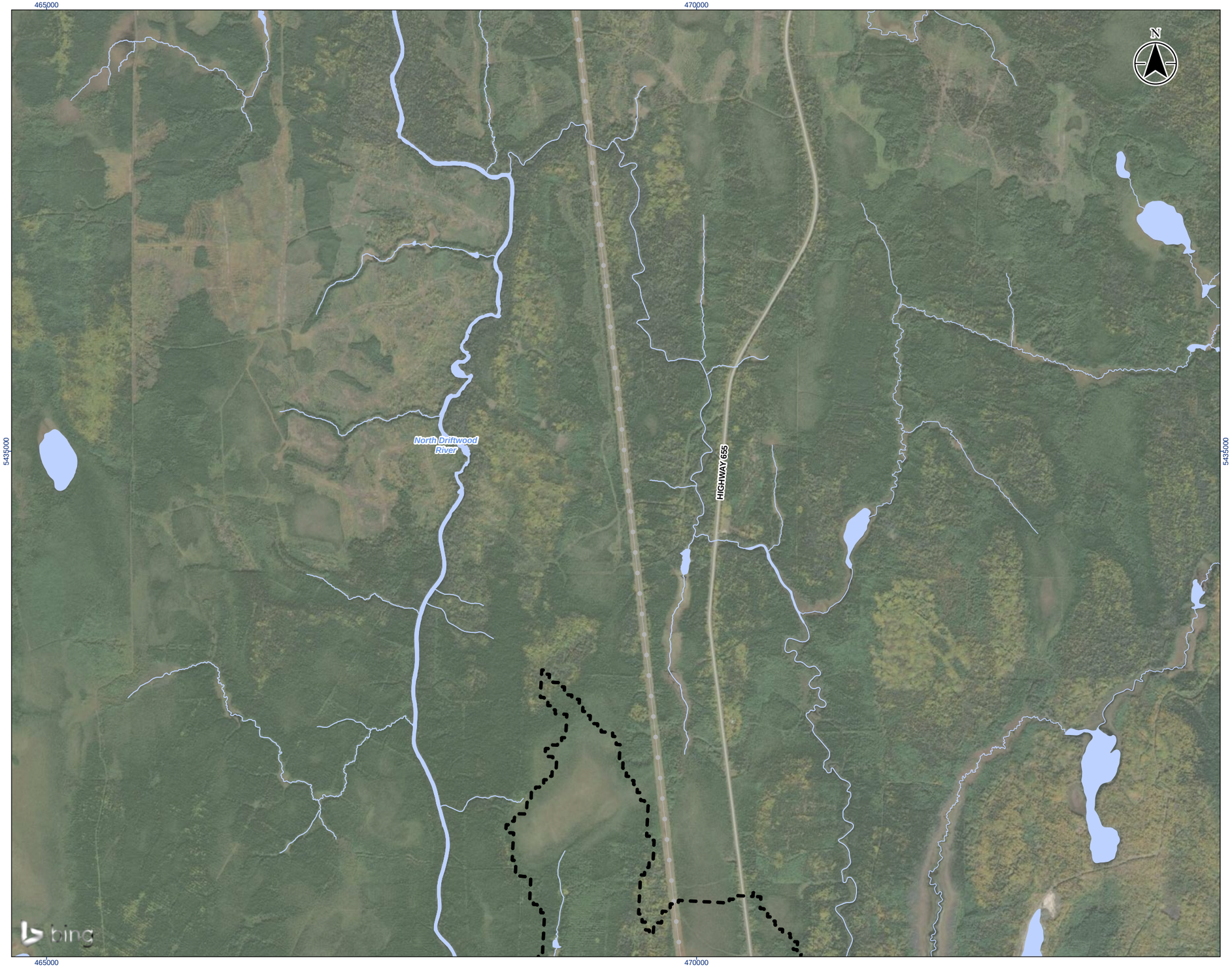

Stantec

Legend

Local Study Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

1:30,000 (At original document size of 11x17)

Notes

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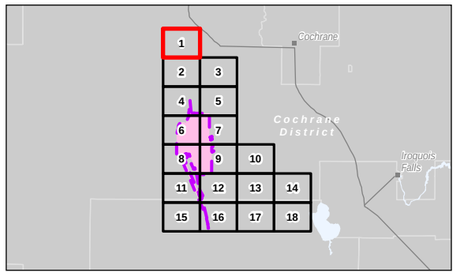

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.1

Title
Field Sampling Locations

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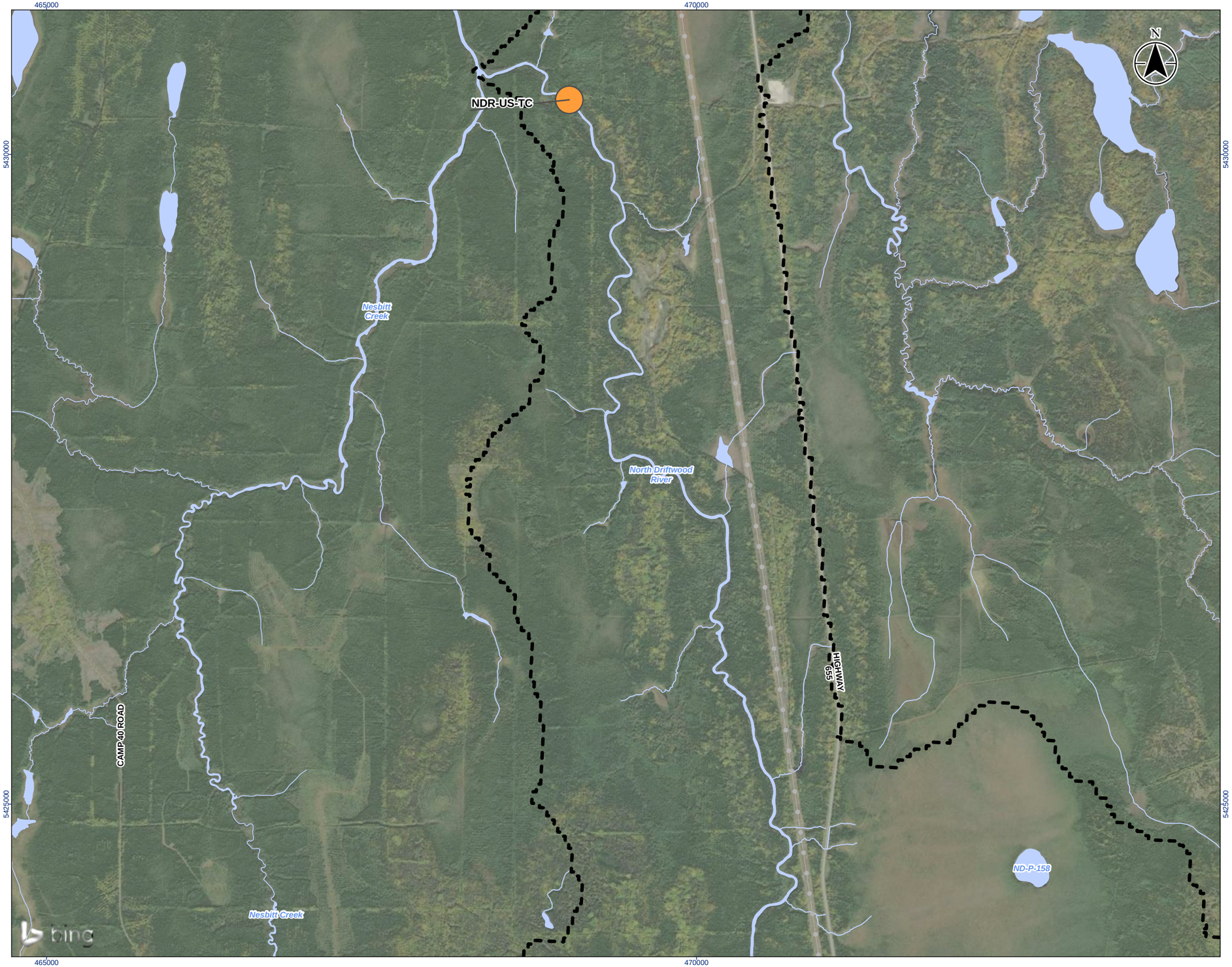

Stantec

Legend

Local Study Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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Notes

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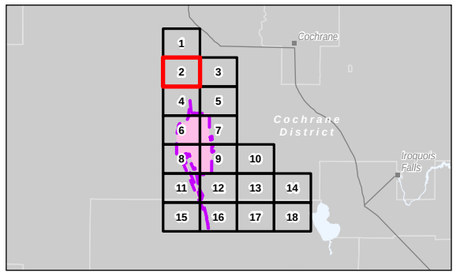

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.2

Title
Field Sampling Locations

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475000

480000

5430000

5425000

DECEPTION LAKE ROAD

Buskegau River

N

bing

Stantec

Legend

Local Study Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Aquatic Sampling Locations

Surface Water

Habitat Assessment

Benthic Sediment

Fish Community

Fish Tissue

eDNA

Zooplankton and Phytoplankton

0 0.5 1 km

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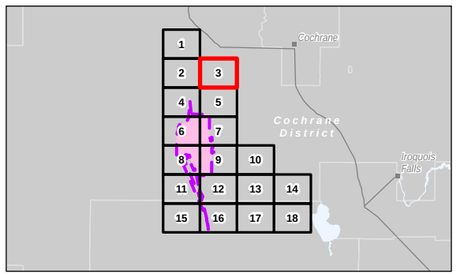

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.3

Title
Field Sampling Locations

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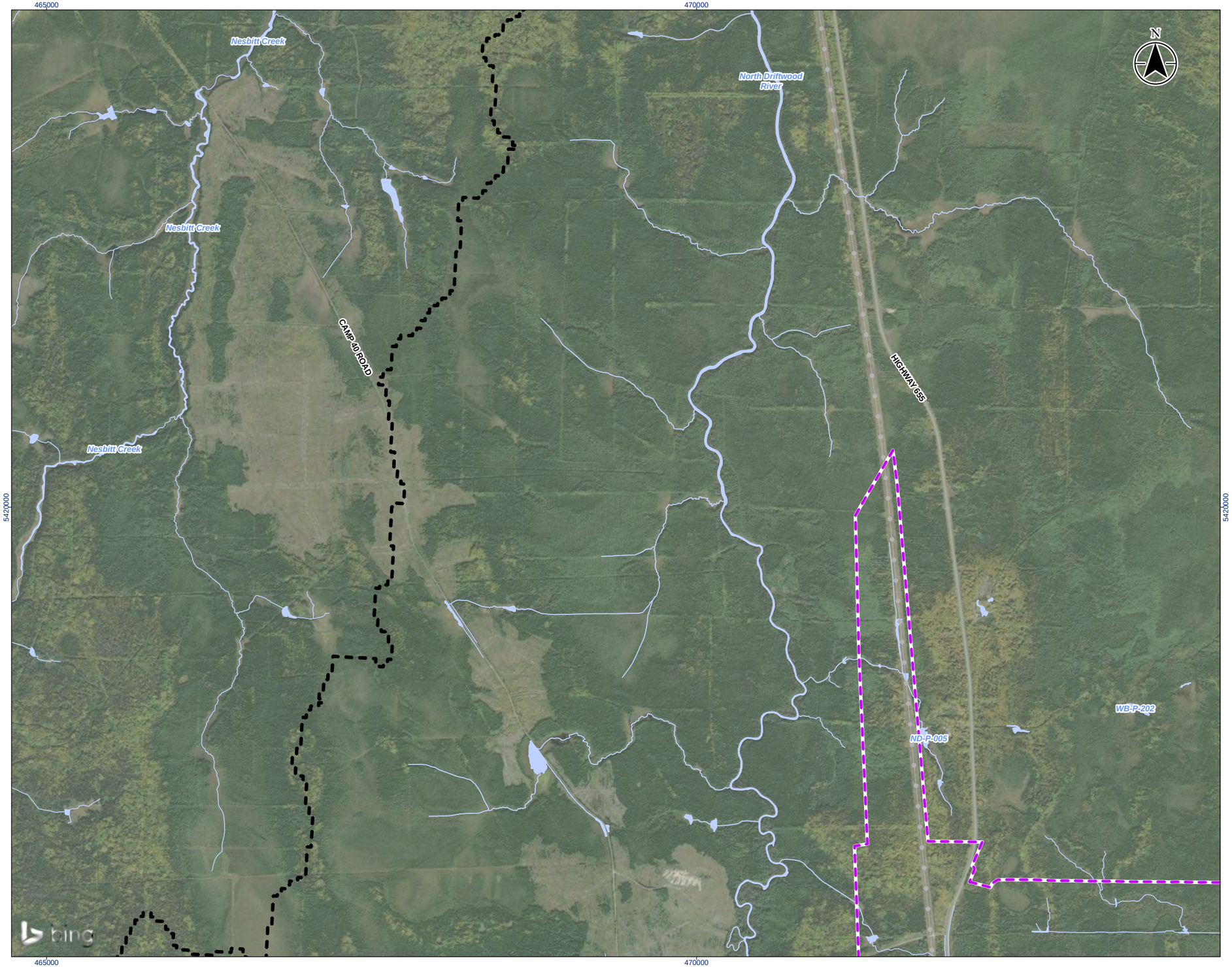

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

1:30,000 (At original document size of 11x17)

Notes

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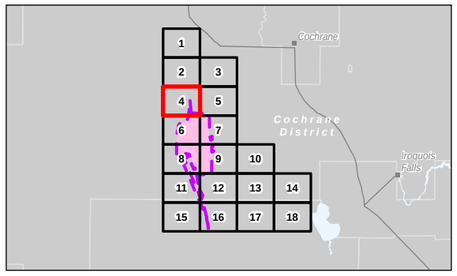

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.4

Title
Field Sampling Locations

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475000
480000
5420000
N
Buskegau River
West Buskegau River
WB-P-197
WB-P-198
WB-P-199
WB-P-178
WB-P-177
tmc
475000
480000
5420000

Stantec

Legend

Project Area
Local Study Area

Base Features

Existing Transmission Line
Watercourse
Waterbody

Aquatic Sampling Locations

Surface Water
Habitat Assessment
Benthic Sediment
Fish Community
Fish Tissue
eDNA
Zooplankton and Phytoplankton

0 0.5 1 km

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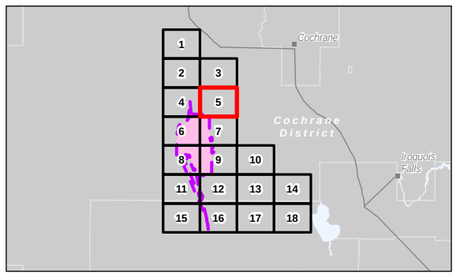

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.5

Title
Field Sampling Locations

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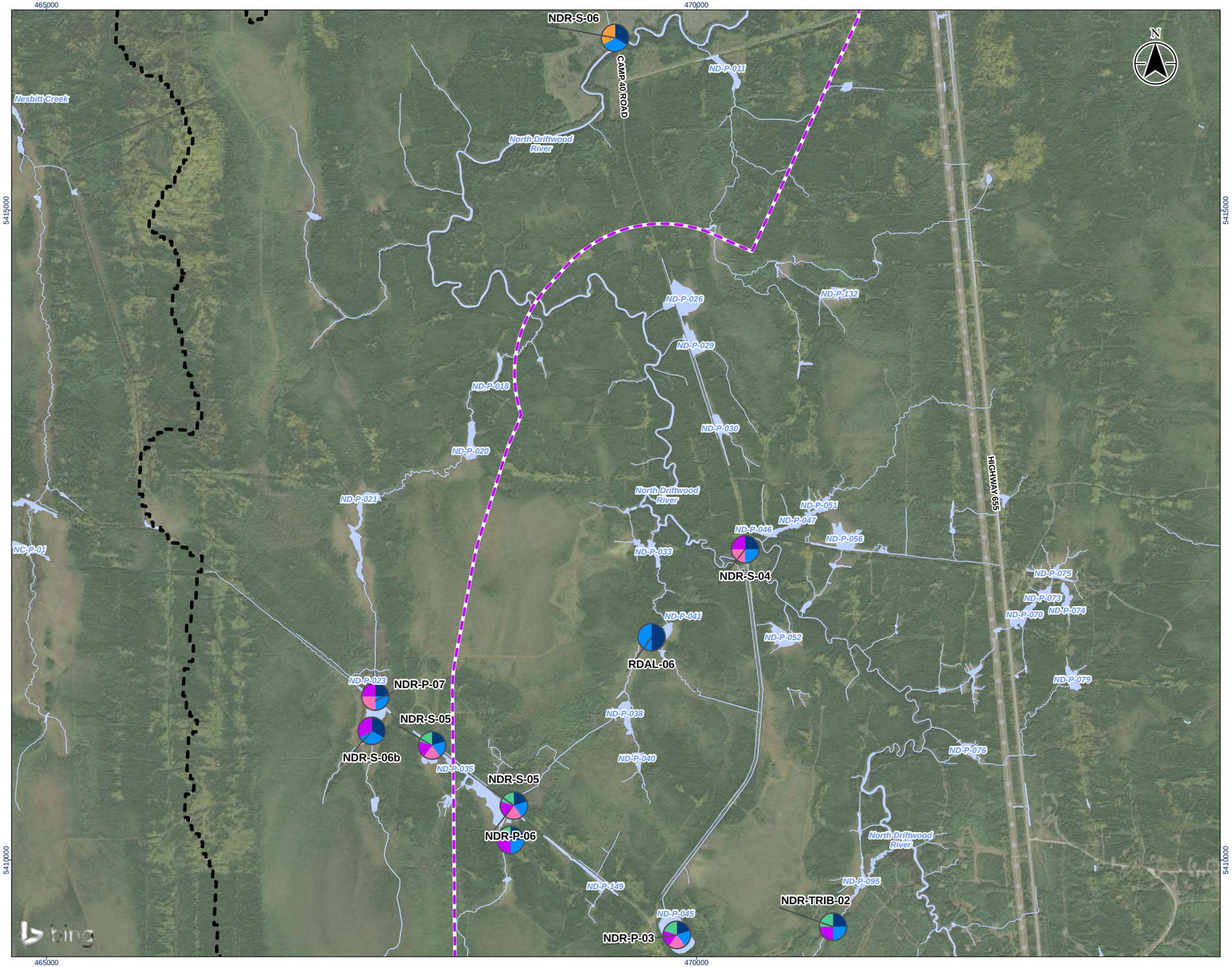

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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Notes

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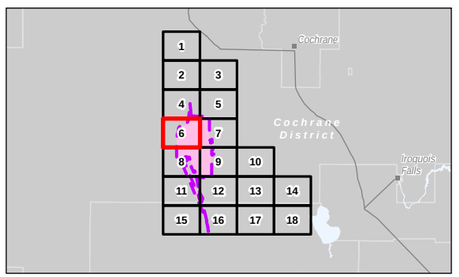

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.6

Title
Field Sampling Locations

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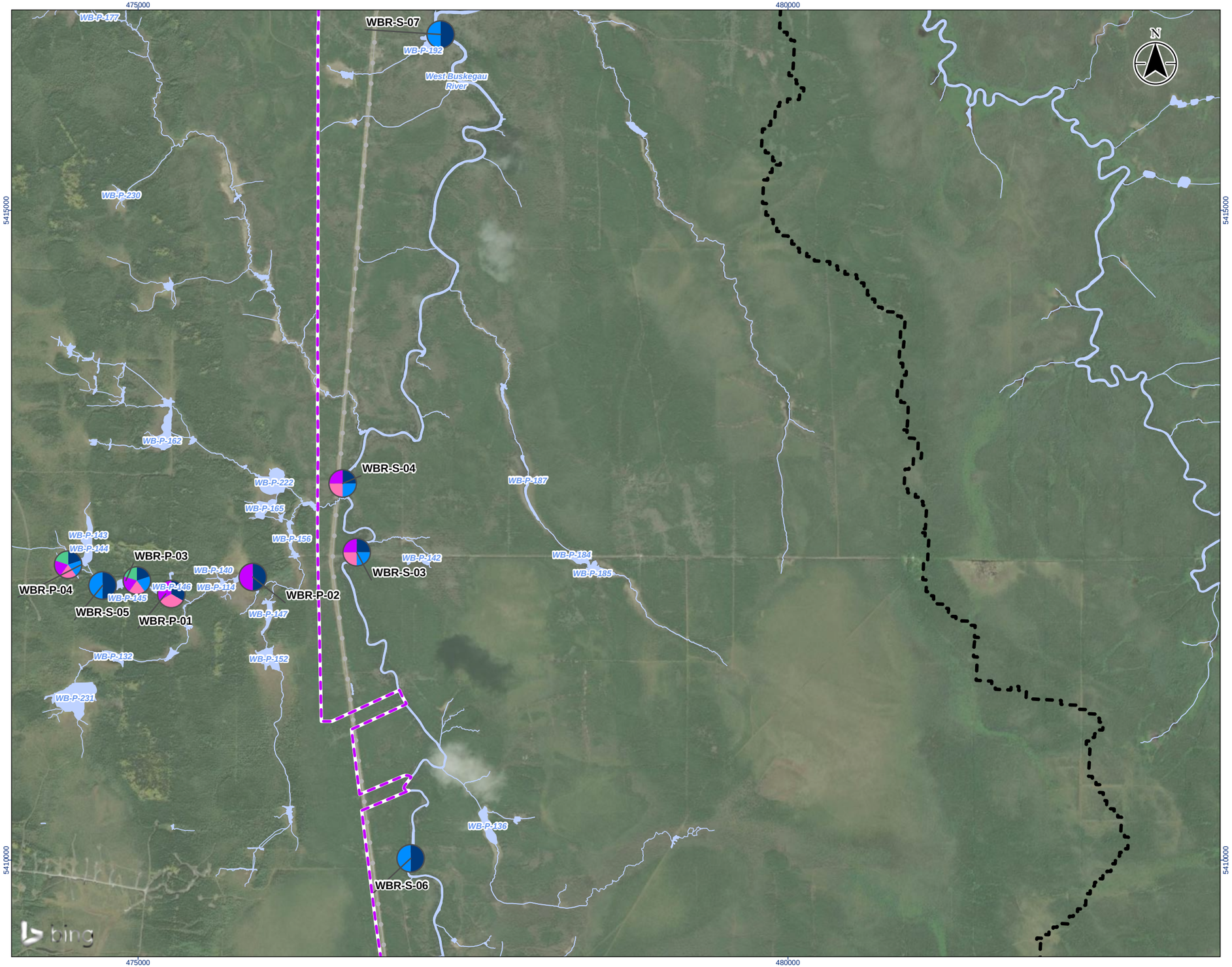

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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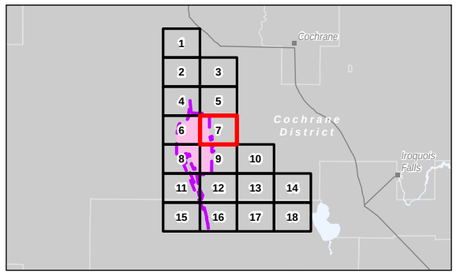

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.7

Title
Field Sampling Locations

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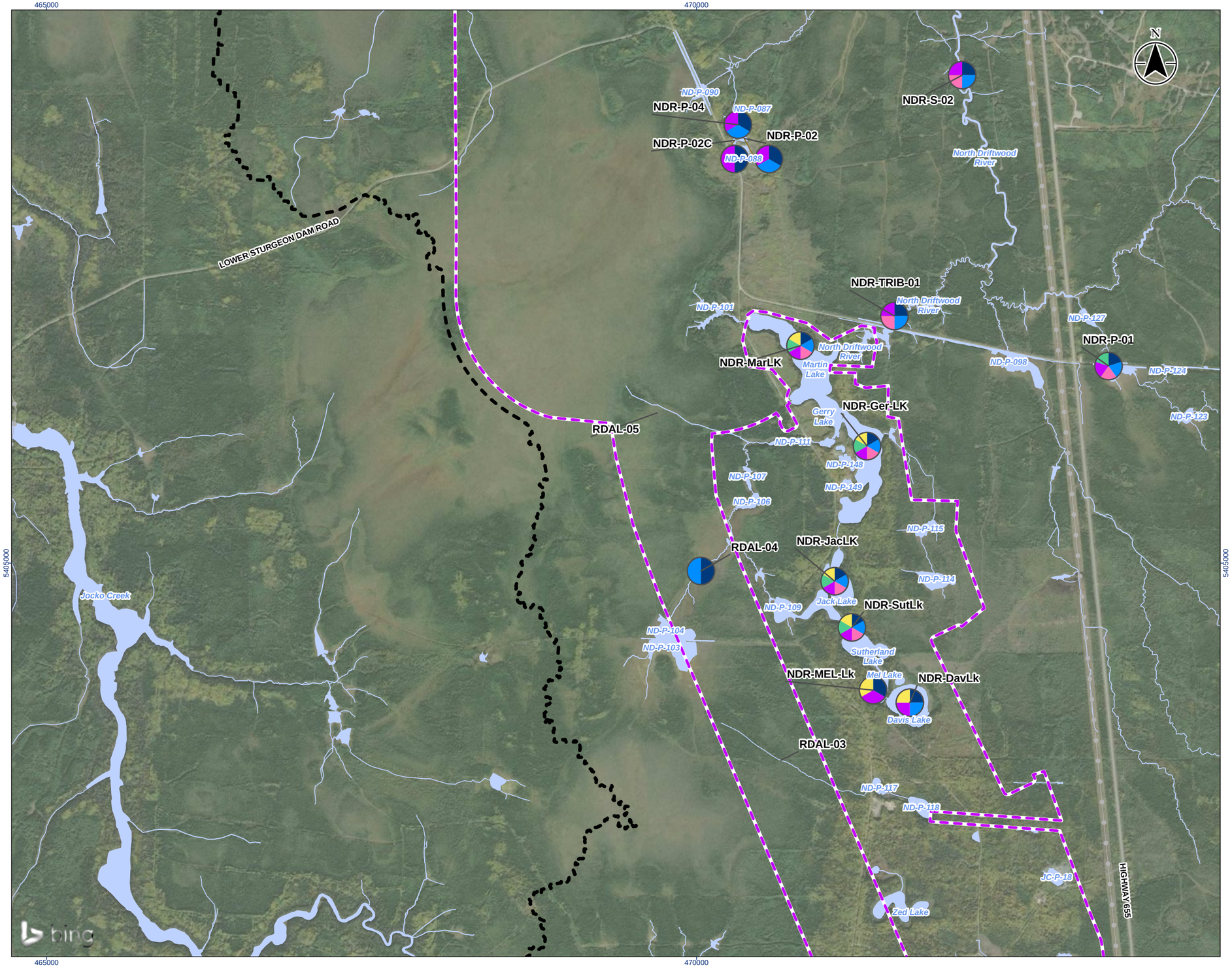

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

1:30,000 (At original document size of 11x17)

Notes

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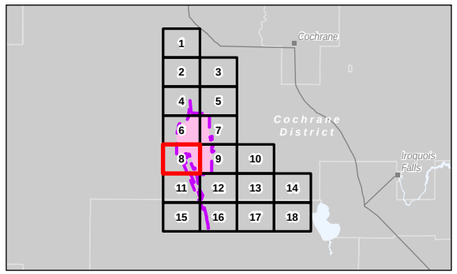

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.8

Title
Field Sampling Locations

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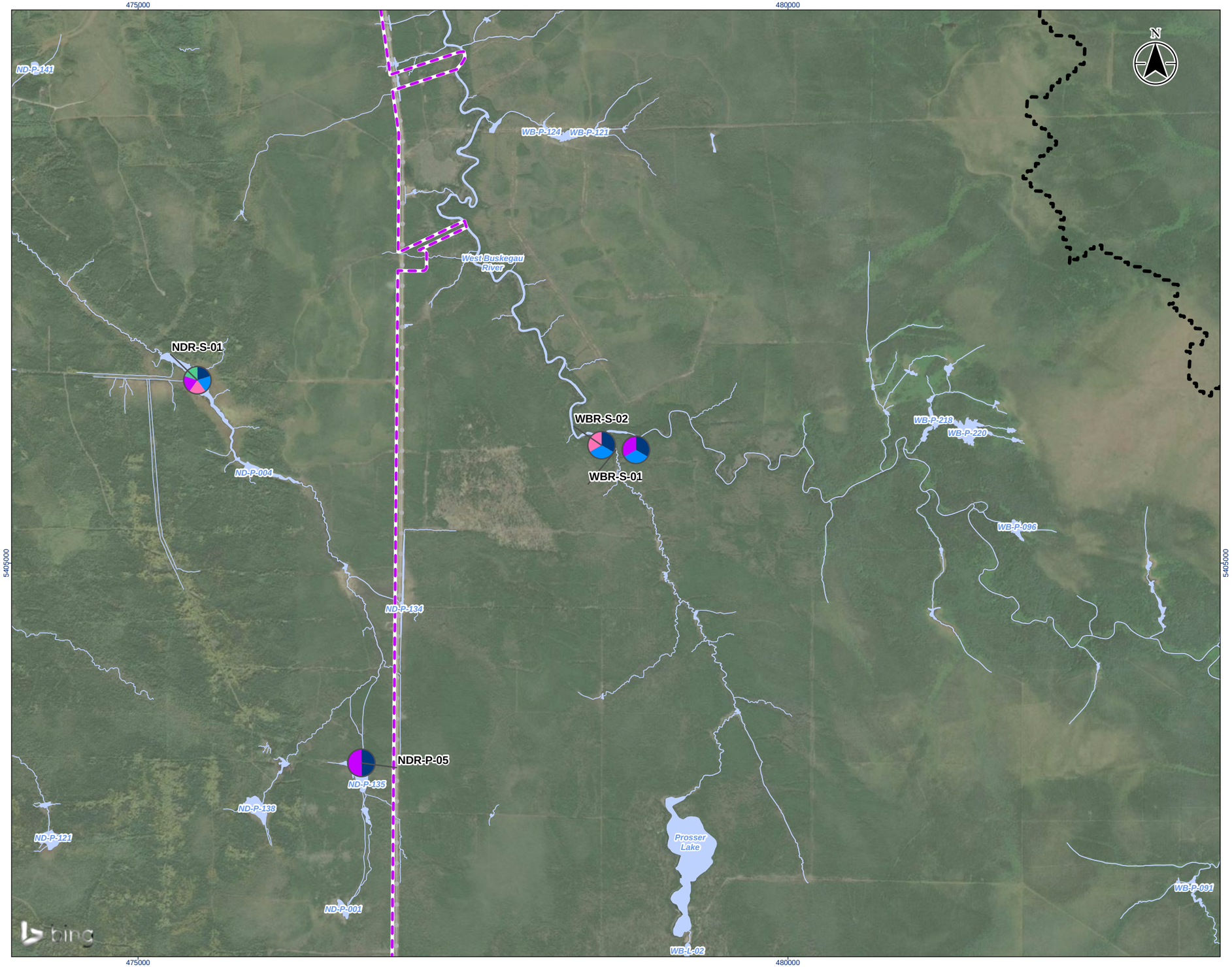

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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Notes

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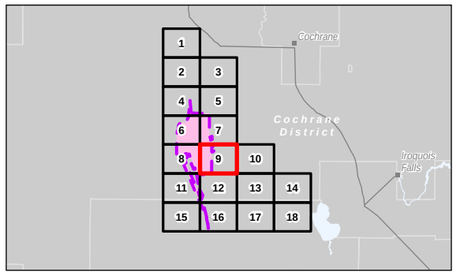

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.9

Title
Field Sampling Locations

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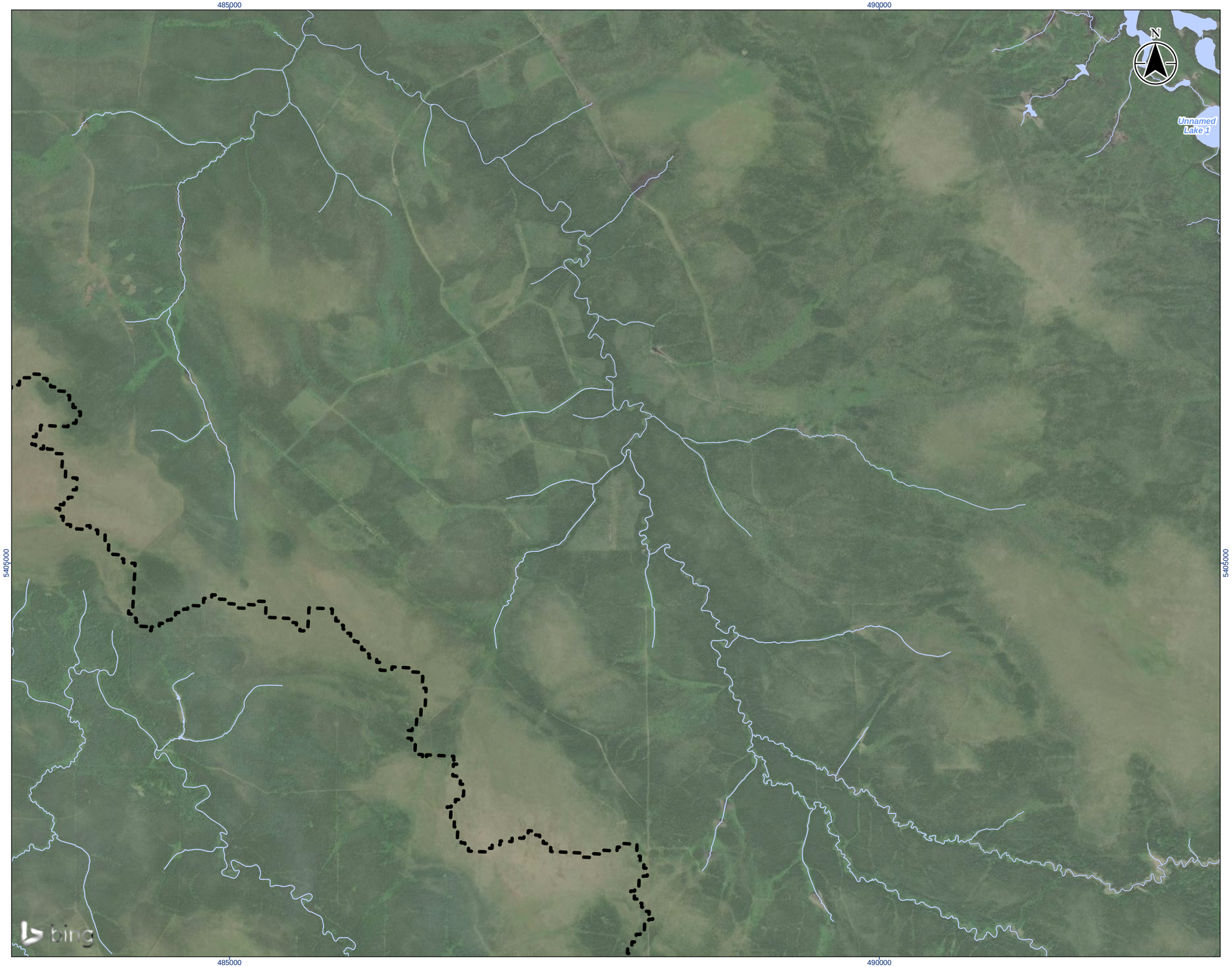

Stantec

Legend

- Local Study Area
- Watercourse
- Waterbody

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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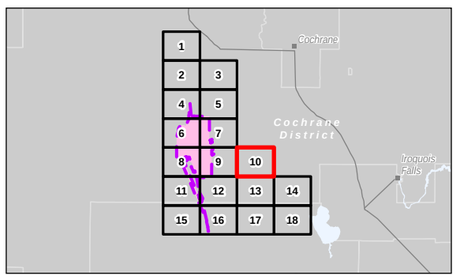

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.10

Title
Field Sampling Locations

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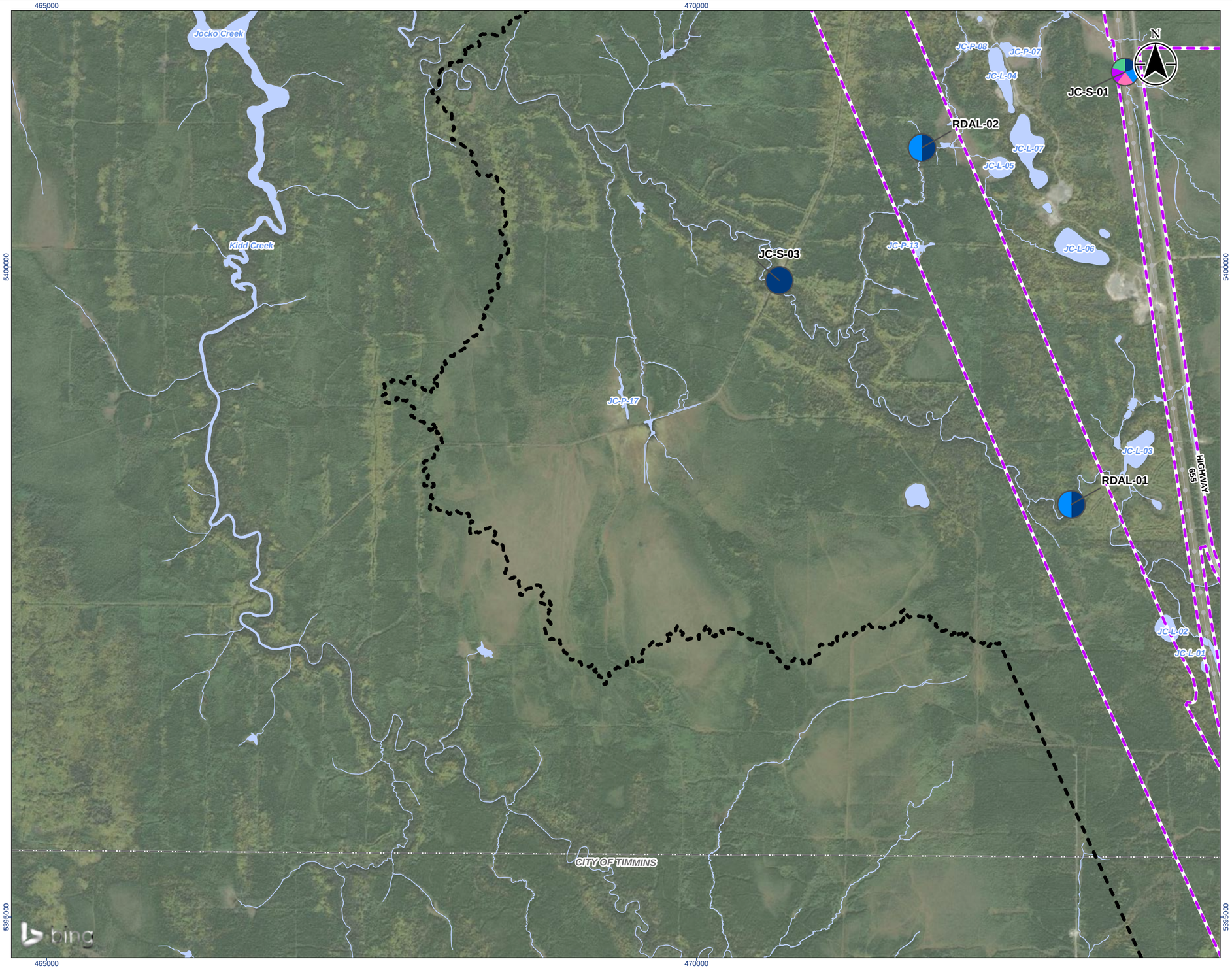

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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Notes

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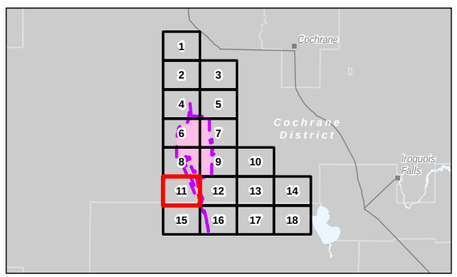

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.11

Title
Field Sampling Locations

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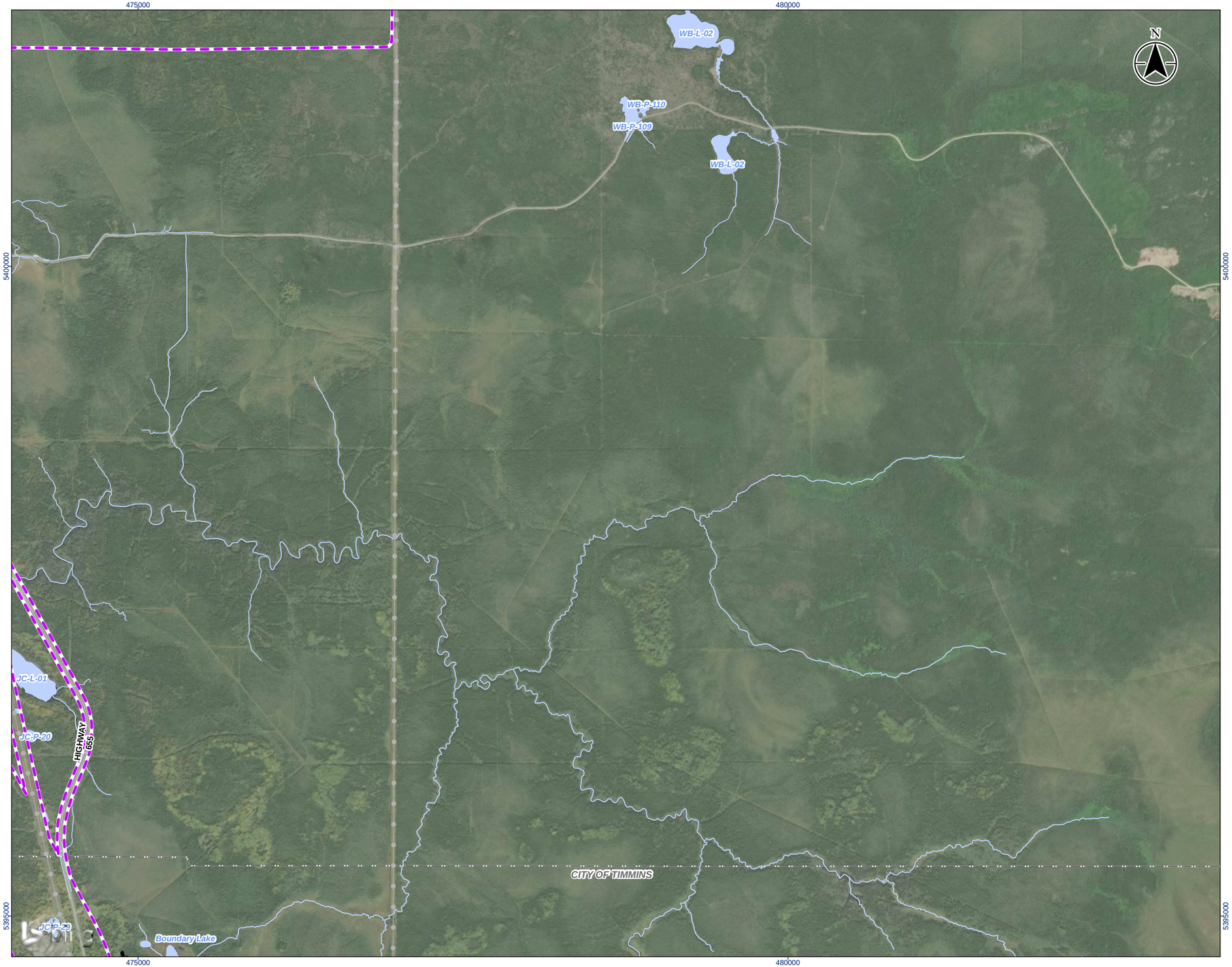

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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Notes

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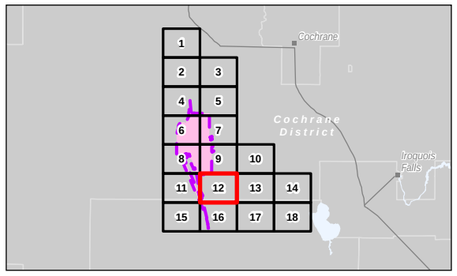

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.12

Title
Field Sampling Locations

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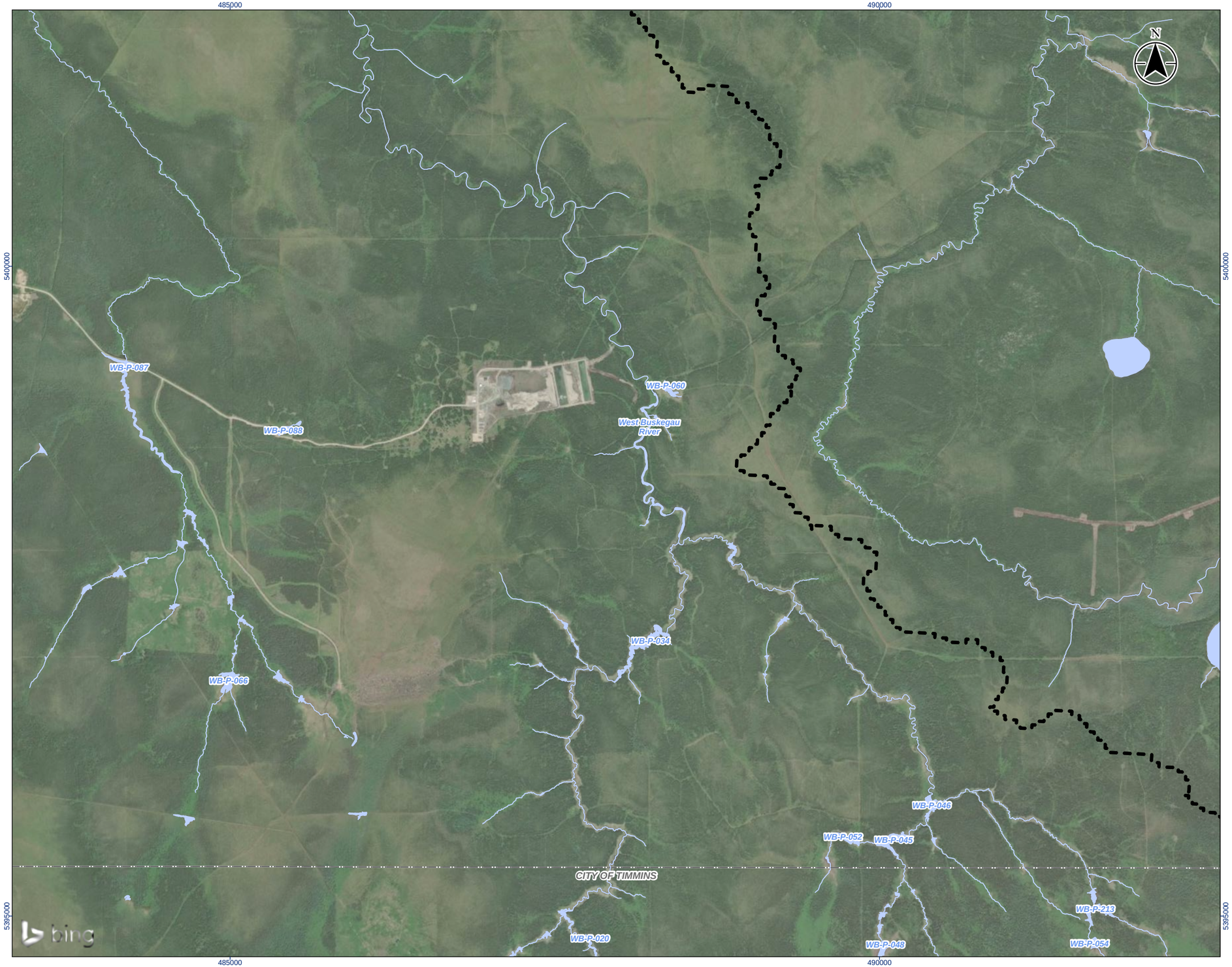

Stantec

Legend

- Local Study Area
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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Notes

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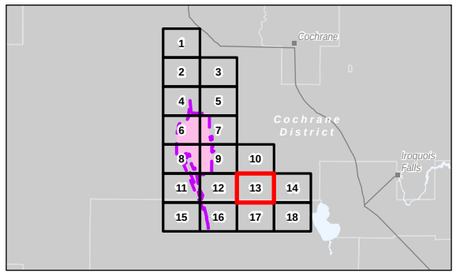

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.13

Title
Field Sampling Locations

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Stantec

Legend

- Local Study Area
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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Notes

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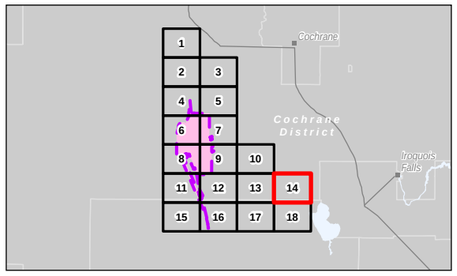

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.14

Title
Field Sampling Locations

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Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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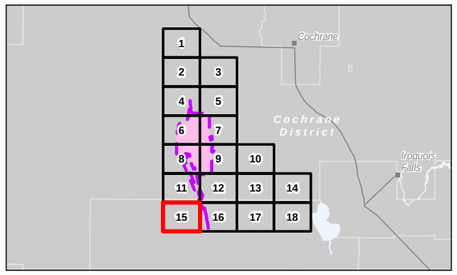

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.15

Title
Field Sampling Locations

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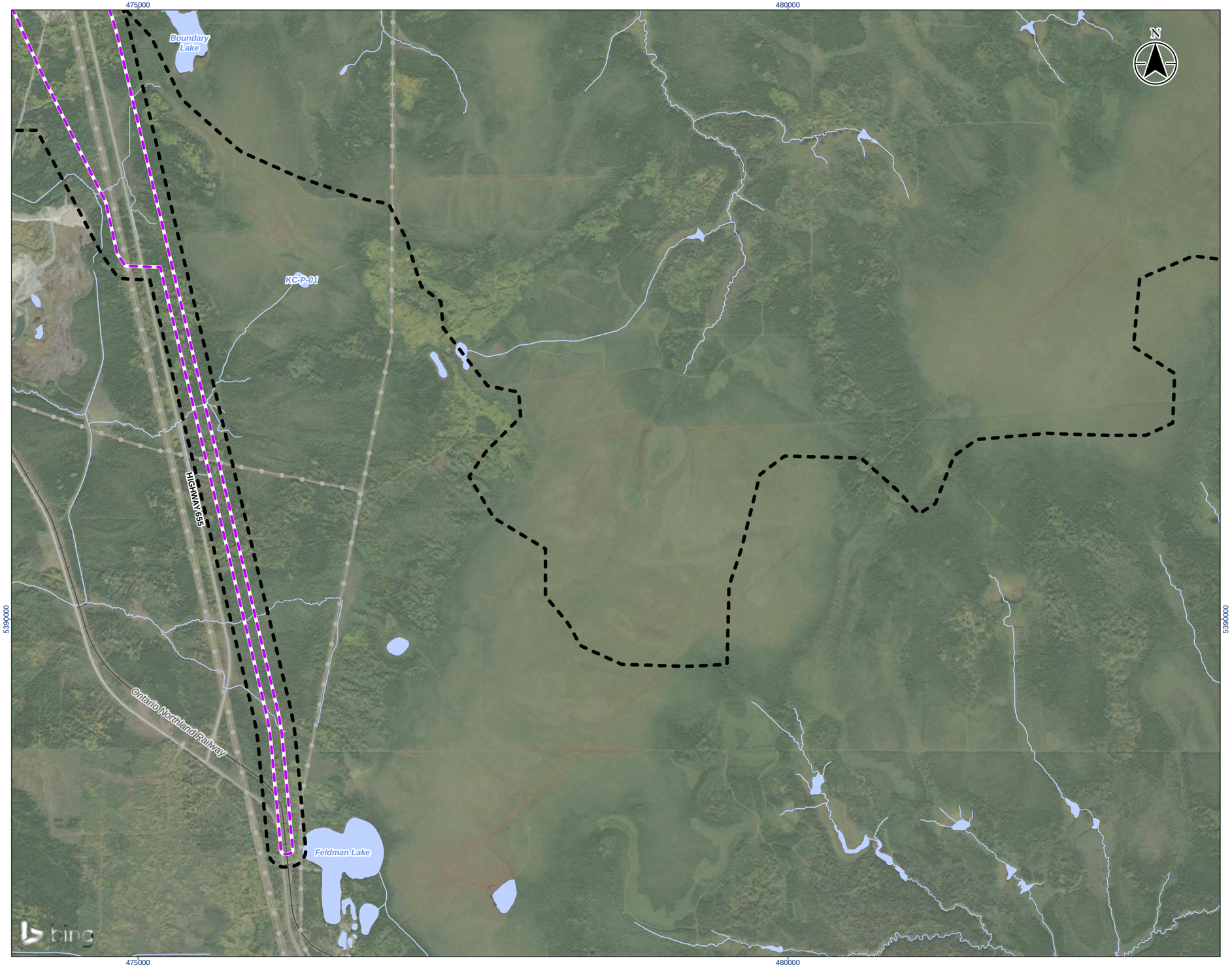

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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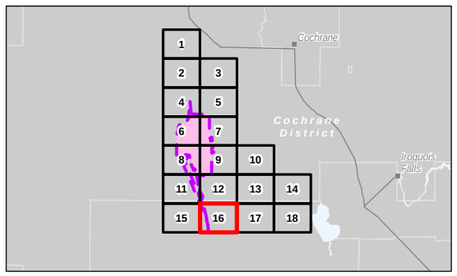

Project Location
Timmins, Ontario

160930456 REV6
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Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.16

Title
Field Sampling Locations

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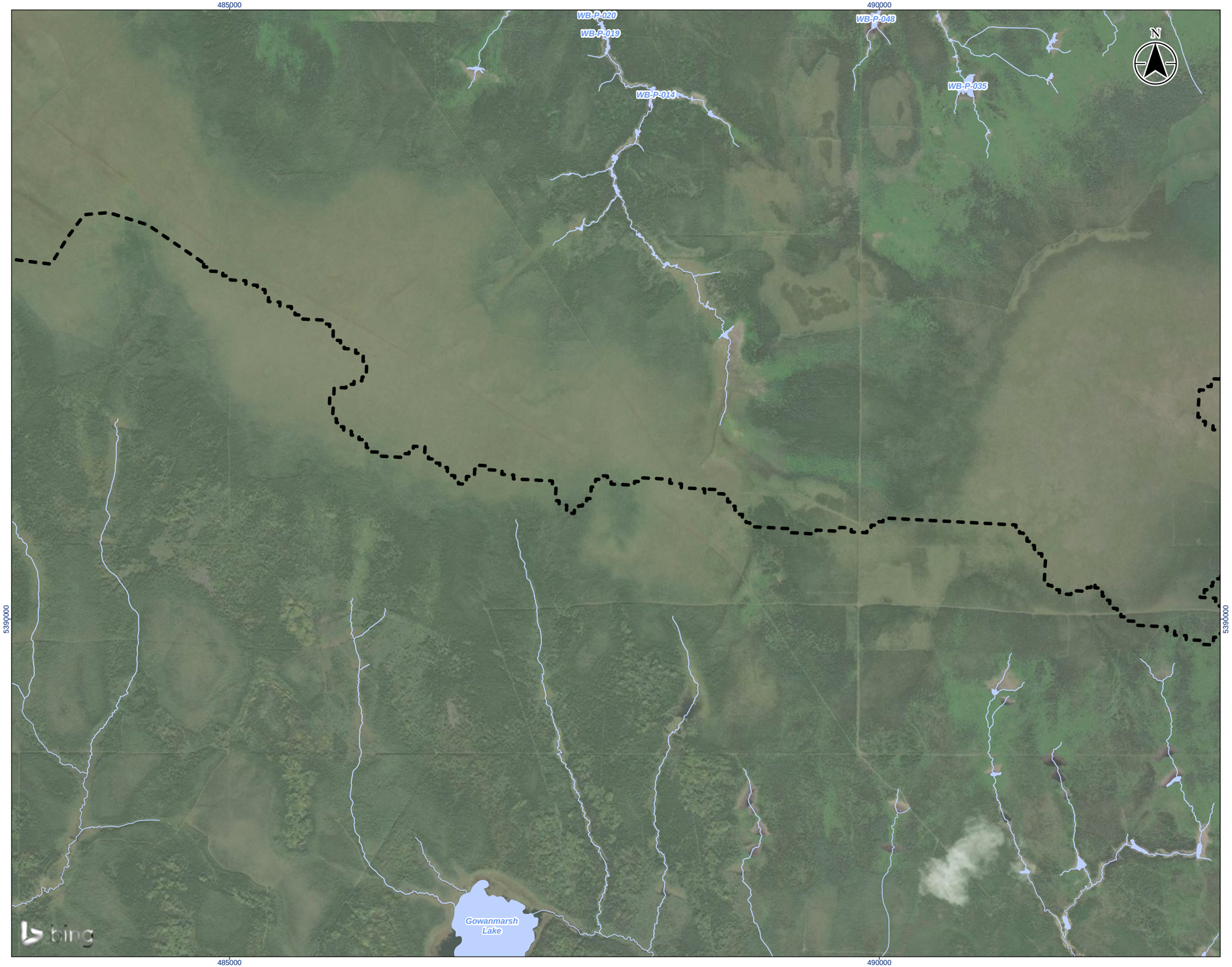

Stantec

Legend

- Local Study Area
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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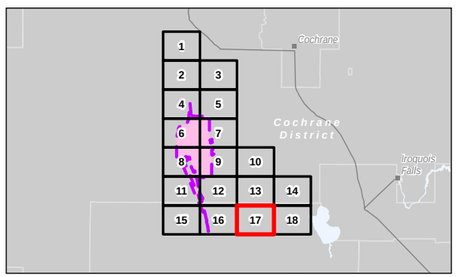

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.17

Title
Field Sampling Locations

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Stantec

Legend

- Local Study Area
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Aquatic Sampling Locations

- Surface Water
- Habitat Assessment
- Benthic Sediment
- Fish Community
- Fish Tissue
- eDNA
- Zooplankton and Phytoplankton

0 0.5 1 km

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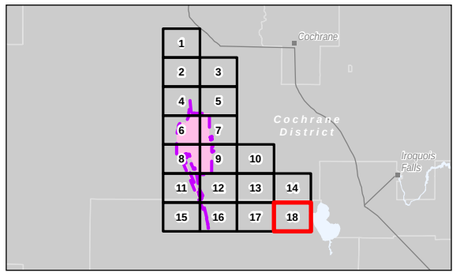

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.18

Title
Field Sampling Locations

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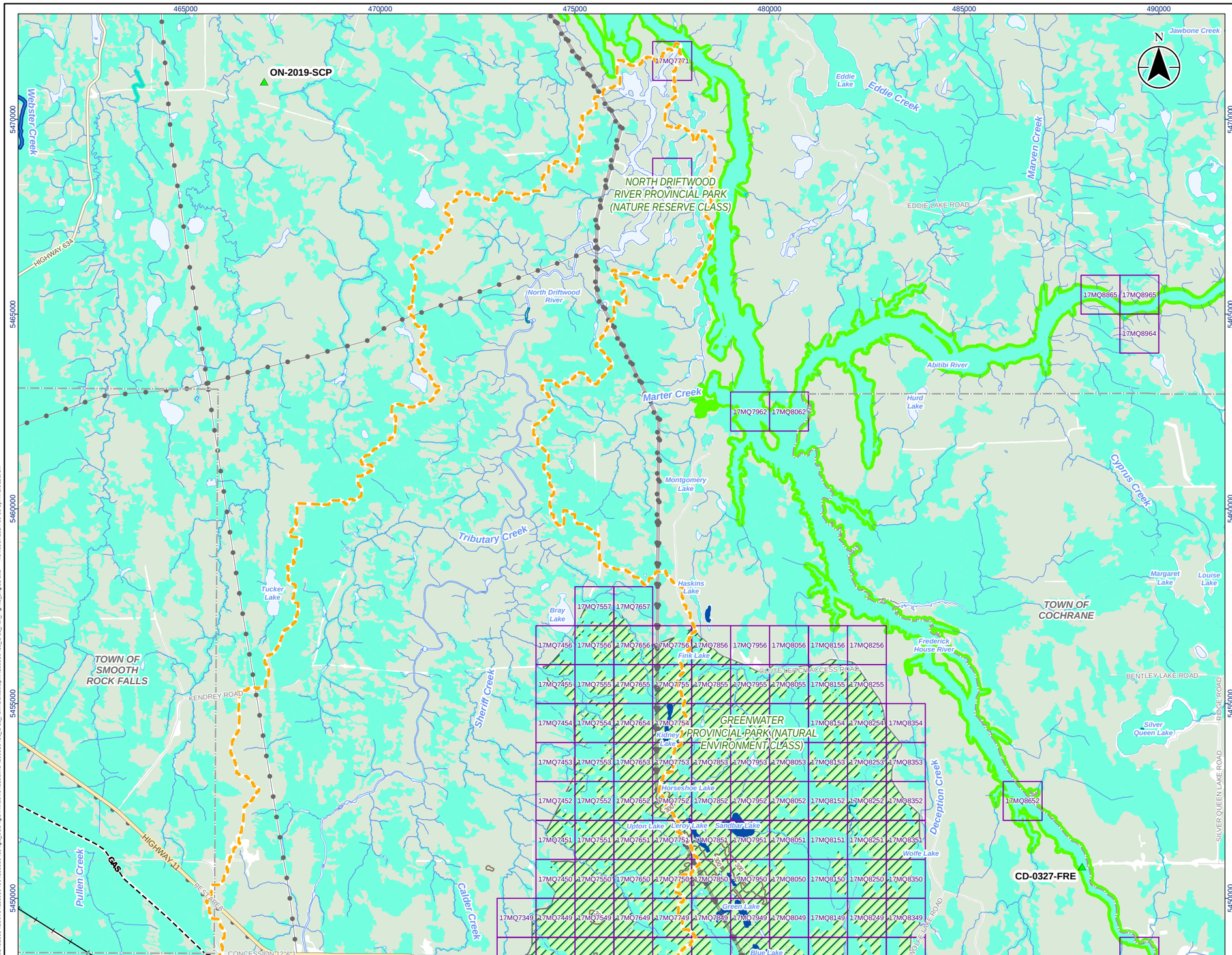

Stantec

Legend

- Regional Study Area
- Fish Survey Point (ARA)
- Thermal Regime, Cold
- Thermal Regime, Cool
- Aquatic Species at Risk Distribution
- Fish Spawning Area
- Provincial Park
- Thermal Regime, Cold
- Thermal Regime, Cool

Base Features

- Hydro Line
- Natural Gas Pipeline
- Railway
- Watercourse (Intermittent)
- Watercourse (Permanent)
- Waterbody
- Wooded Area
- Municipal Boundary, Lower
- 1 km UTM Grid

0 2 4 km

1:100,000 (At original document size of 11x17)

Notes

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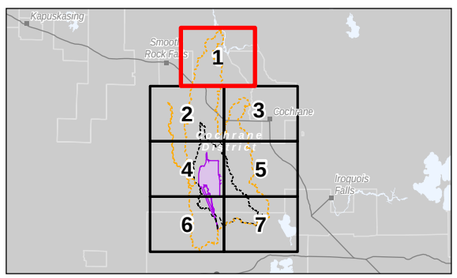

Project Location
Timmins, Ontario

REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.1

Title
Background Data

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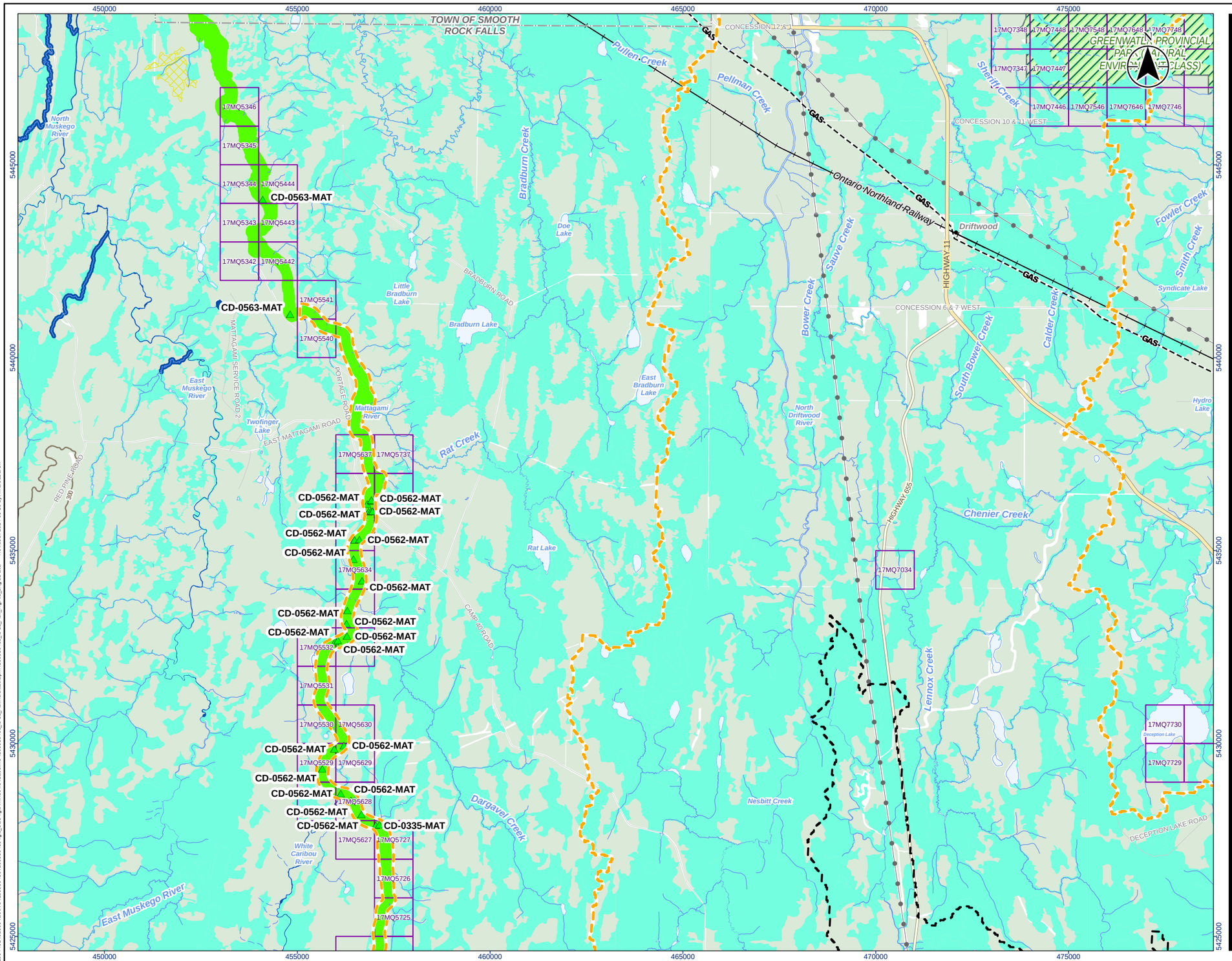

Stantec

Legend

- Local Study Area
- Regional Study Area
- Fish Survey Point (ARA)
- Thermal Regime, Cold
- Aquatic Species at Risk Distribution
- Significant Ecological Area
- Provincial Park
- Thermal Regime, Cold
- Thermal Regime, Cool

Base Features

- Hydro Line
- Natural Gas Pipeline
- Railway
- Watercourse (Intermittent)
- Watercourse (Permanent)
- Waterbody
- Wooded Area
- Municipal Boundary, Lower
- 1 km UTM Grid

0 2 4 km

1:100,000 (At original document size of 11x17)

Notes

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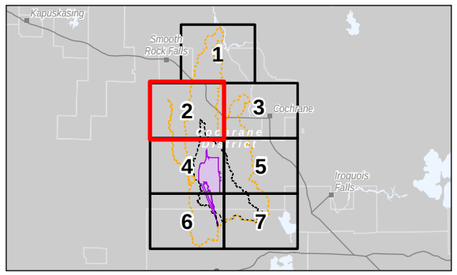

Project Location
Timmins, Ontario

REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.2

Title
Background Data

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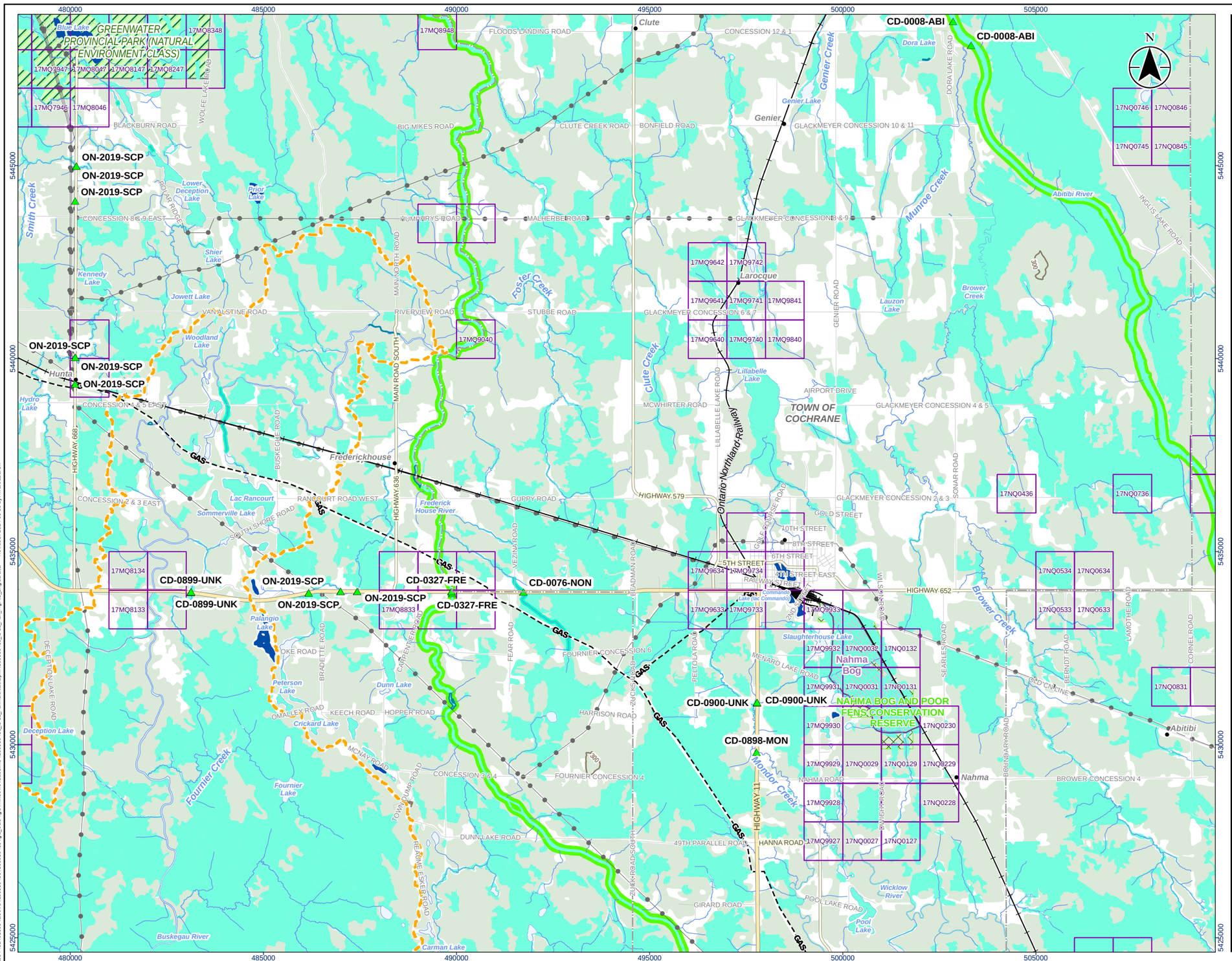

Stantec

Legend

- Regional Study Area
- Fish Survey Point (ARA)
- Thermal Regime, Cool
- Aquatic Species at Risk Distribution
- Candidate ANSI, Life Science
- Conservation Reserve (Regulated)
- Fish Spawning Area
- Provincial Park
- Thermal Regime, Cold
- Thermal Regime, Cool

Base Features

- Submerged Communication Line
- Hydro Line
- Natural Gas Pipeline
- Railway
- Constructed Drain
- Watercourse (Intermittent)
- Watercourse (Permanent)
- Waterbody
- Wooded Area
- Municipal Boundary, Lower
- 1 km UTM Grid

0 2 4 km

1:100,000 (At original document size of 11x17)

Notes

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Project Location
Timmins, Ontario

REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.3

Title
Background Data

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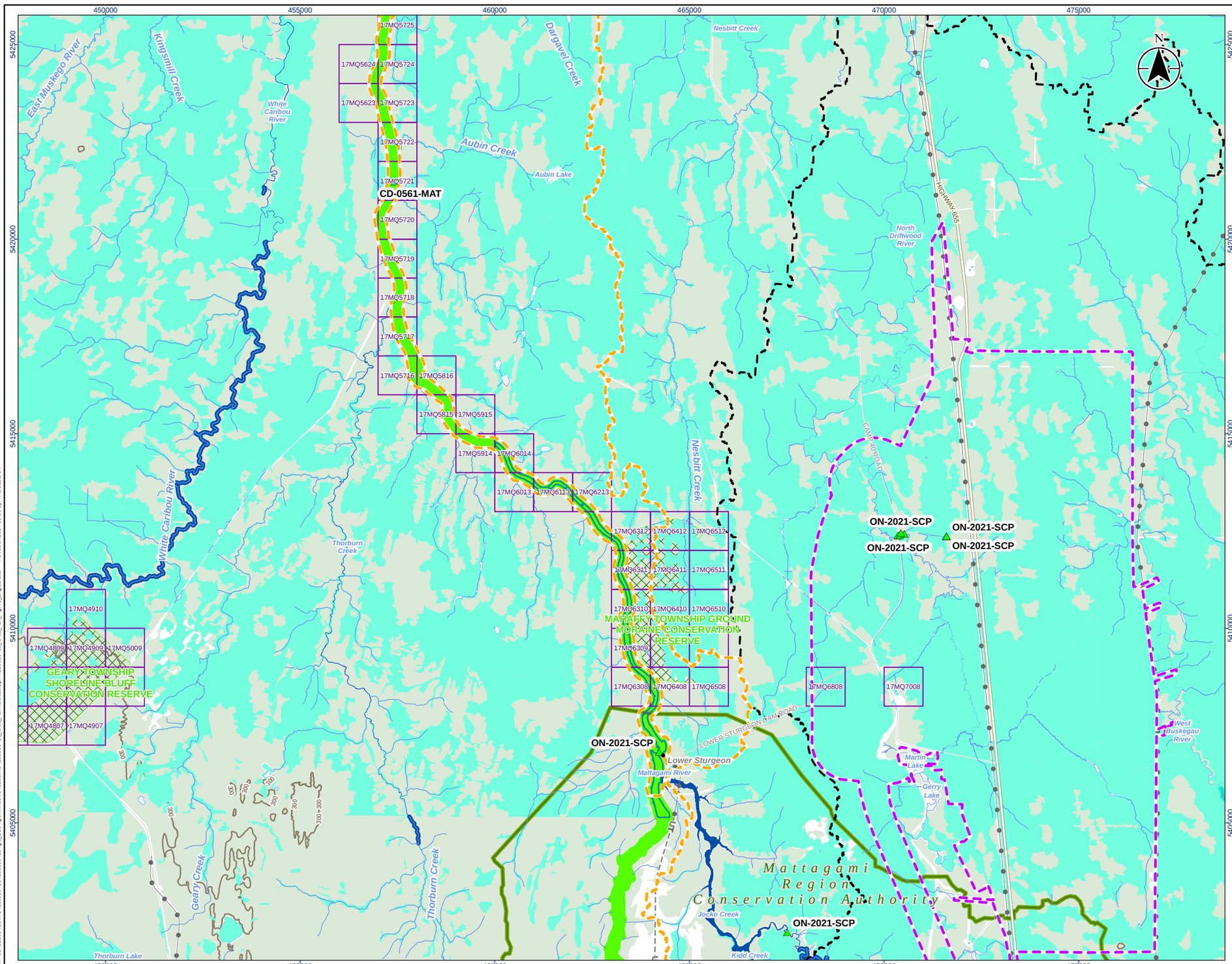

Stantec

Legend

- Project Area
- Local Study Area
- Regional Study Area
- Fish Survey Point (ARA)
- Thermal Regime, Cold
- Thermal Regime, Cool
- Aquatic Species at Risk Distribution
- Conservation Authority Administrative Boundary
- Conservation Reserve (Regulated)
- Fish Spawning Area
- Thermal Regime, Cold
- Thermal Regime, Cool

Base Features

- Hydro Line
- Unknown Transmission Line
- Watercourse (Intermittent)
- Watercourse (Permanent)
- Waterbody
- Wooded Area
- 1 km UTM Grid

0 2 4 km

1:100,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
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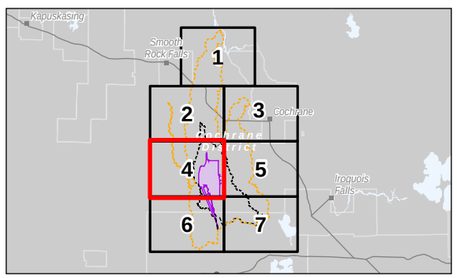

Project Location
Timmins, Ontario

REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.4

Title
Background Data

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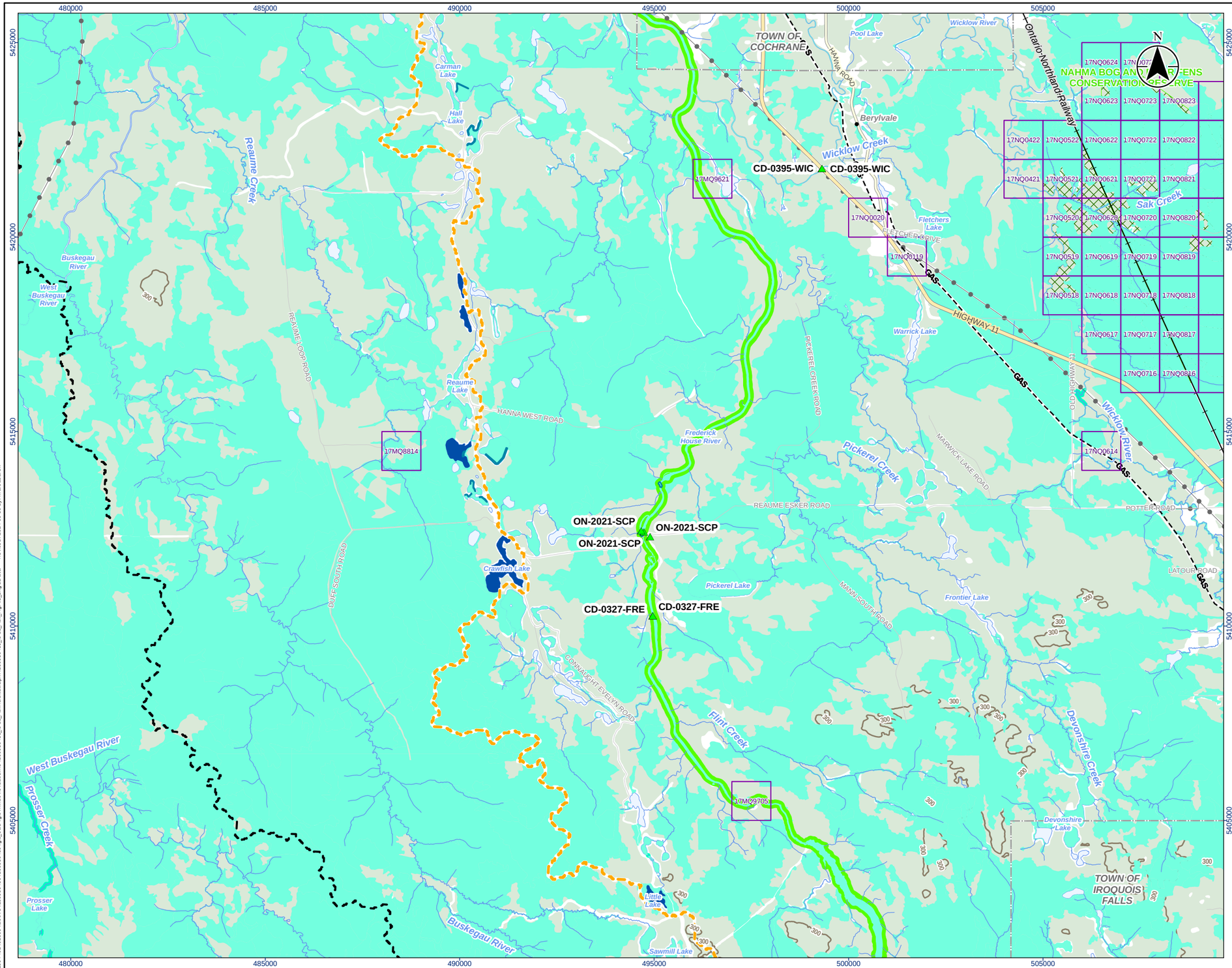

Stantec

Legend

- Local Study Area
- Regional Study Area
- Fish Survey Point (ARA)
- Thermal Regime, Cool
- Aquatic Species at Risk Distribution
- Conservation Reserve (Regulated)
- Fish Spawning Area
- Thermal Regime, Cold
- Thermal Regime, Cool

Base Features

- Hydro Line
- Natural Gas Pipeline
- Railway
- Watercourse (Intermittent)
- Watercourse (Permanent)
- Waterbody
- Wooded Area
- Municipal Boundary, Lower
- 1 km UTM Grid

0 2 4 km

1:100,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
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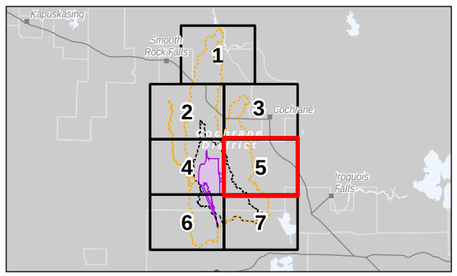

Project Location
Timmins, Ontario

REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.5

Title
Background Data

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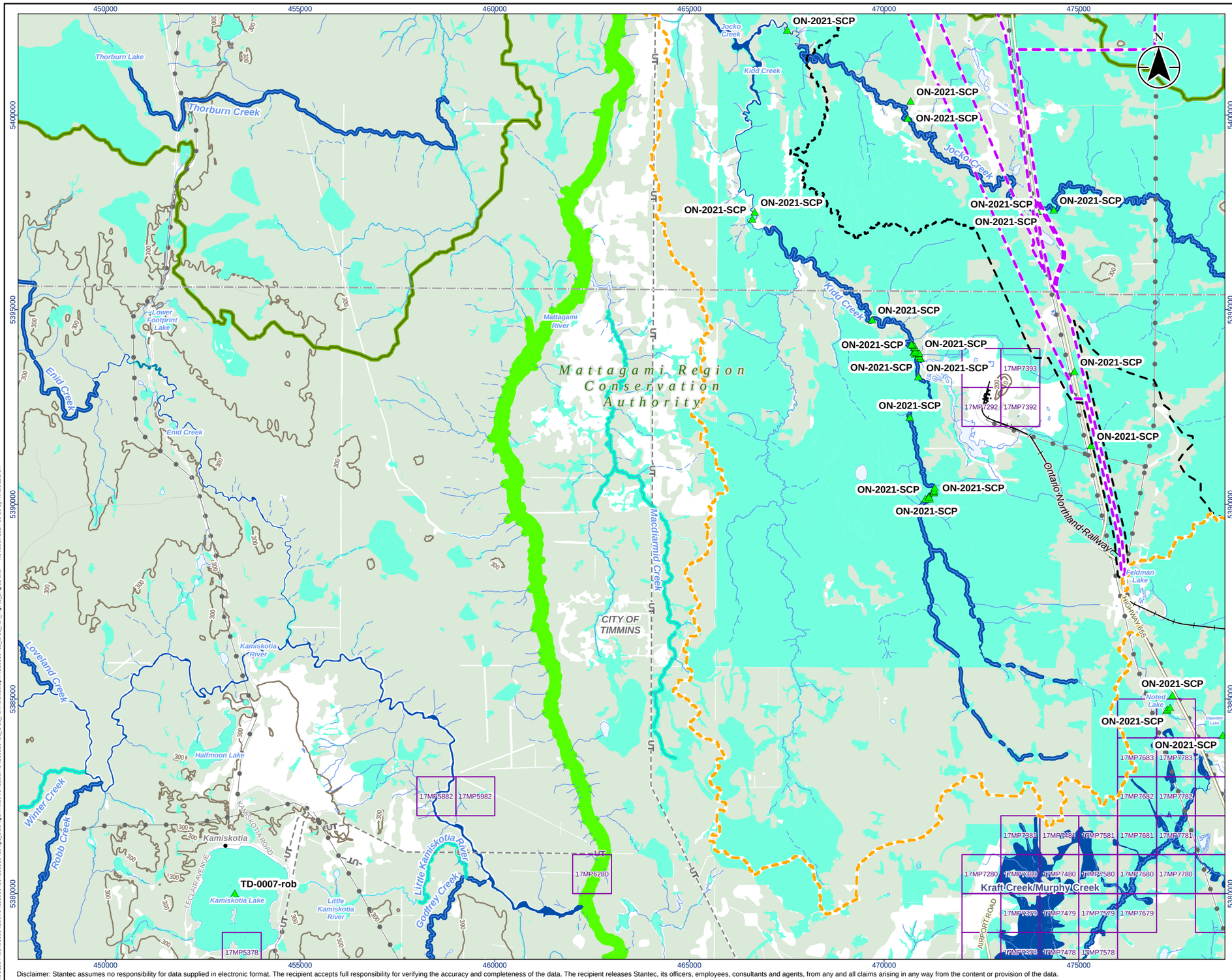

Stantec

Legend

- Project Area
- Local Study Area
- Regional Study Area
- Fish Survey Point (ARA)
- Thermal Regime, Cold
- Thermal Regime, Cool
- Aquatic Species at Risk Distribution
- Conservation Authority Administrative Boundary
- Fish Spawning Area
- Thermal Regime, Cold
- Thermal Regime, Cool

Base Features

- Hydro Line
- Unknown Pipeline
- Unknown Transmission Line
- Railway
- Watercourse (Intermittent)
- Watercourse (Permanent)
- Waterbody
- Wooded Area
- Municipal Boundary, Lower
- 1 km UTM Grid

0 2 4 km

1:100,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
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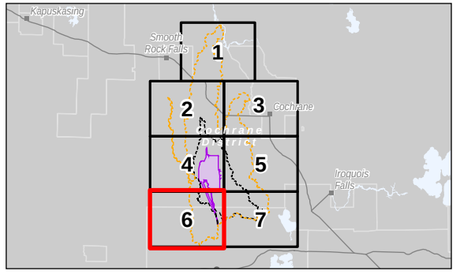

Project Location
Timmins, Ontario

REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.6

Title
Background Data

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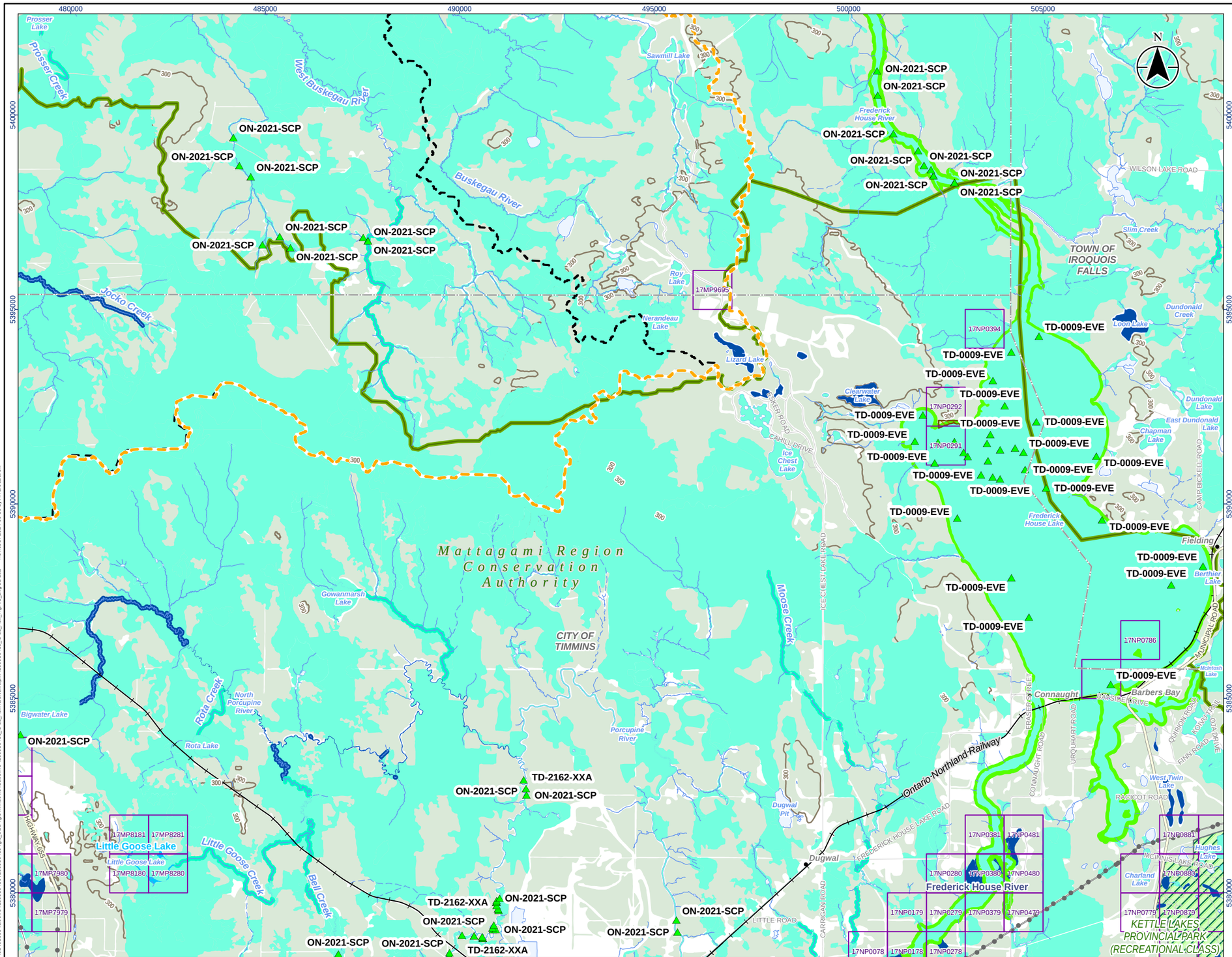

Stantec

Legend

- Local Study Area
- Regional Study Area
- Fish Survey Point (ARA)
- Thermal Regime, Cold
- Thermal Regime, Cool
- Aquatic Species at Risk Distribution
- ANSI, Earth Science
- Conservation Authority Administrative Boundary
- Provincial Park
- Thermal Regime, Cold
- Thermal Regime, Cool

Base Features

- Hydro Line
- Railway
- Watercourse (Intermittent)
- Watercourse (Permanent)
- Waterbody
- Wooded Area
- Municipal Boundary, Lower
- 1 km UTM Grid

0 2 4 km

1:100,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
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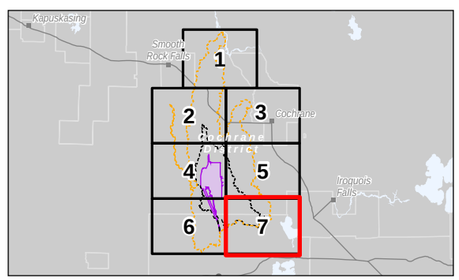

Project Location
Timmins, Ontario

REV6
Prepared by MDA on 2024-09-30
Technical Review by ABC on yyyy-mm-dd

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.7

Title
Background Data

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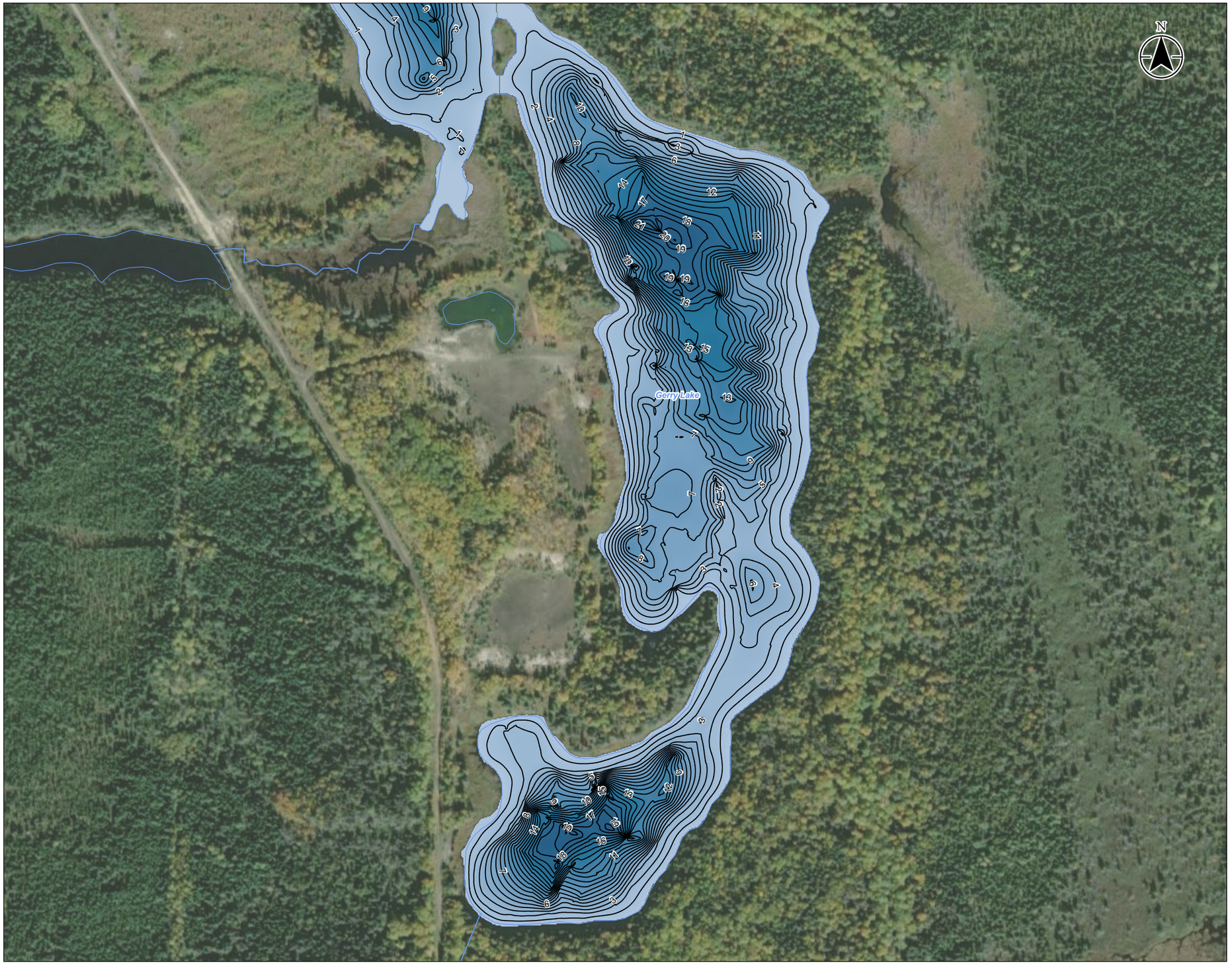

Stantec

CANADA NICKEL COMPANY

Legend

- Bathymetric Contour (1 m Intervals)
- Waterbody
- Watercourse

0 110 220 Meters

1:3,700 (At original document size of 11x17)

Notes

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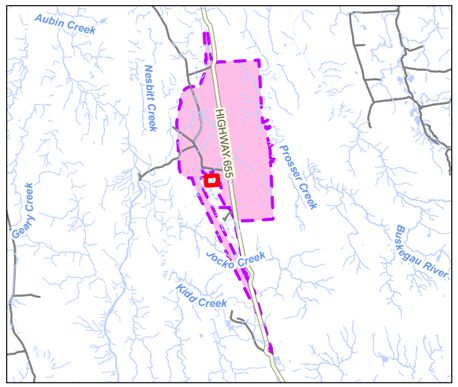
3. Orthoimagery: Maxar



Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.6.1

Title
Gerry Lake Bathymetry

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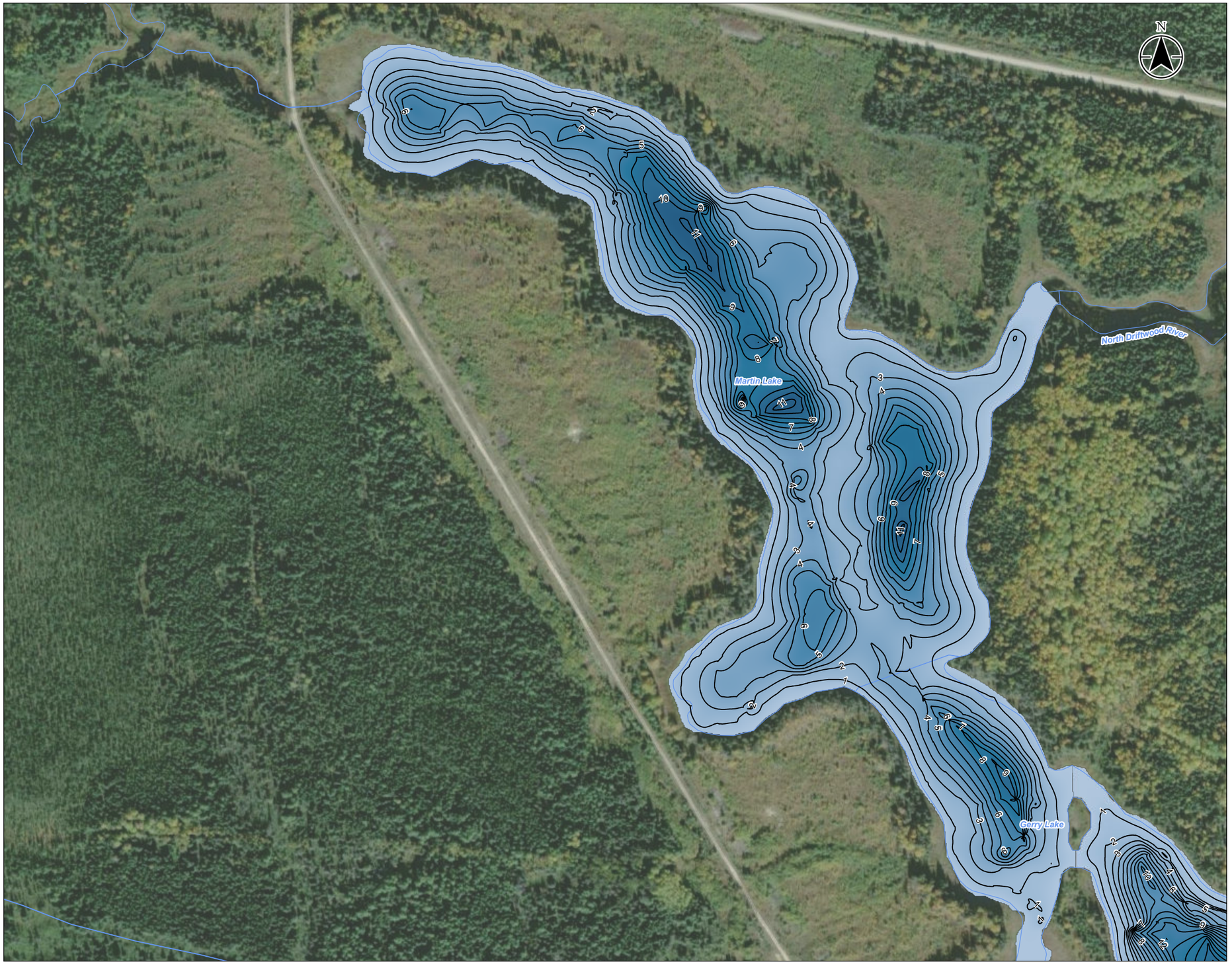

Stantec

CANADA NICKEL COMPANY

Legend

- Bathymetric Contour (1 m Intervals)
- Waterbody
- Watercourse

0 125 250 Meters

1:4,000 (At original document size of 11x17)

Notes

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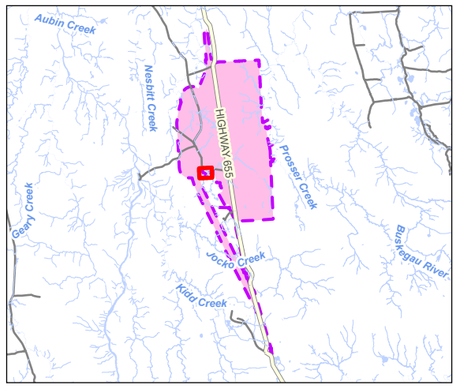

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.6.2

Title
Martin Lake Bathymetry

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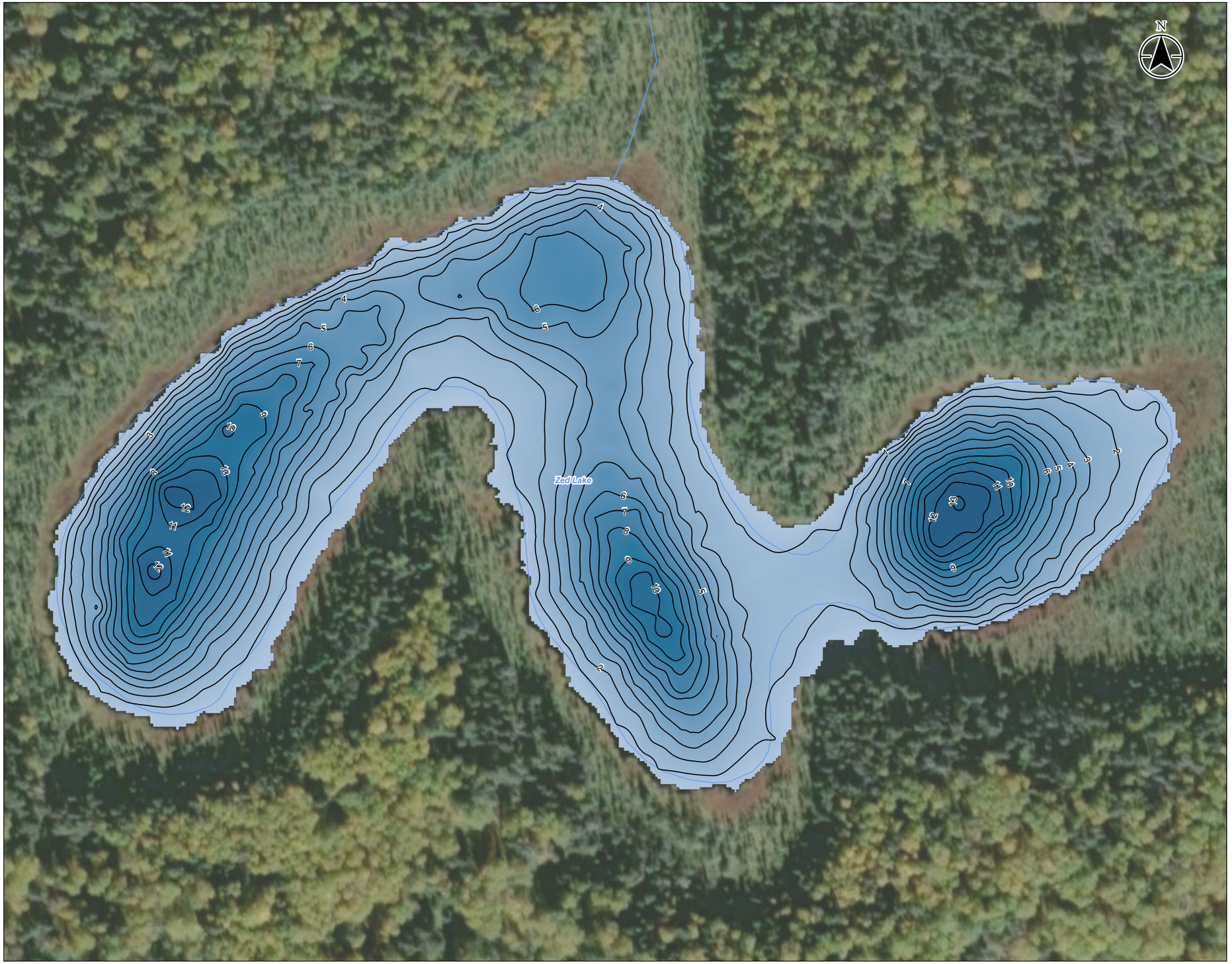

Stantec

CANADA NICKEL COMPANY

Legend

- Bathymetric Contour (1 m Intervals)
- Waterbody
- Watercourse

0 40 80 Meters

1:1,500 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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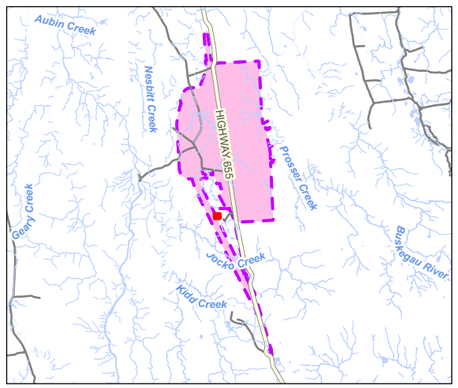
3. Orthoimagery: Maxar, Microsoft



Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.6.3

Title
Zed Lake Bathymetry

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Stantec

CANADA NICKEL COMPANY

Legend

- Bathymetric Contour (1 m Intervals)
- Waterbody
- Watercourse

0 75 150 Meters

1:2,500 (At original document size of 11x17)

Notes

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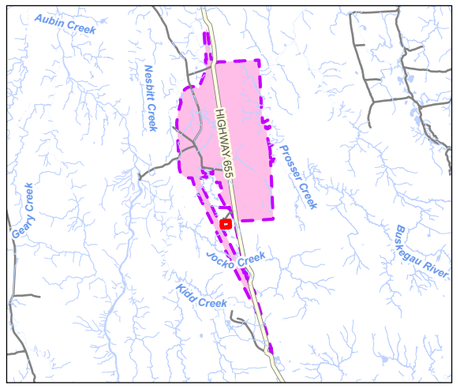
3. Orthoimagery: Maxar, Microsoft



Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.6.4

Title
Unnamed Lake South of Zed Lake Bathymetry

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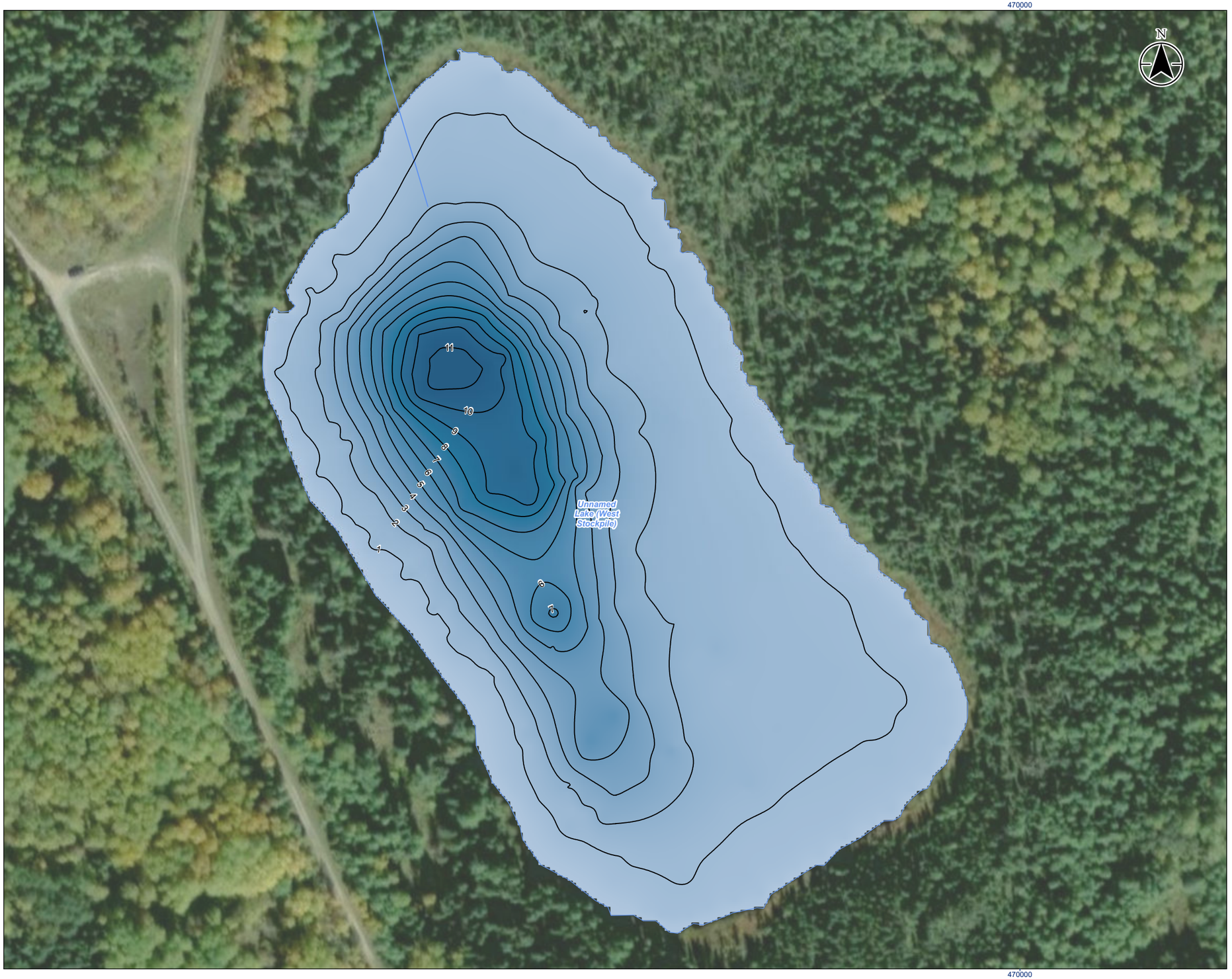

Stantec

CANADA NICKEL COMPANY

Legend

- Bathymetric Contour (1 m Intervals)
- Waterbody
- Watercourse

0 40 80 Meters

1:1,500 (At original document size of 11x17)

Notes

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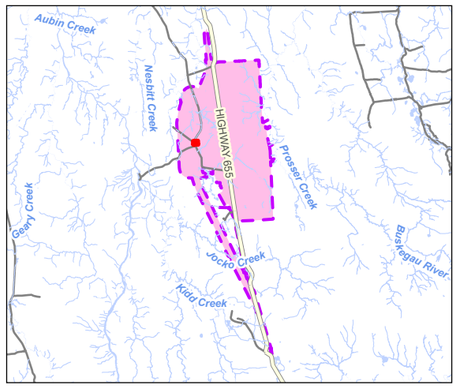
3. Orthoimagery: Maxar, Microsoft



Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.6.5

Title
Unnamed Lake - Ore Stockpile Bathymetry

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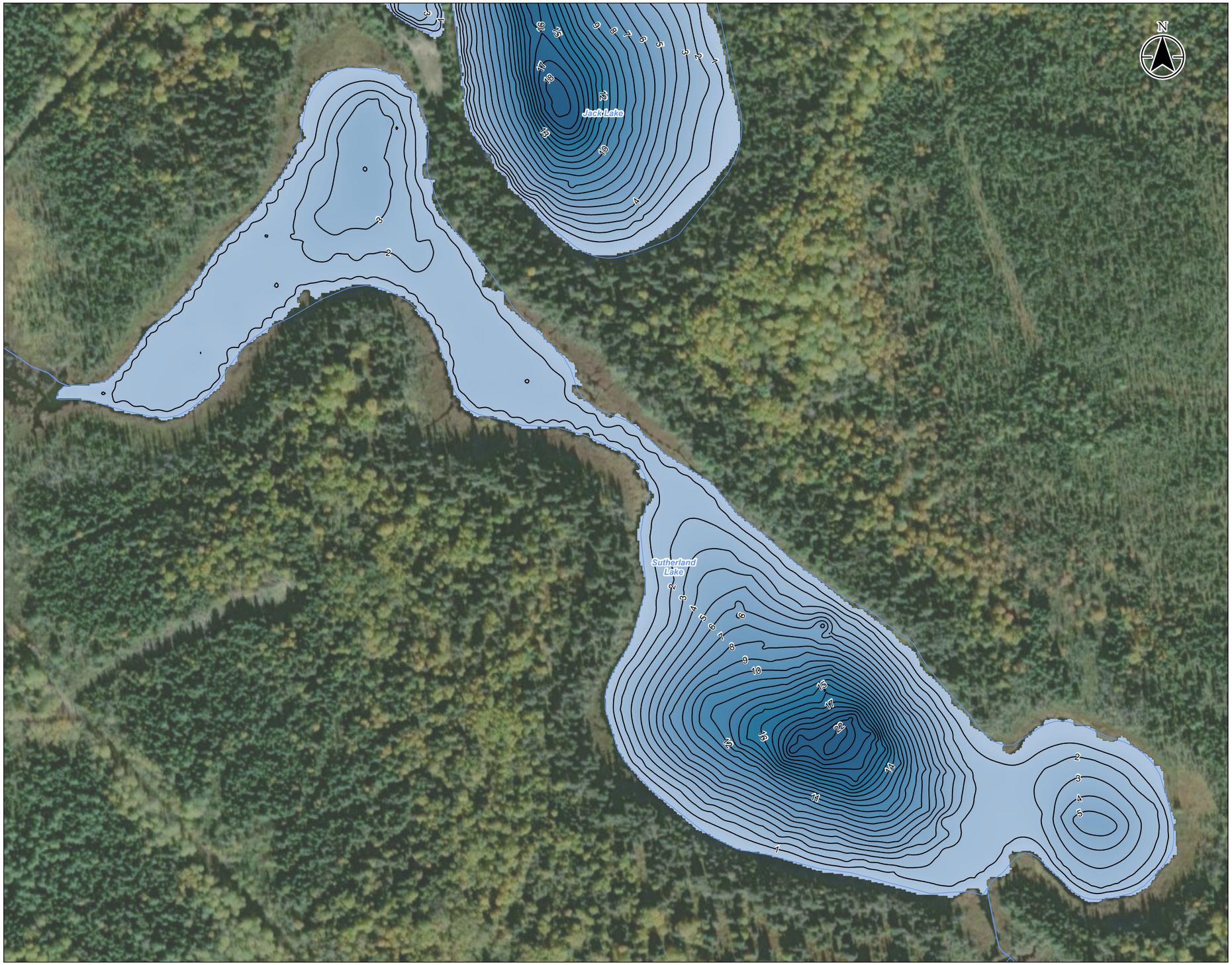

Stantec

CANADA NICKEL COMPANY

Legend

- Bathymetric Contour (1 m Intervals)
- Waterbody
- Watercourse

0 75 150 Meters

1:2,500 (At original document size of 11x17)

Notes

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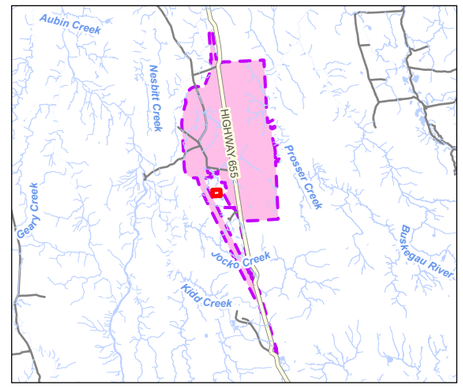
3. Orthoimagery: Maxar, Microsoft



Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.6.6

Title
Sutherland Lake Bathymetry

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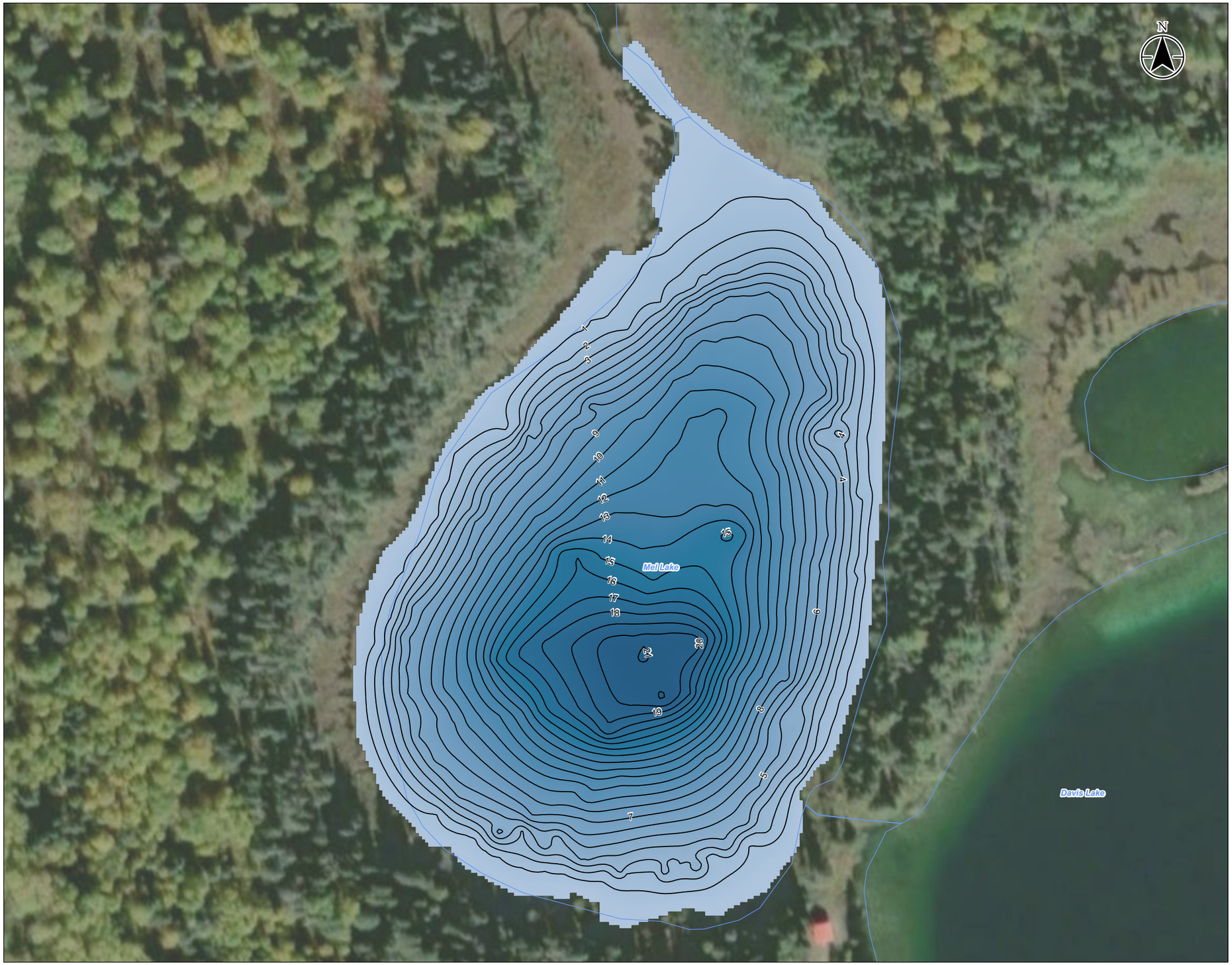

Stantec

CANADA NICKEL COMPANY

Legend

- Bathymetric Contour (1 m Intervals)
- Waterbody
- Watercourse

0 30 60 Meters

1:1,200 (At original document size of 11x17)

Notes

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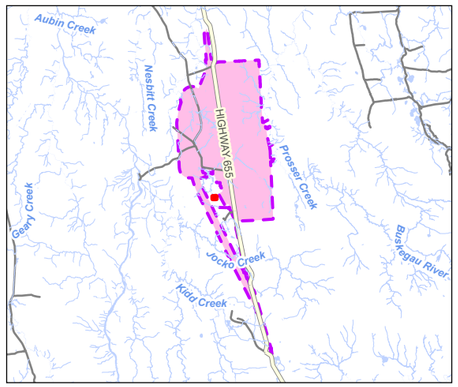

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.6.7

Title
Mel Lake Bathymetry

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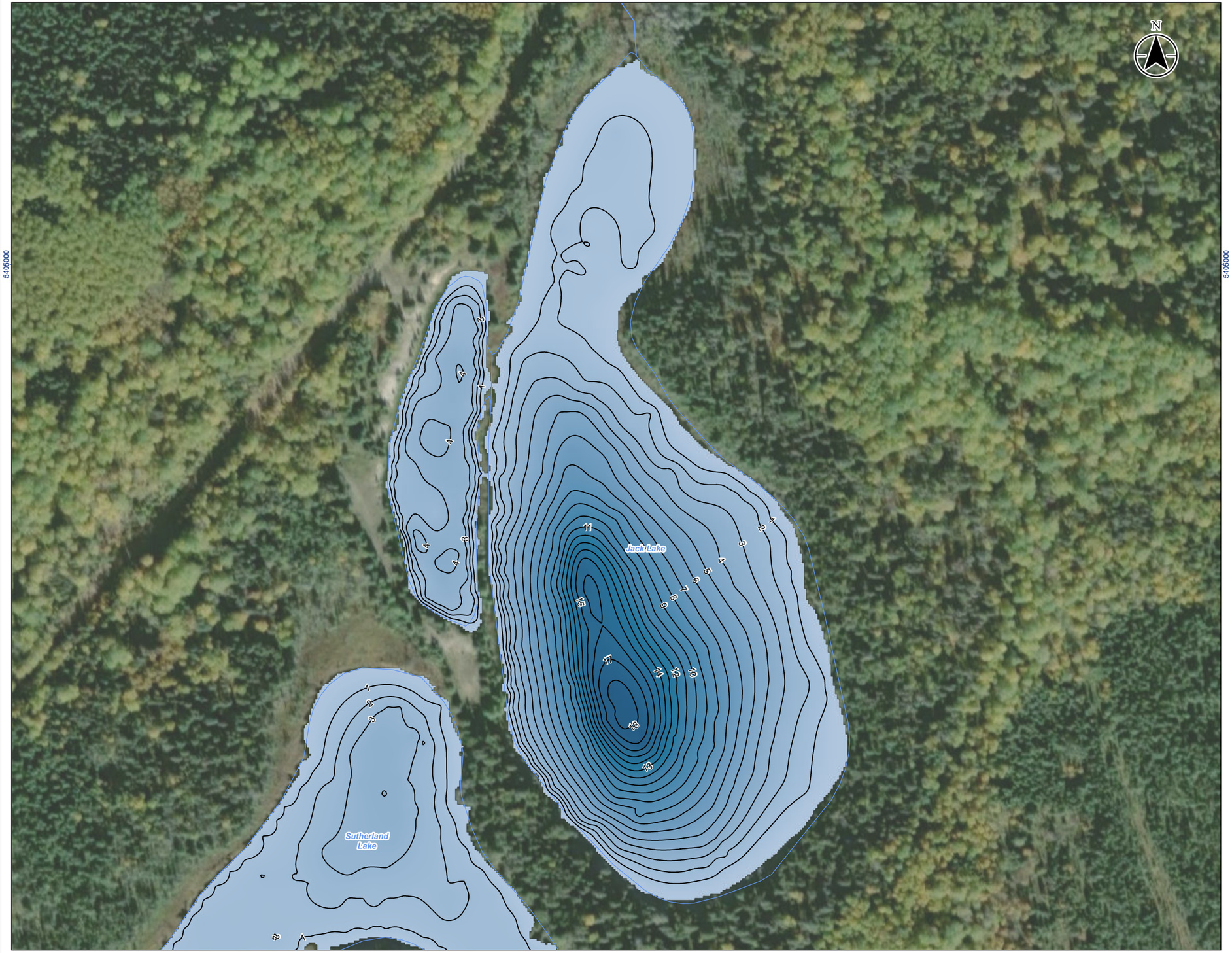

Stantec

CANADA NICKEL COMPANY

Legend

- Bathymetric Contour (1 m Intervals)
- Waterbody
- Watercourse

0 60 120 Meters

1:2,000 (At original document size of 11x17)

Notes

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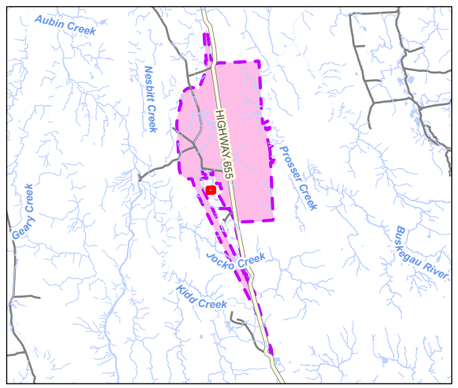
3. Orthoimagery: Maxar, Microsoft



Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.6.8

Title
Jack Lake Bathymetry

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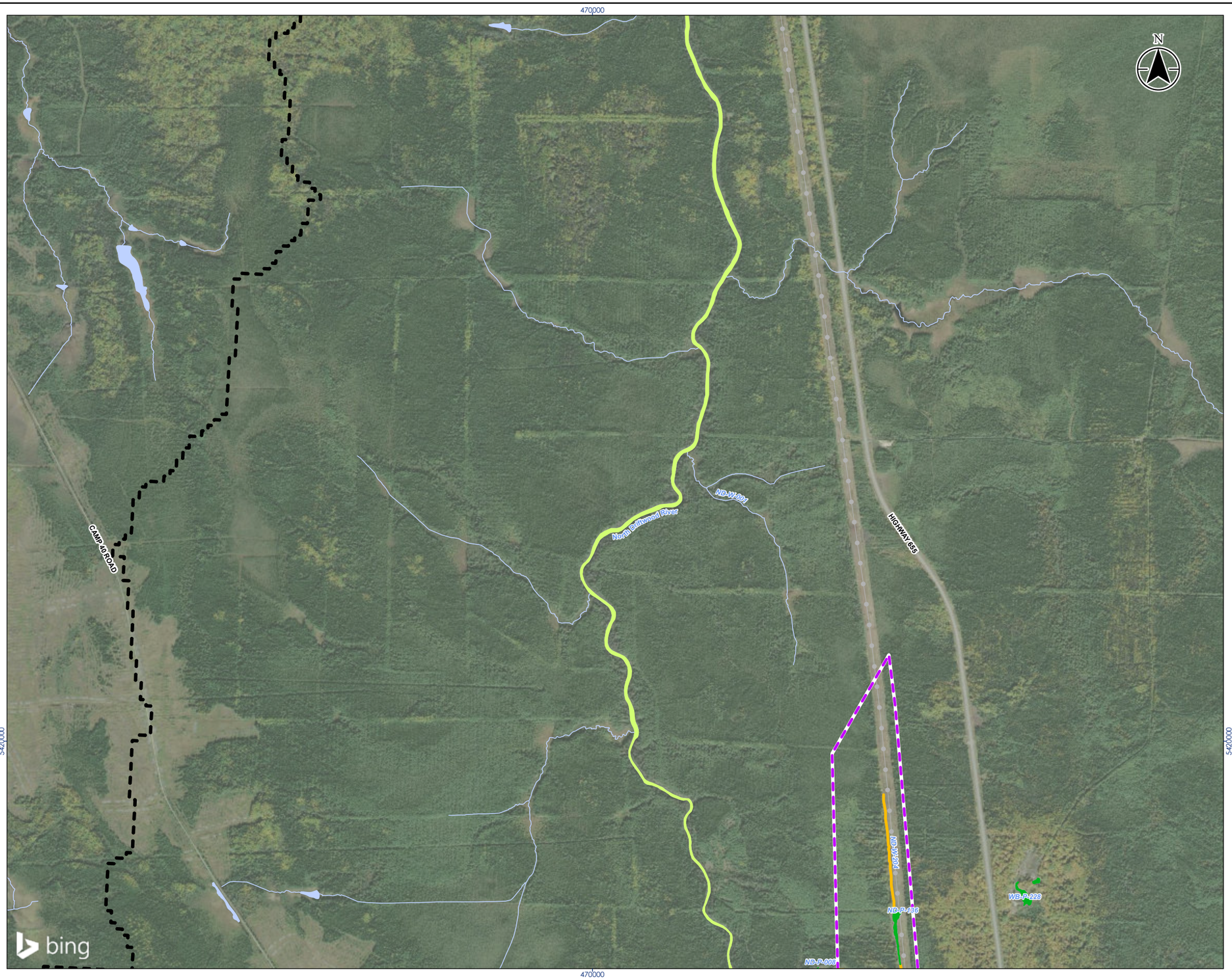

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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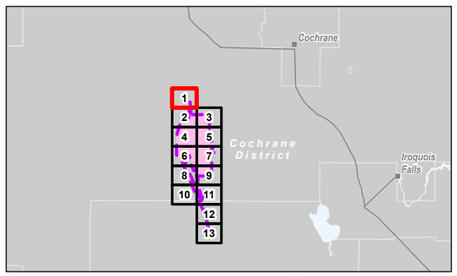

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.1

Title
Habitat Classification

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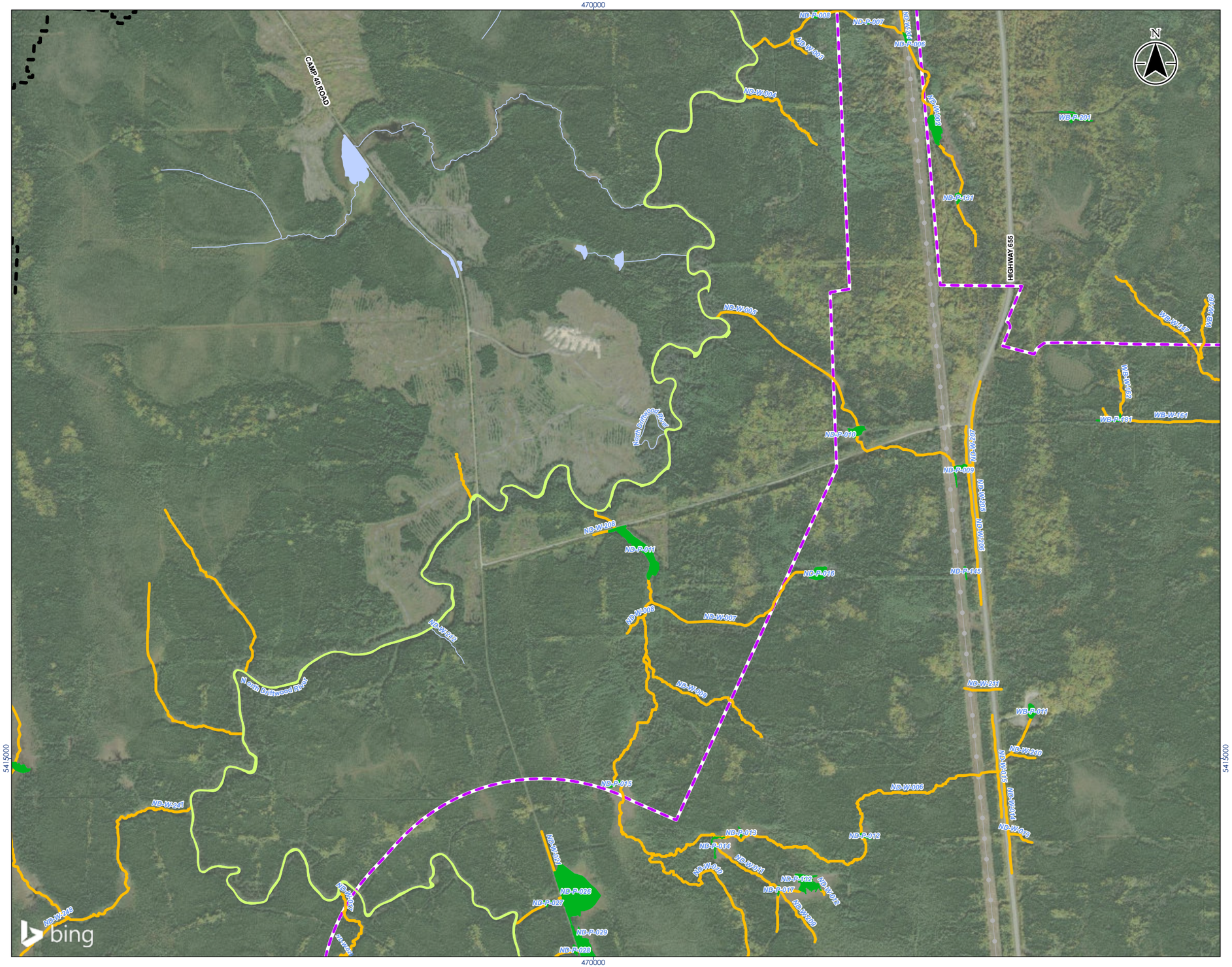

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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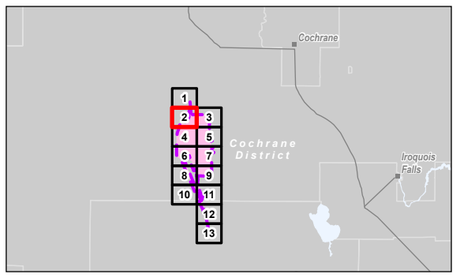

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.2

Title
Habitat Classification

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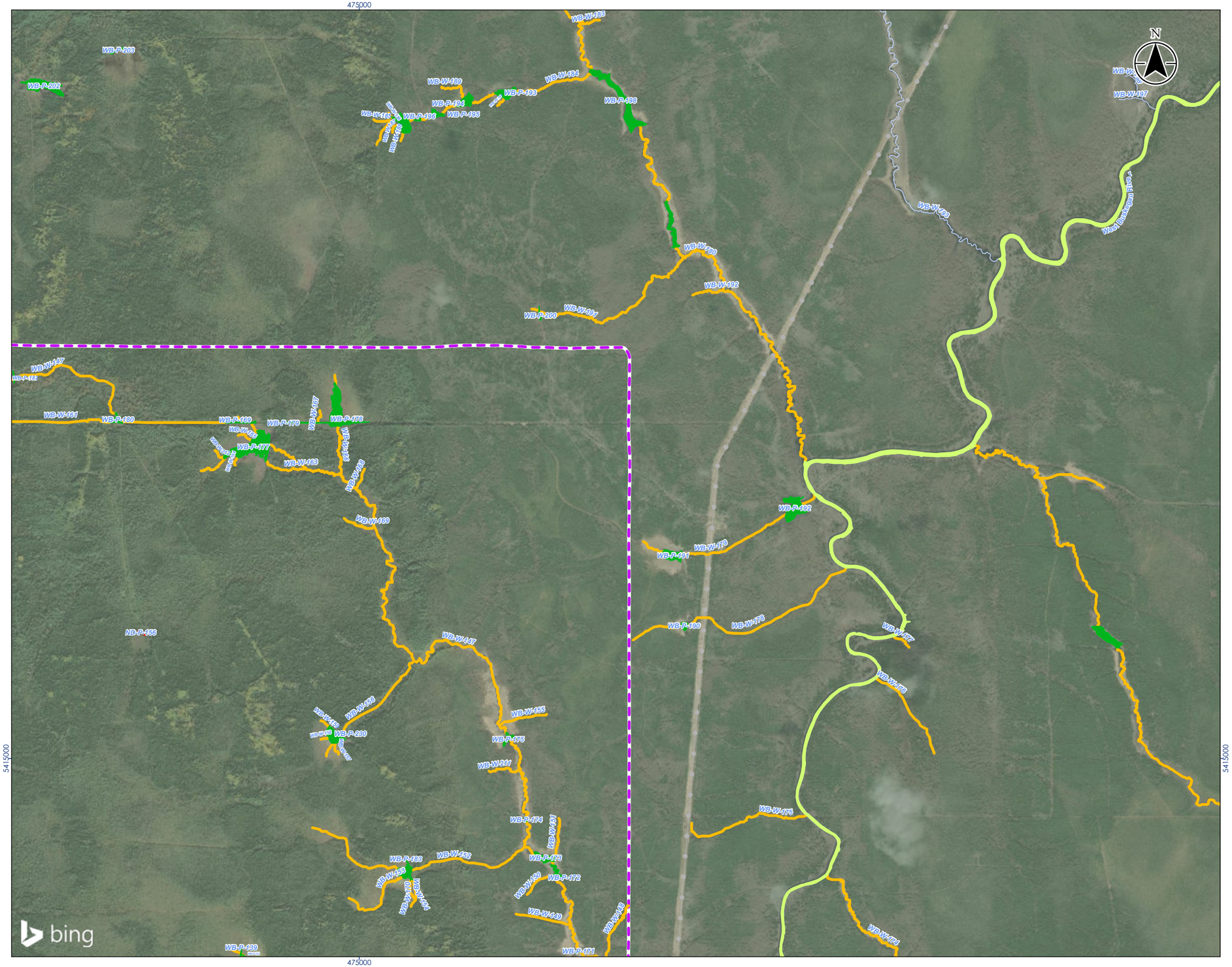

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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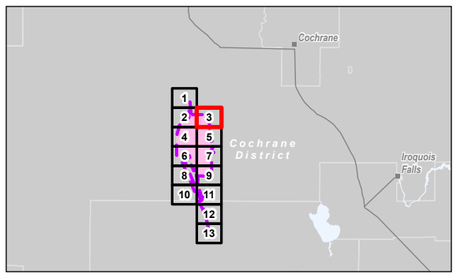

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.3

Title
Habitat Classification

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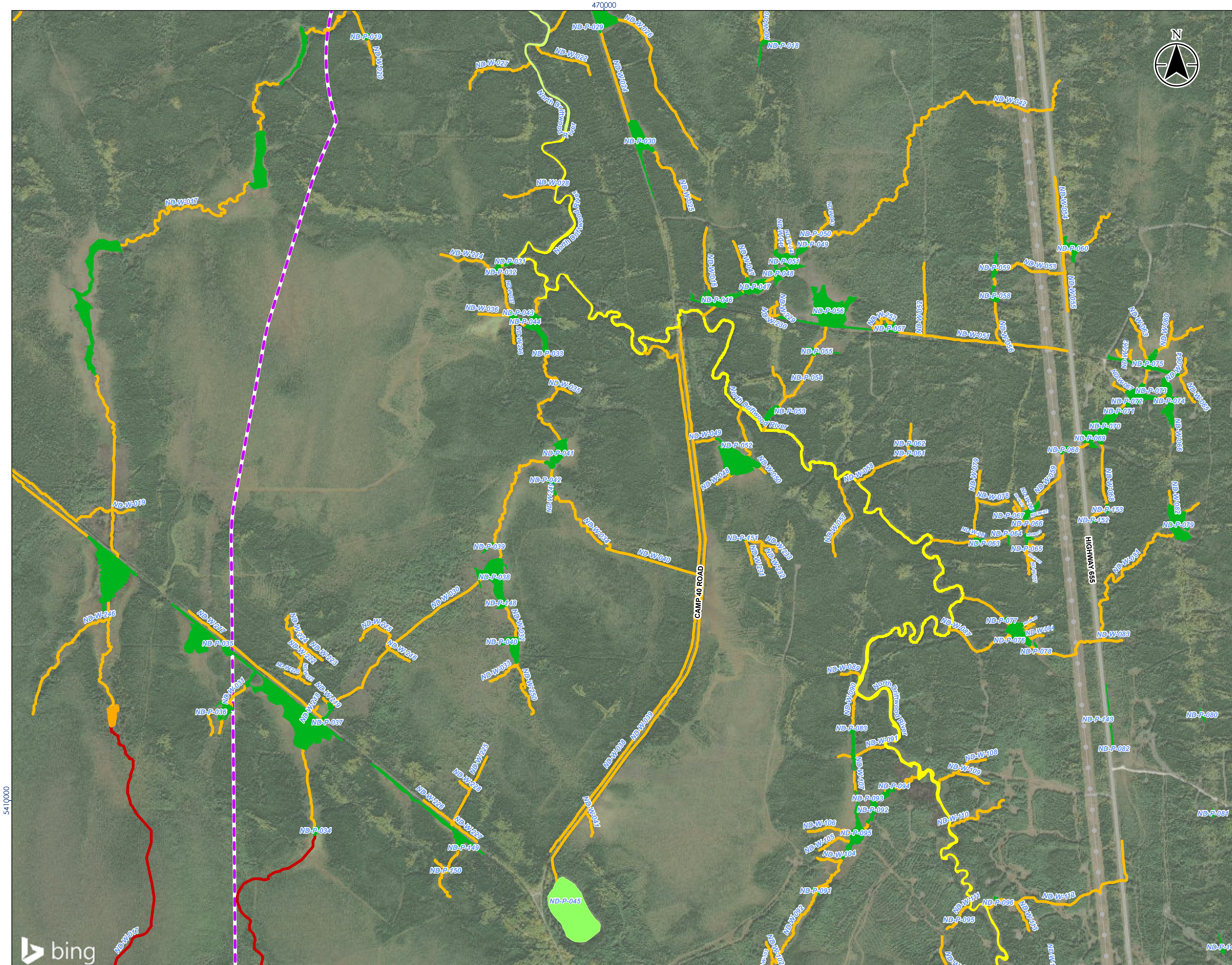

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Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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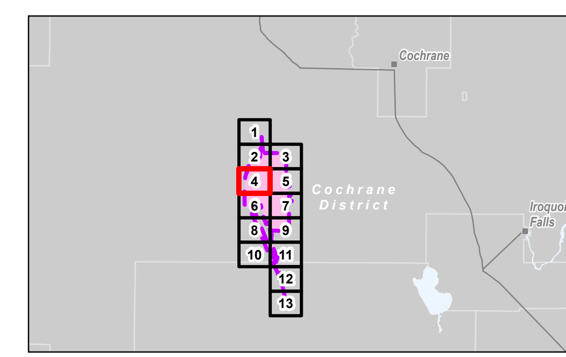


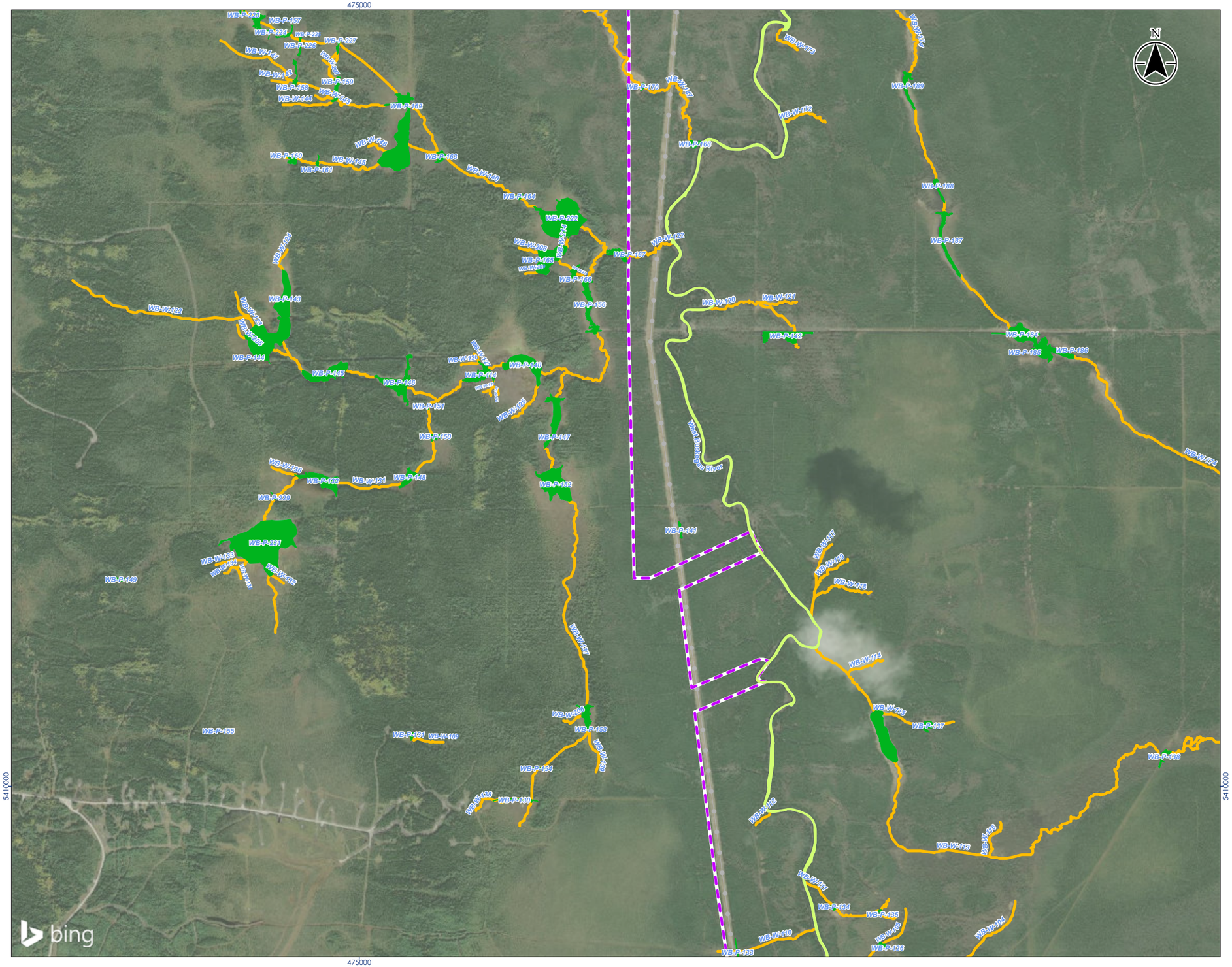
Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.4

Title
Habitat Classification



Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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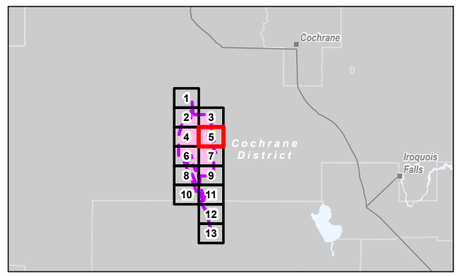

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.5

Title
Habitat Classification

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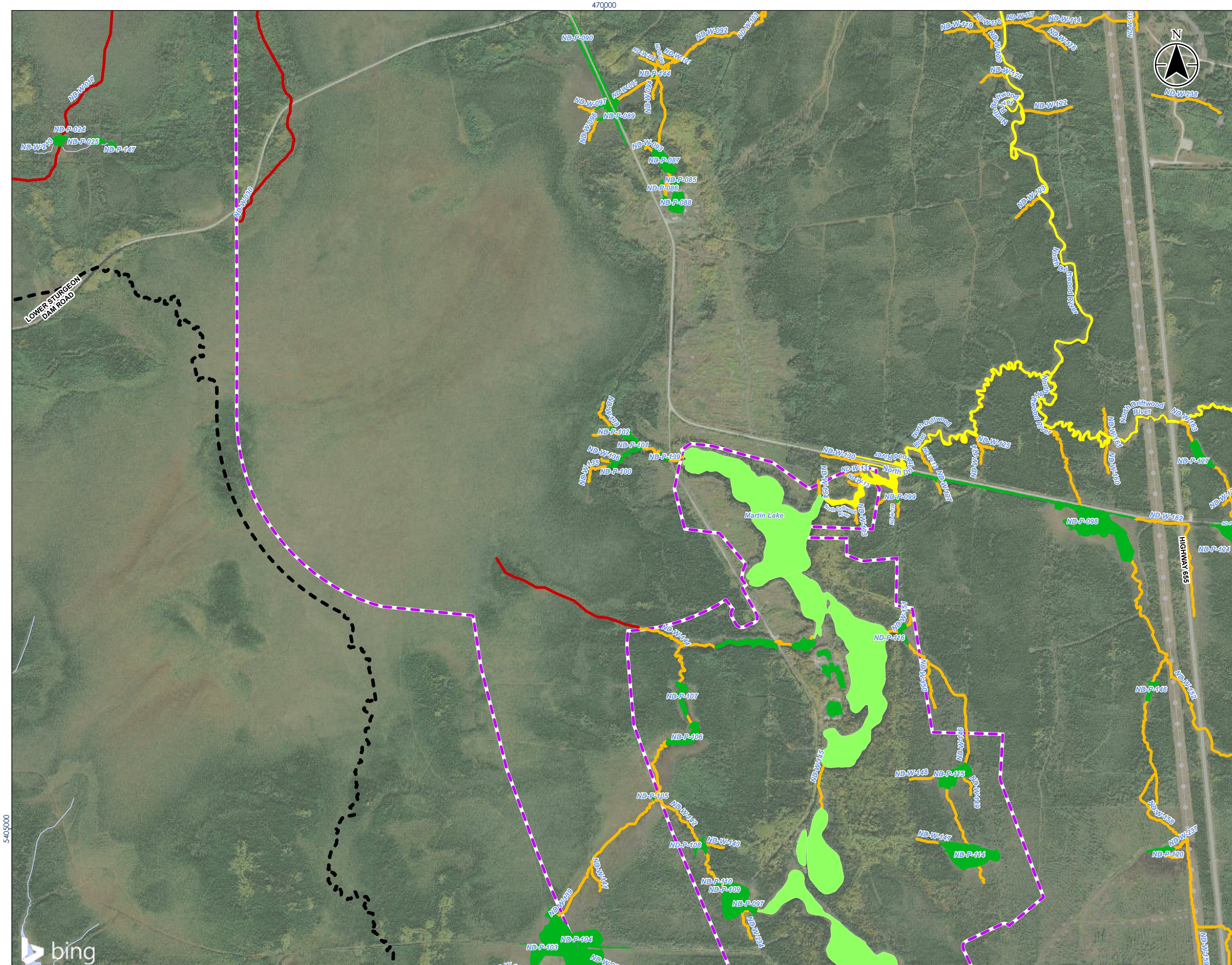

Legend

Project Area

Local Study Area

Base Features

Existing Transmission Line

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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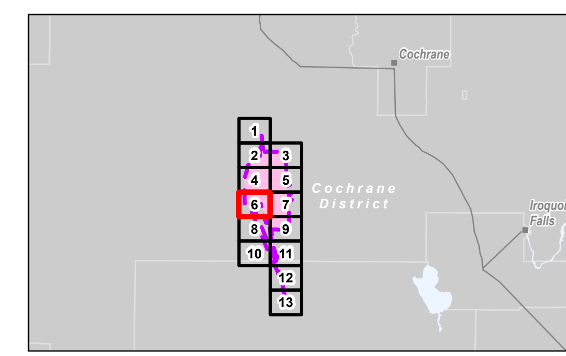

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.6

Title
Habitat Classification

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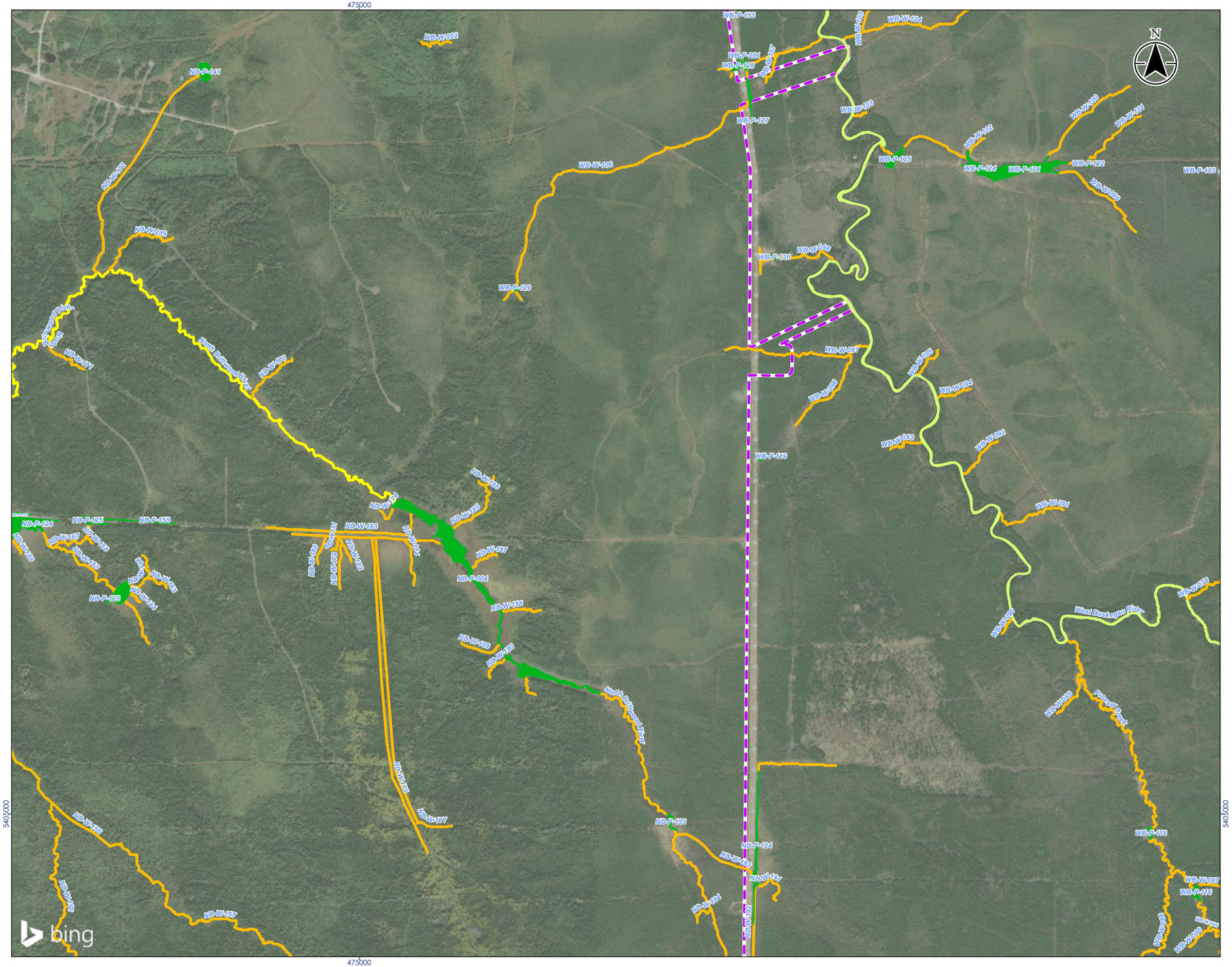

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Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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Notes

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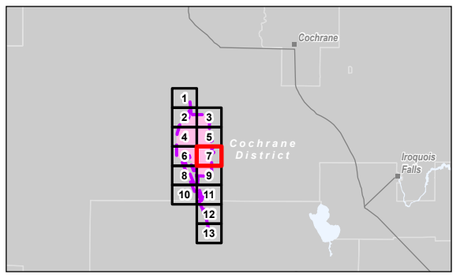


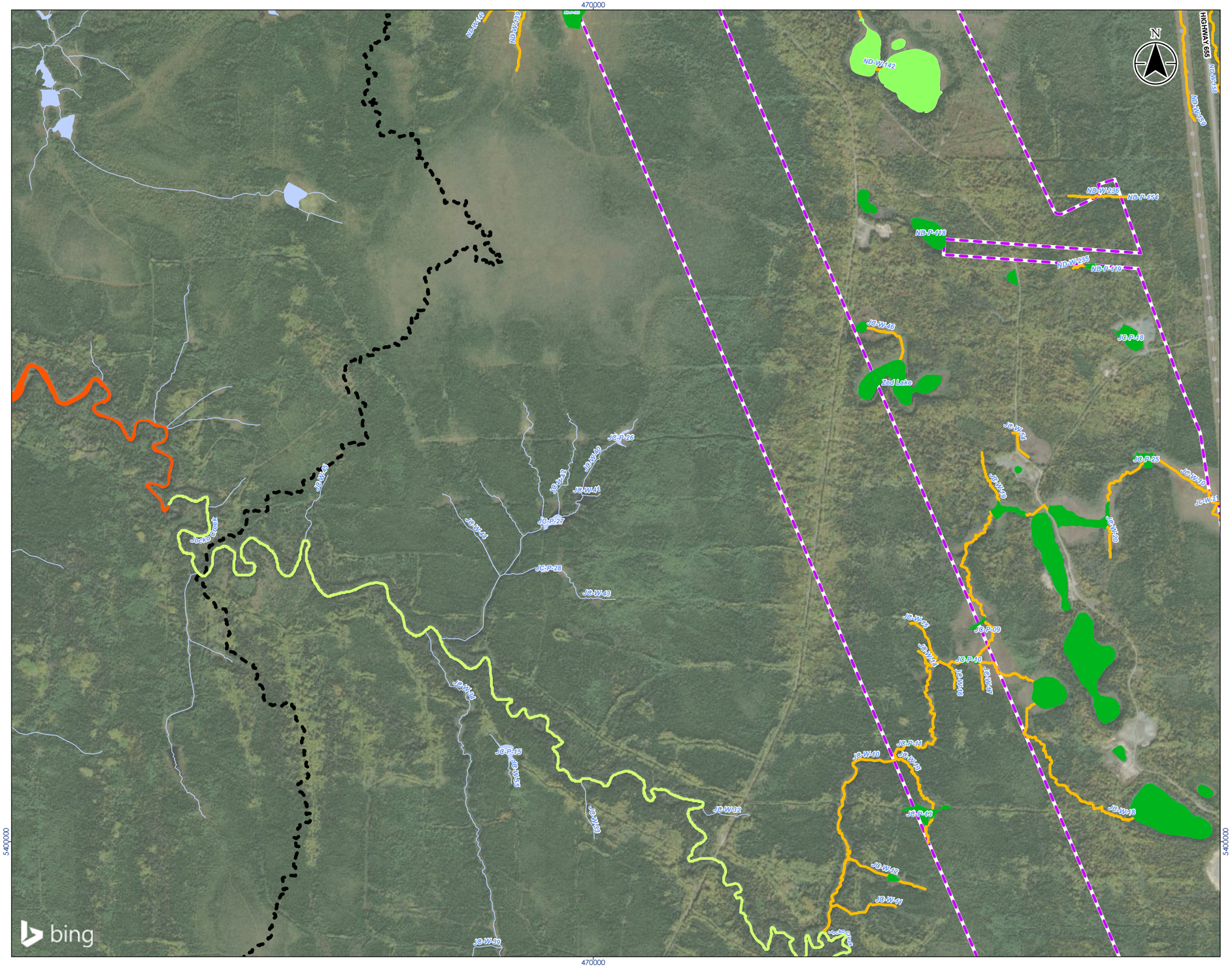
Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.7

Title
Habitat Classification



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Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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Notes

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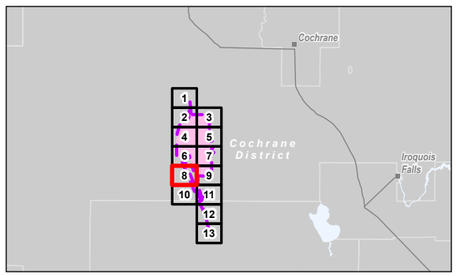


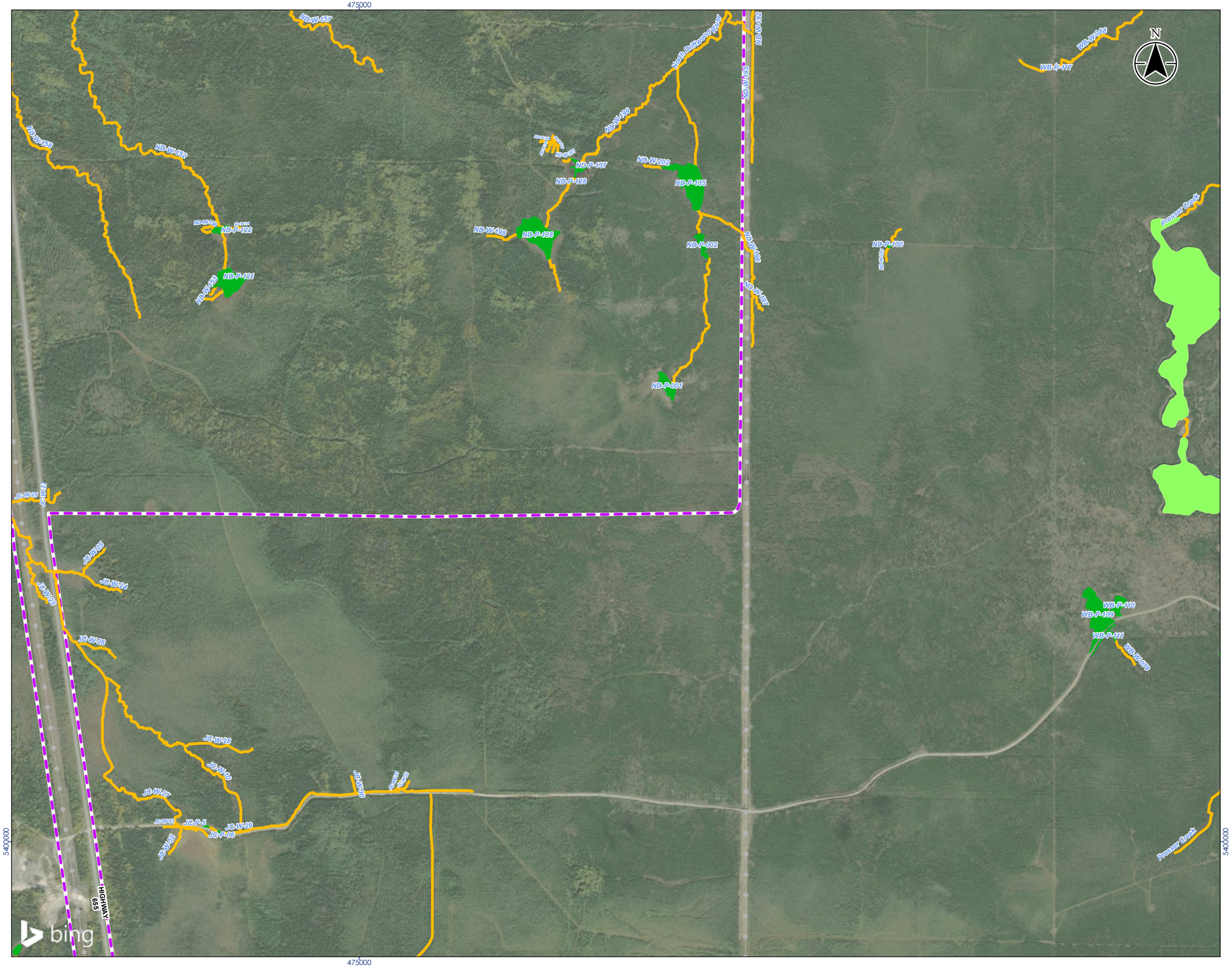
Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.8

Title
Habitat Classification



Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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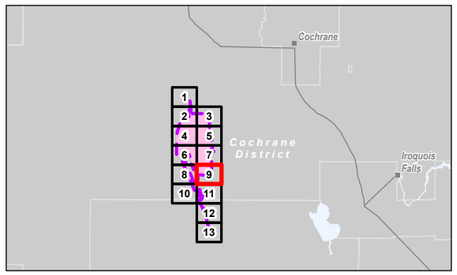

Project Location
Timmins, Ontario

160930456 REV6
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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.9

Title
Habitat Classification

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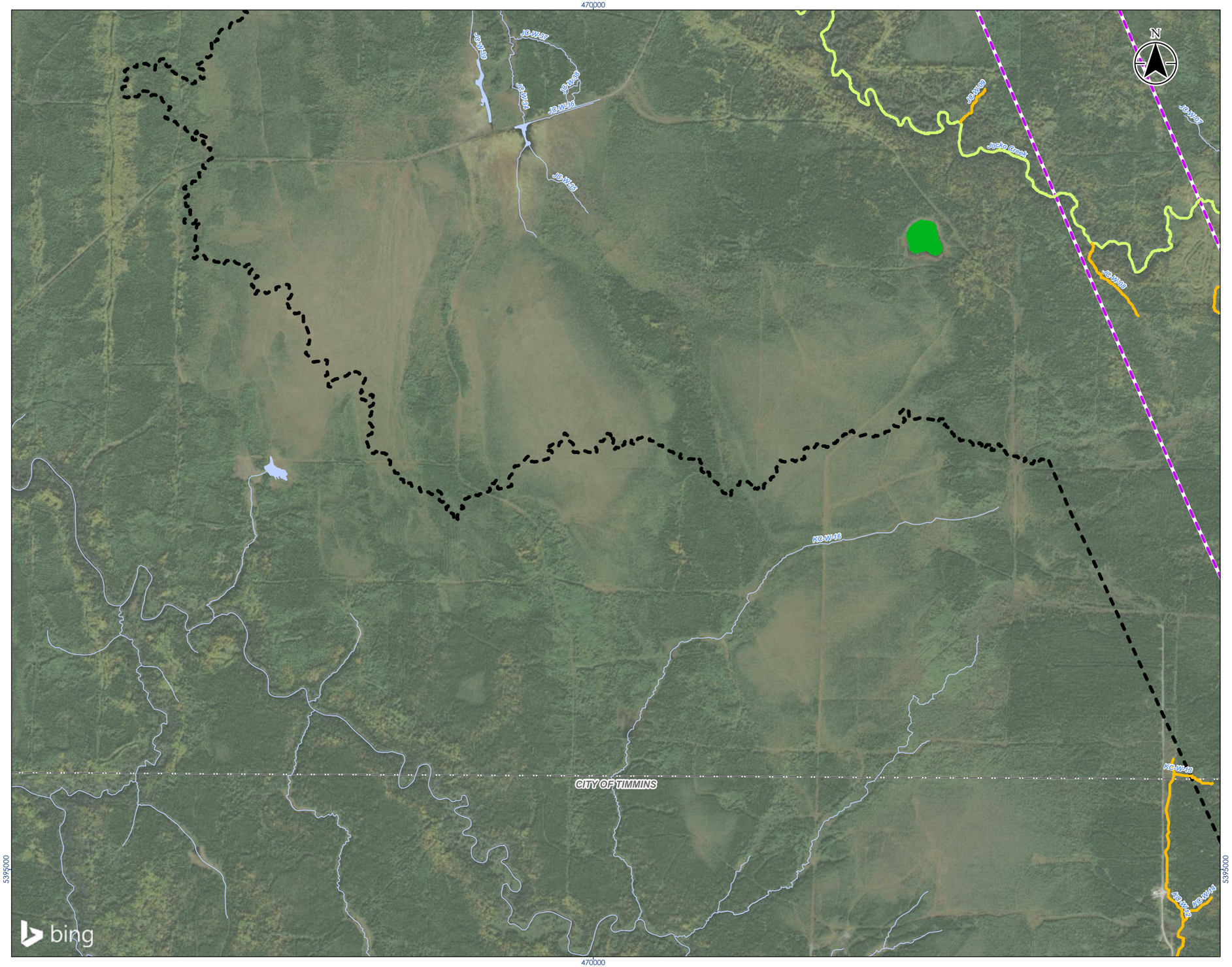

Stantec

Legend

- Project Area
- Local Study Area
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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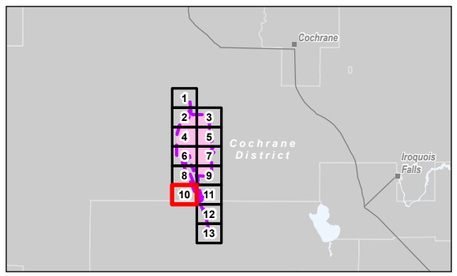

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.10

Title
Habitat Classification

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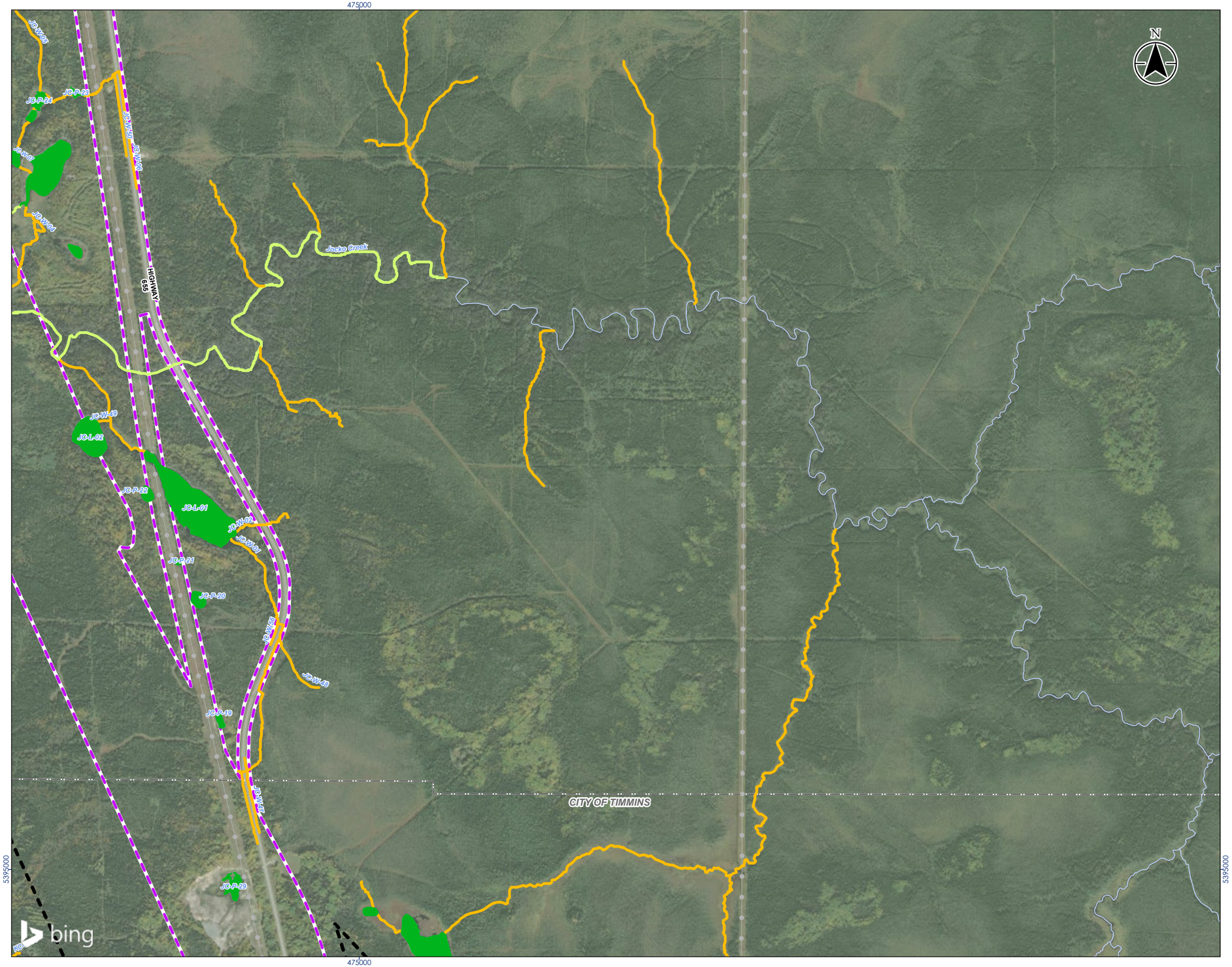

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Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Municipal Boundary - Lower Tier

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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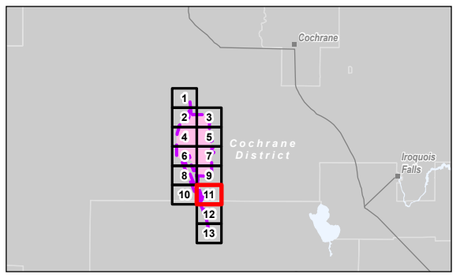

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.11

Title
Habitat Classification

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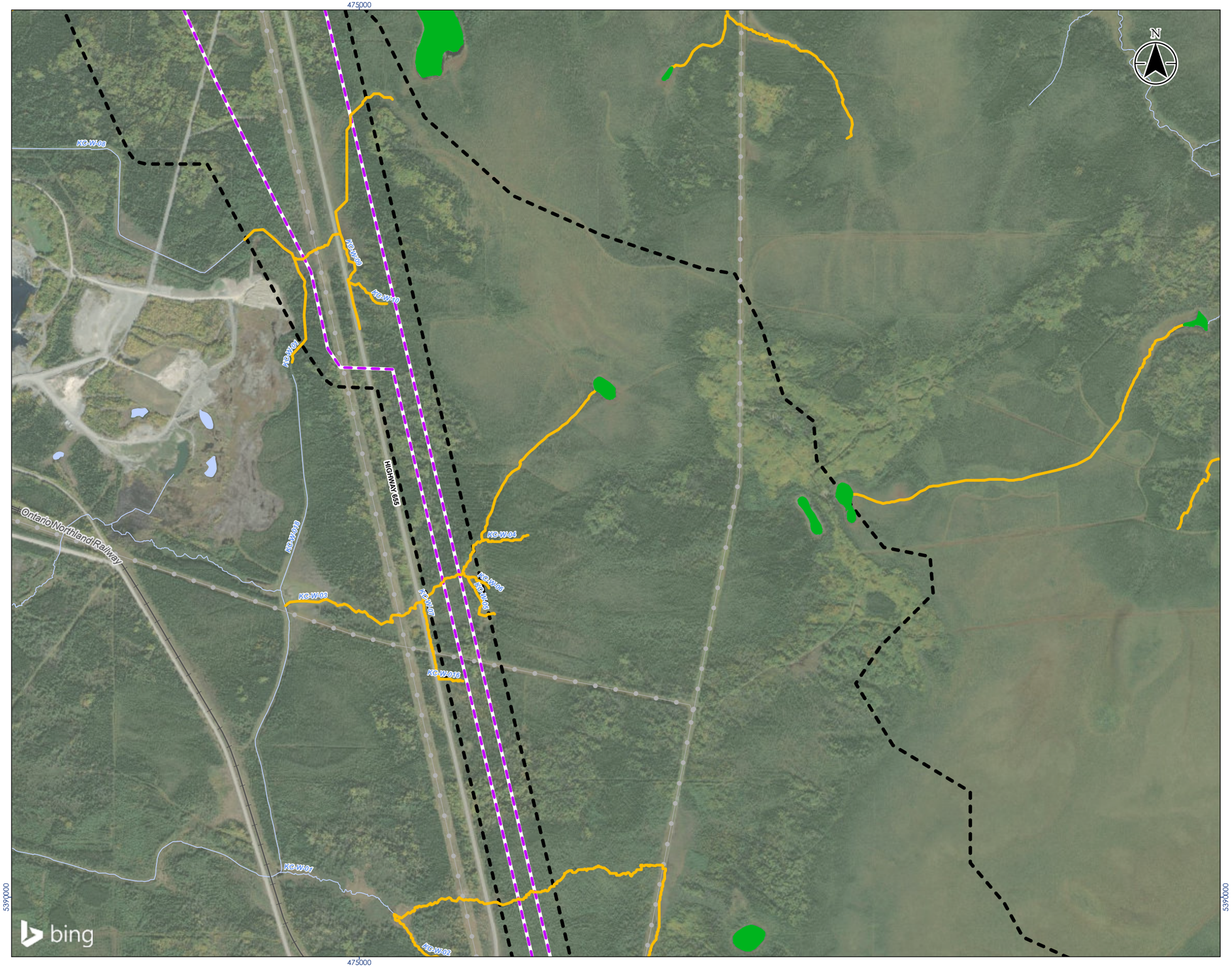

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Railway
- Watercourse
- Municipal Boundary - Lower Tier

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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Notes

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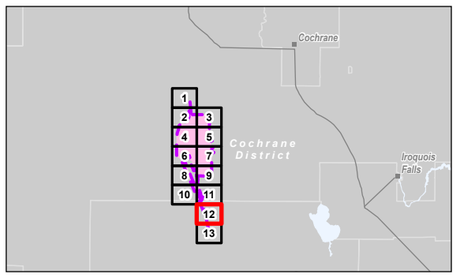

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.12

Title
Habitat Classification

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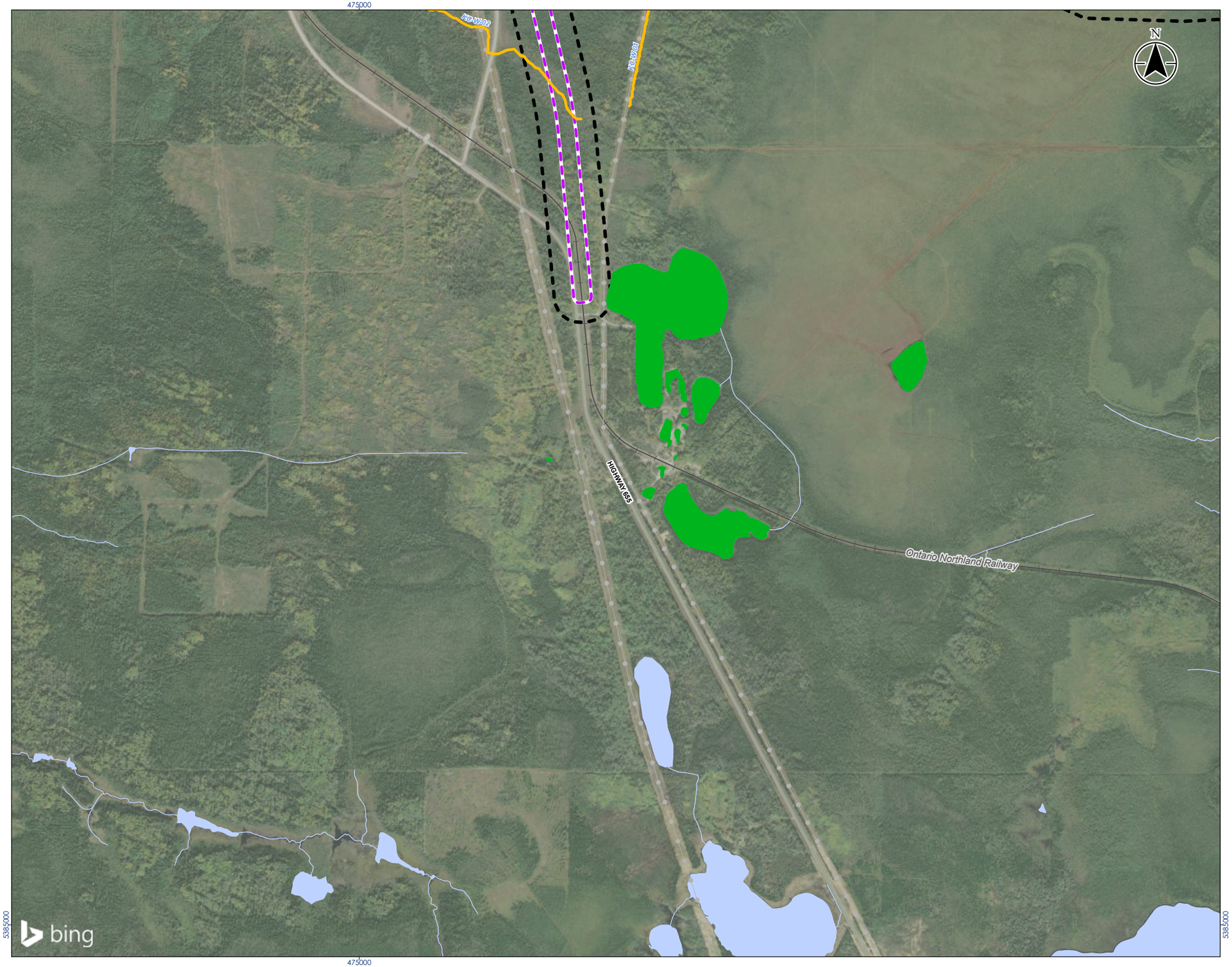

Stantec

Legend

- Project Area
- Local Study Area

Base Features

- Existing Transmission Line
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Fish Habitat Class

- A
- B
- C
- D
- E
- F
- Not Fish Habitat

0 0.5 1 km

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Notes

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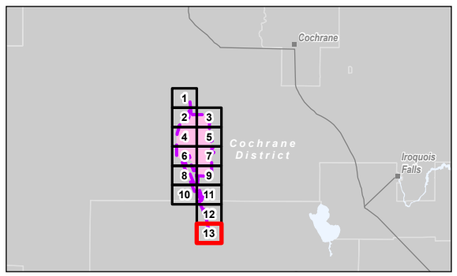

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7.13

Title
Habitat Classification

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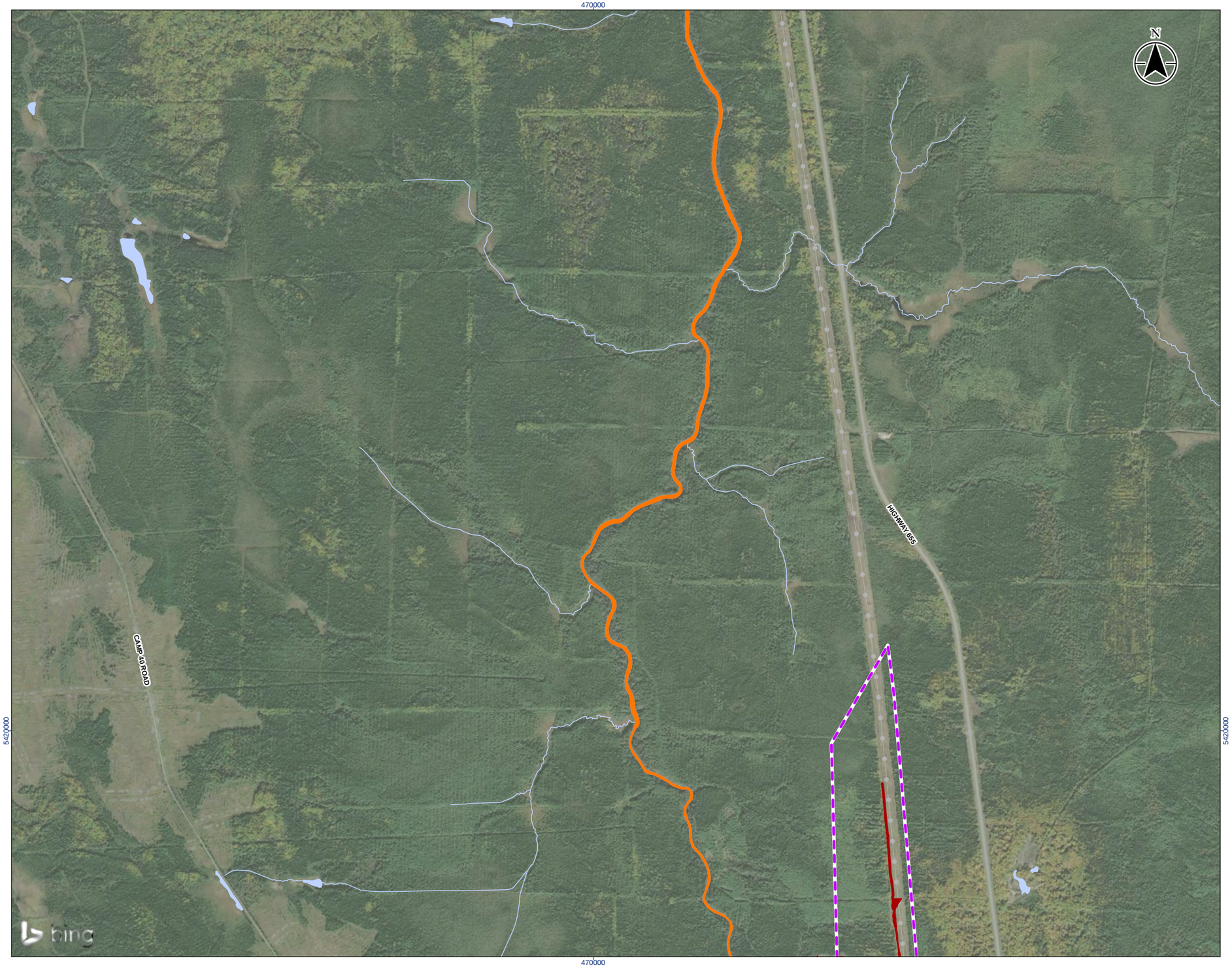

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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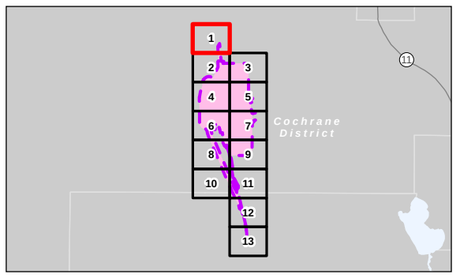

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-30

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.1

Title
Walleye Adult Habitat

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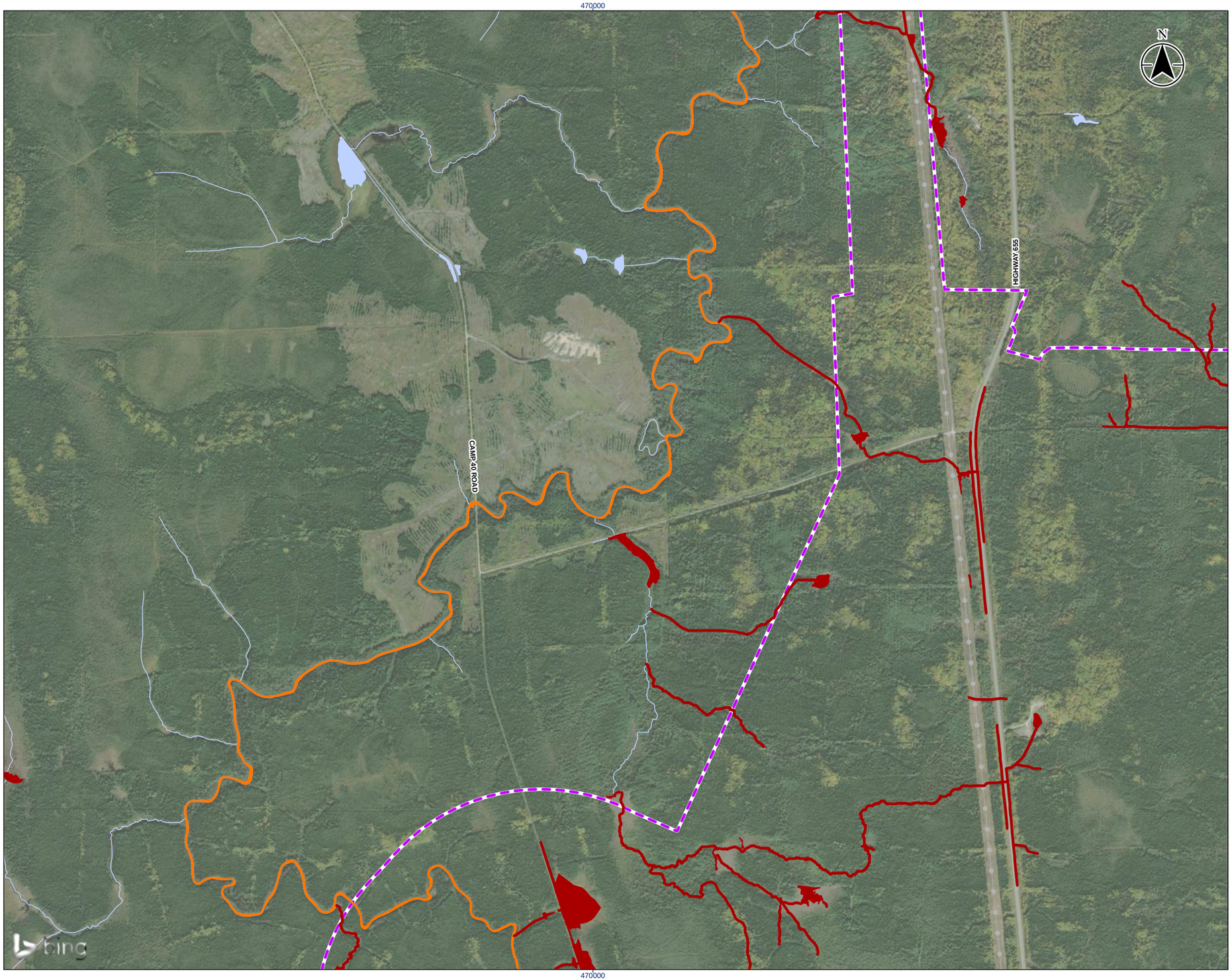

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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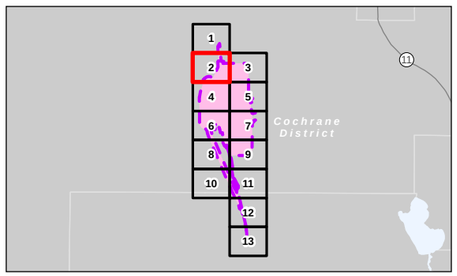

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-30

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.2

Title
Walleye Adult Habitat

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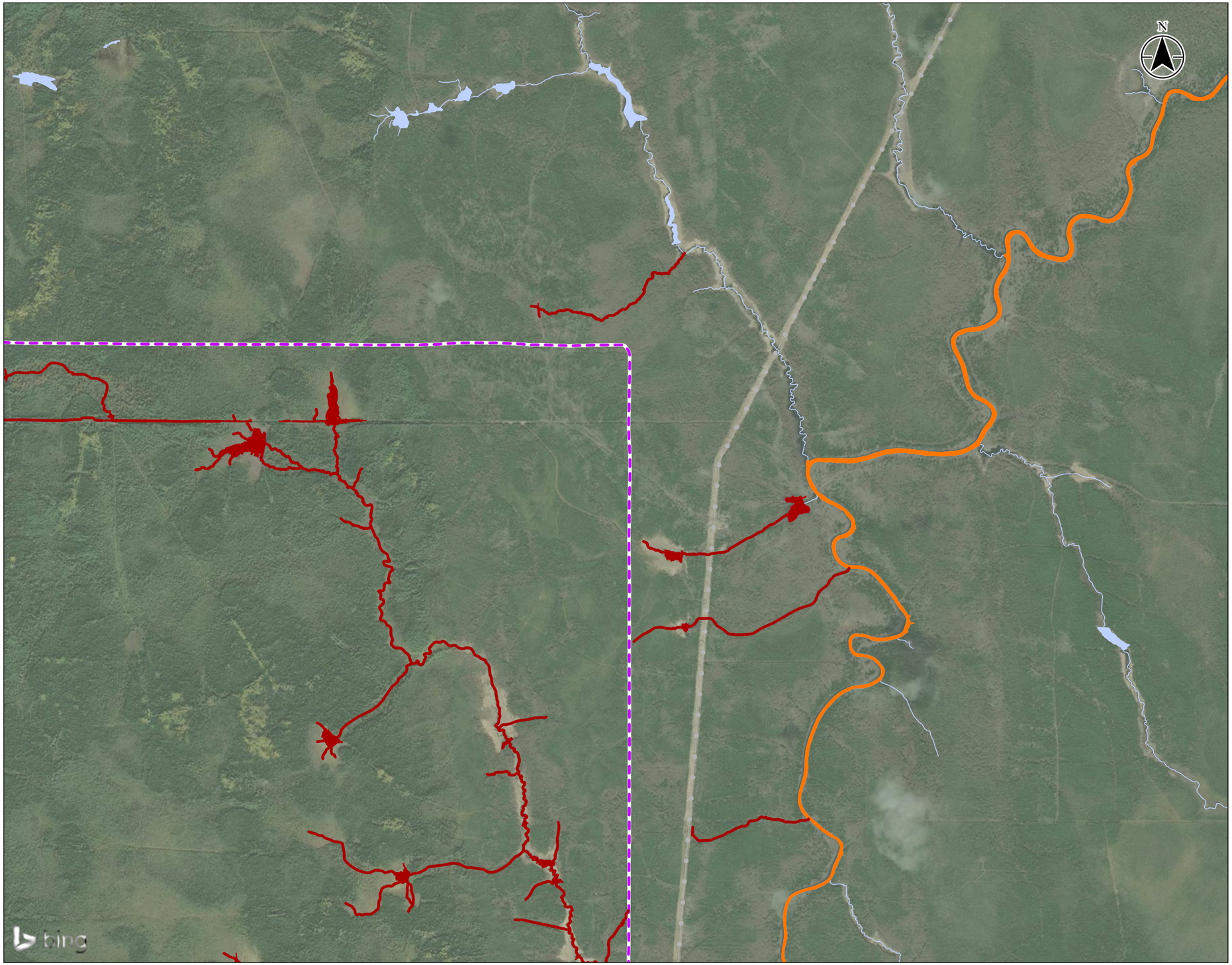

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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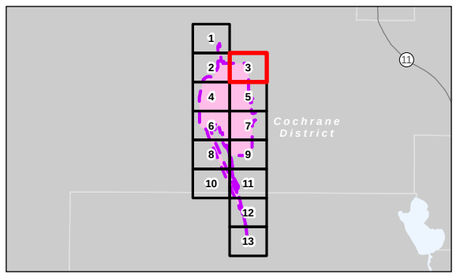

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-30

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.3

Title
Walleye Adult Habitat

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Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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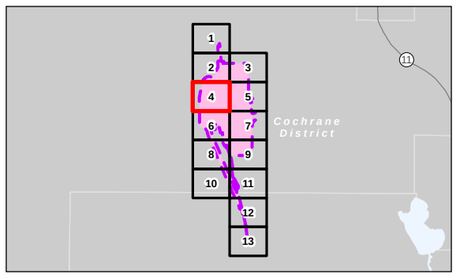

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-30

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.4

Title
Walleye Adult Habitat

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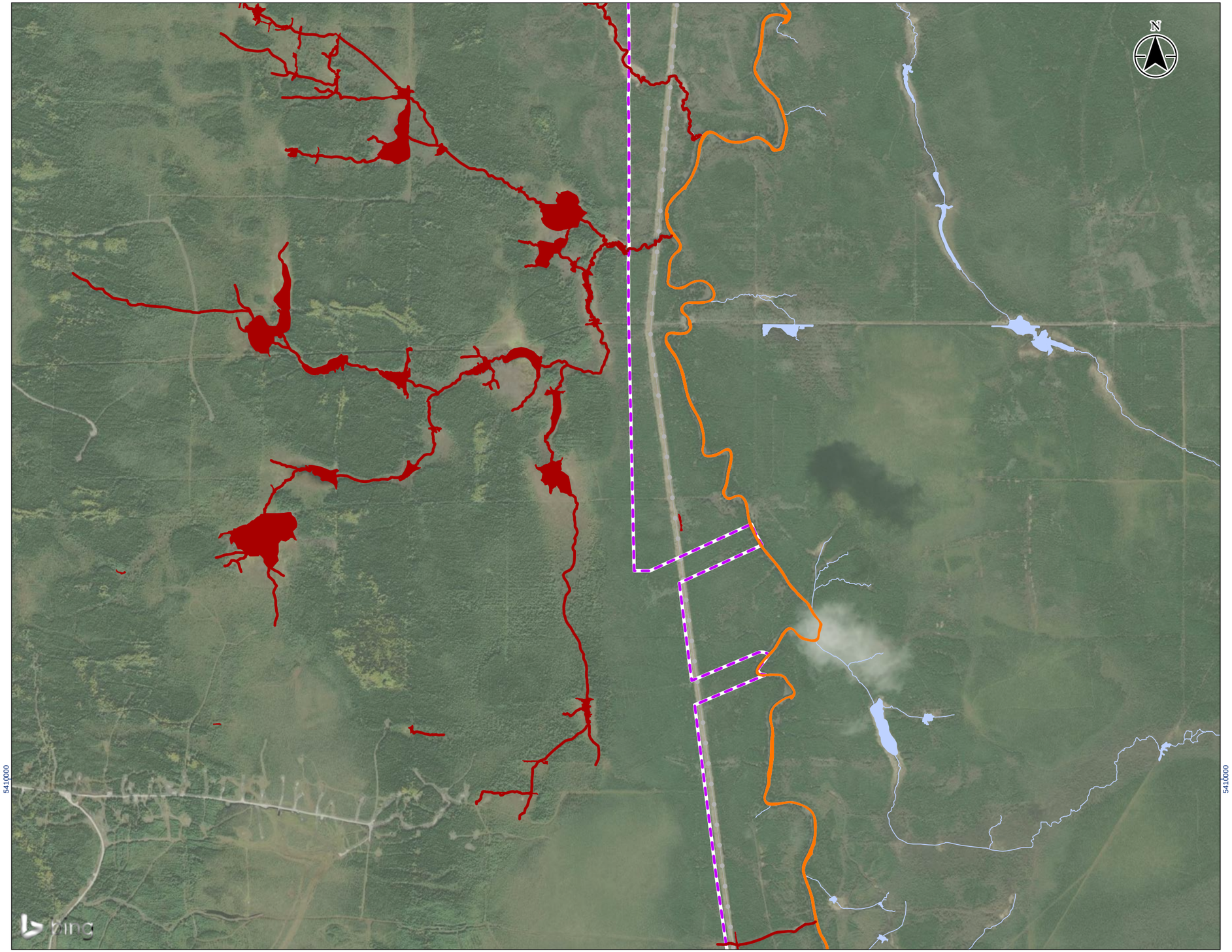

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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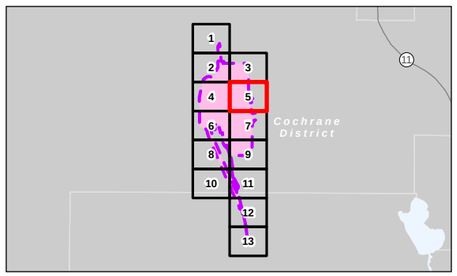

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-30

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.5

Title
Walleye Adult Habitat

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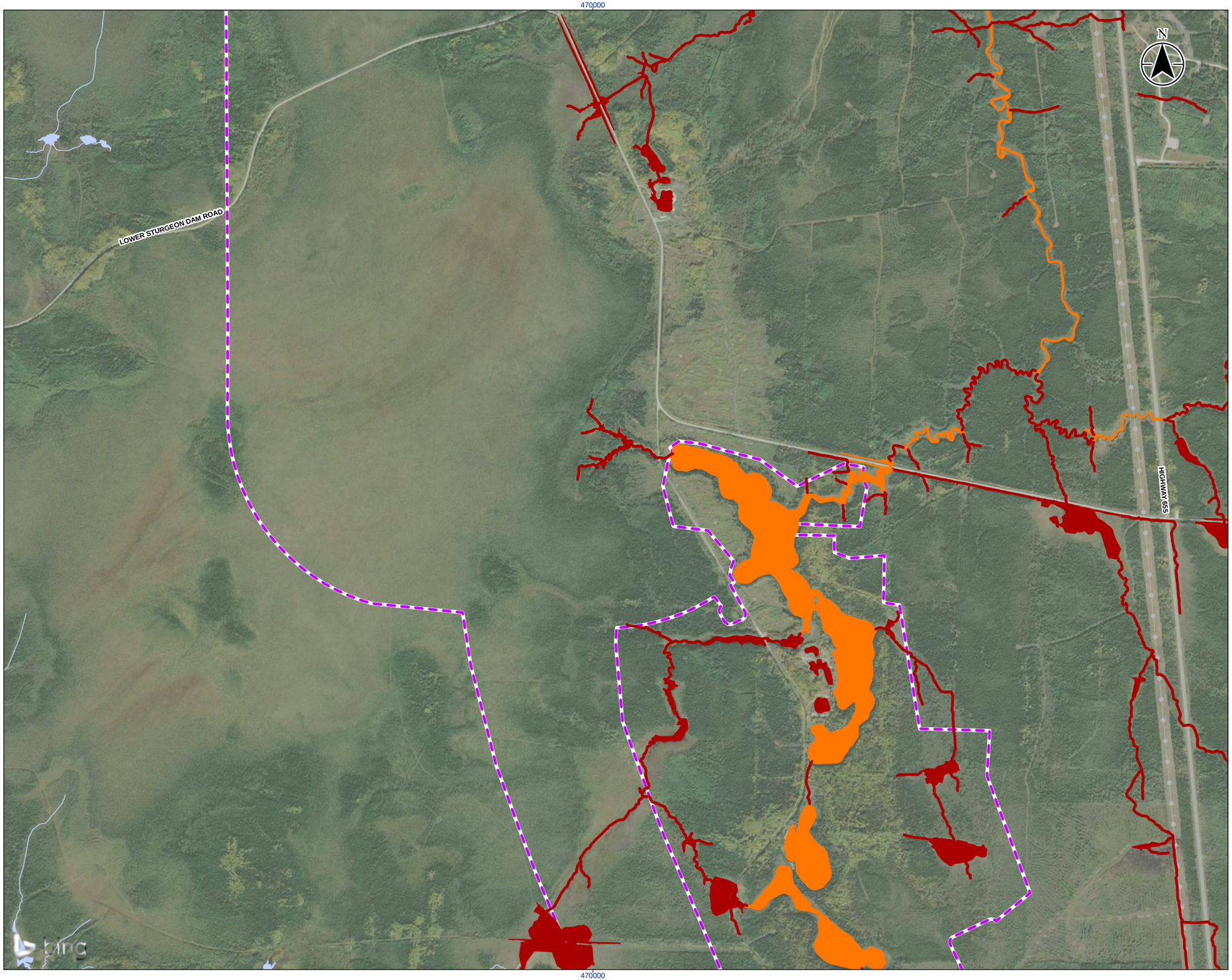

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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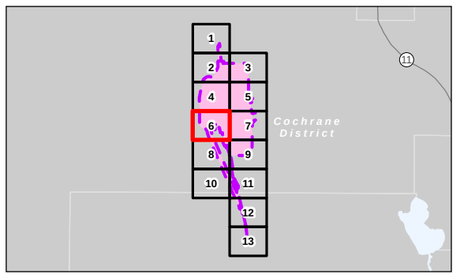

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-30

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.6

Title
Walleye Adult Habitat

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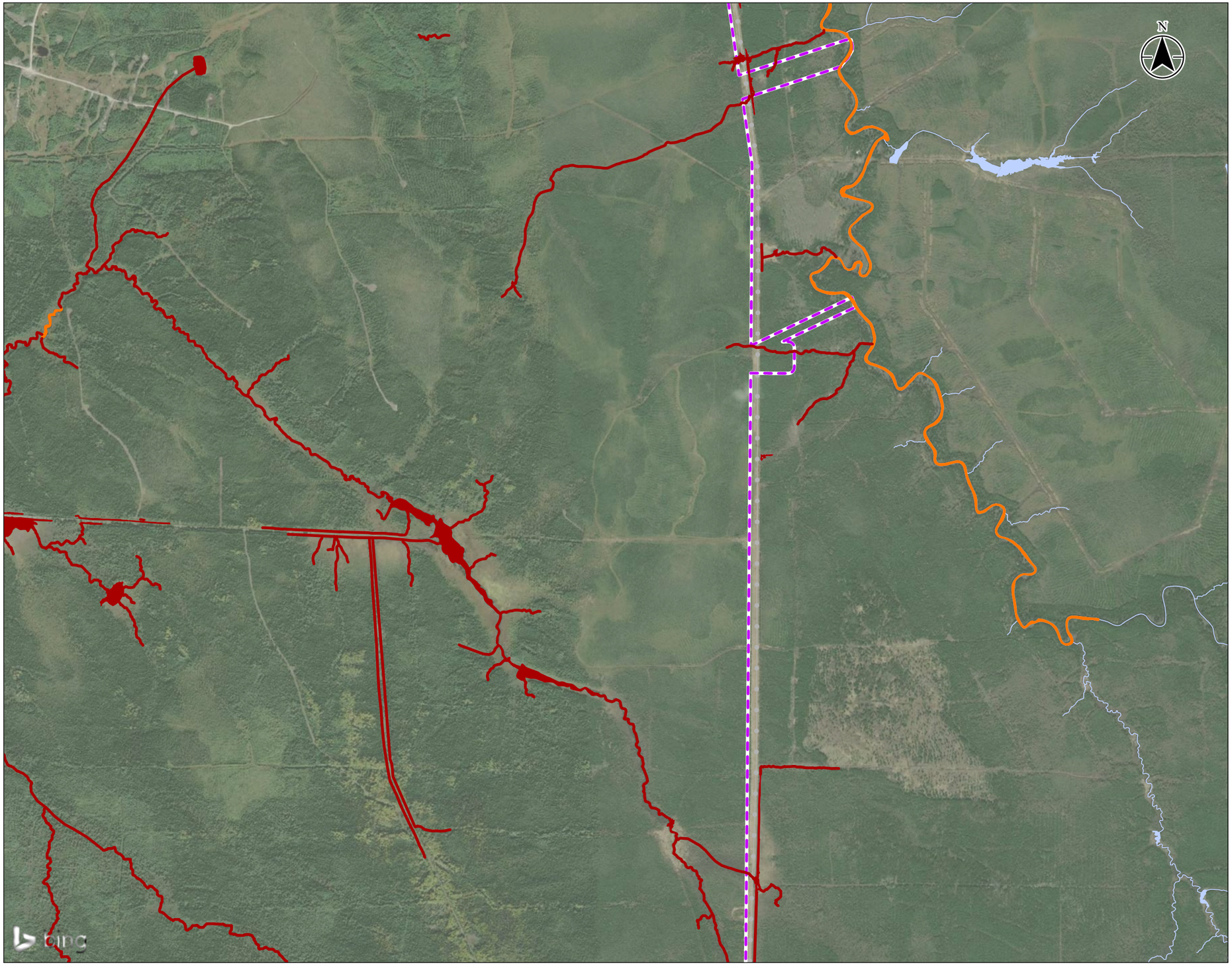

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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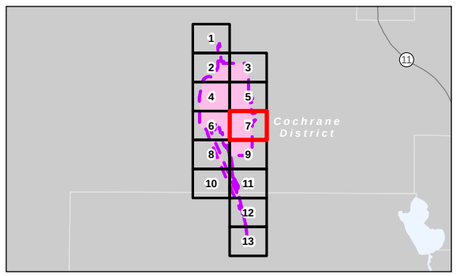

Project Location
Timmins, Ontario

160930456 REV6
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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.7

Title
Walleye Adult Habitat

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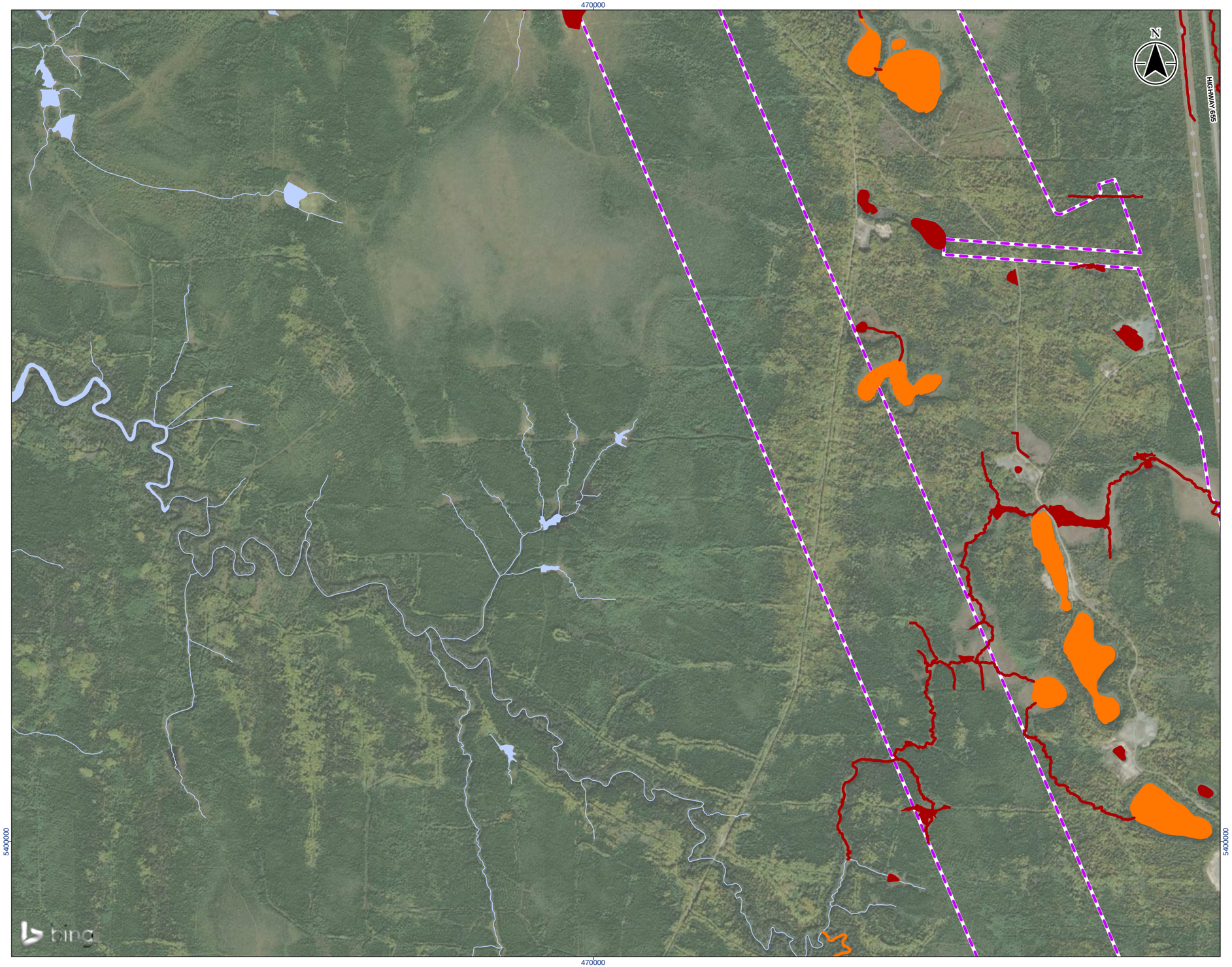

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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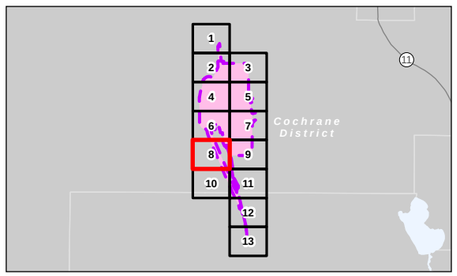

Project Location
Timmins, Ontario

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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.8

Title
Walleye Adult Habitat

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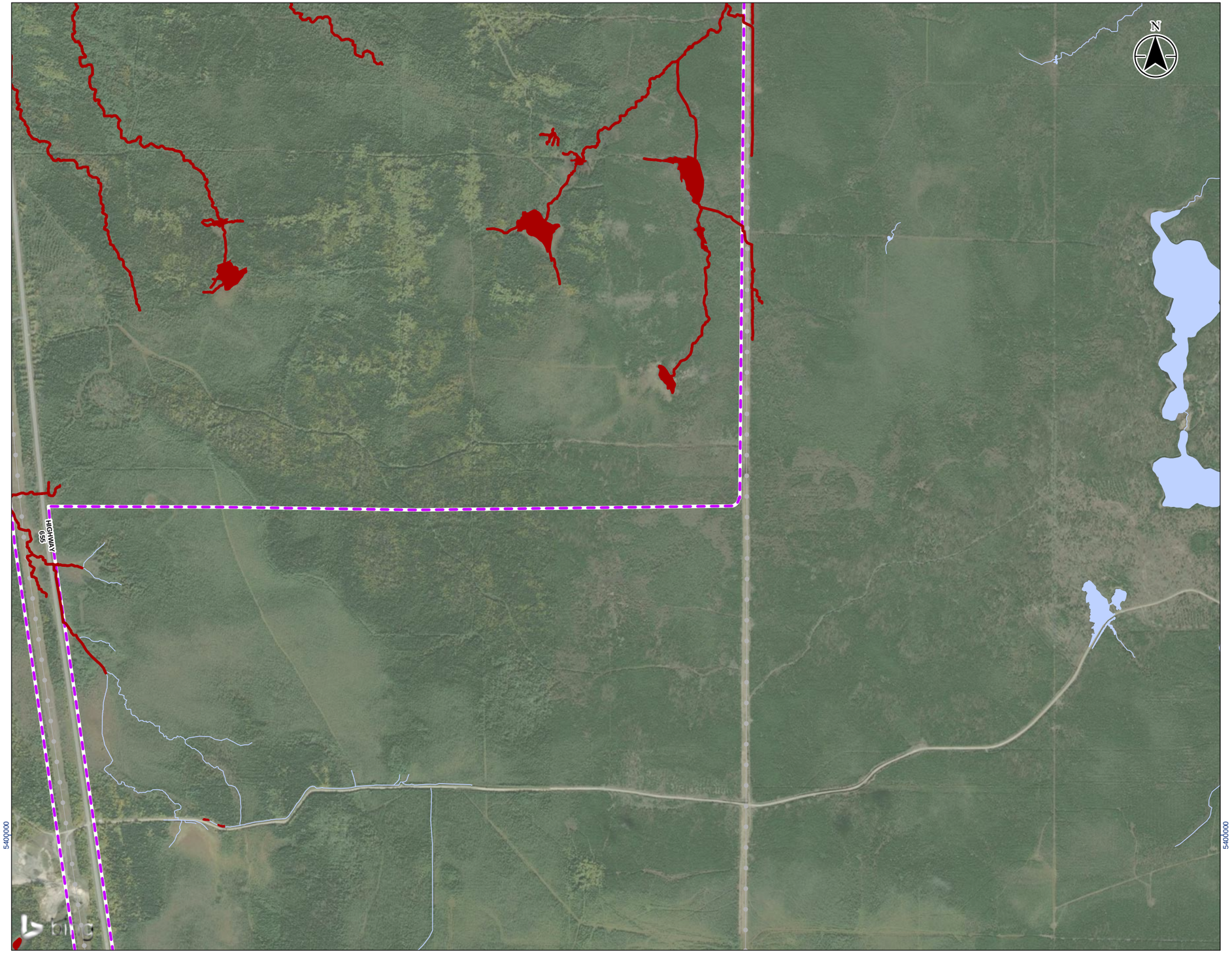

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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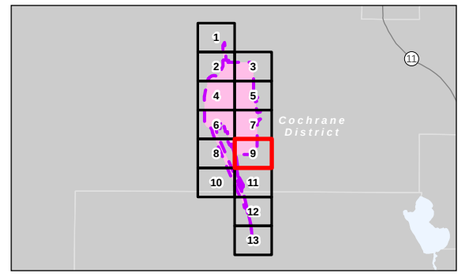

Project Location
Timmins, Ontario

160930456 REV6
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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.9

Title
Walleye Adult Habitat

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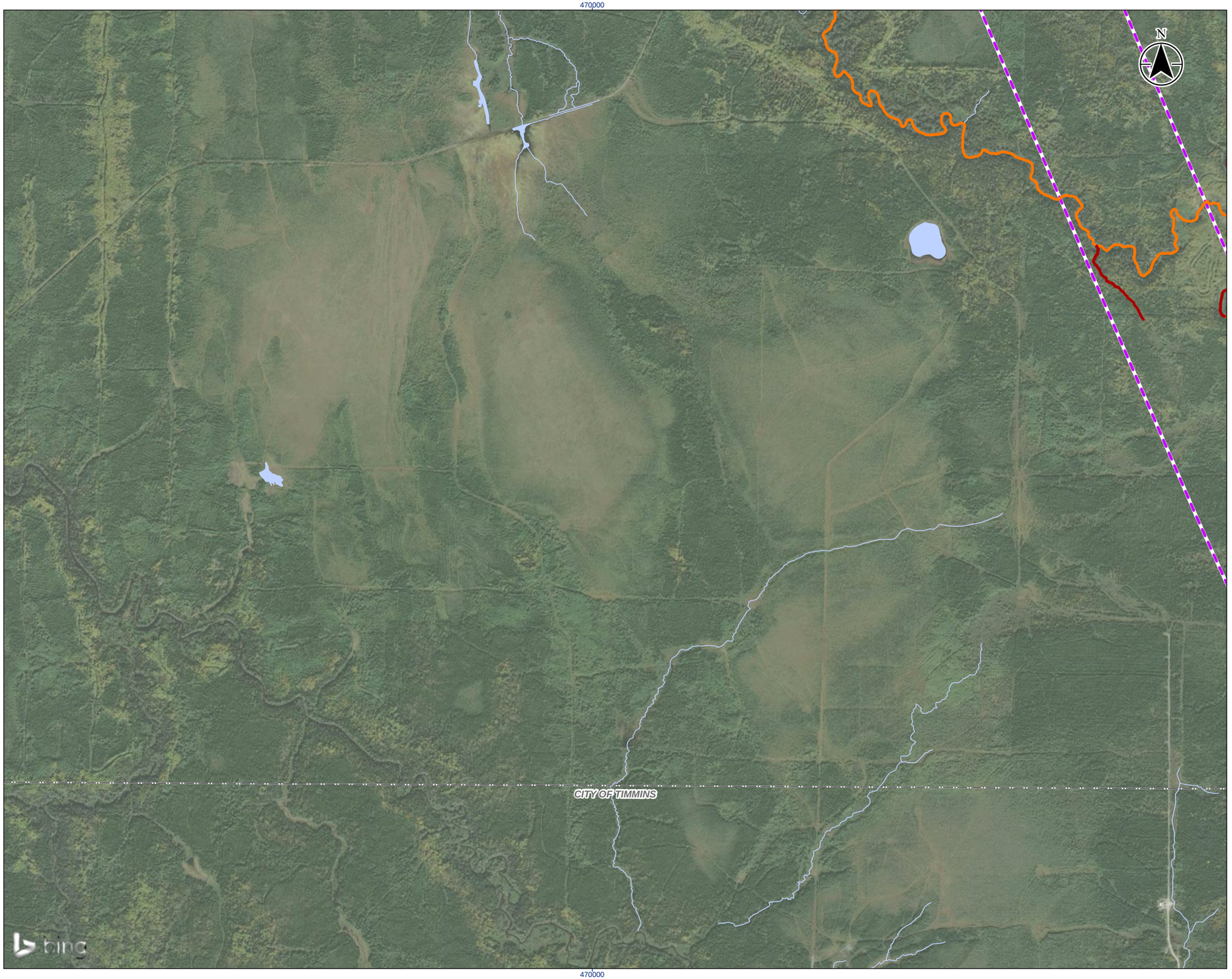

Stantec

Legend

Assessment Area Type
- Project Area
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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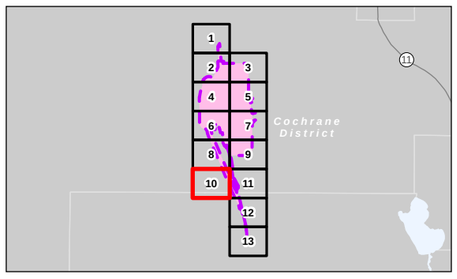

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-30

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.10

Title
Walleye Adult Habitat

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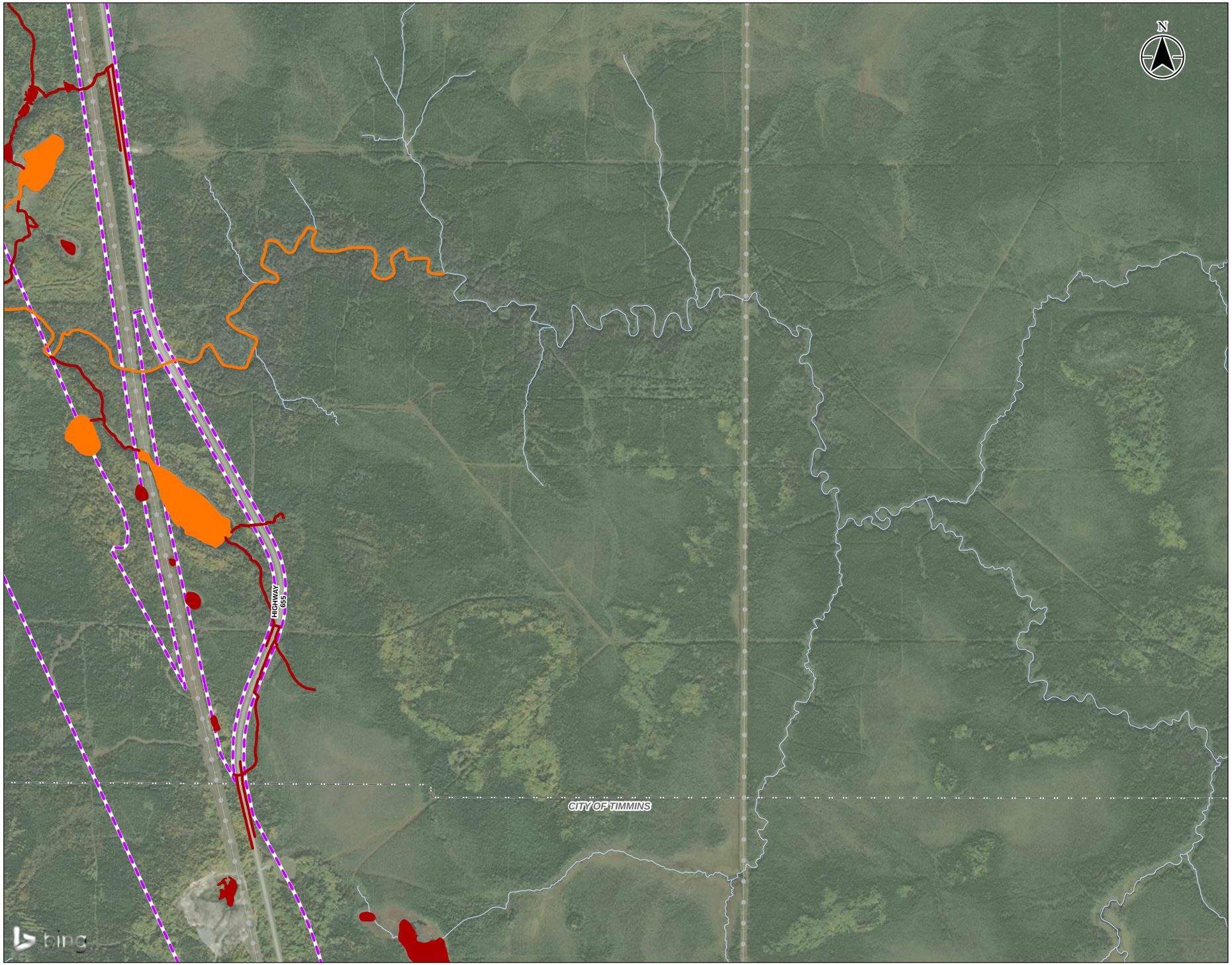

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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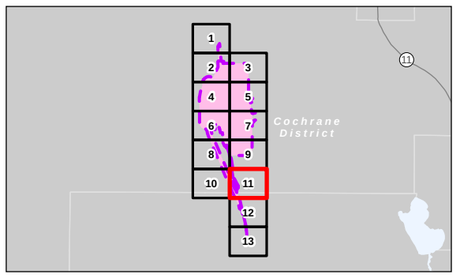

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-30

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.11

Title
Walleye Adult Habitat

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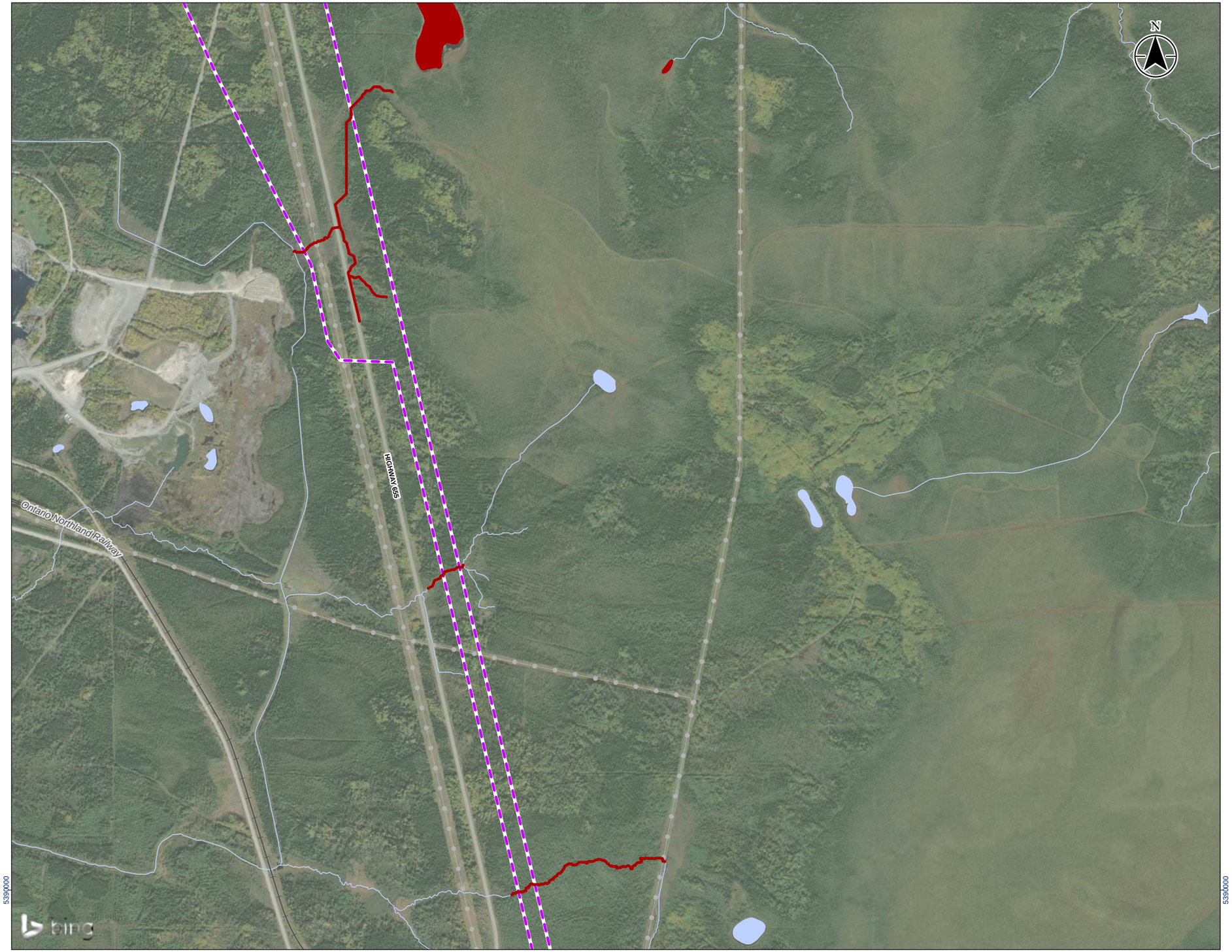

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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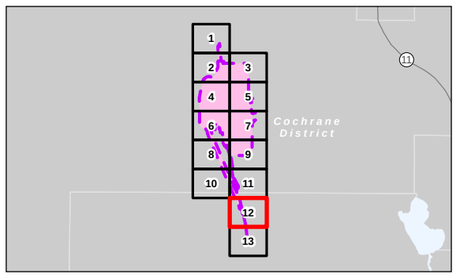

Project Location
Timmins, Ontario

160930456 REV6
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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.12

Title
Walleye Adult Habitat

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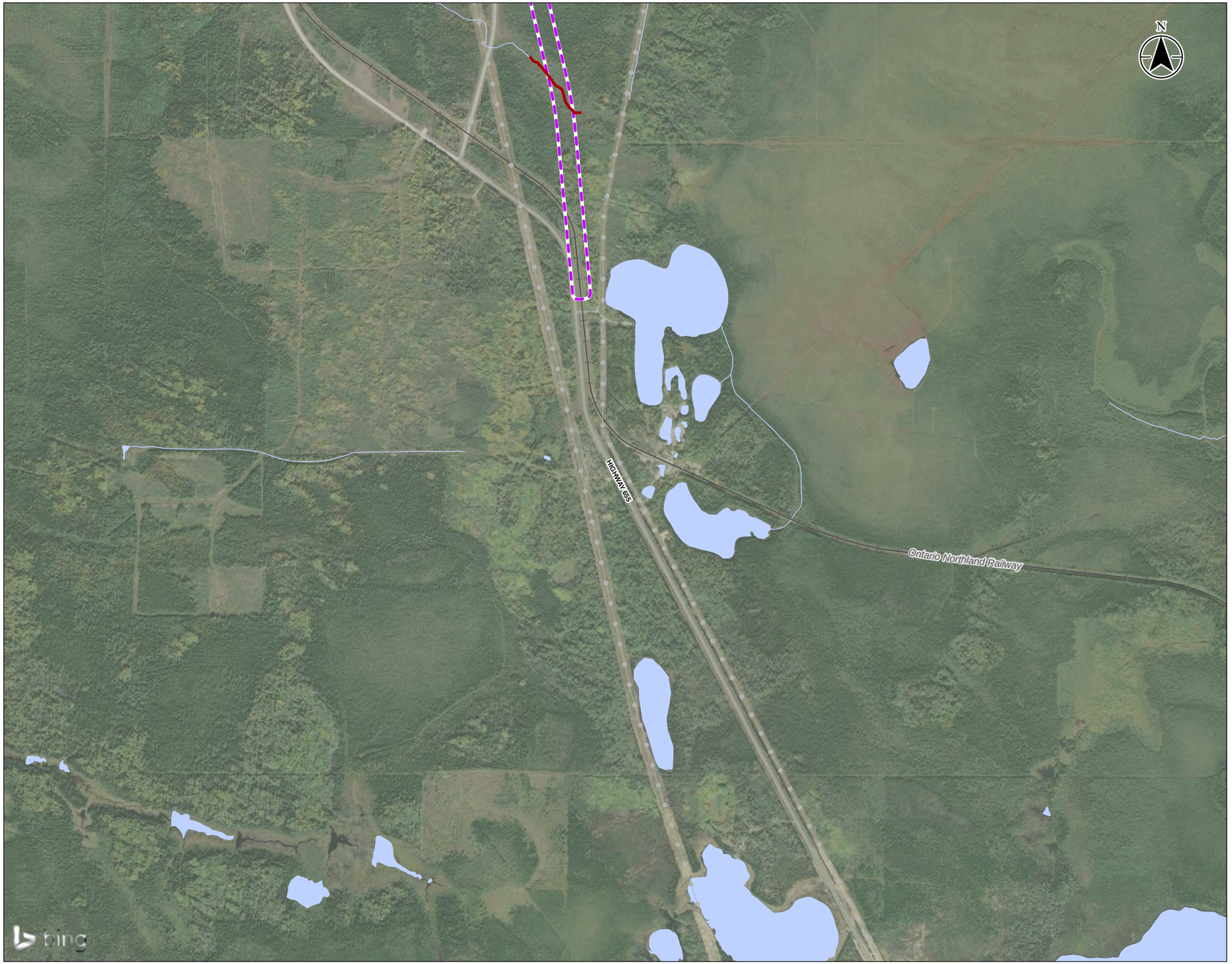

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Adult Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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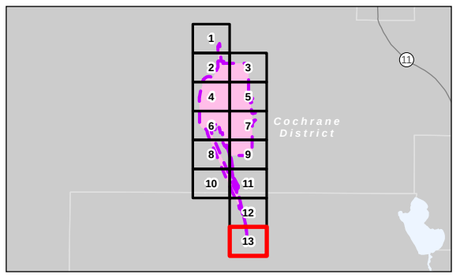

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-30

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8.13

Title
Walleye Adult Habitat

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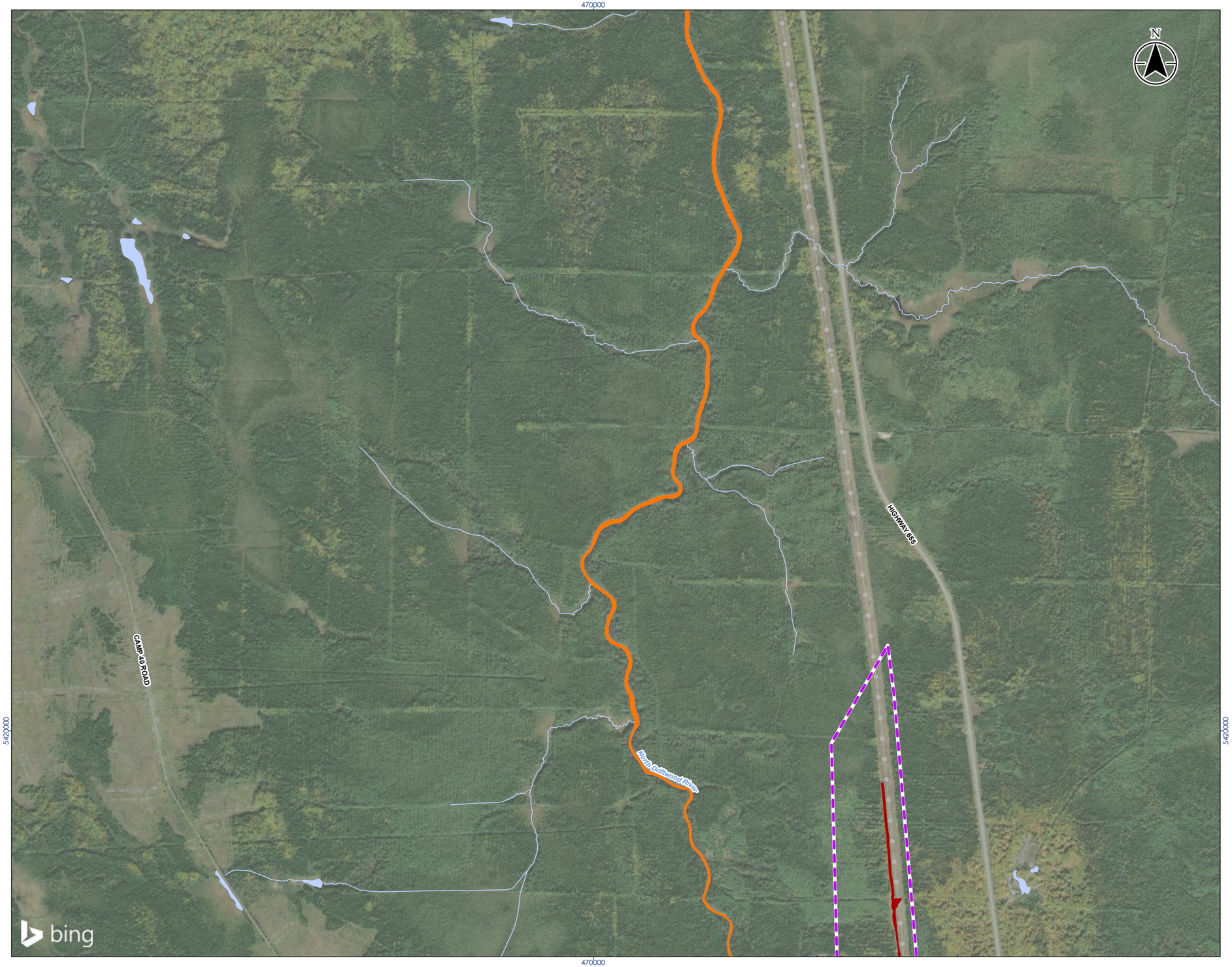

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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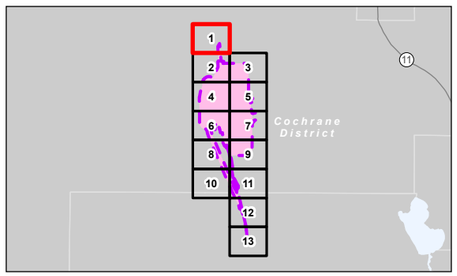

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.1

Title
Walleye Spawning/Rearing Habitat

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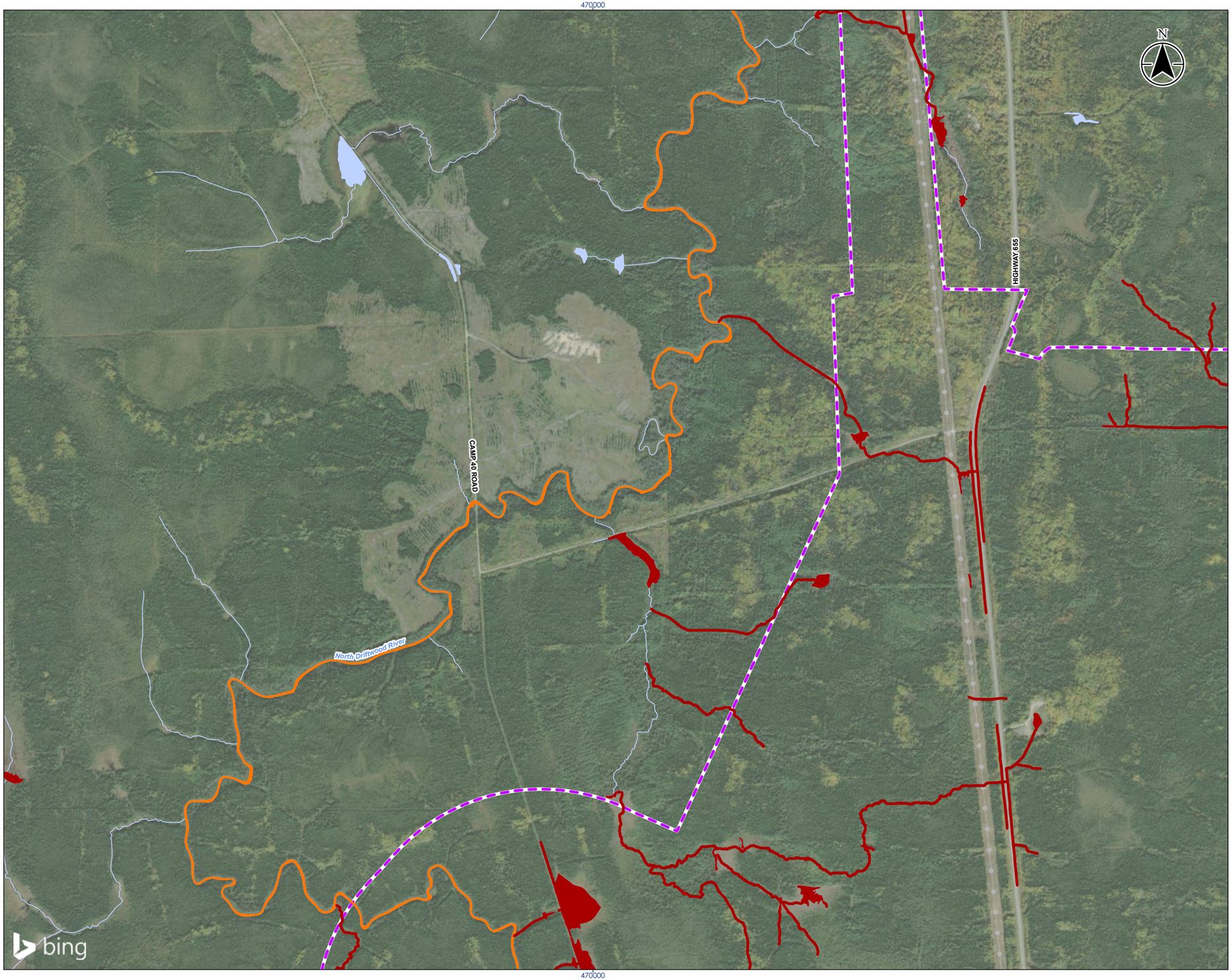

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes
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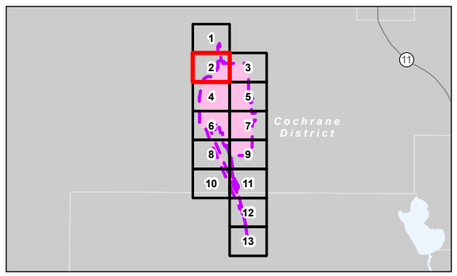

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.2

Title
Walleye Spawning/Rearing Habitat

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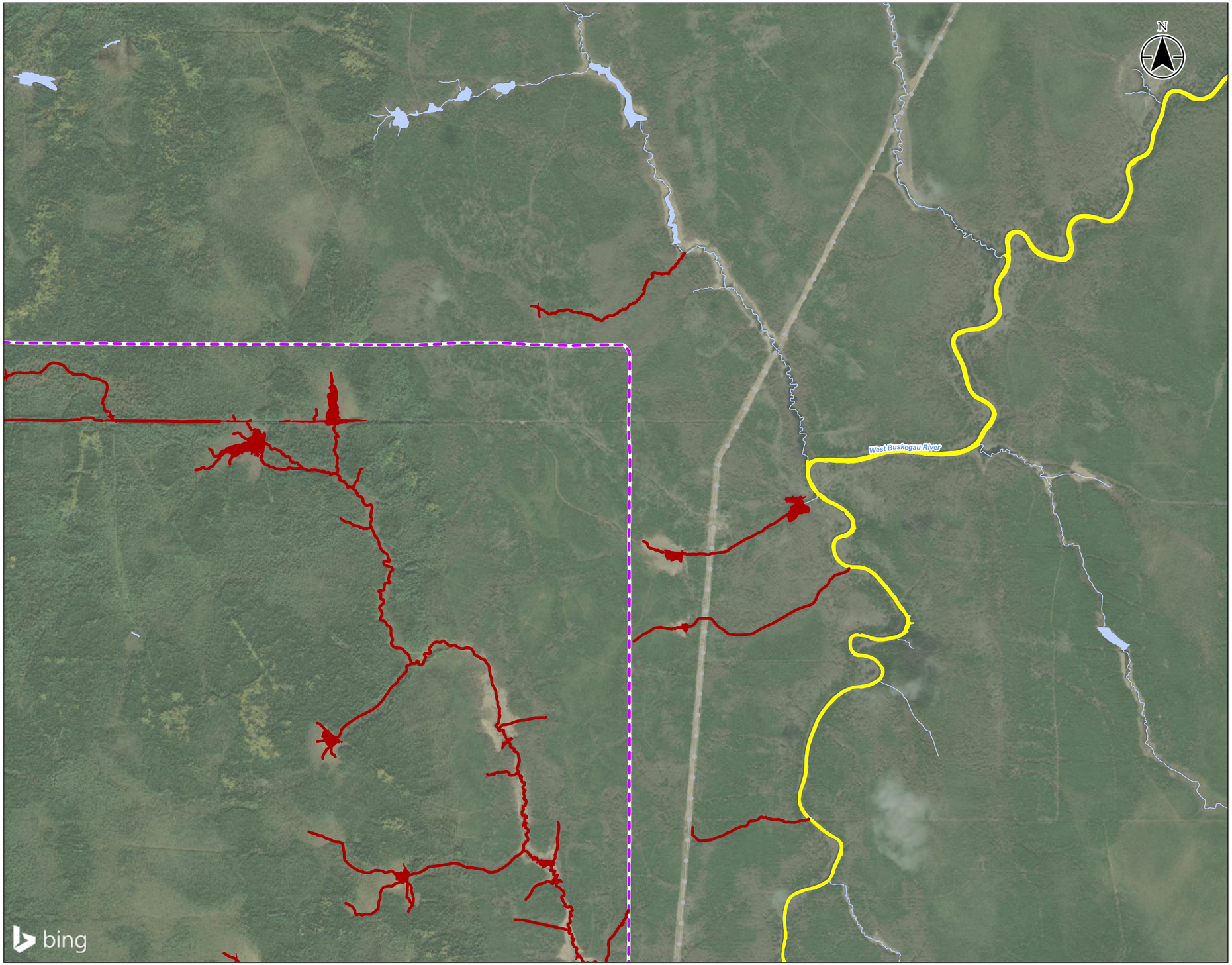

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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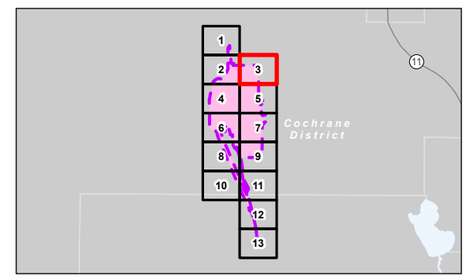

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.3

Title
Walleye Spawning/Rearing Habitat

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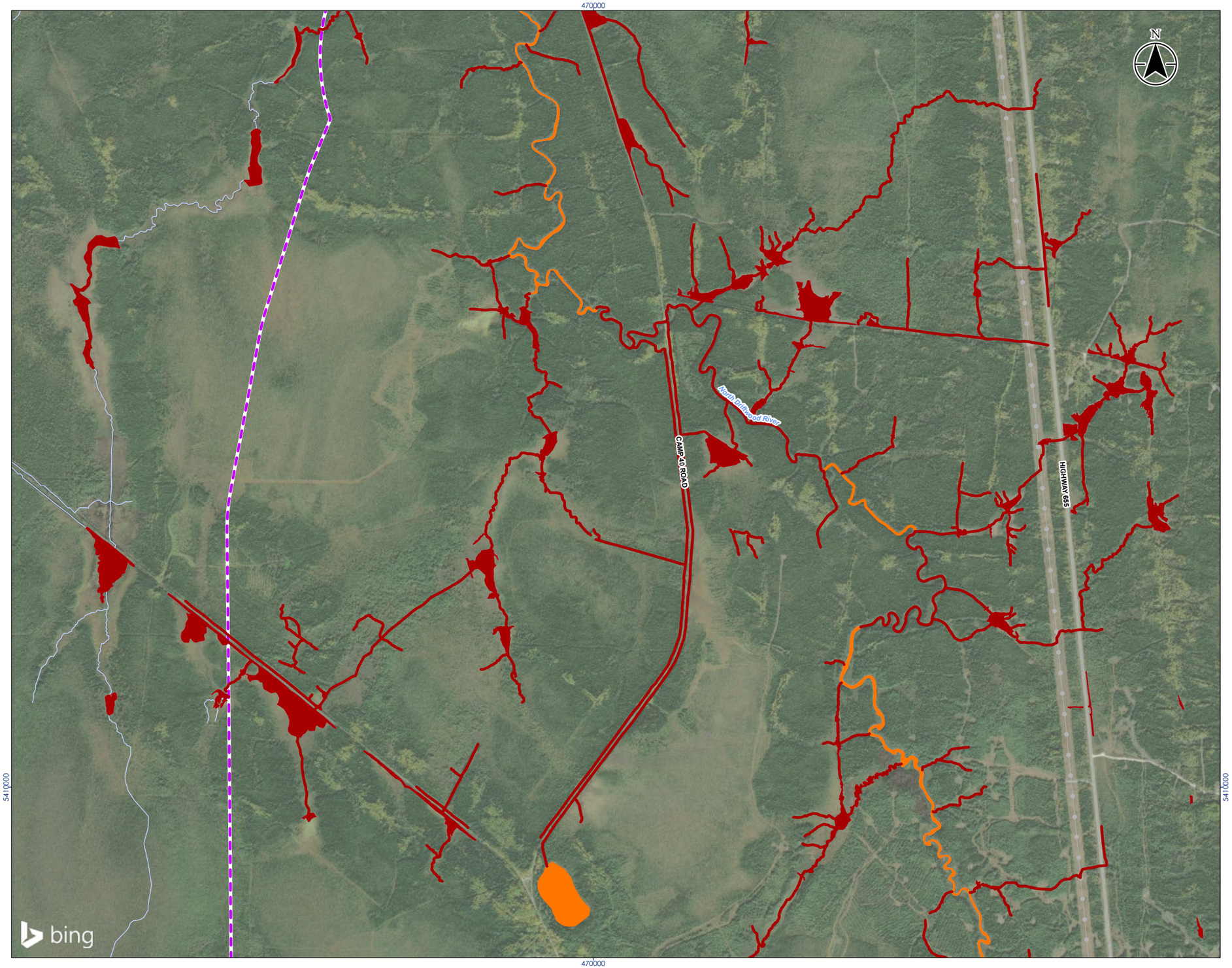
Revised: 2024-09-11 By: mpicarreta
J:\active\160\930\456\workfiles\MXD\160930456_Fish_Fish_Habitat_Walleye_Spawning.mxd



Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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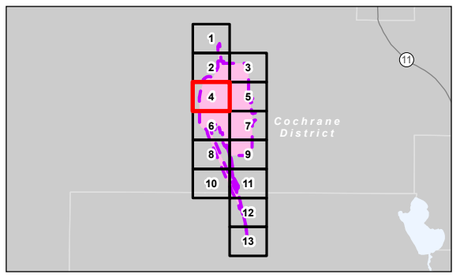

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.4

Title
Walleye Spawning/Rearing Habitat

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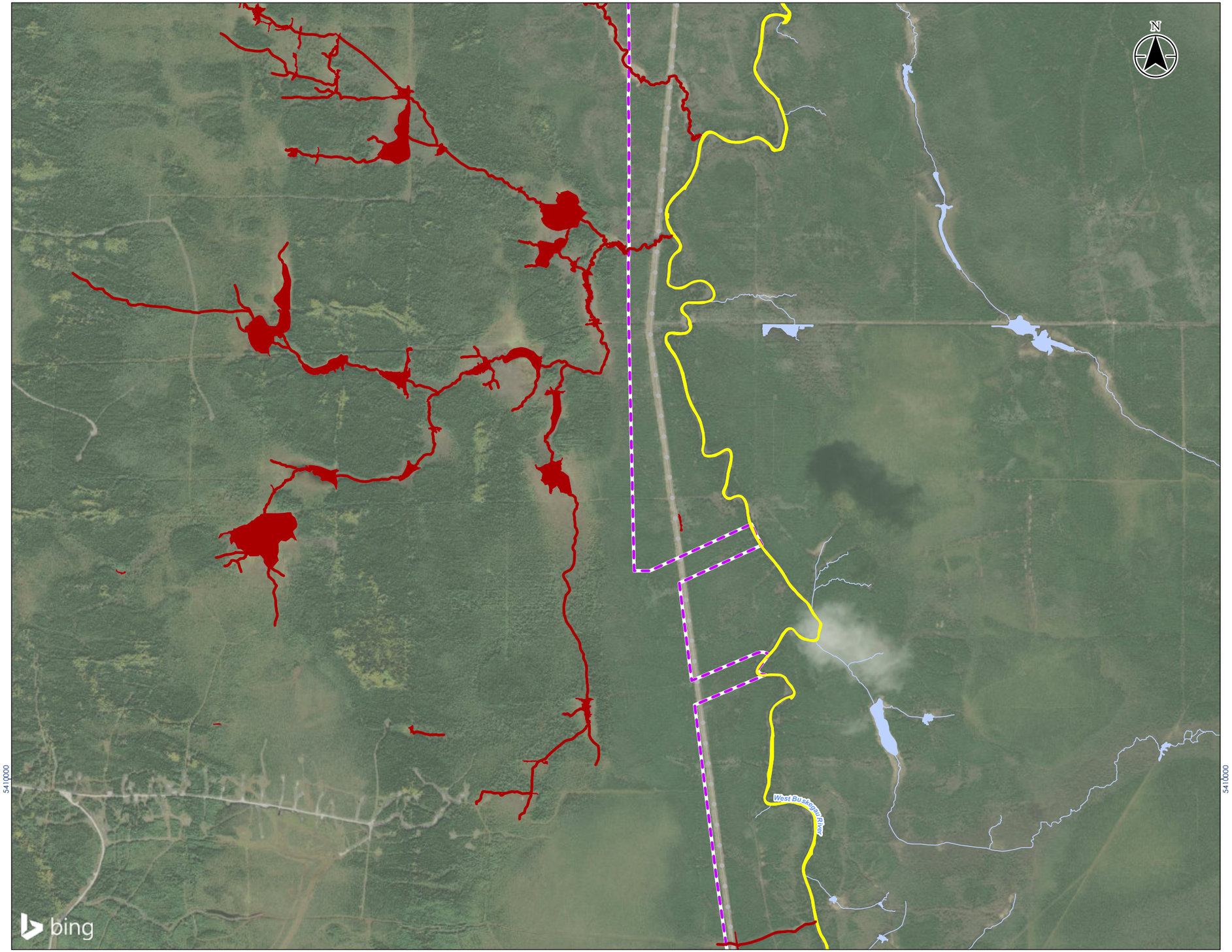

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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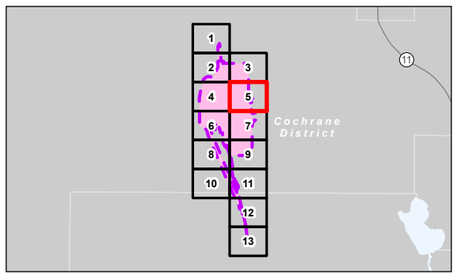

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.5

Title
Walleye Spawning/Rearing Habitat

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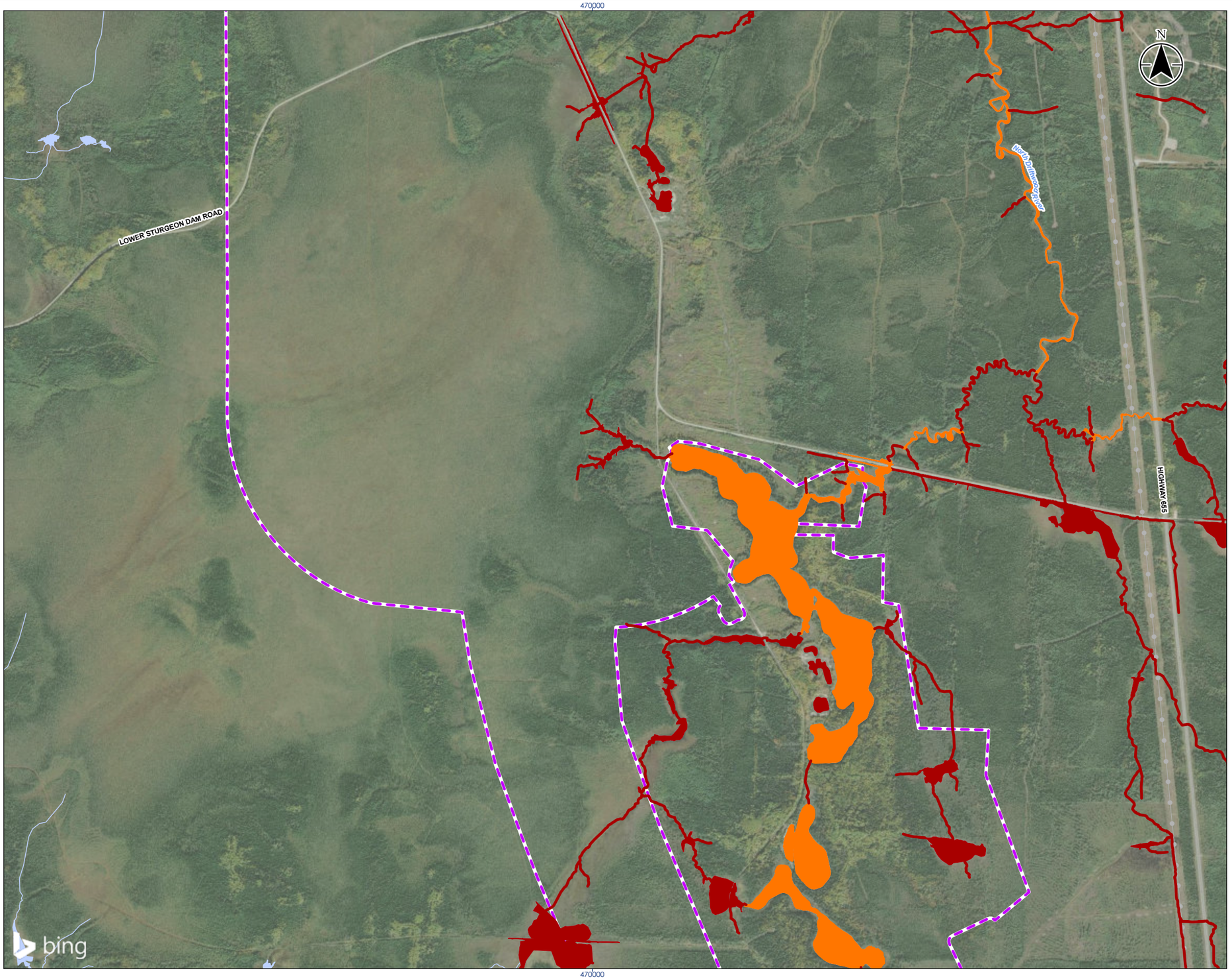

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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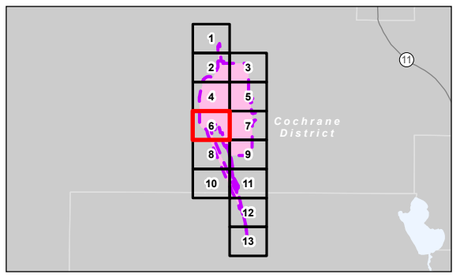

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.6

Title
Walleye Spawning/Rearing Habitat

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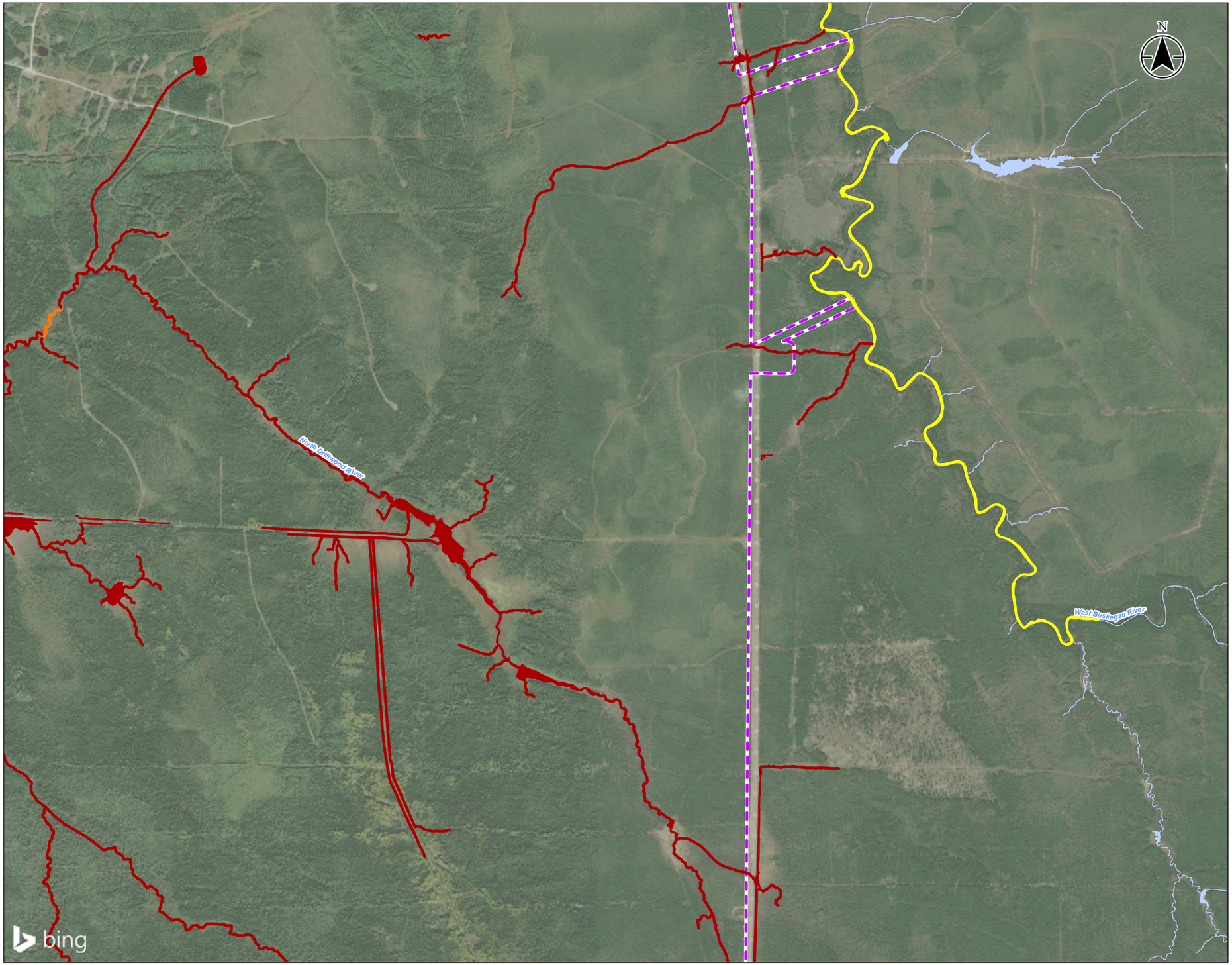

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes
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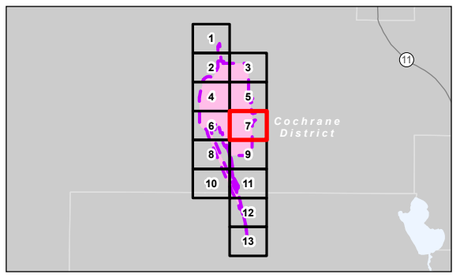

Project Location
Timmins, Ontario

160930456 REV6
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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.7

Title
Walleye Spawning/Rearing Habitat

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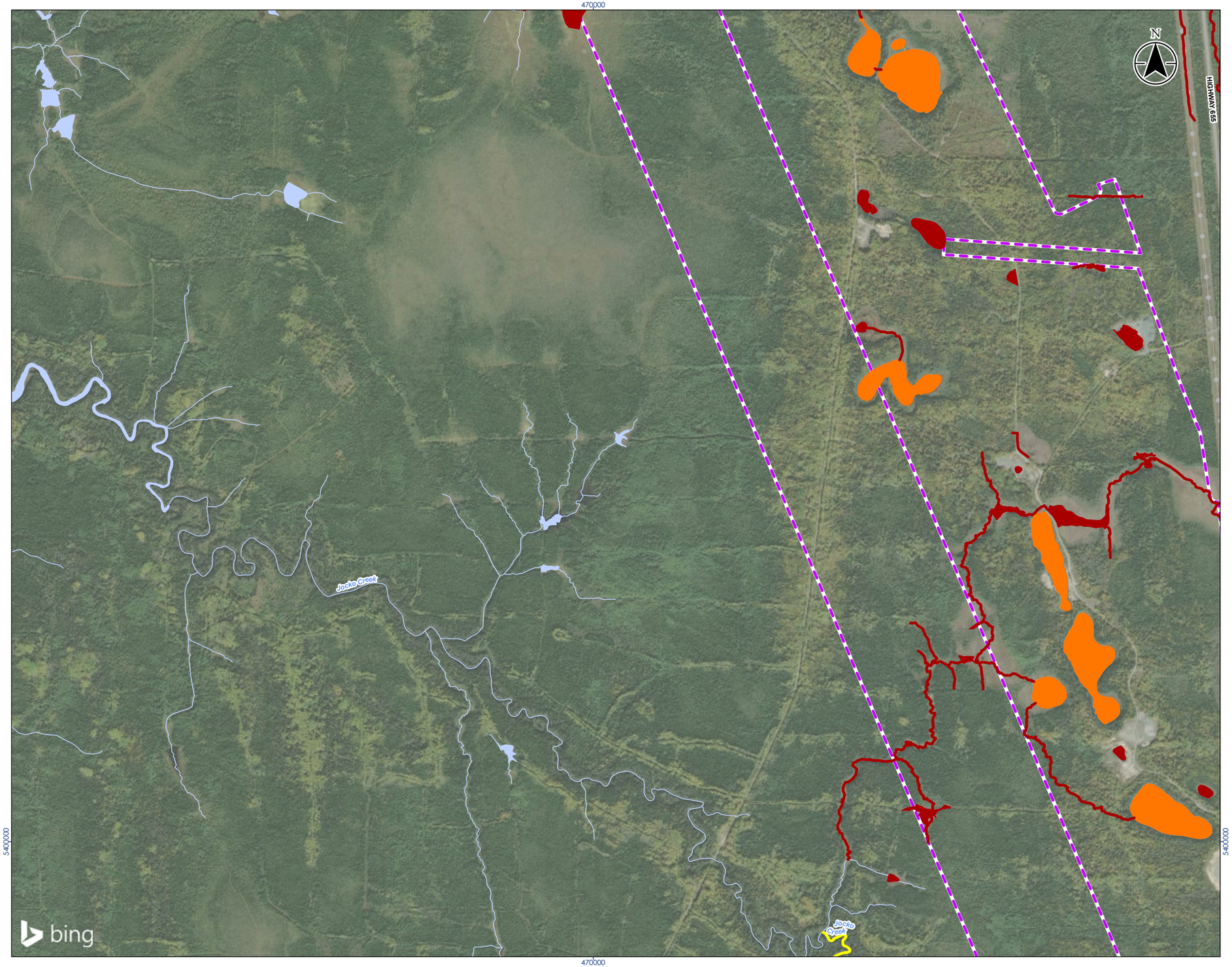

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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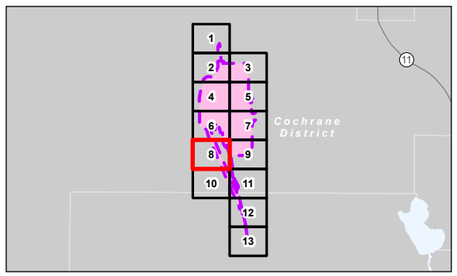

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.8

Title
Walleye Spawning/Rearing Habitat

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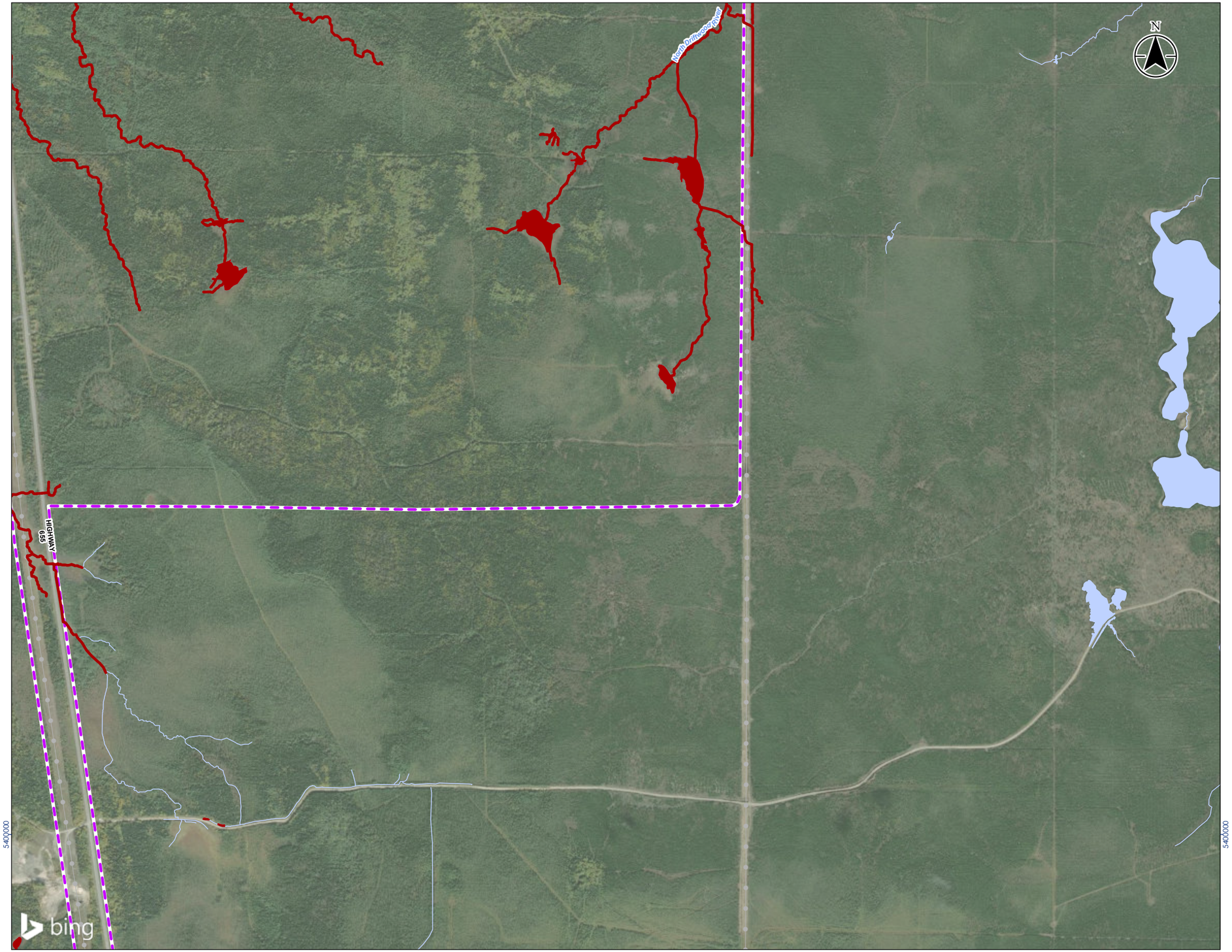

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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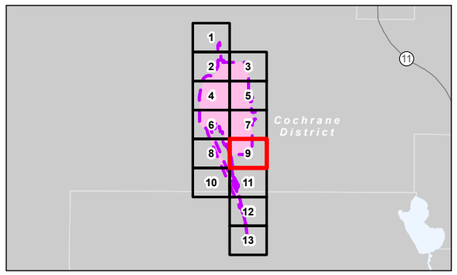

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.9

Title
Walleye Spawning/Rearing Habitat

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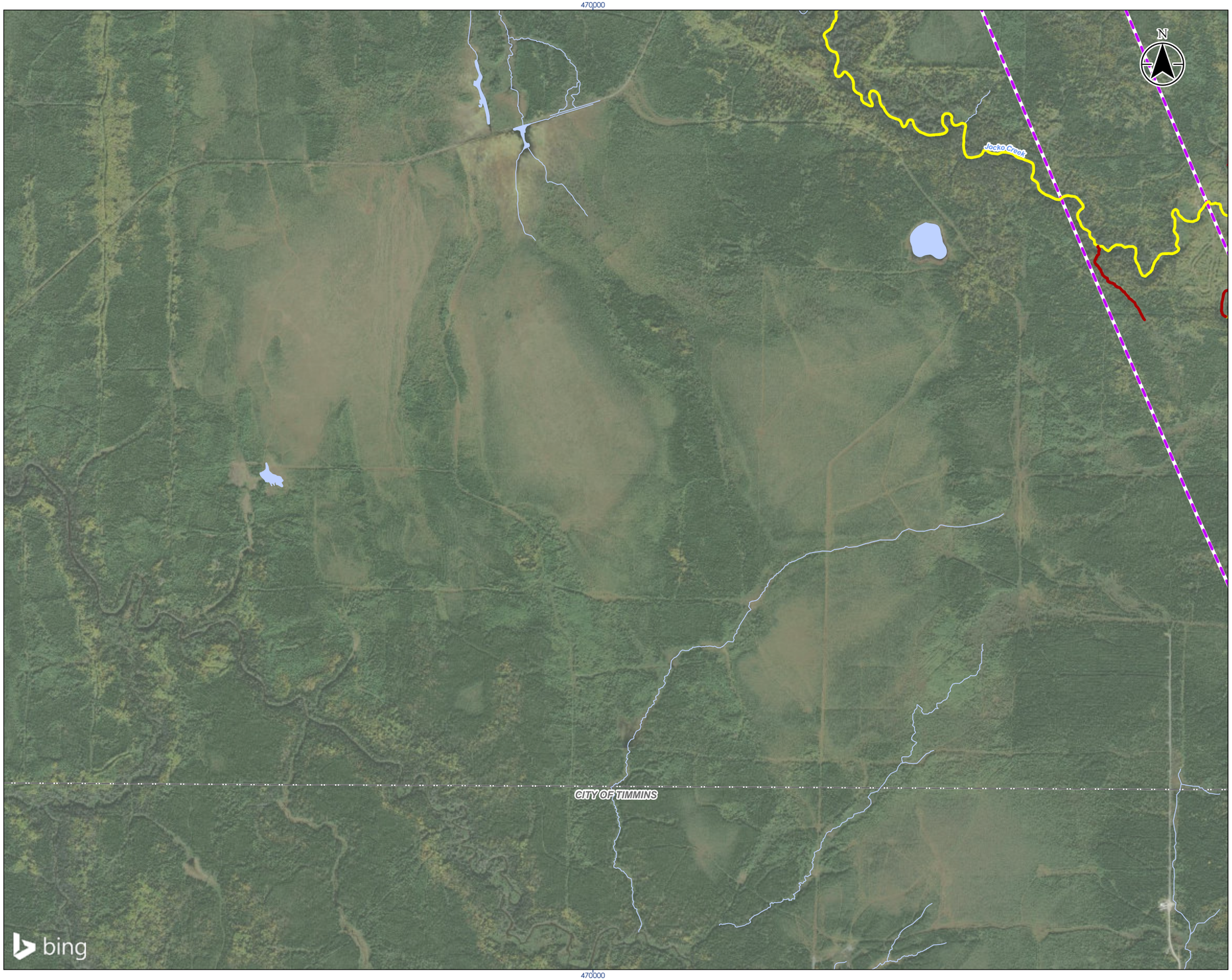

Stantec

Legend

Assessment Area Type
- Project Area
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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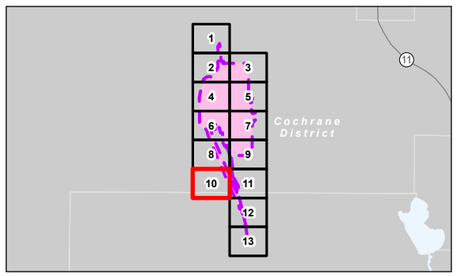

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.10

Title
Walleye Spawning/Rearing Habitat

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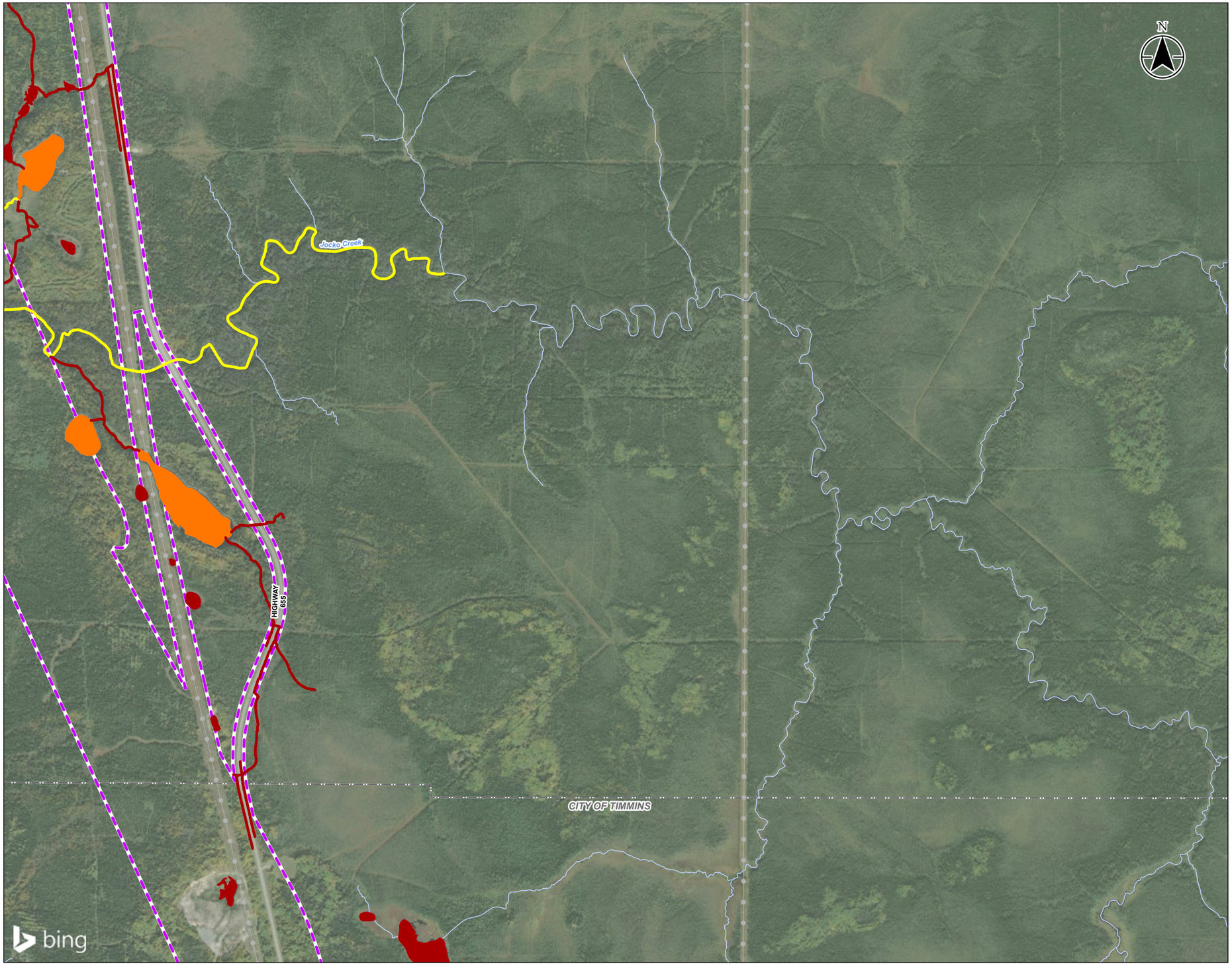

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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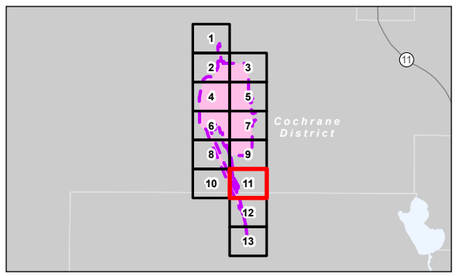

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.11

Title
Walleye Spawning/Rearing Habitat

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Revised: 2024-09-11 By: mpicarreta
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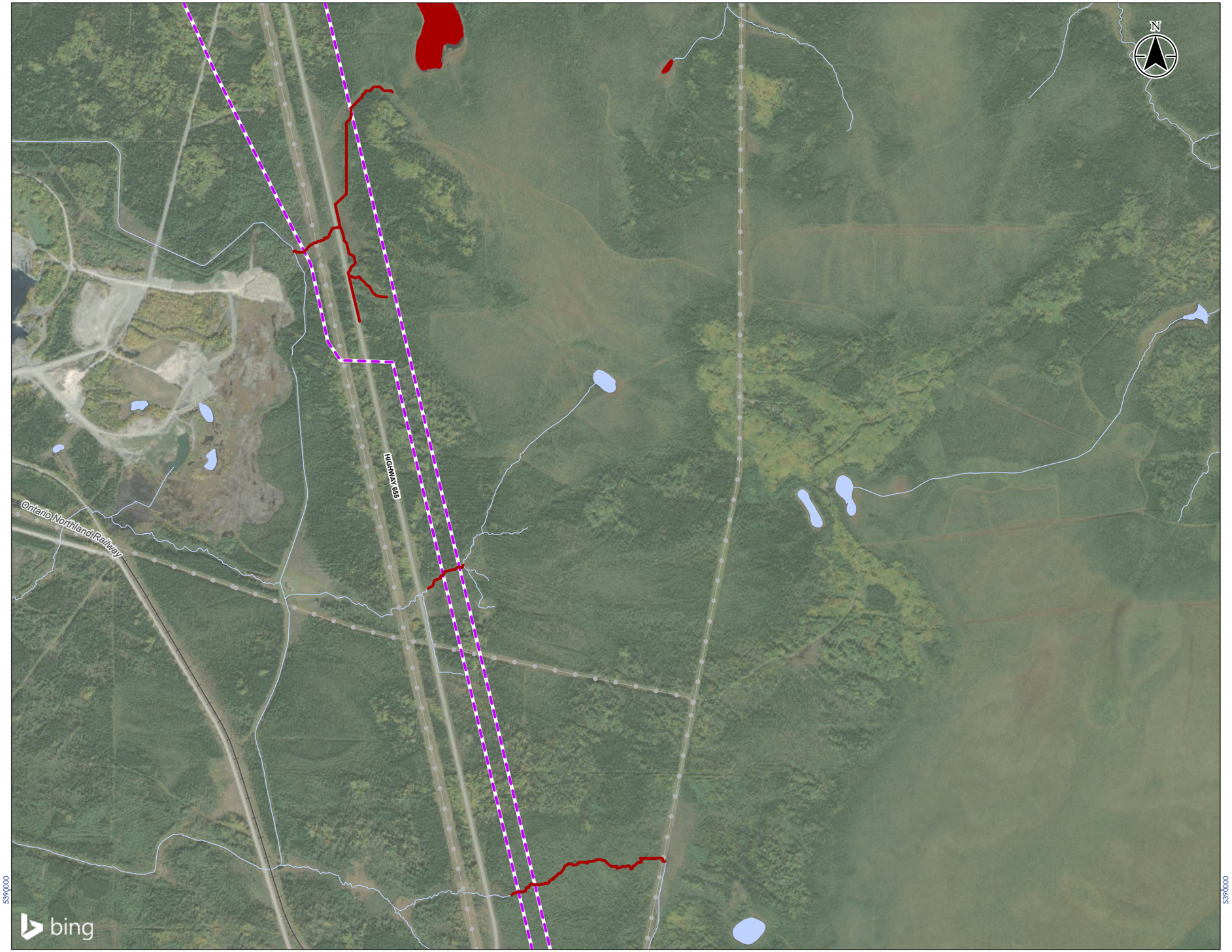

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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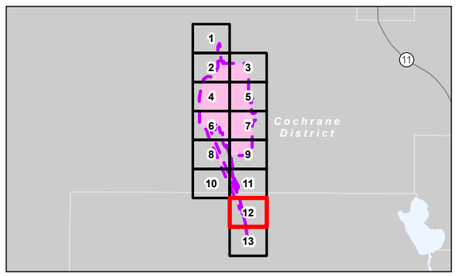

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.12

Title
Walleye Spawning/Rearing Habitat

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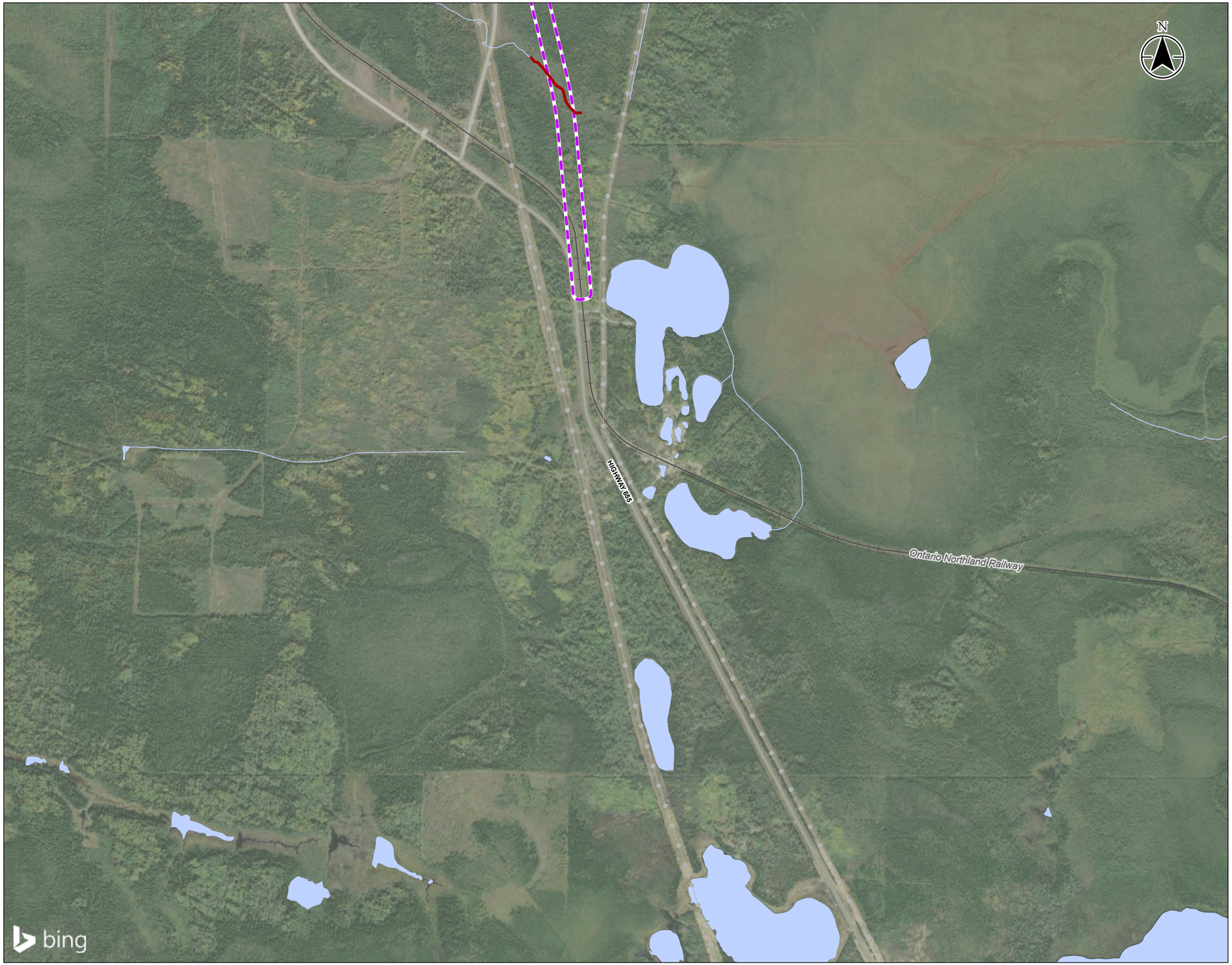

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Spawning/Rearing Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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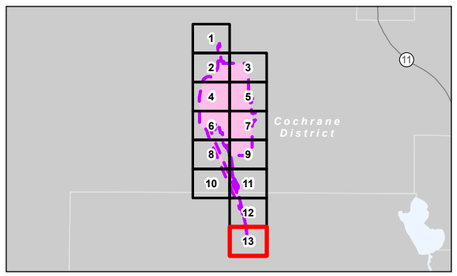

Project Location
Timmins, Ontario

160930456 REV6
Prepared by MDA on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.9.13

Title
Walleye Spawning/Rearing Habitat

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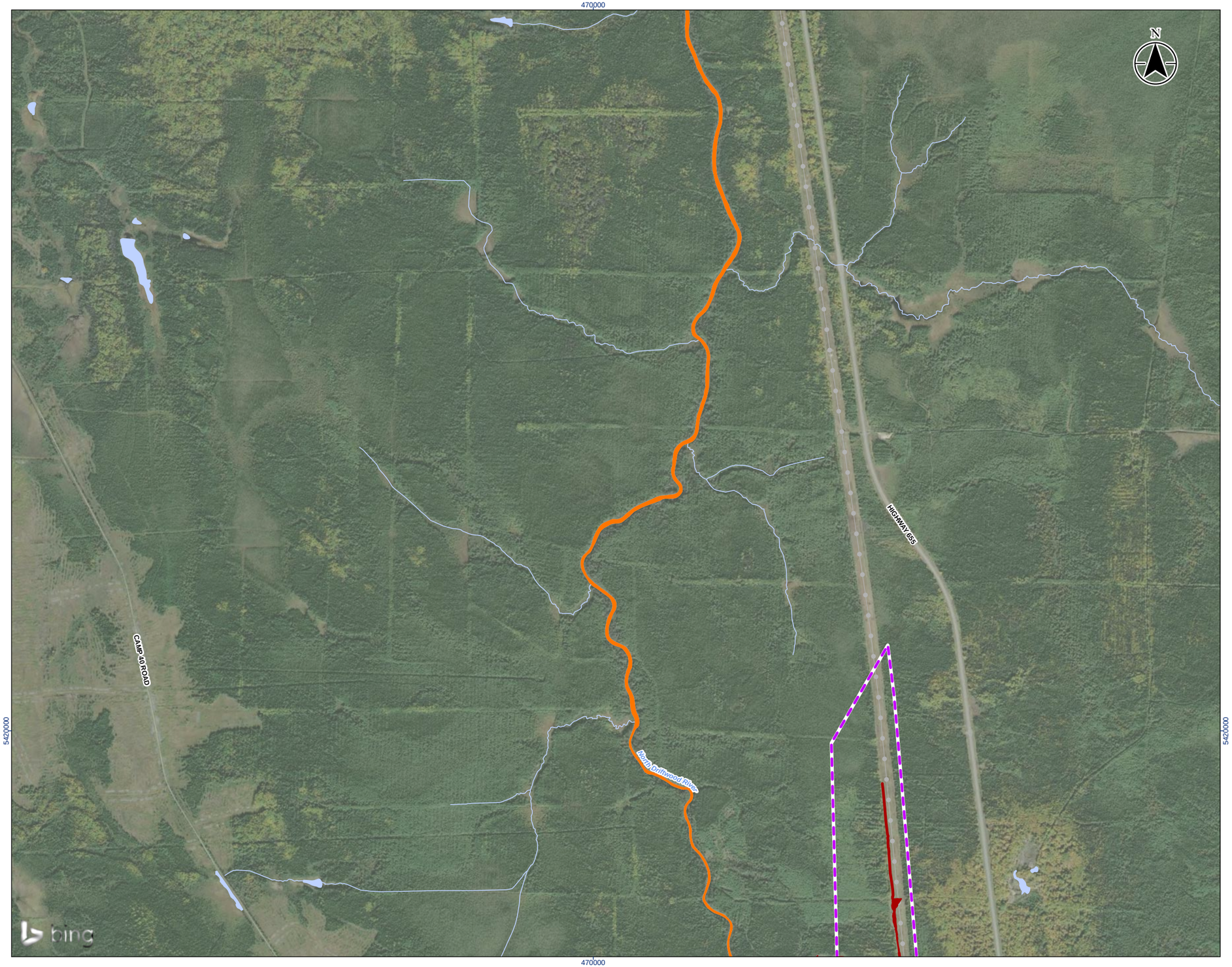

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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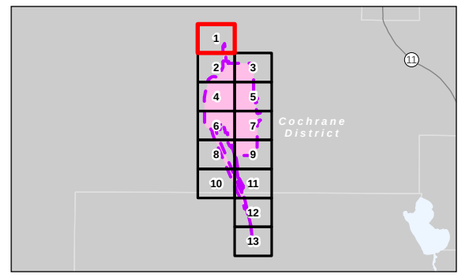

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.1

Title
Walleye Overwintering Habitat

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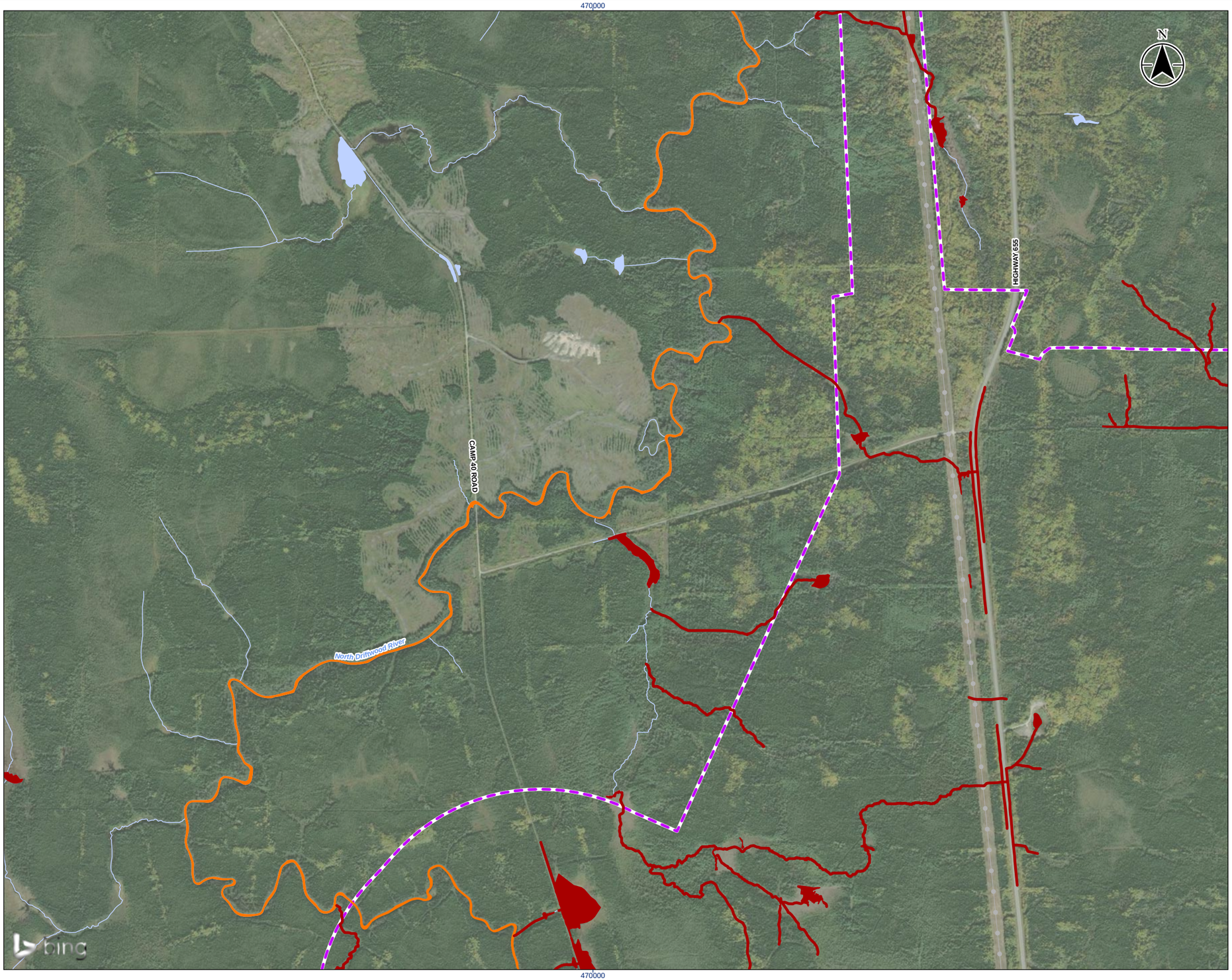

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes
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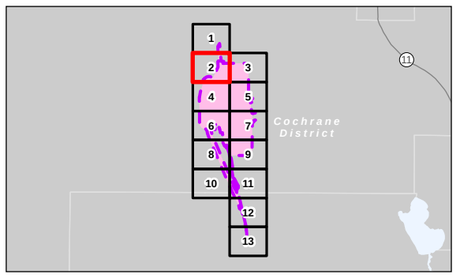

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.2

Title
Walleye Overwintering Habitat

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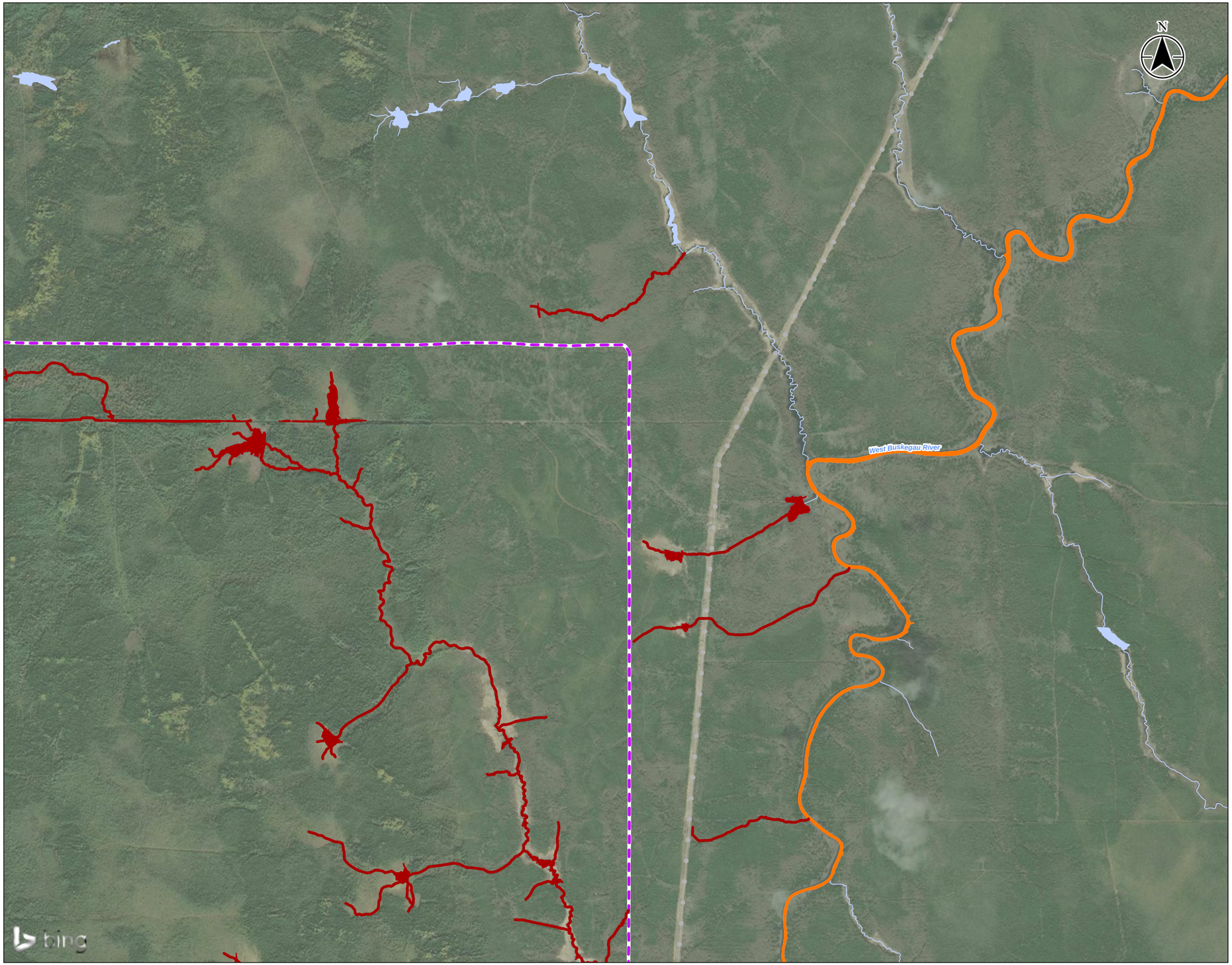

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes
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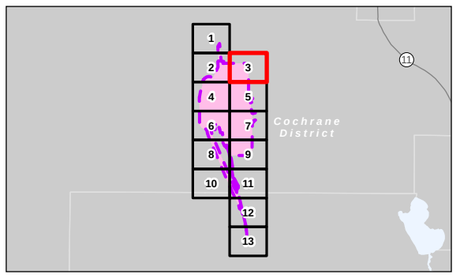

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.3

Title
Walleye Overwintering Habitat

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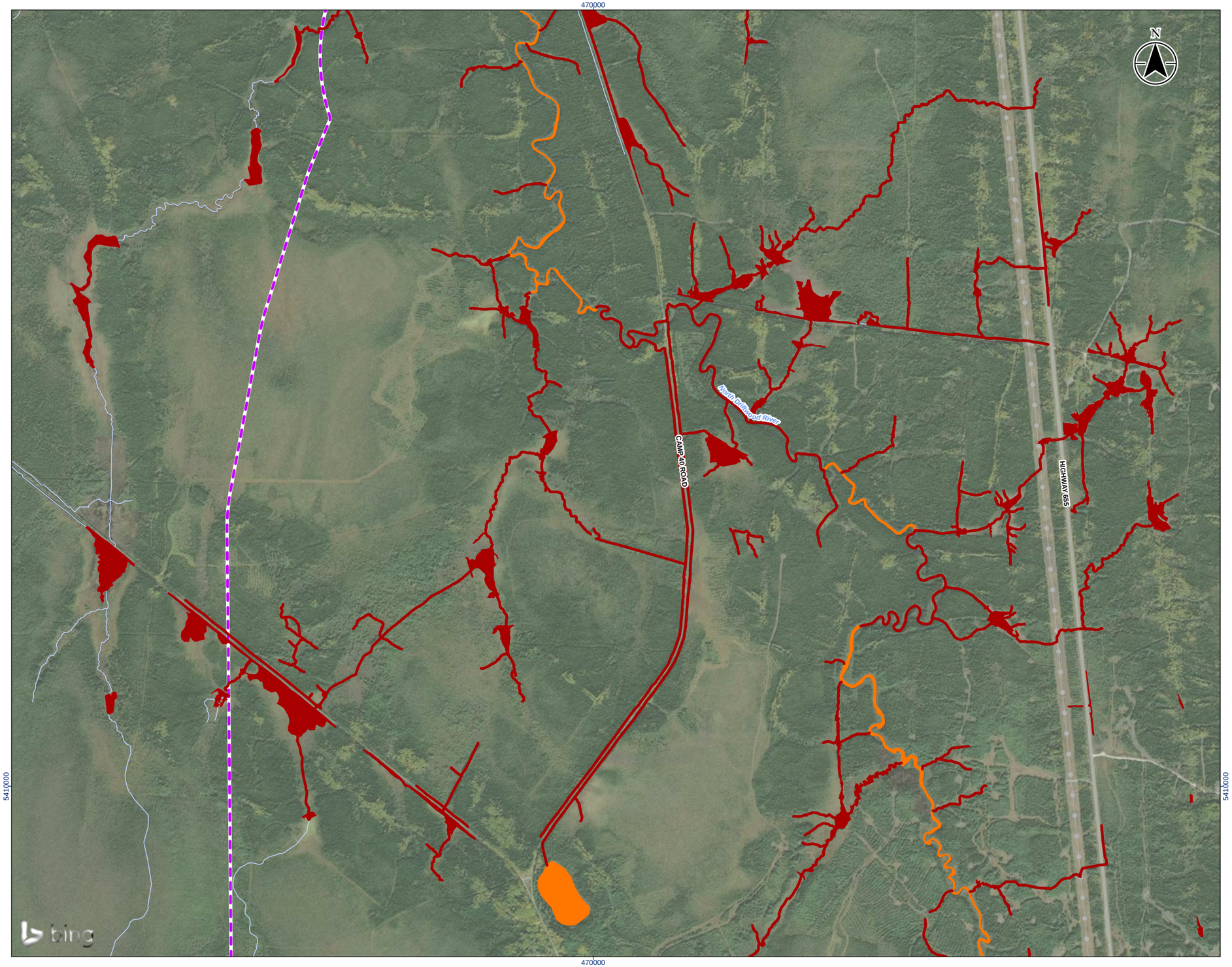

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes
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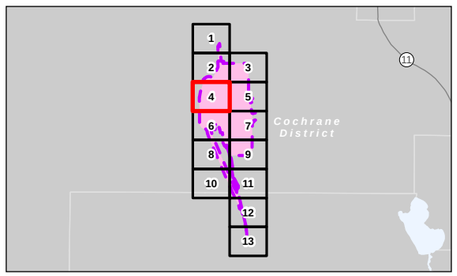

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.4

Title
Walleye Overwintering Habitat

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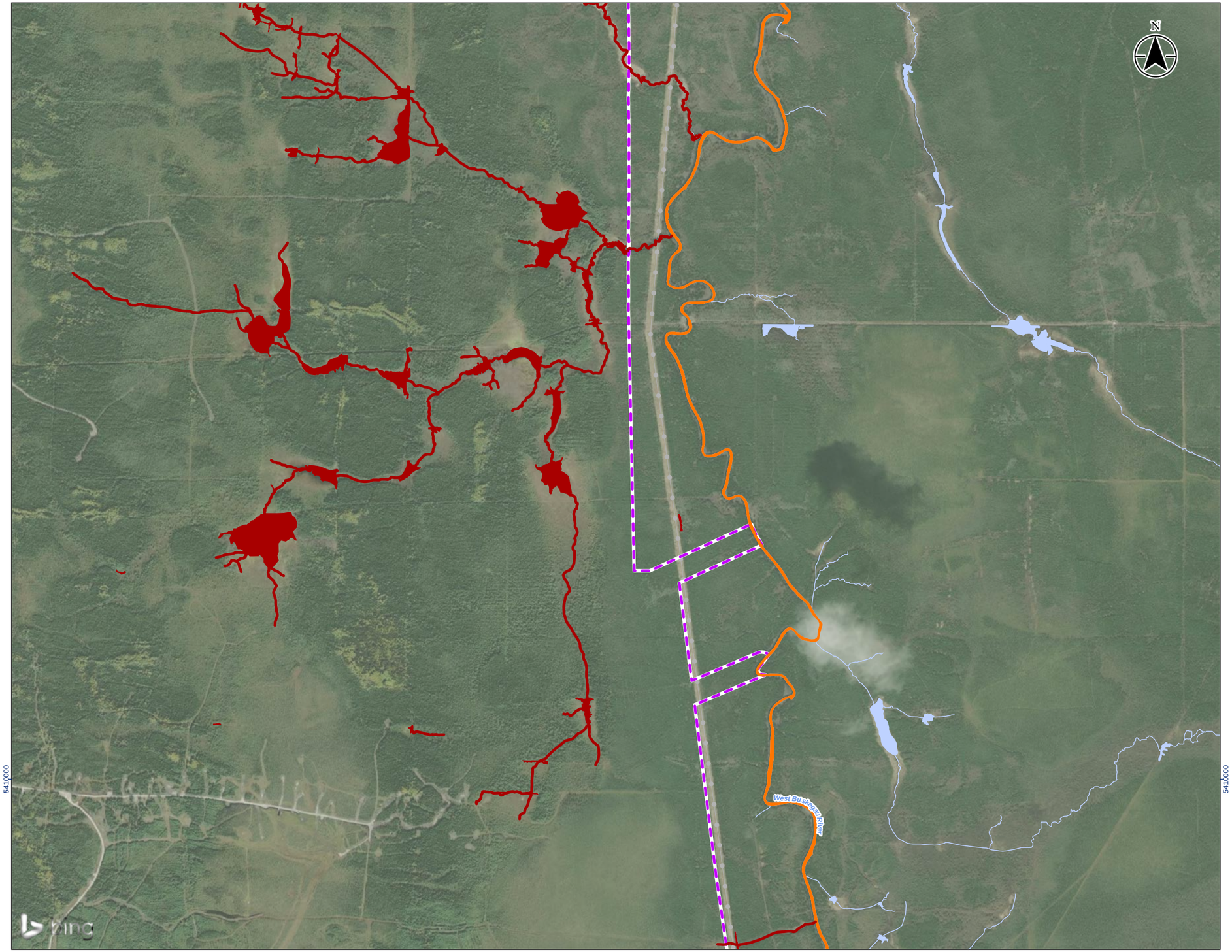

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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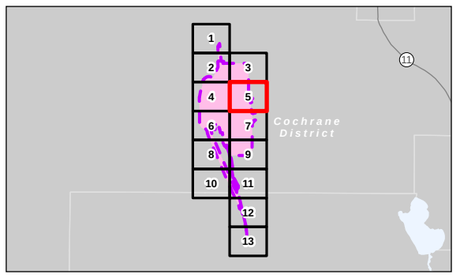

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.5

Title
Walleye Overwintering Habitat

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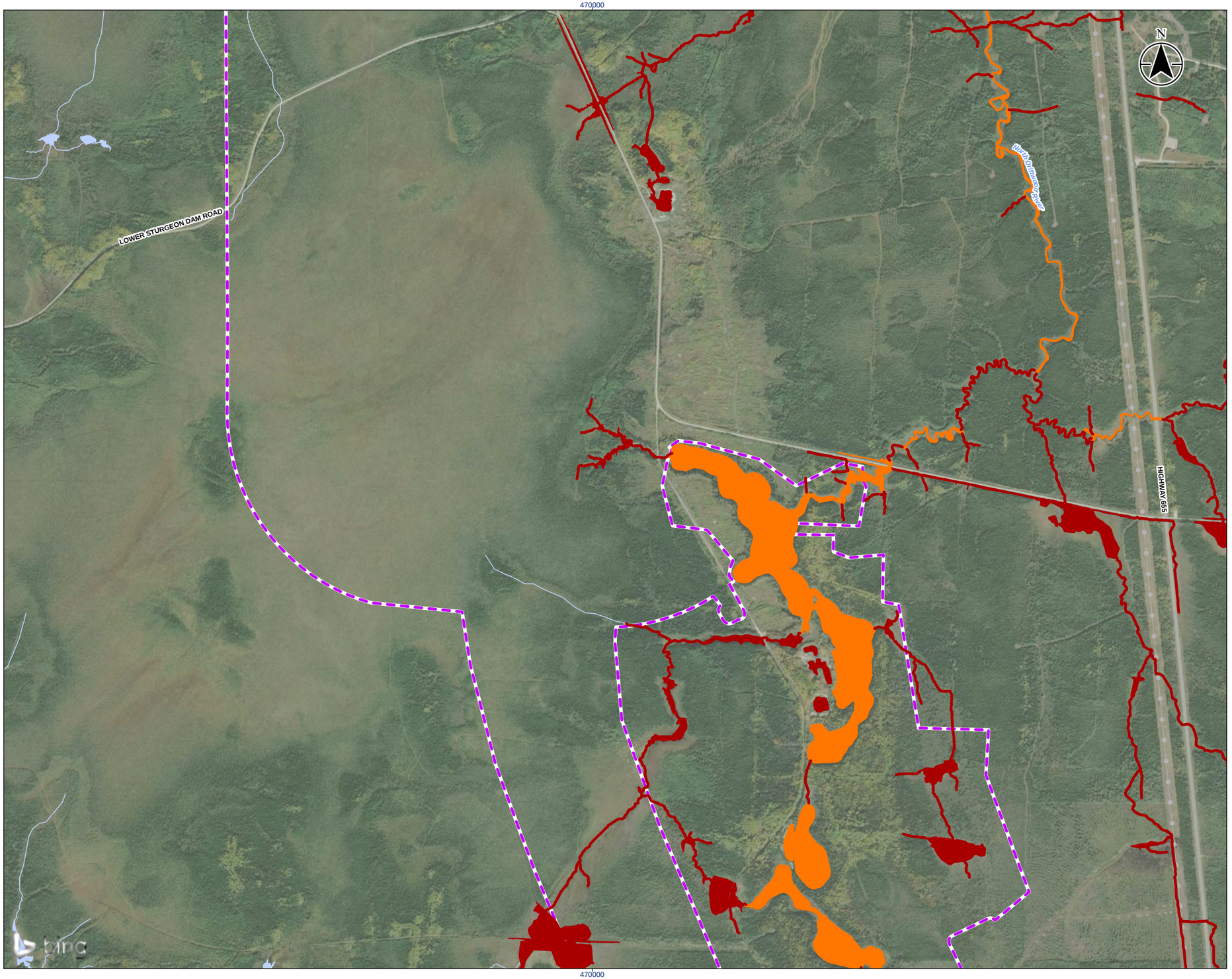

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes
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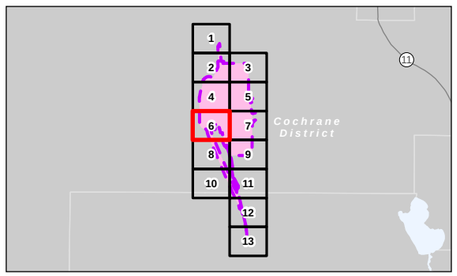

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.6

Title
Walleye Overwintering Habitat

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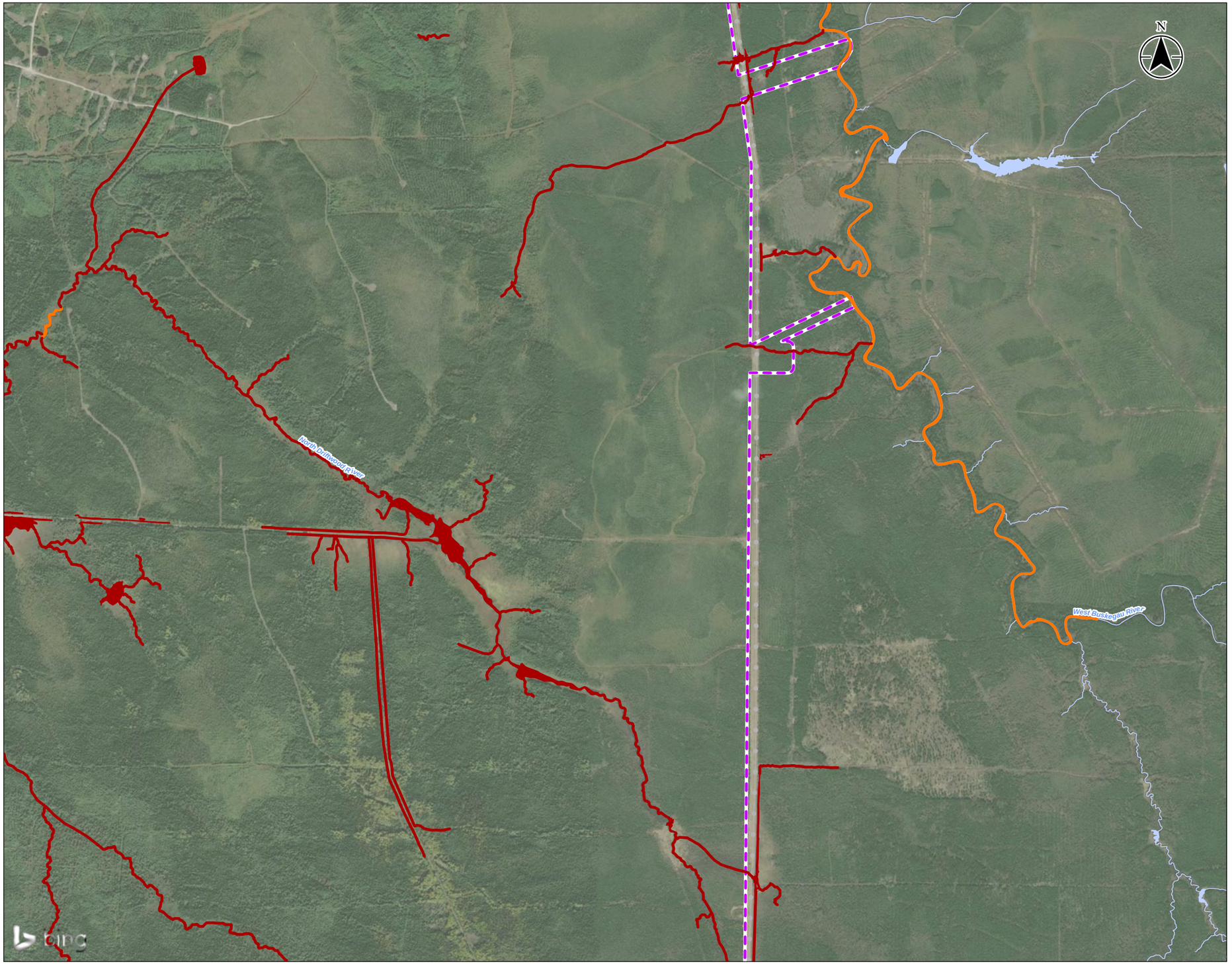

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes
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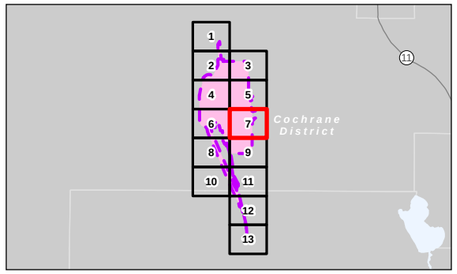

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.7

Title
Walleye Overwintering Habitat

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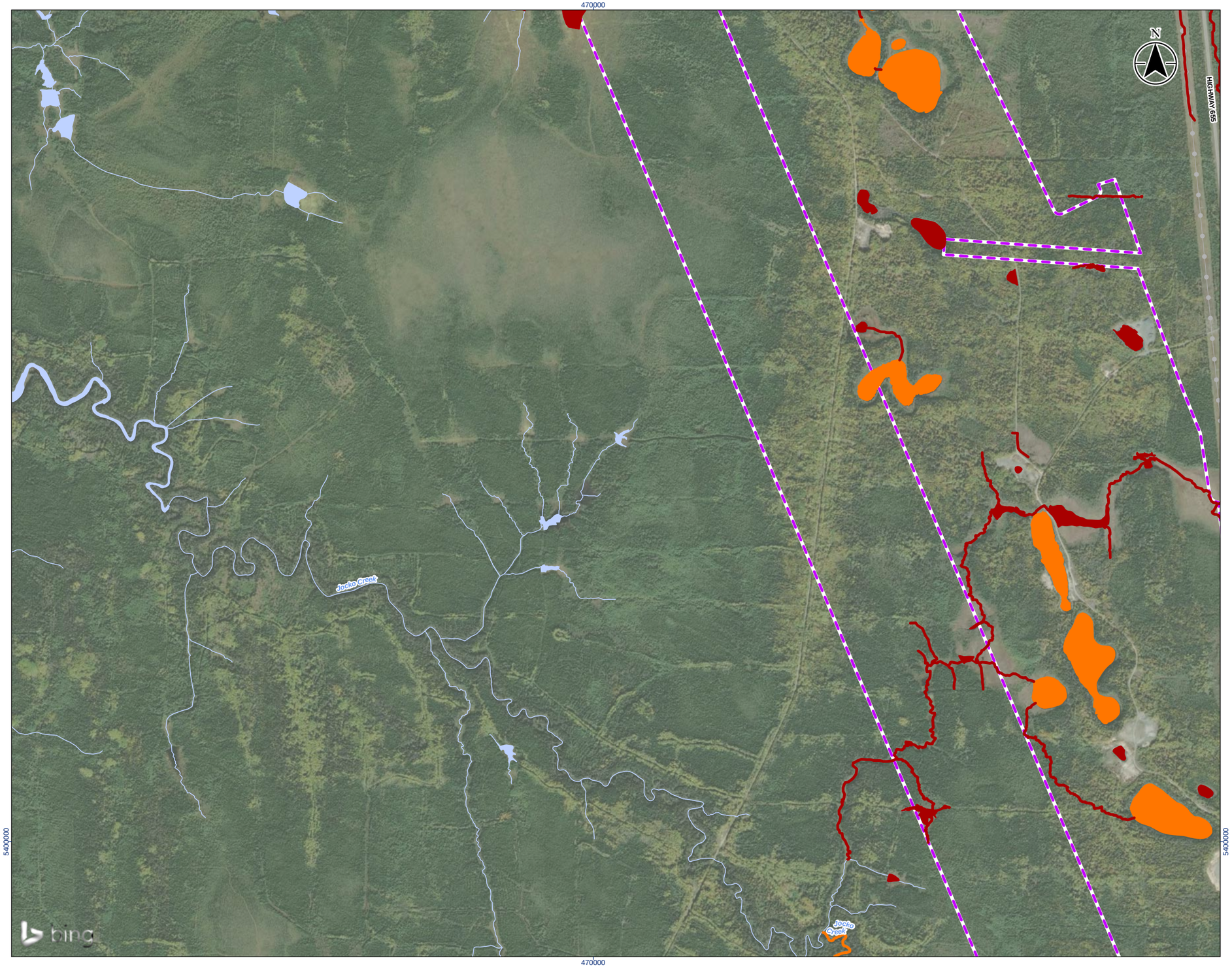

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes
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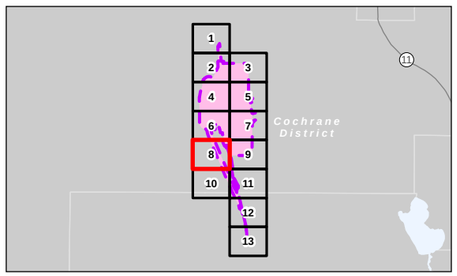

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.8

Title
Walleye Overwintering Habitat

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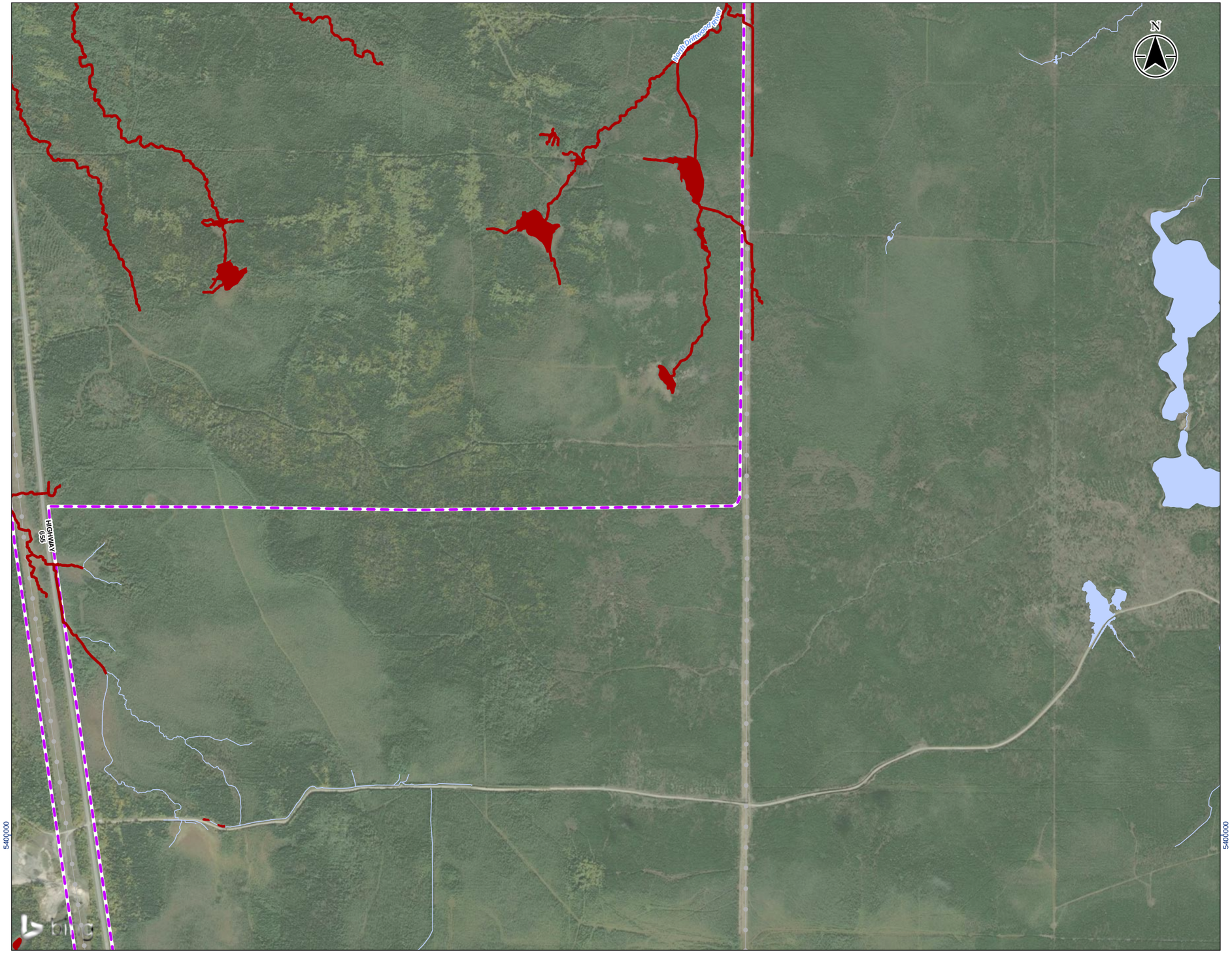

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes
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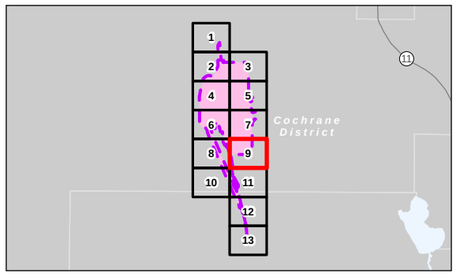

Project Location
Timmins, Ontario

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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.9

Title
Walleye Overwintering Habitat

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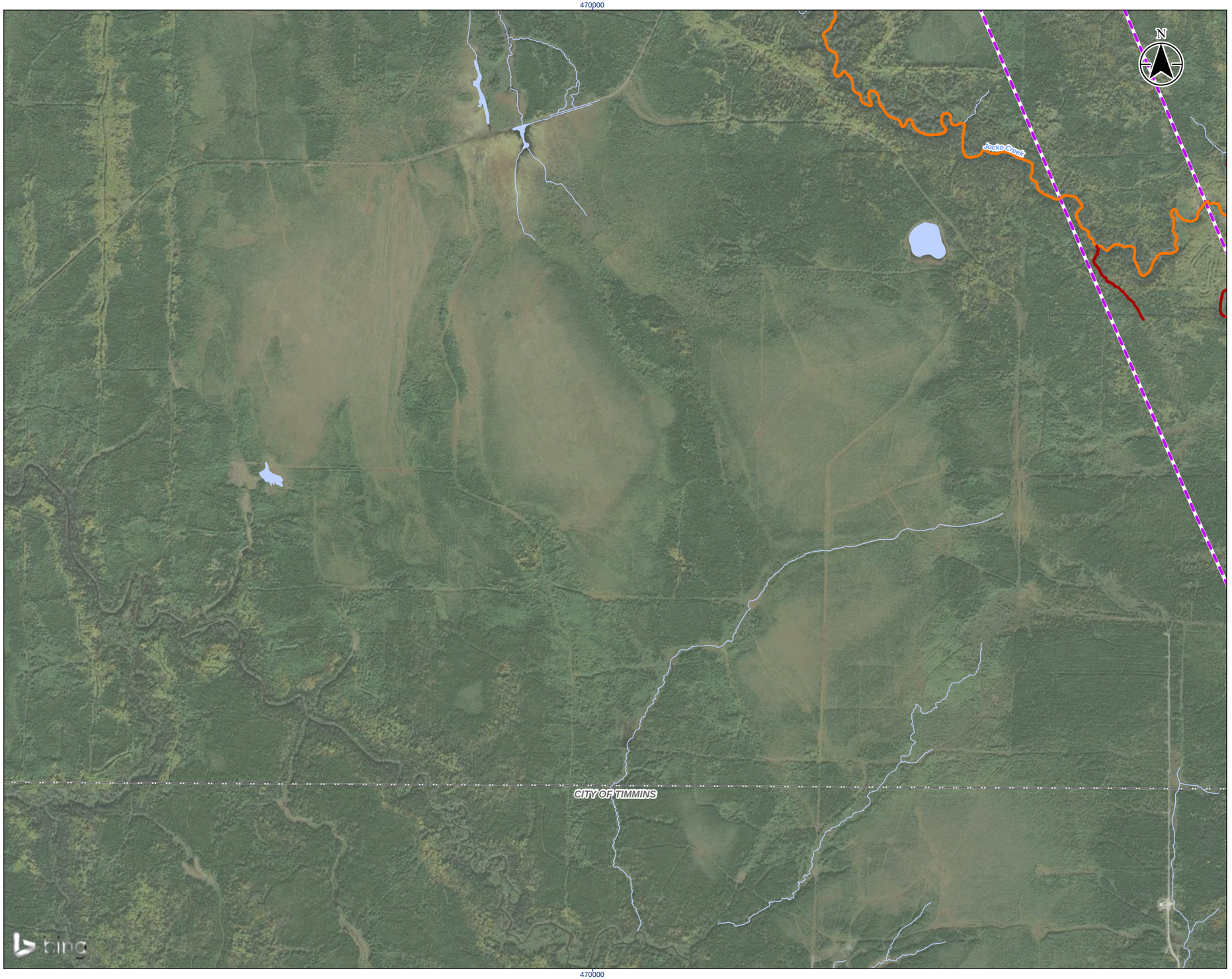

Stantec

Legend

Assessment Area Type
- Project Area
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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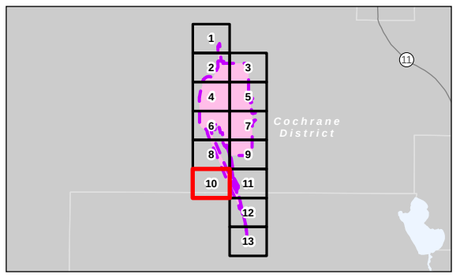

Project Location
Timmins, Ontario

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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.10

Title
Walleye Overwintering Habitat

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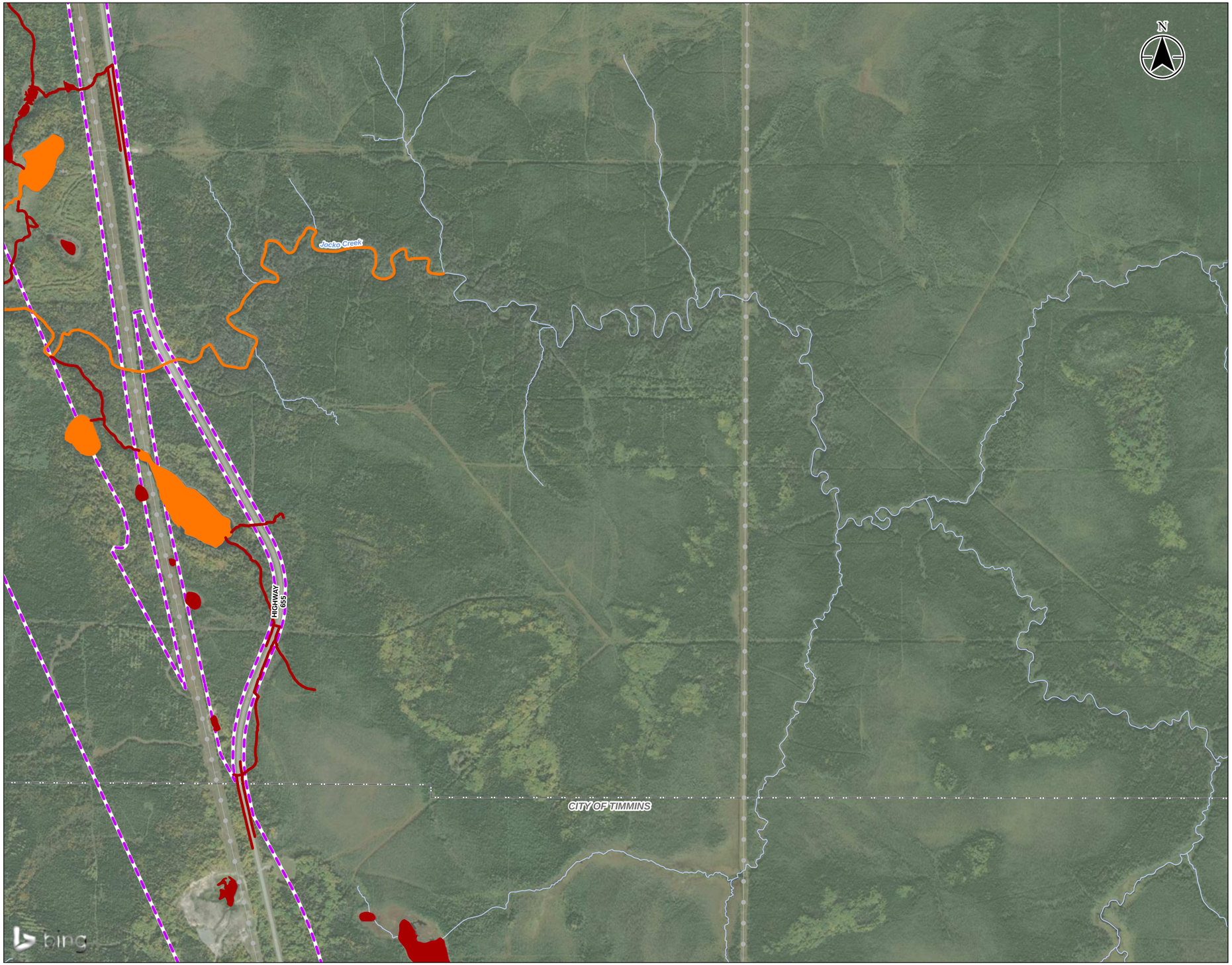

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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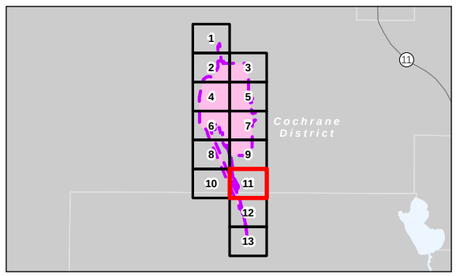

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.11

Title
Walleye Overwintering Habitat

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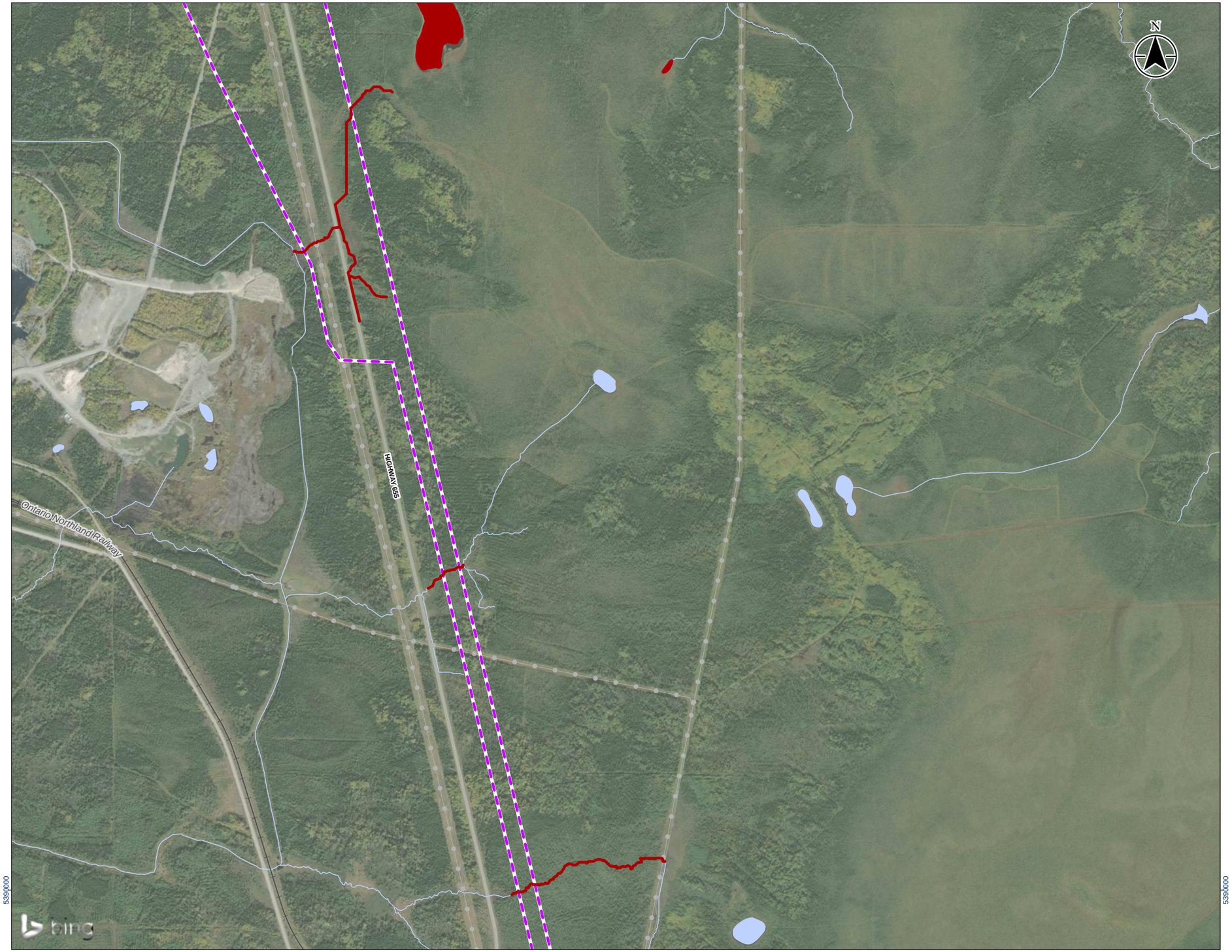

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes
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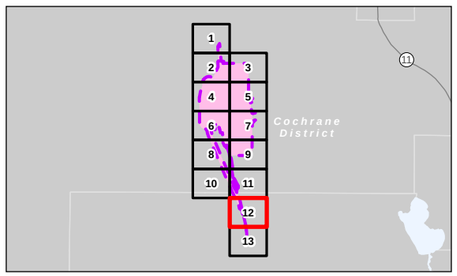

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.12

Title
Walleye Overwintering Habitat

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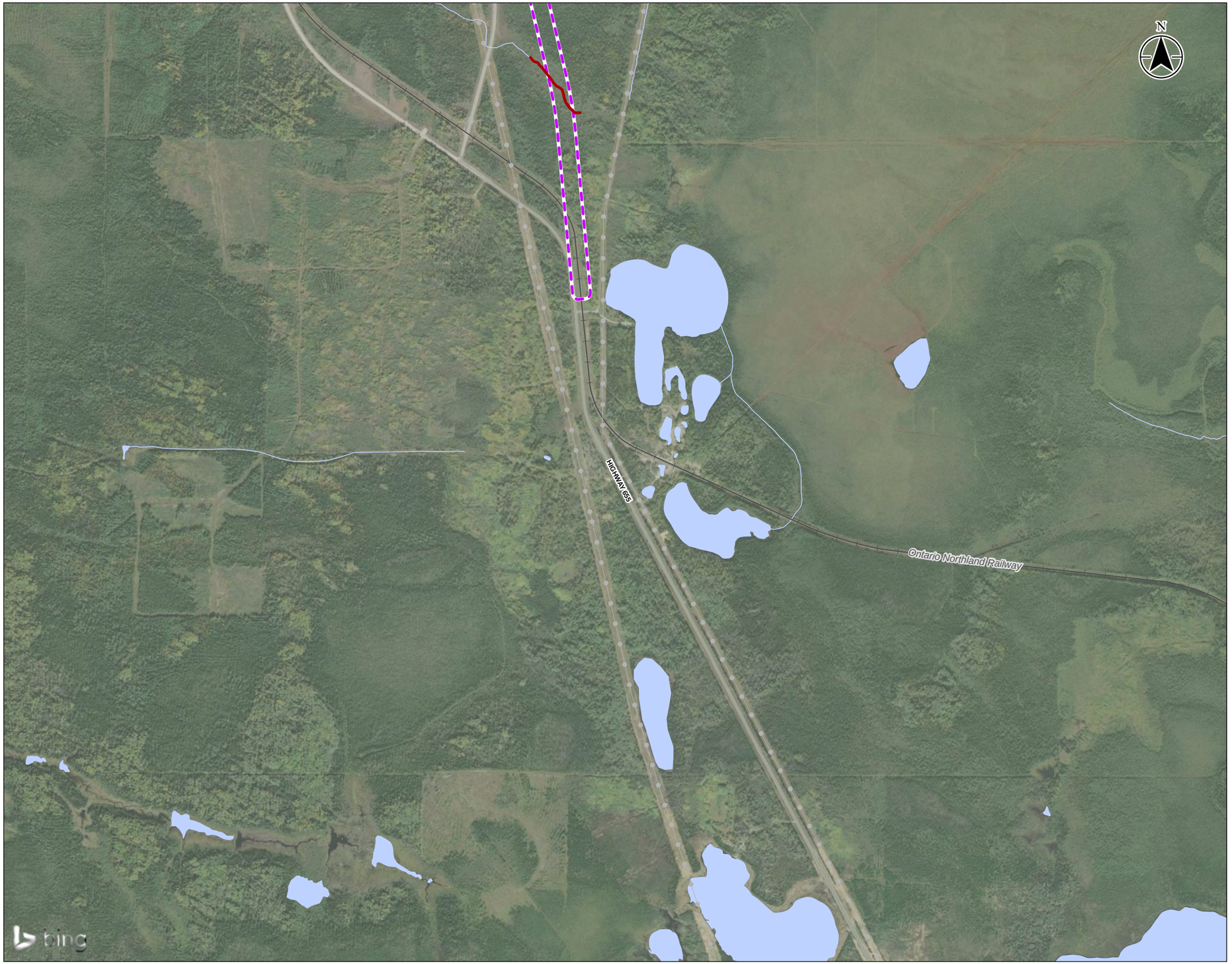

Stantec

Legend

Assessment Area Type
- Project Area

Base Features
- Existing Transmission Line
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Overwintering Habitat Suitability Category
- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes
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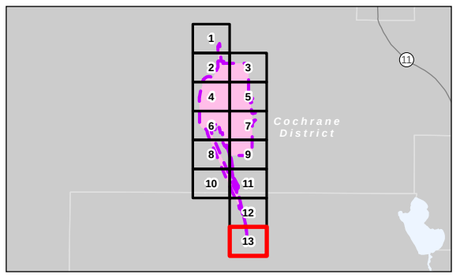

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.10.13

Title
Walleye Overwintering Habitat

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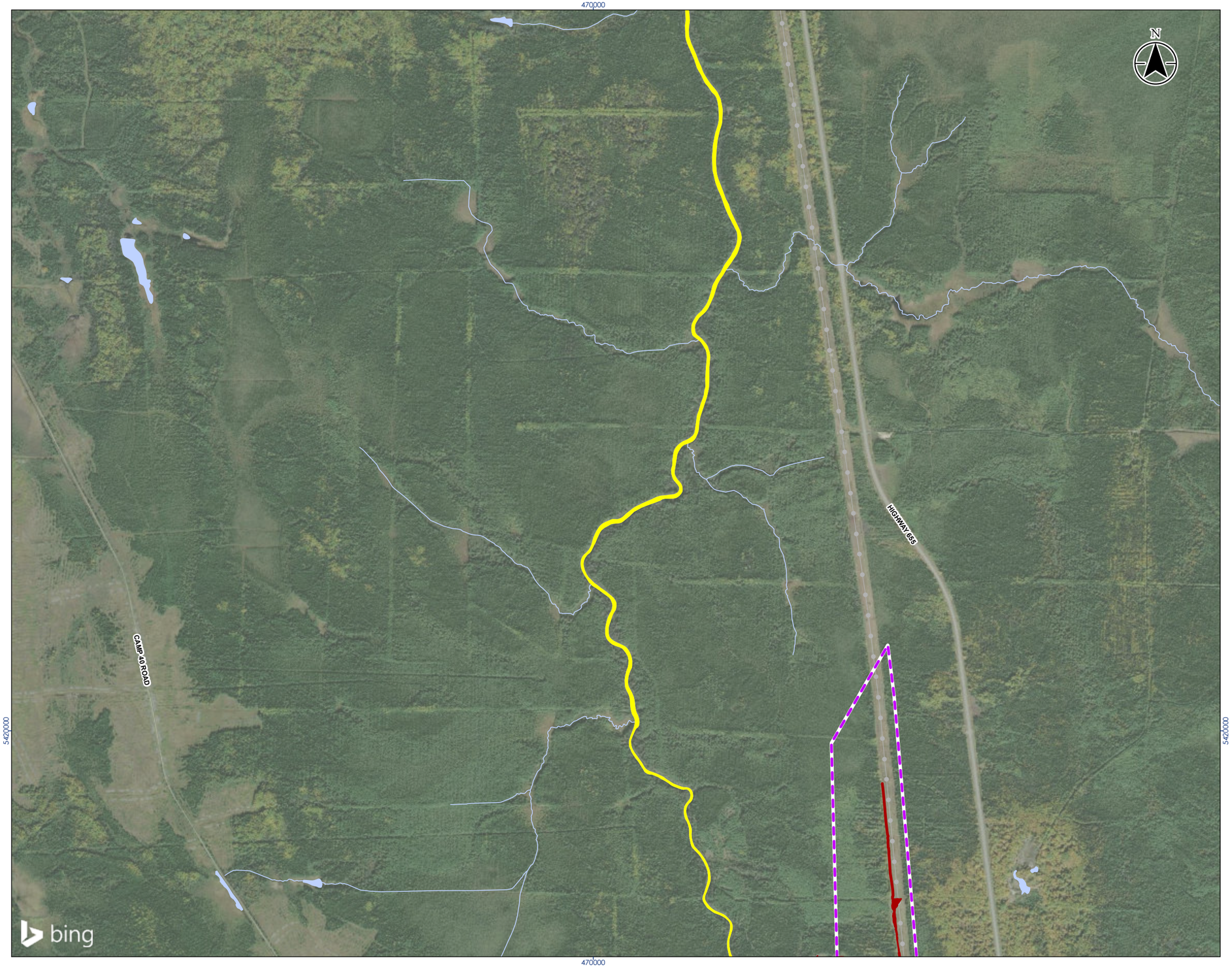

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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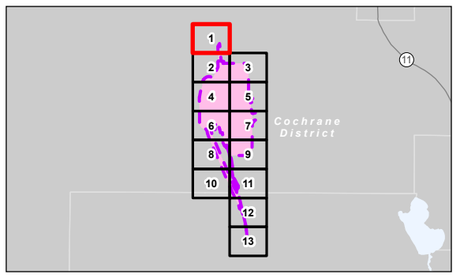

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.1

Title
Northern Pike Adult Habitat

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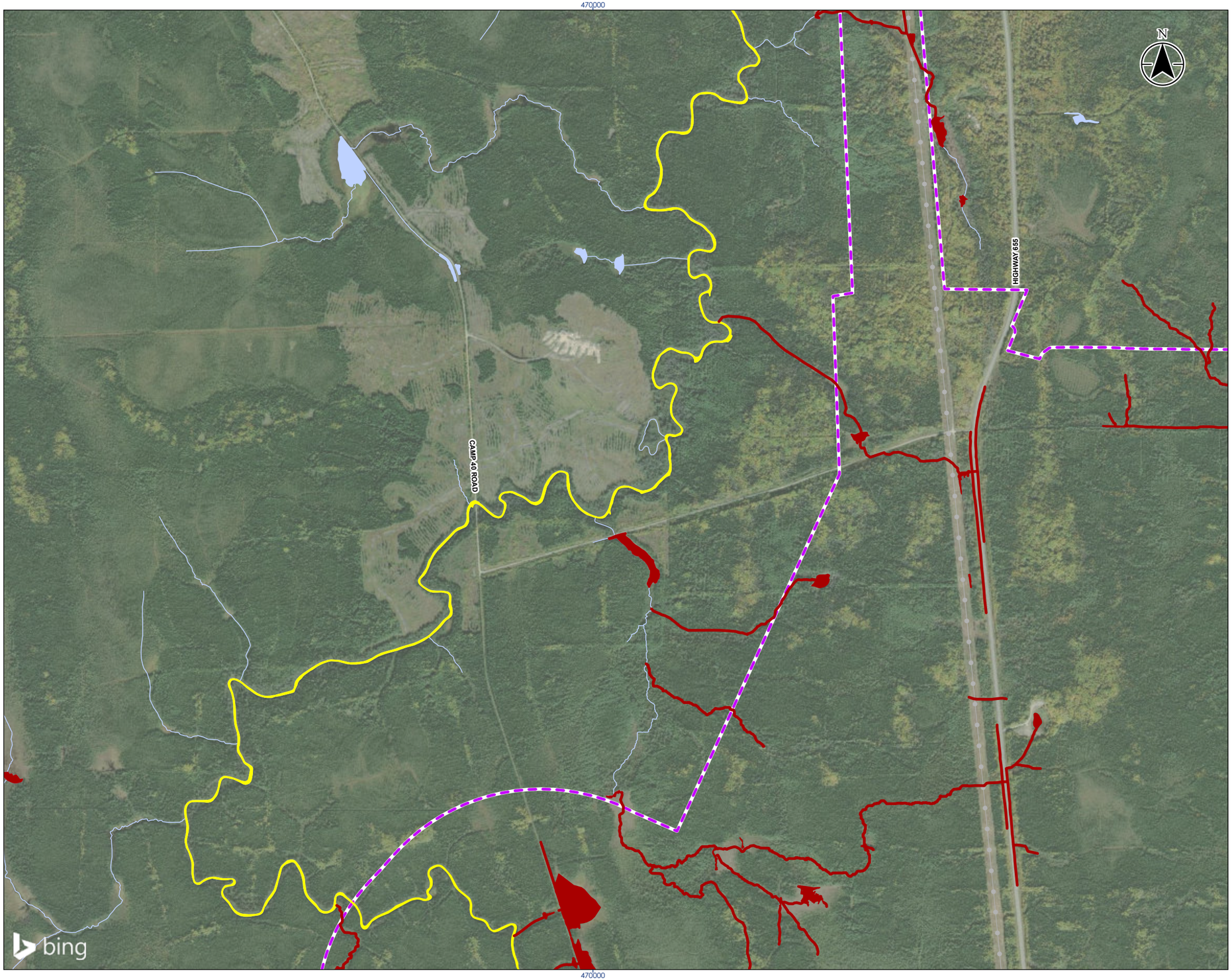

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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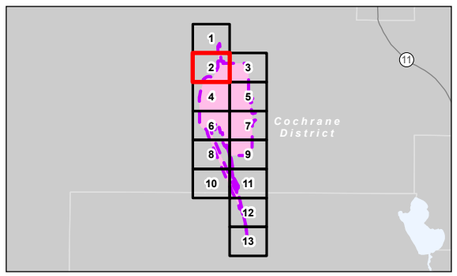

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.2

Title
Northern Pike Adult Habitat

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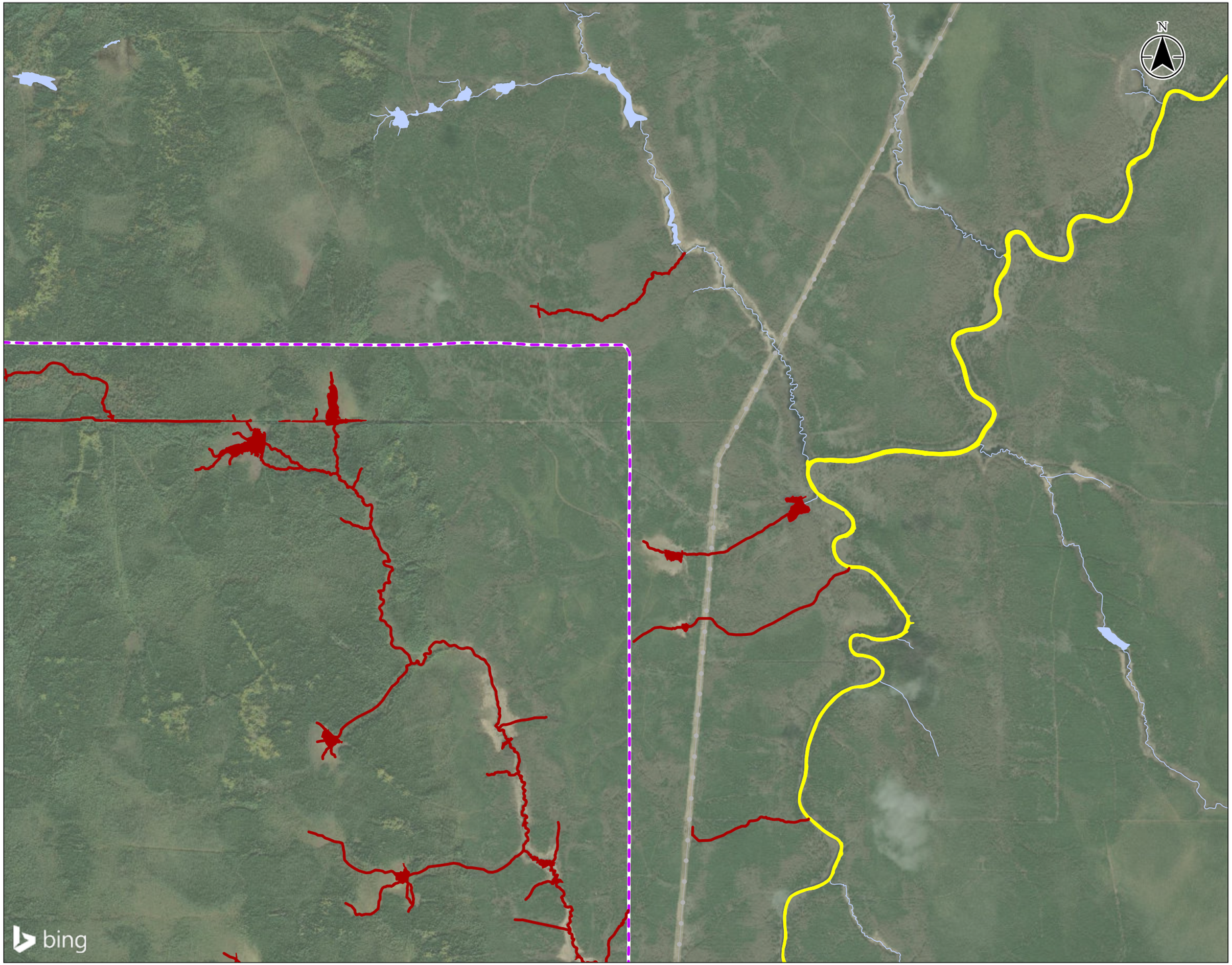

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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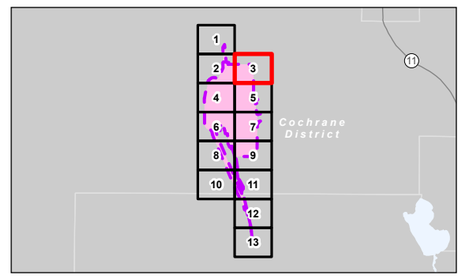

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.3

Title
Northern Pike Adult Habitat

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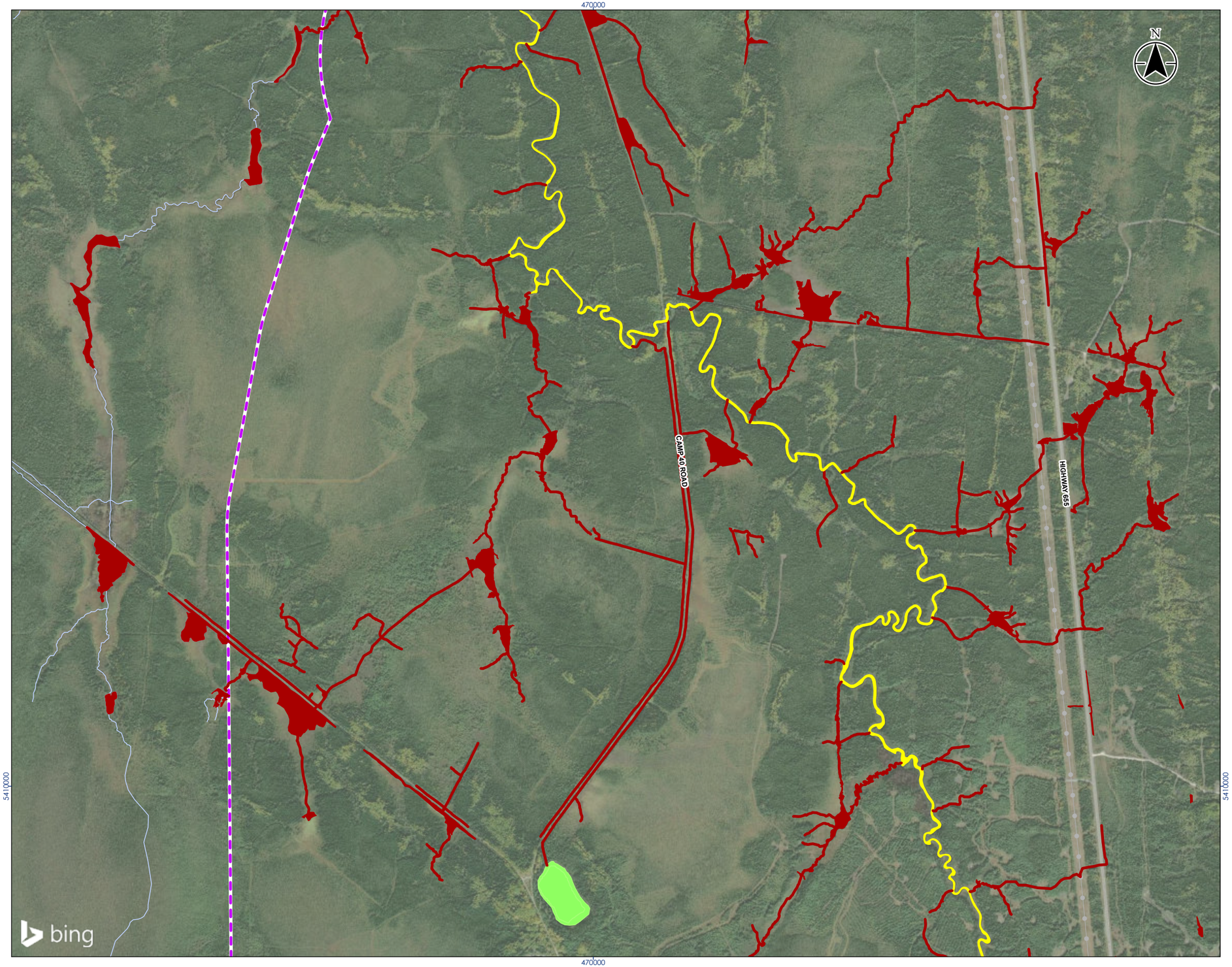

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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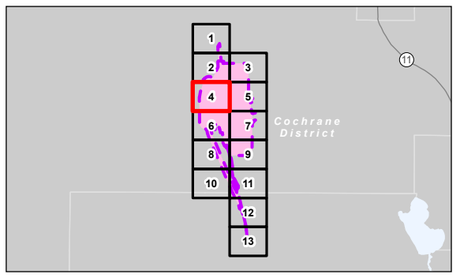

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.4

Title
Northern Pike Adult Habitat

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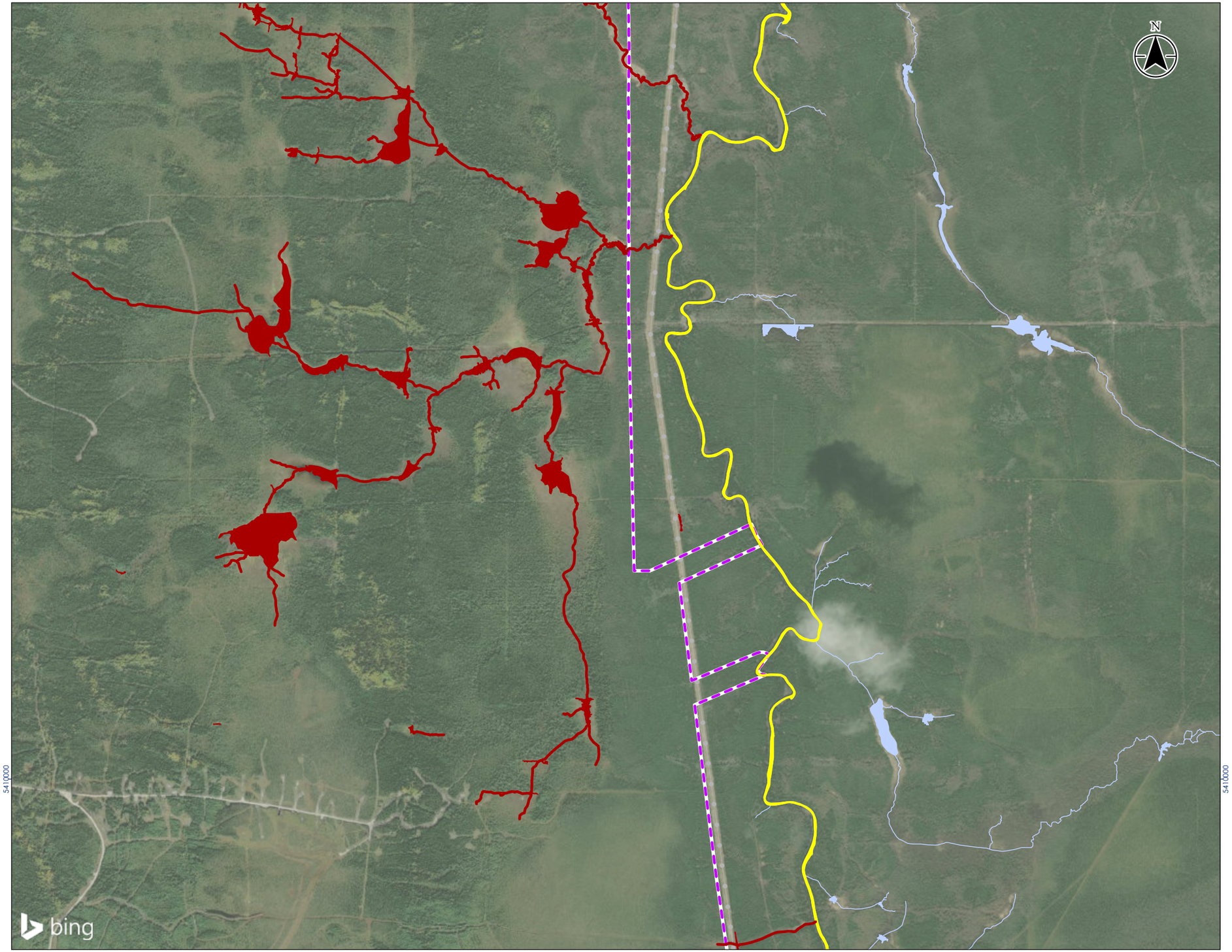

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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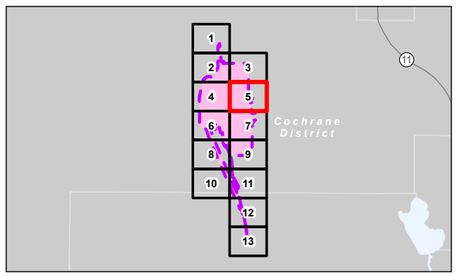

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.5

Title
Northern Pike Adult Habitat

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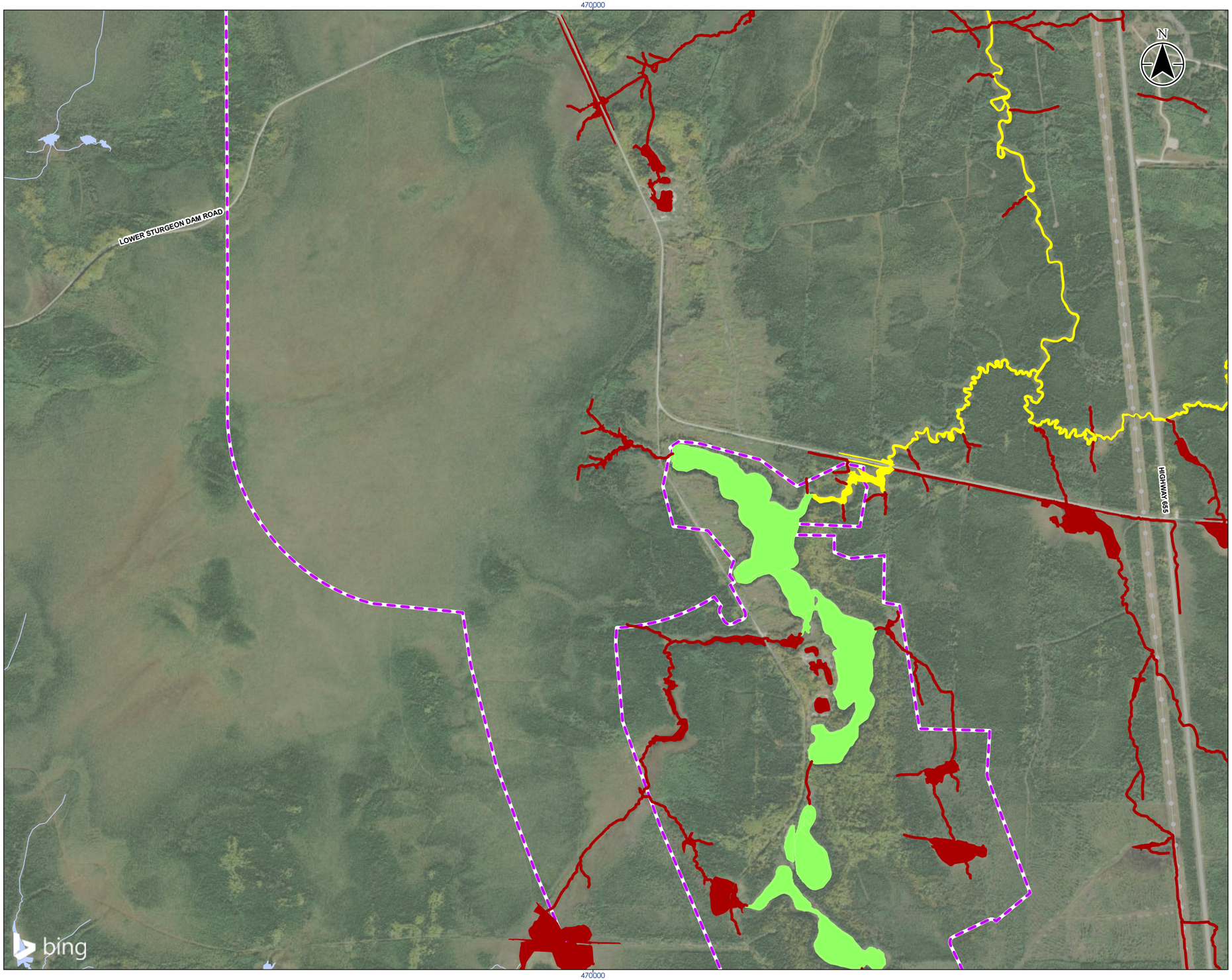

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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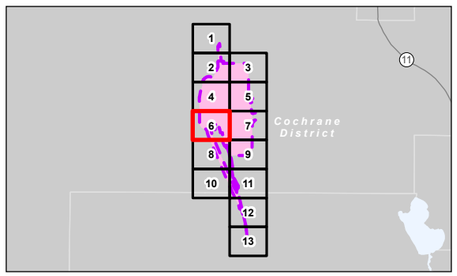

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.6

Title
Northern Pike Adult Habitat

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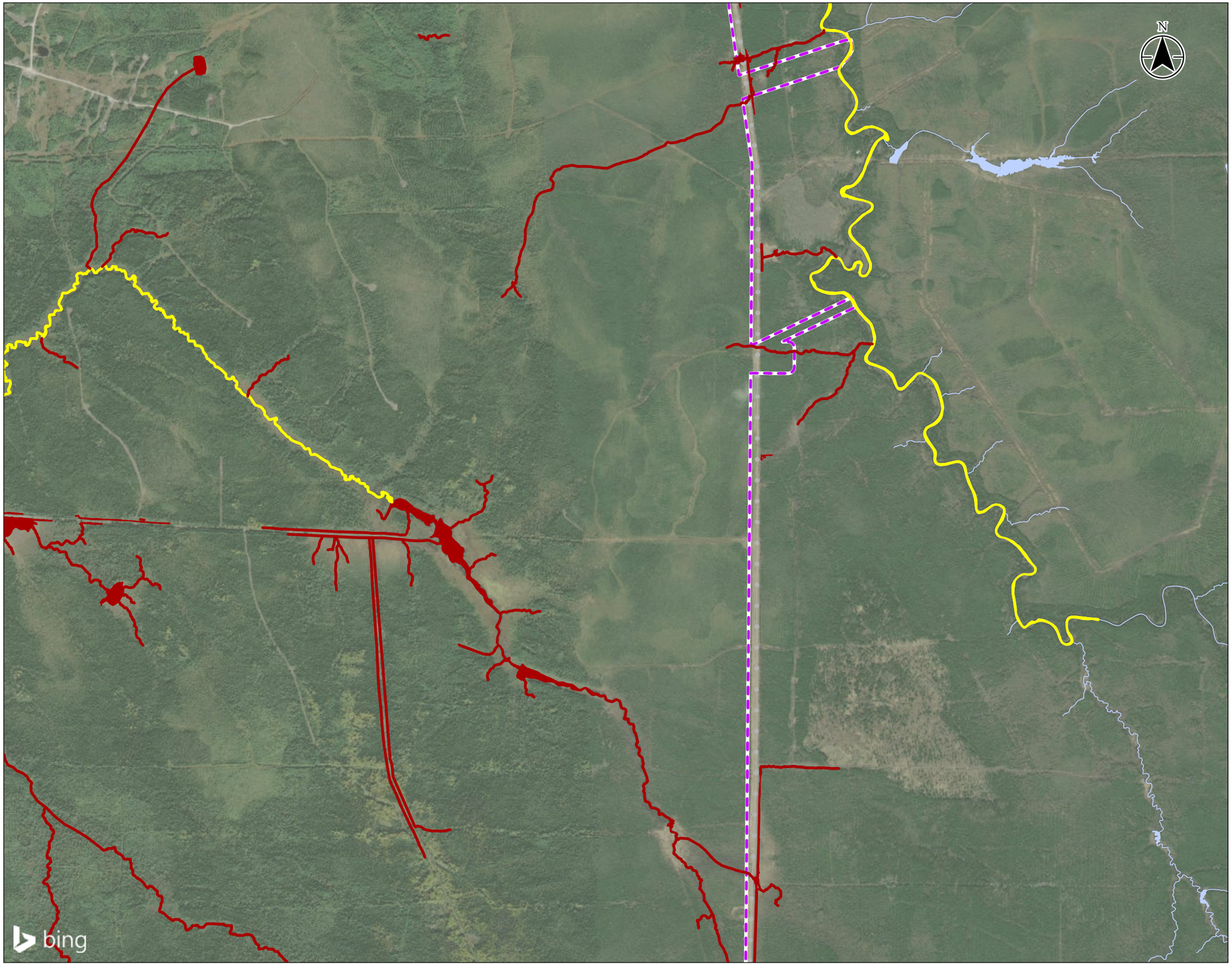

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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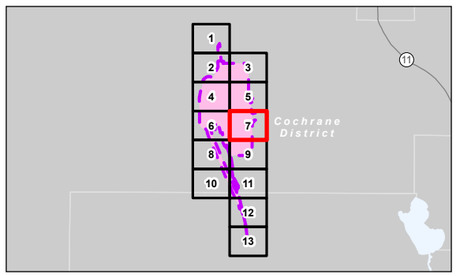

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.7

Title
Northern Pike Adult Habitat

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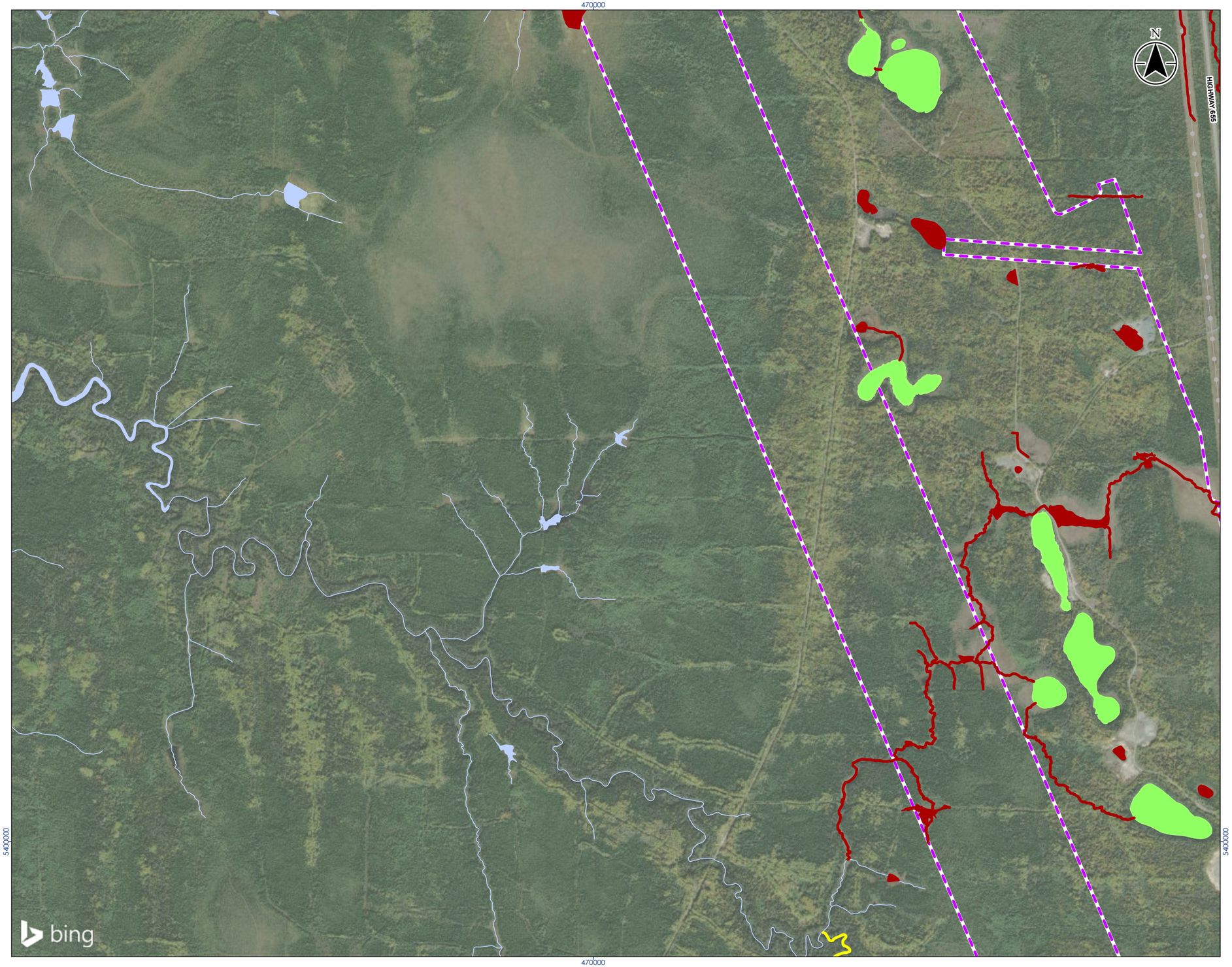

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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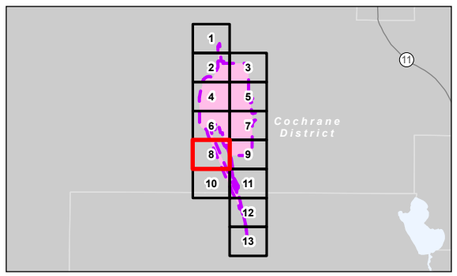

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.8

Title
Northern Pike Adult Habitat

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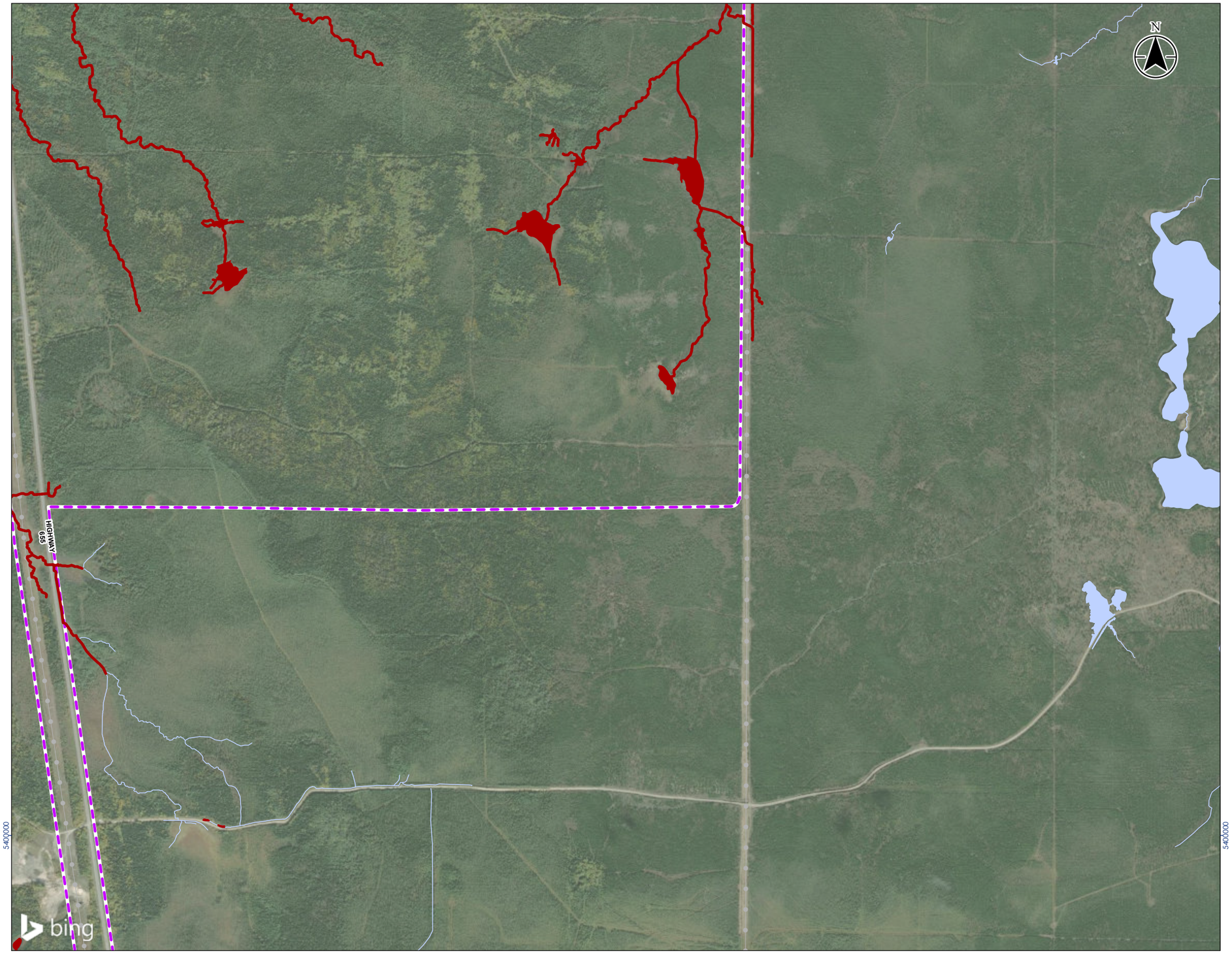

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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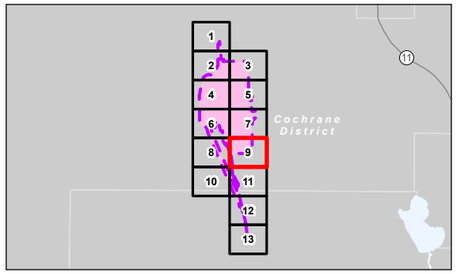

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.9

Title
Northern Pike Adult Habitat

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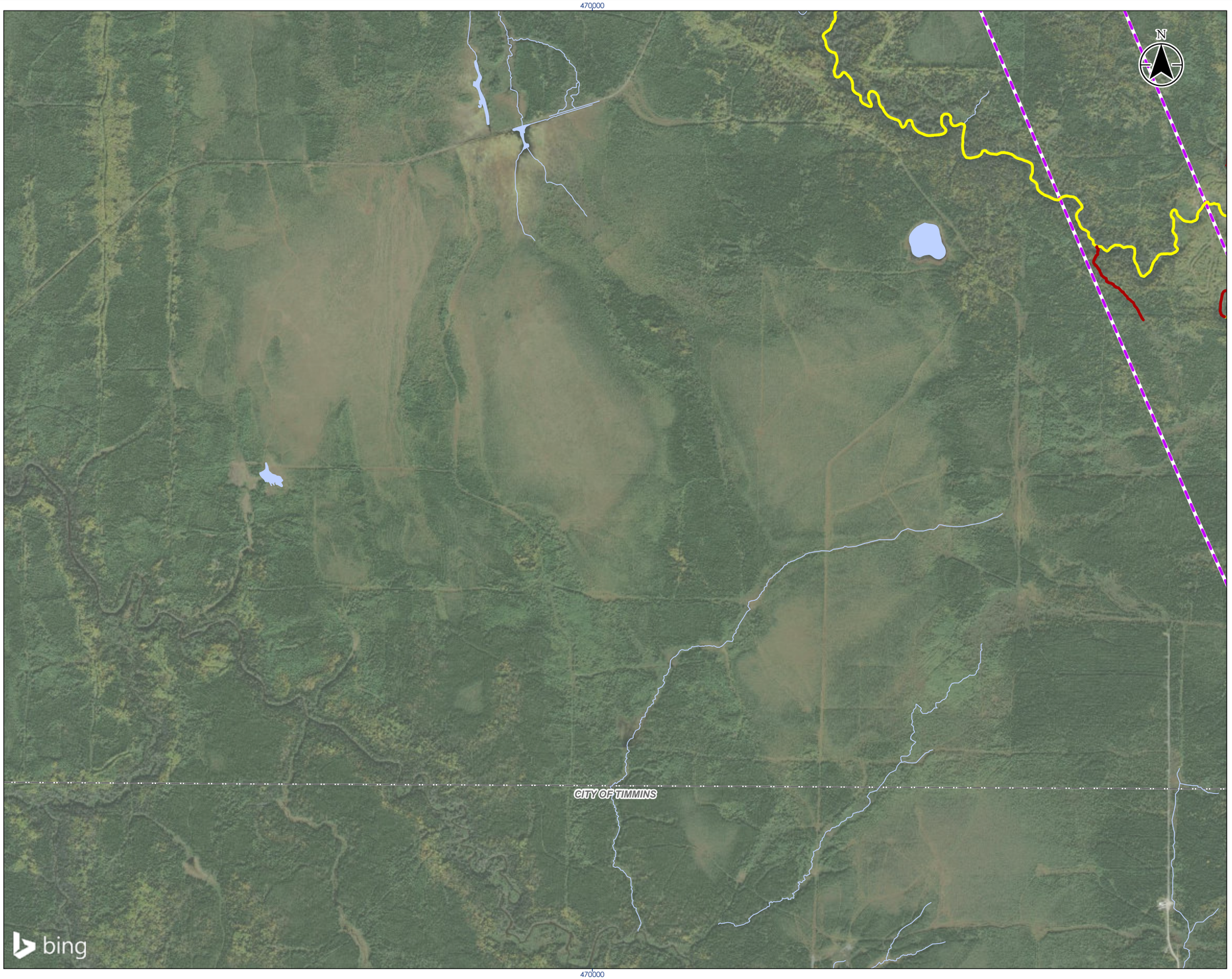

Stantec

Legend

- Project Area
- Municipal Boundary - Lower Tier
- Watercourse
- Waterbody

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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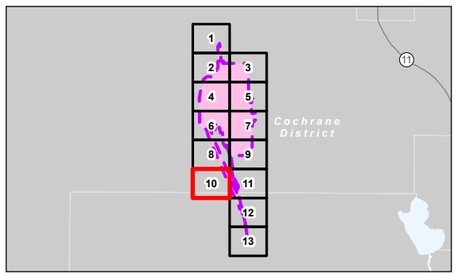

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.10

Title
Northern Pike Adult Habitat

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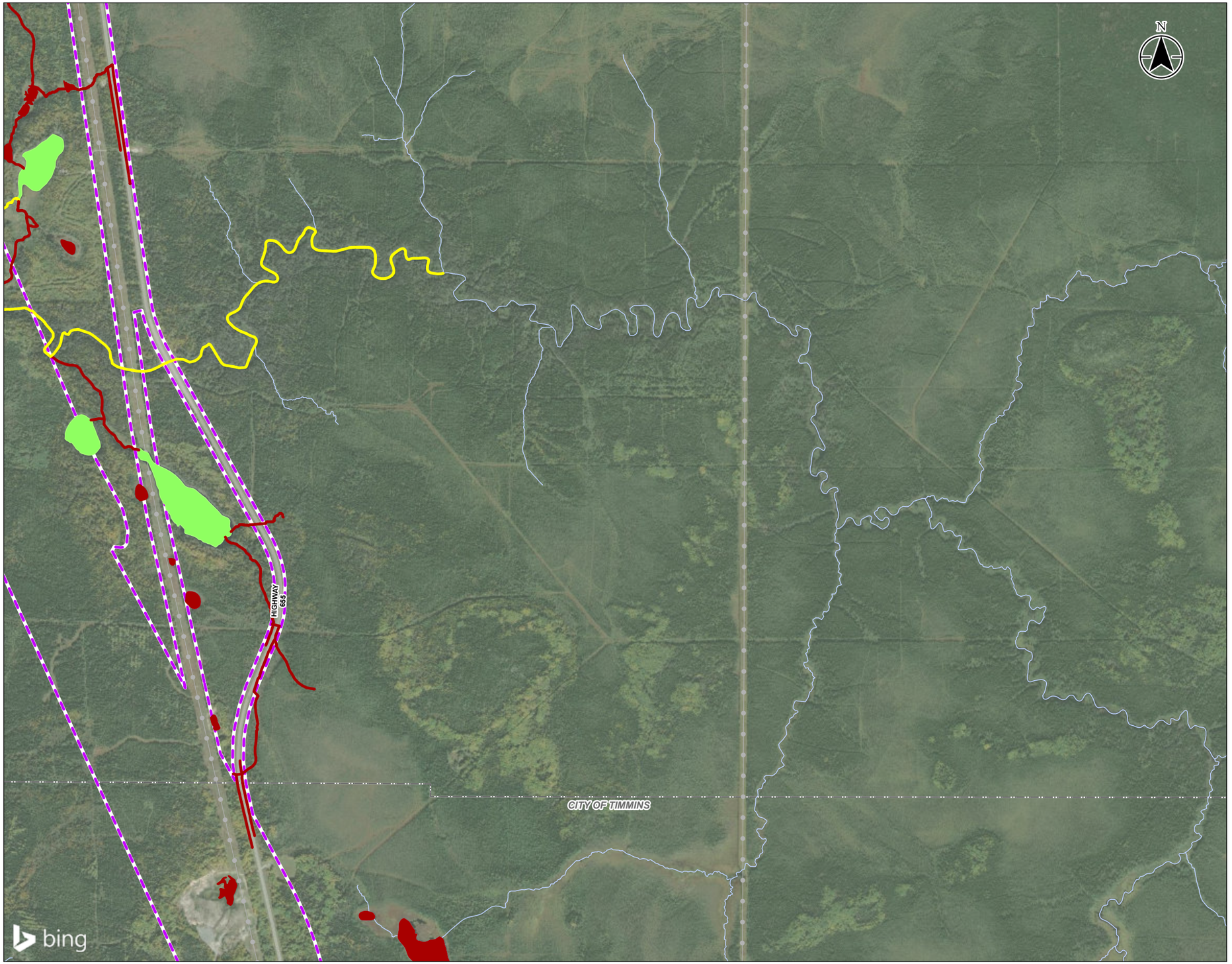

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Municipal Boundary - Lower Tier
- Watercourse
- Waterbody

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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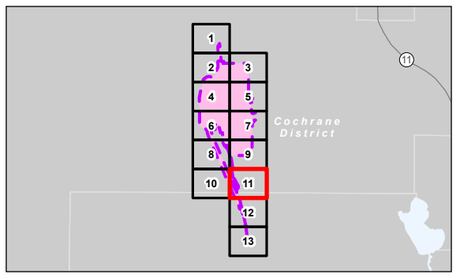

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.11

Title
Northern Pike Adult Habitat

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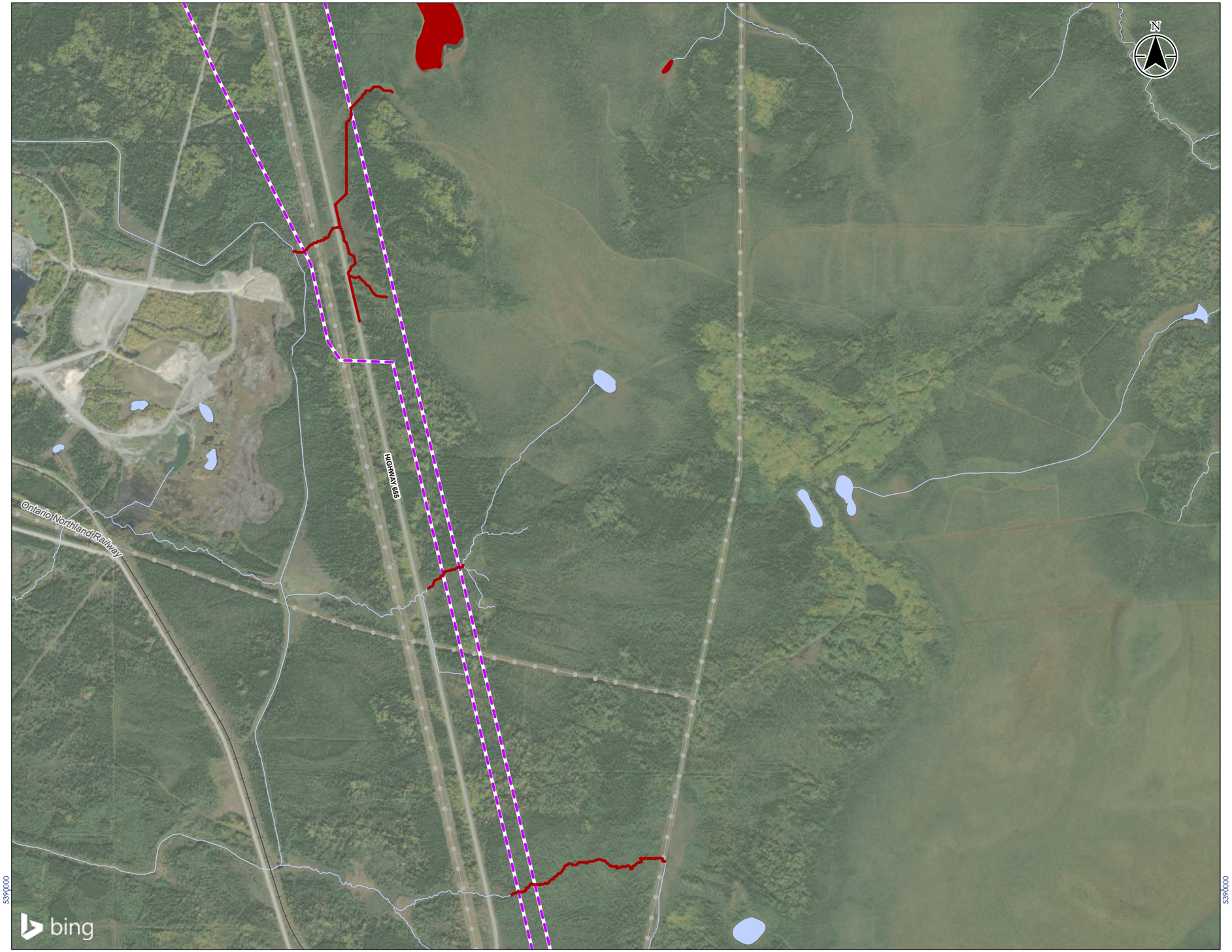

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Municipal Boundary - Lower Tier
- Watercourse
- Waterbody

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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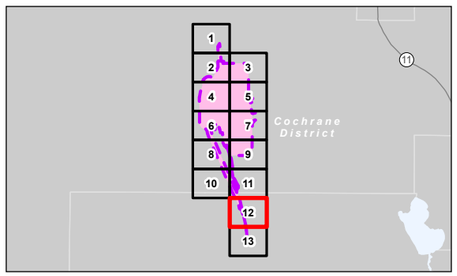

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.12

Title
Northern Pike Adult Habitat

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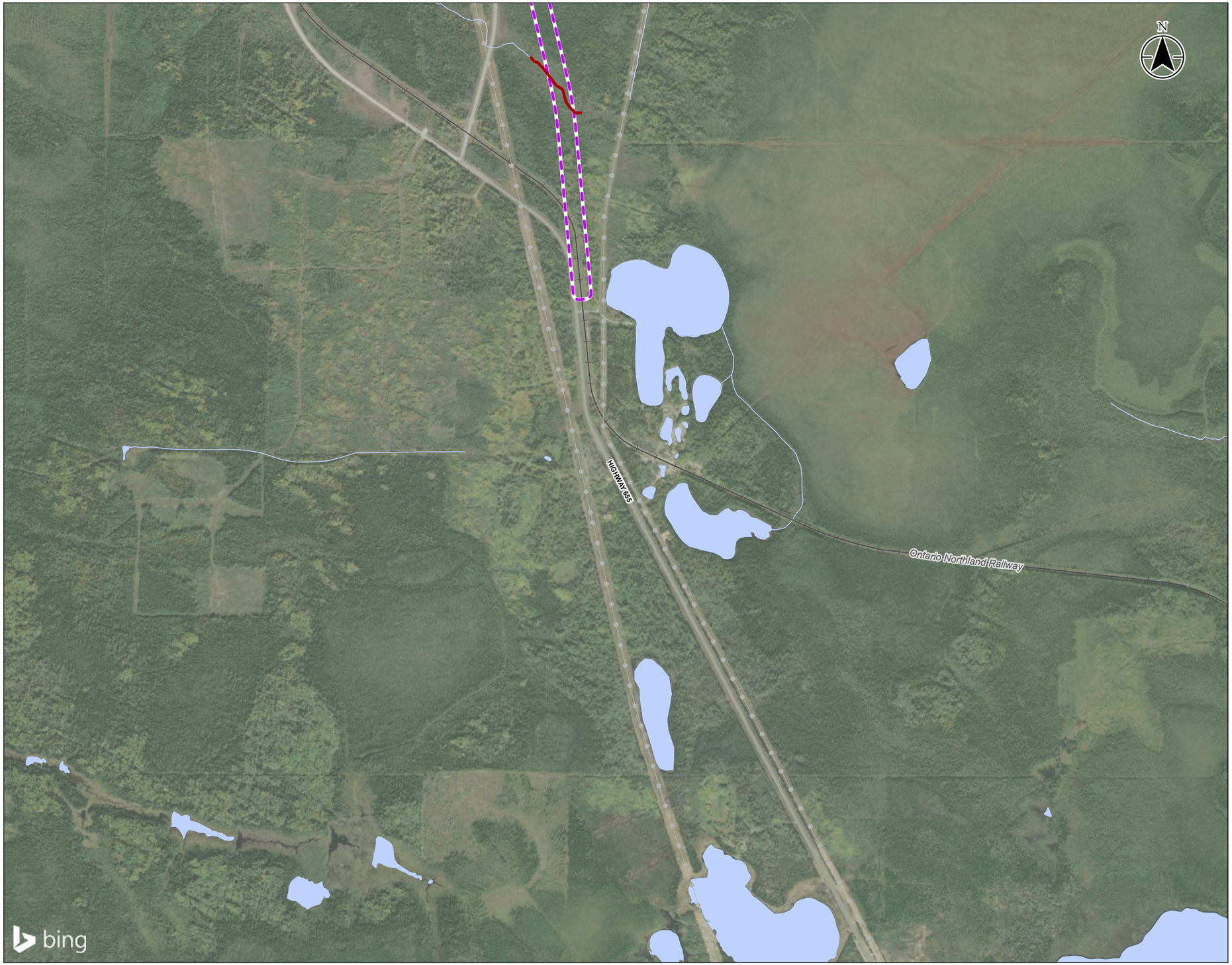

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Municipal Boundary - Lower Tier
- Watercourse
- Waterbody

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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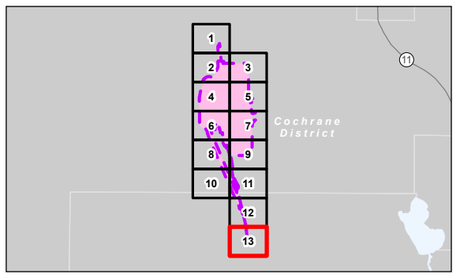

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.11.13

Title
Northern Pike Adult Habitat

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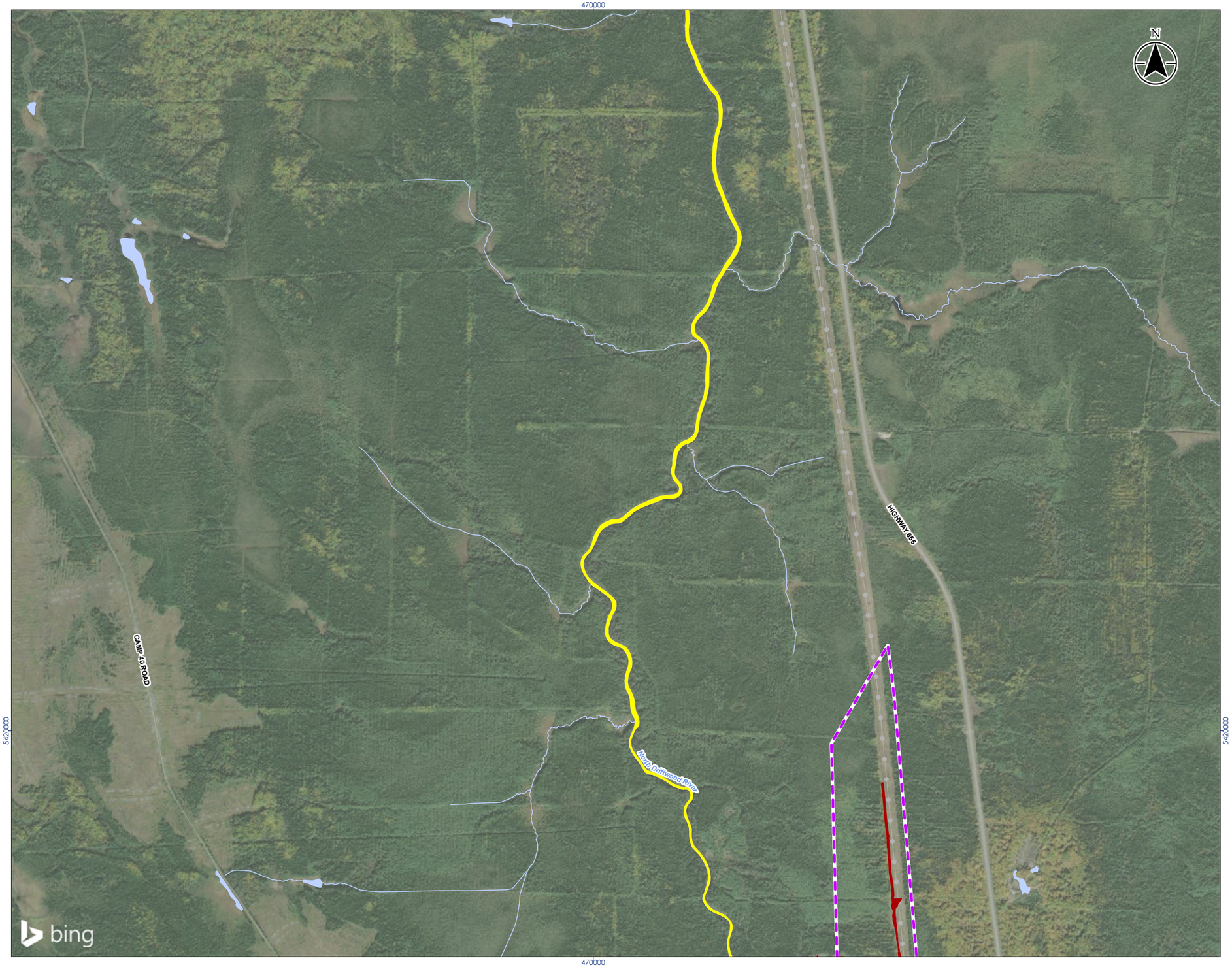

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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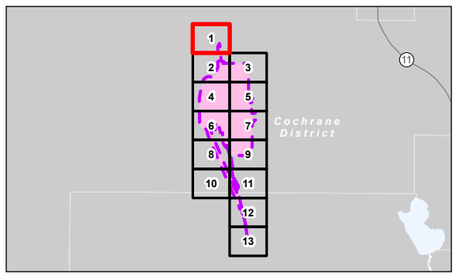

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.1

Title
Northern Pike Spawning/Rearing Habitat

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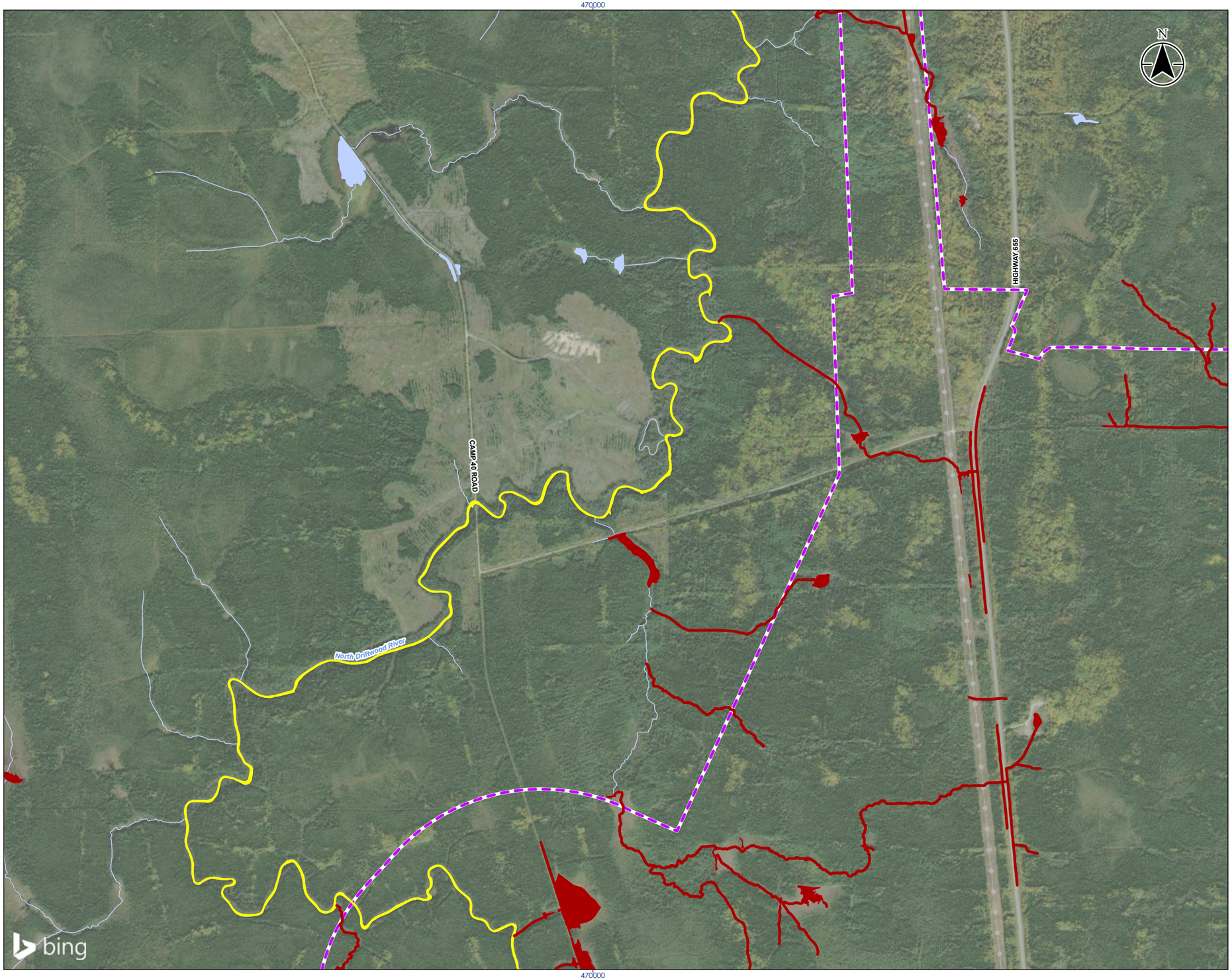

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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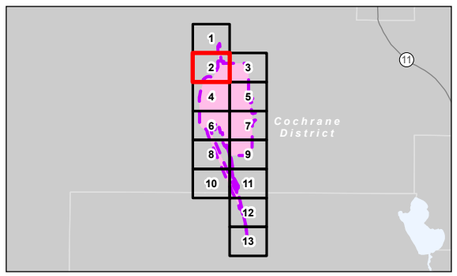

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.2

Title
Northern Pike Spawning/Rearing Habitat

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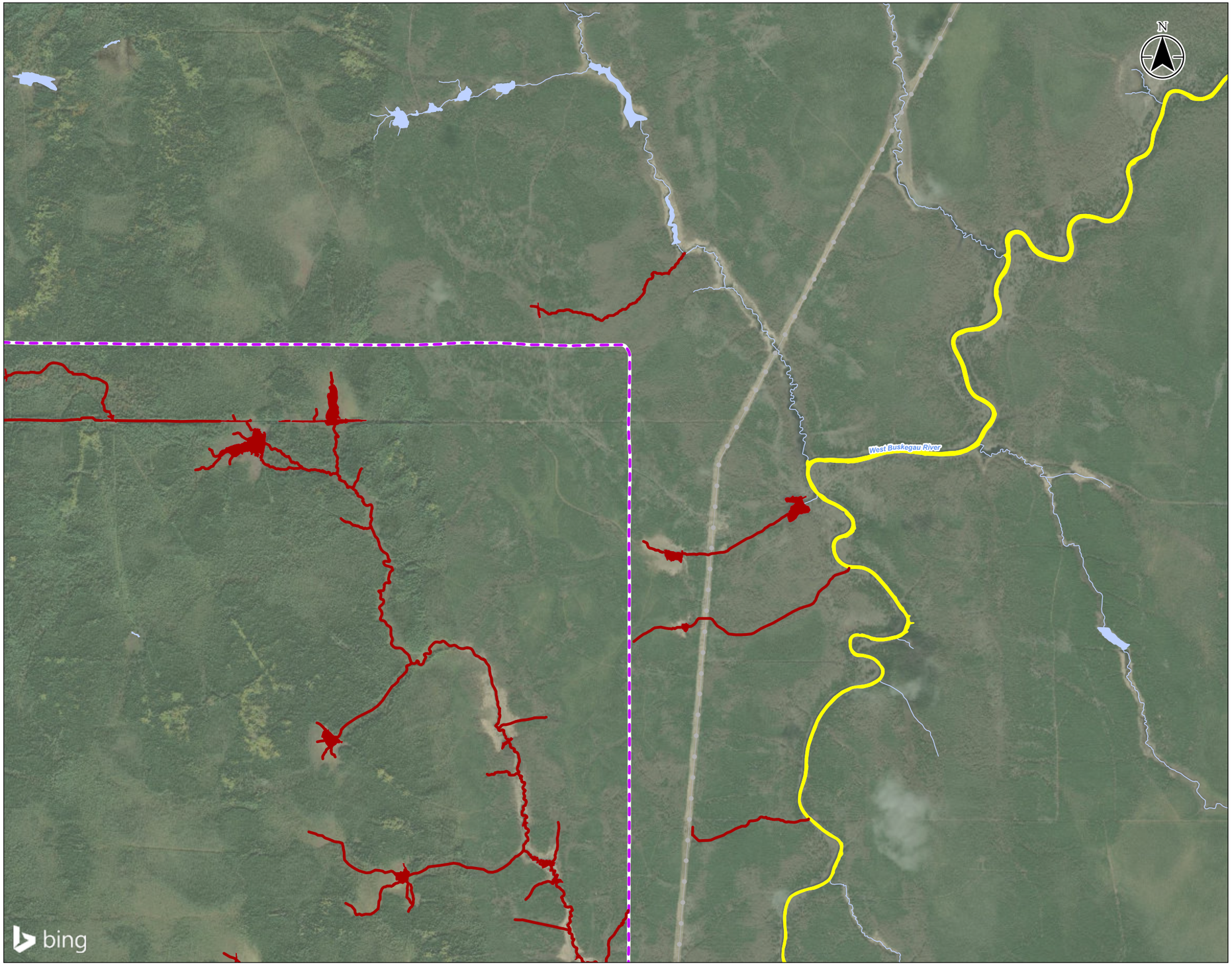

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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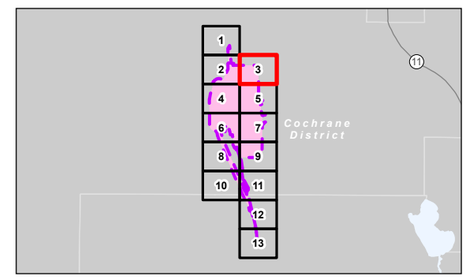

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.3

Title
Northern Pike Spawning/Rearing Habitat

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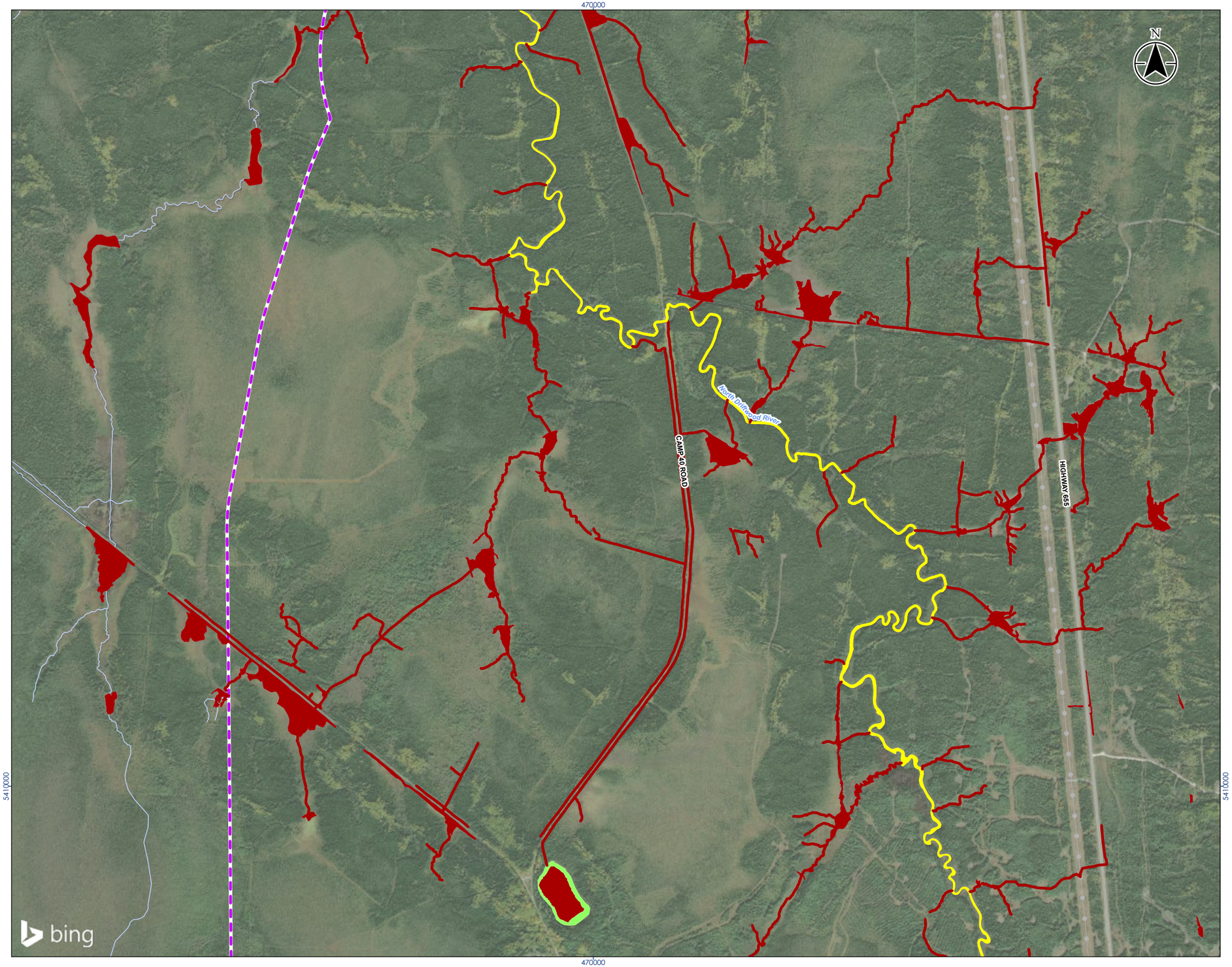
\\cd1220-f01.idir.ad.gov.on.ca\wspace\160930456\Reporting\160930456_A.Rpt_Fish_Fish_Habitat_Plan\Spawning\Figure A.12.3 Northern Pike Spawning Habitat_Revised 2024-09-11.mxd



Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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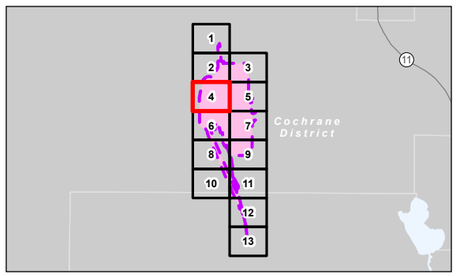

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.4

Title
Northern Pike Spawning/Rearing Habitat

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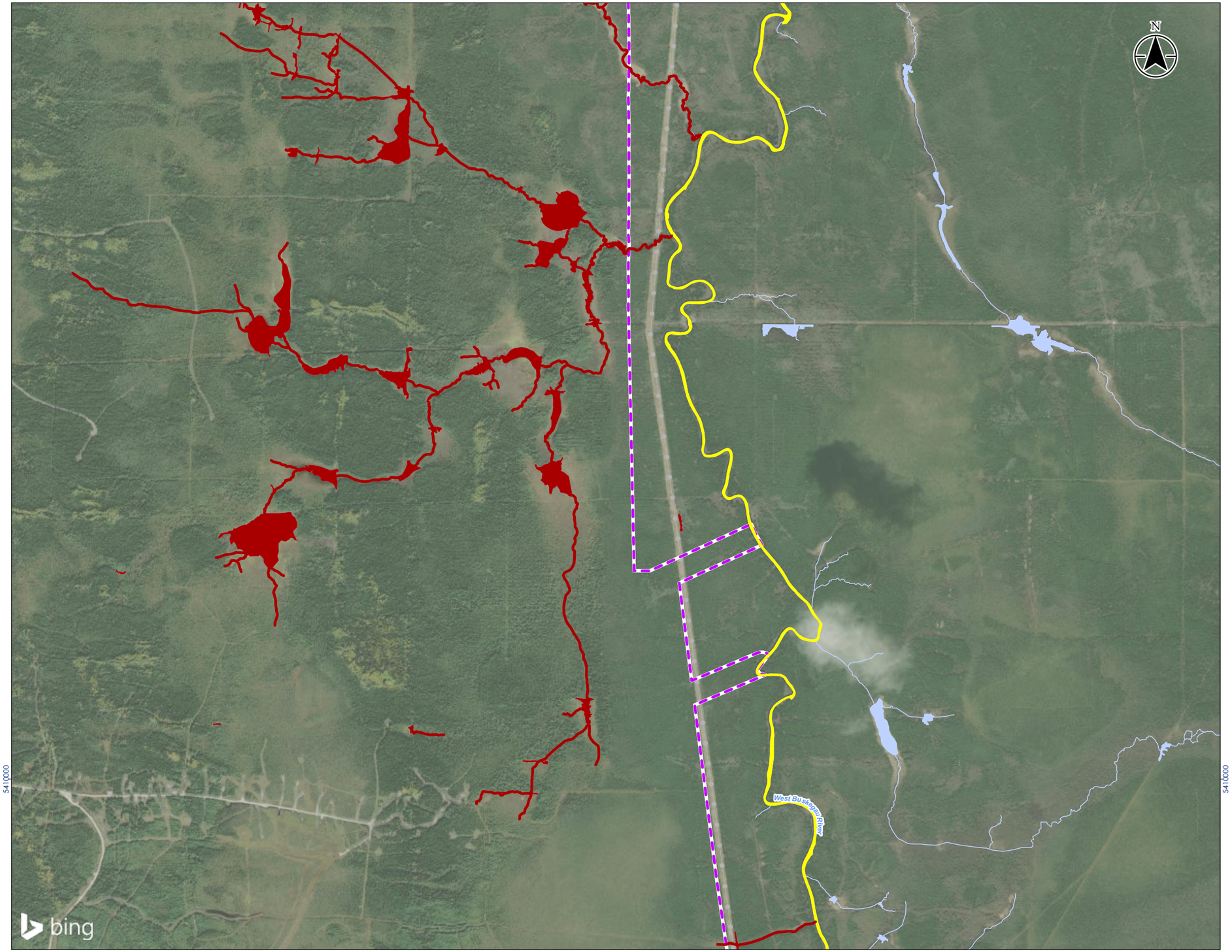

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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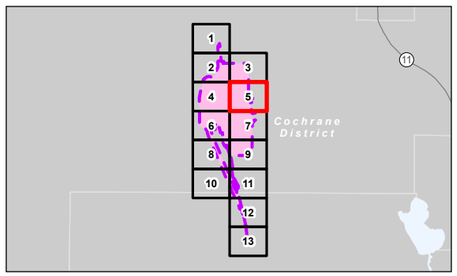

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.5

Title
Northern Pike Spawning/Rearing Habitat

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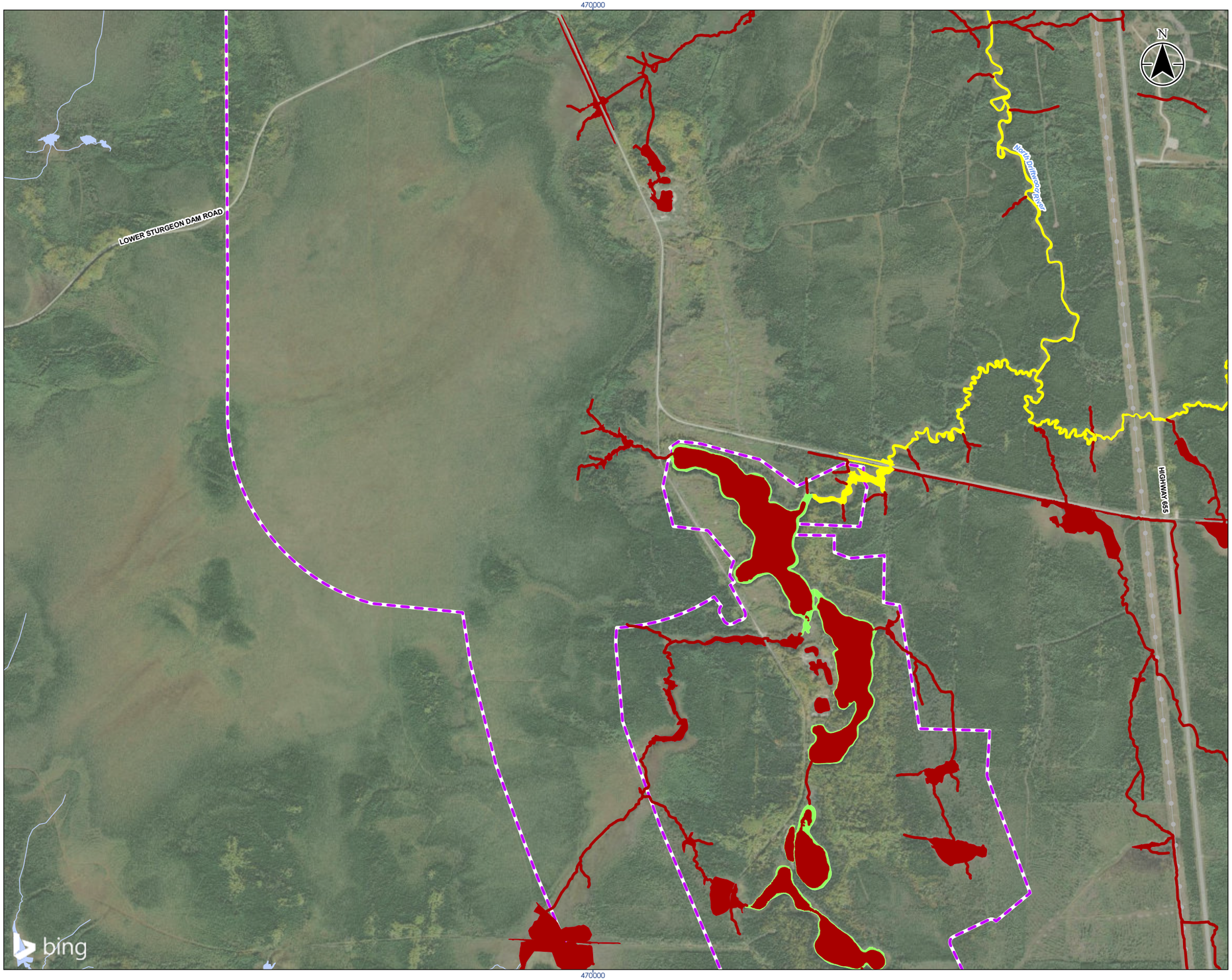

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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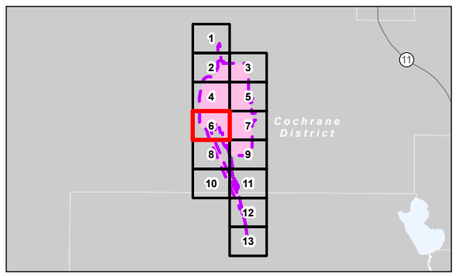

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.6

Title
Northern Pike Spawning/Rearing Habitat

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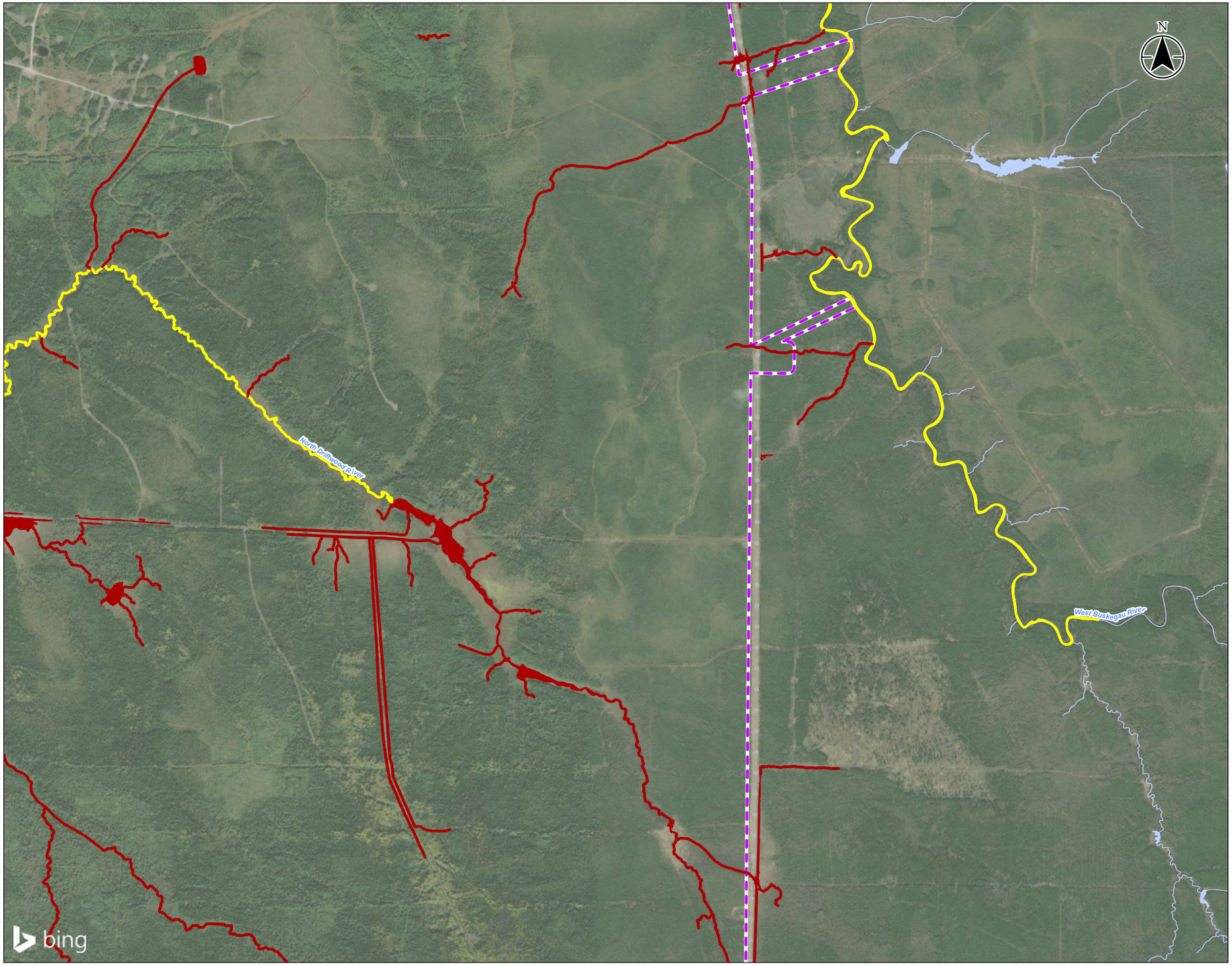

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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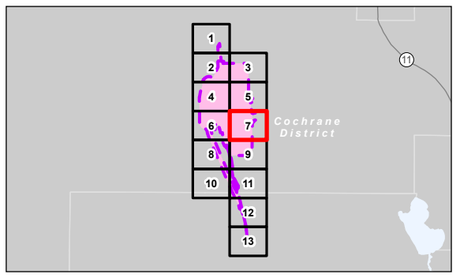

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.7

Title
Northern Pike Spawning/Rearing Habitat

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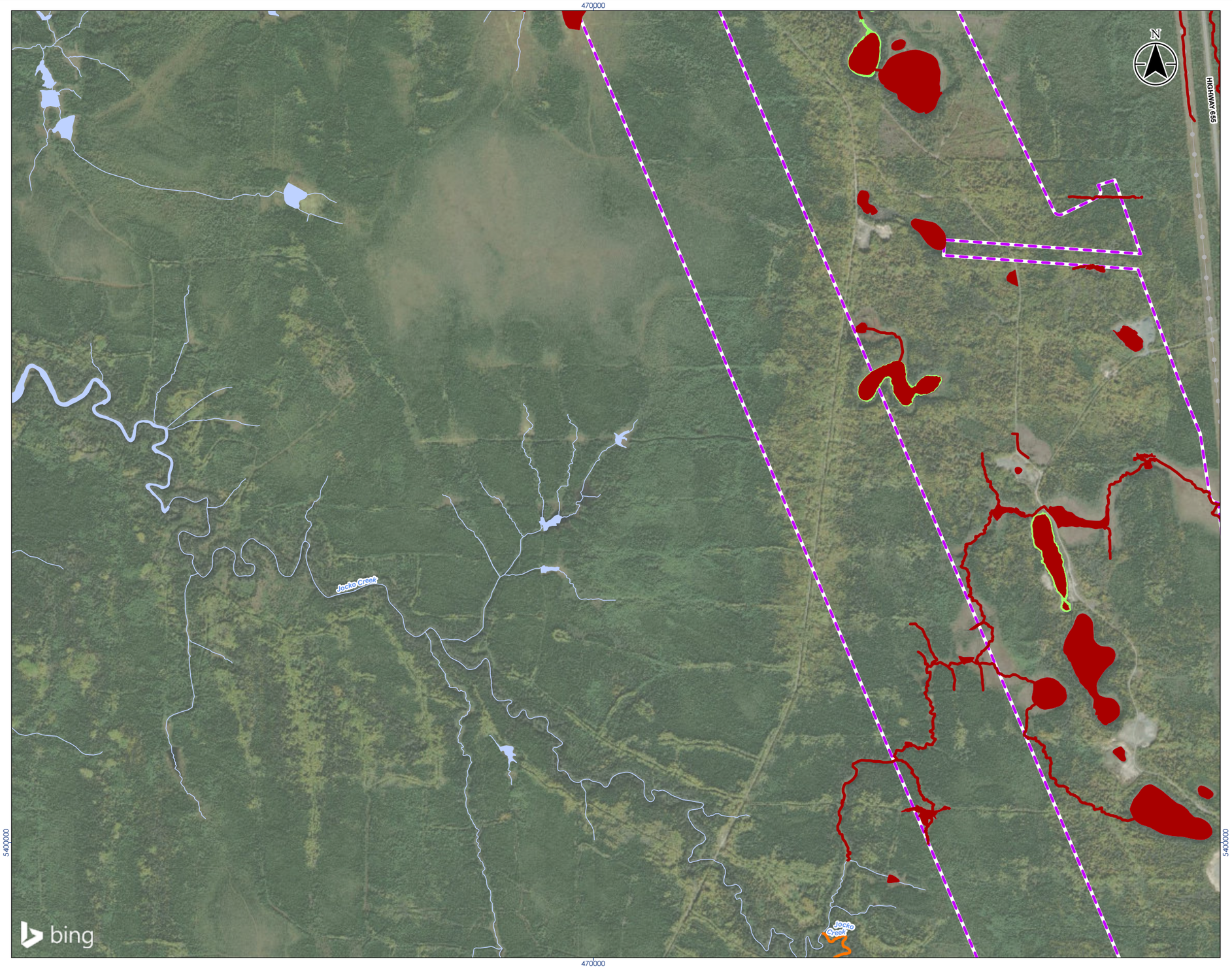

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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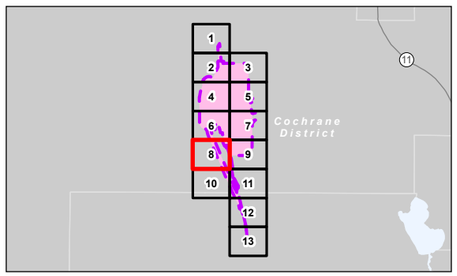

Project Location
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160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.8

Title
Northern Pike Spawning/Rearing Habitat

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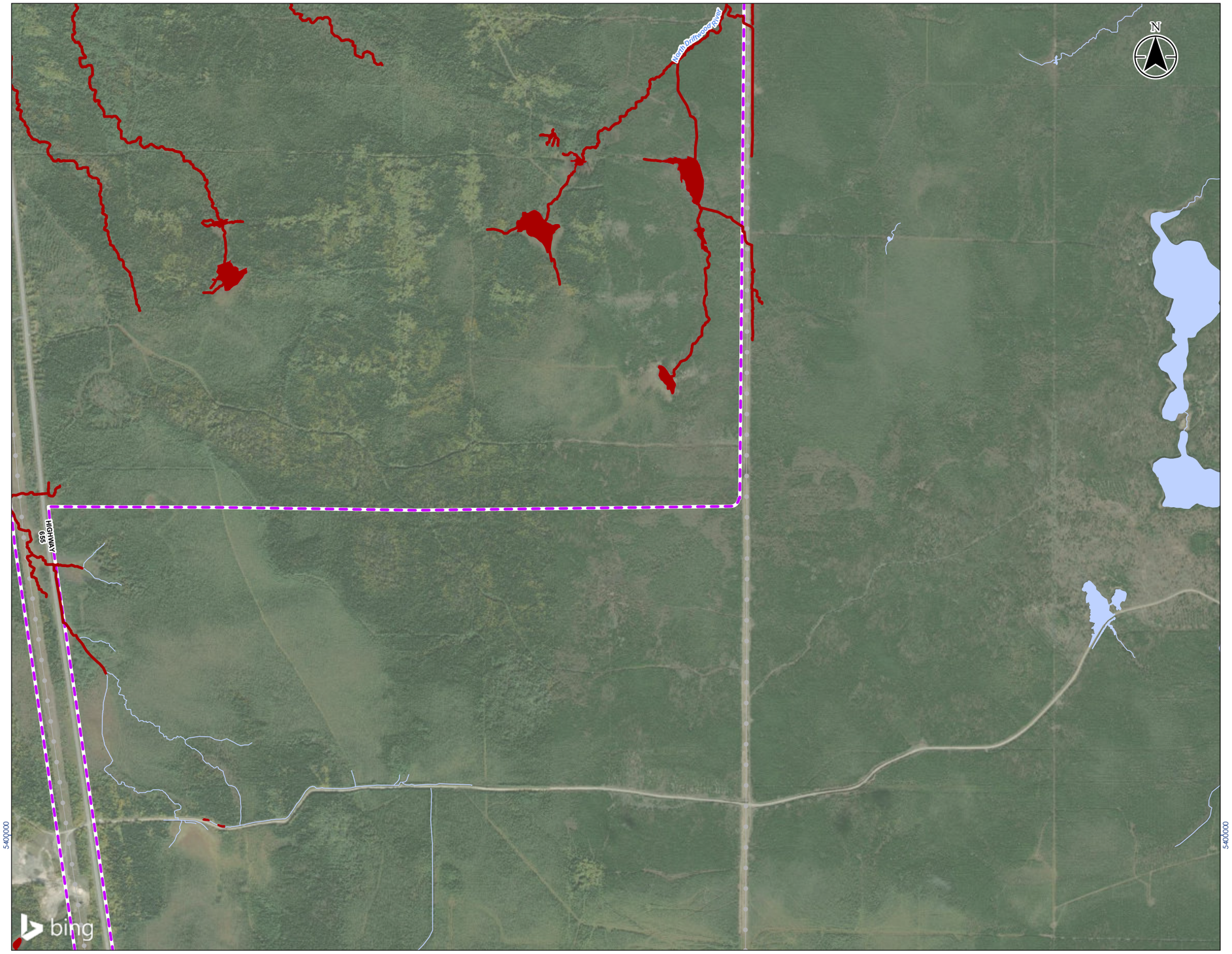

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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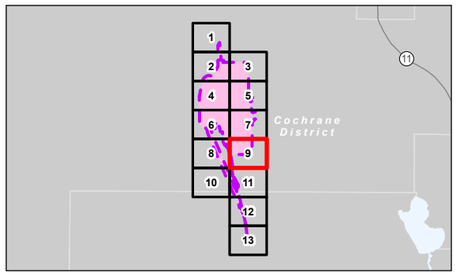

Project Location
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Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.9

Title
Northern Pike Spawning/Rearing Habitat

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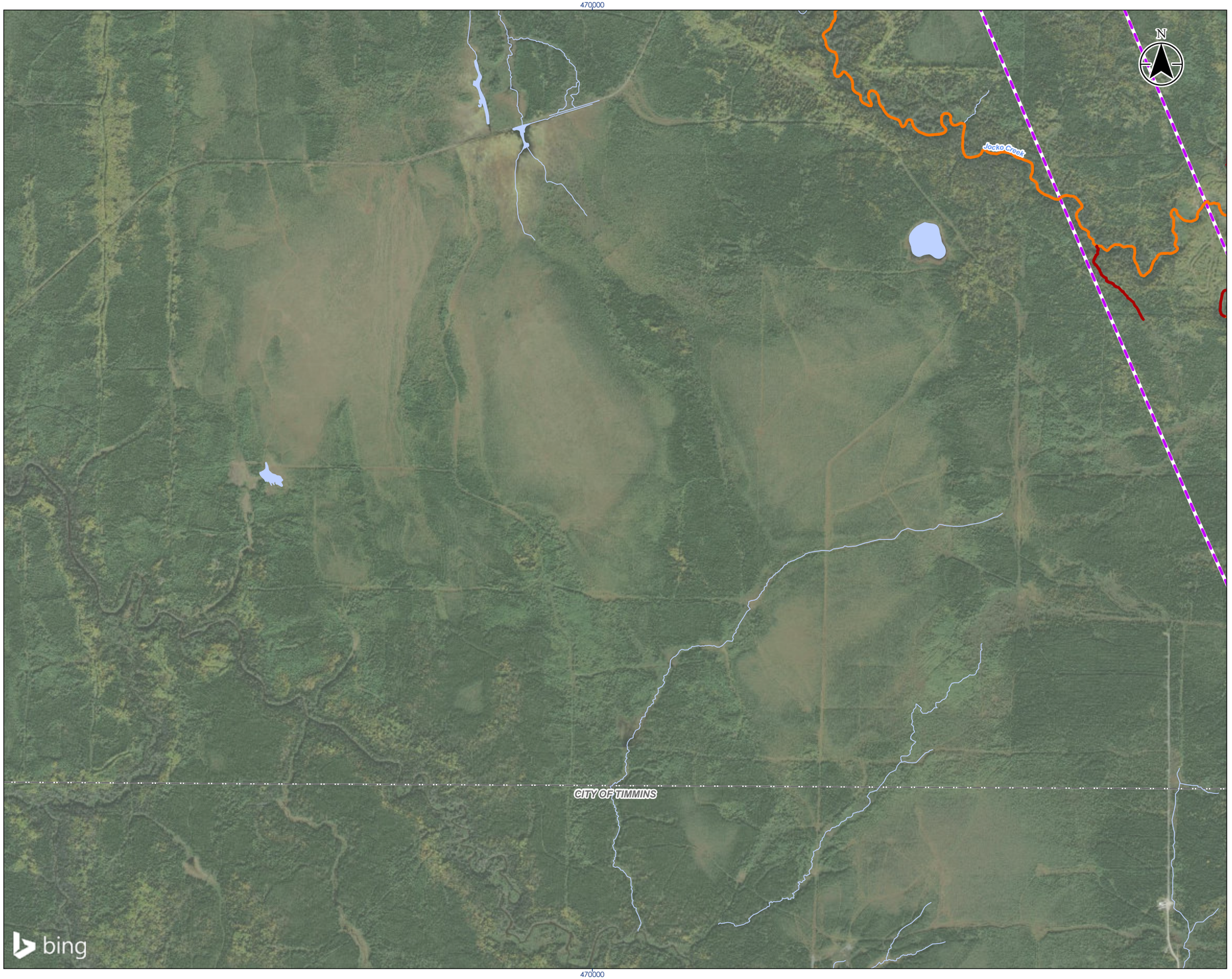

Stantec

Legend

- Project Area
- Municipal Boundary - Lower Tier
- Waterbody
- Watercourse

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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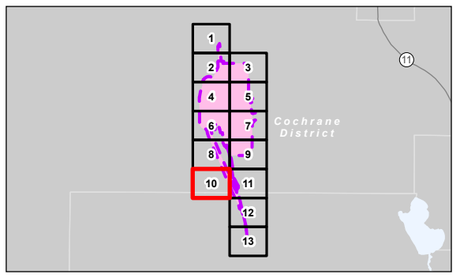

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.10

Title
Northern Pike Spawning/Rearing Habitat

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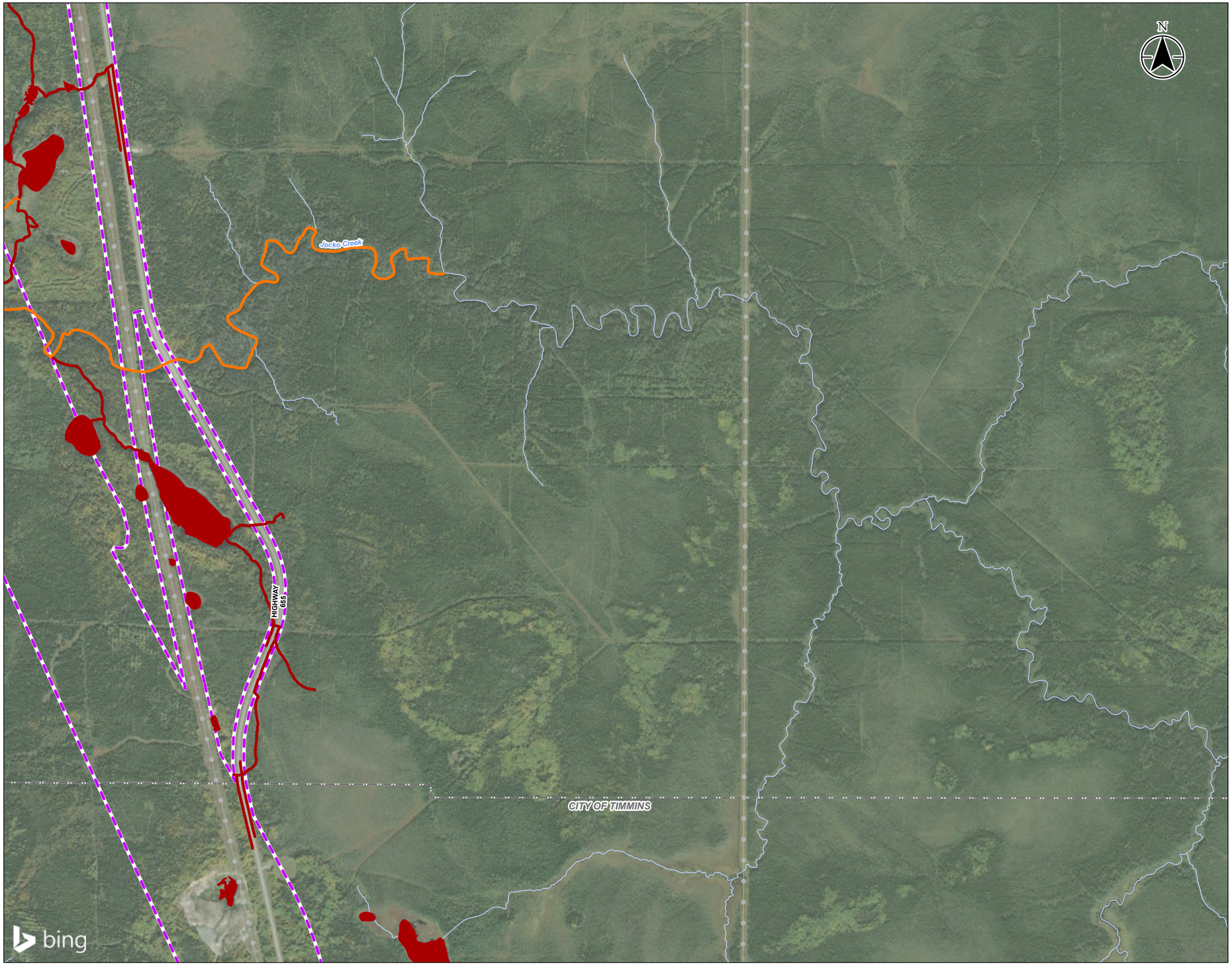

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Municipal Boundary - Lower Tier
- Waterbody
- Watercourse

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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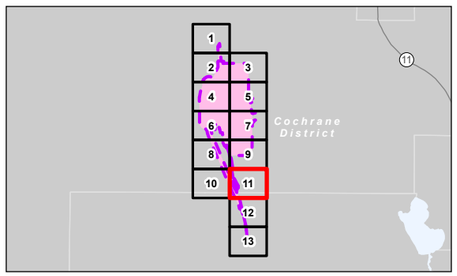

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.11

Title
Northern Pike Spawning/Rearing Habitat

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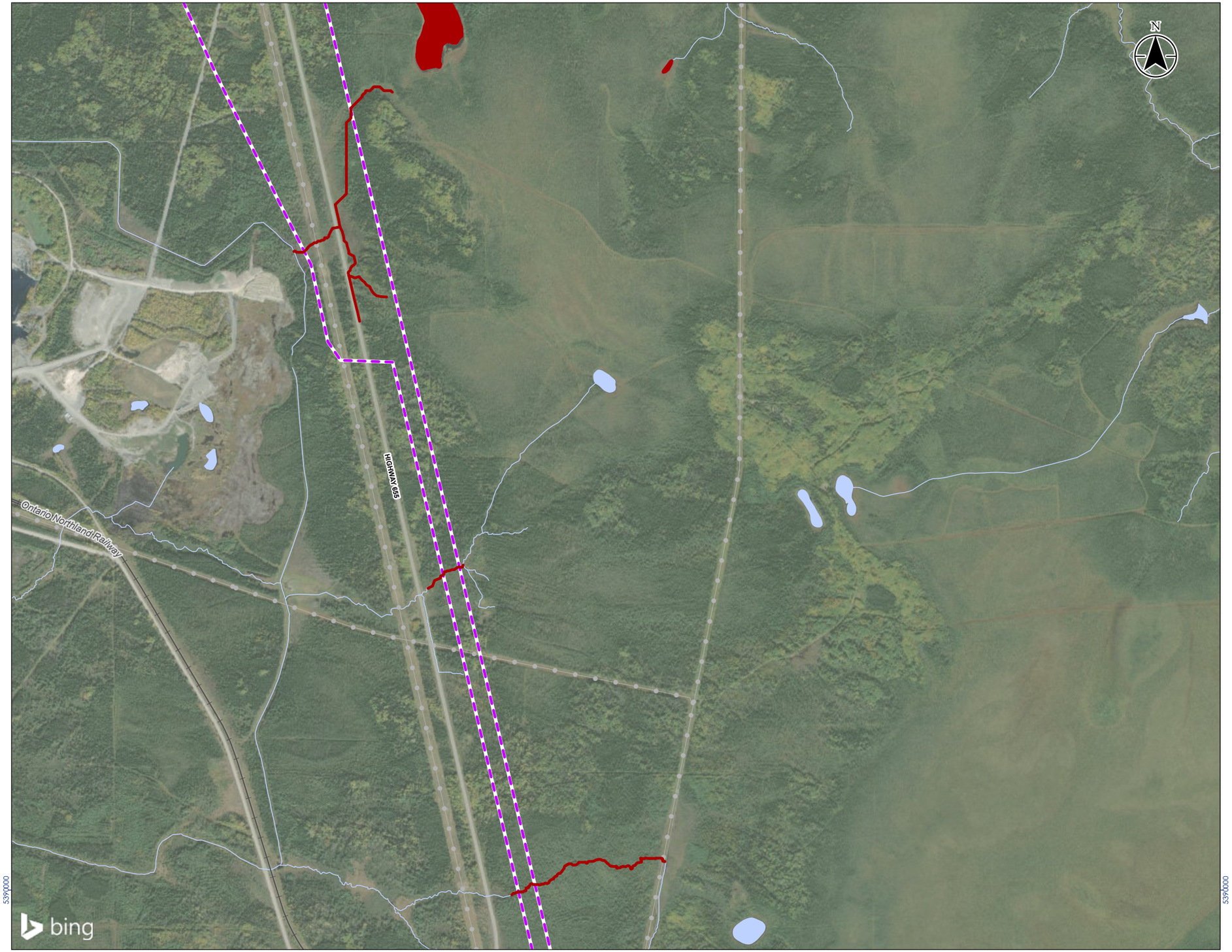

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Municipal Boundary - Lower Tier
- Waterbody
- Watercourse

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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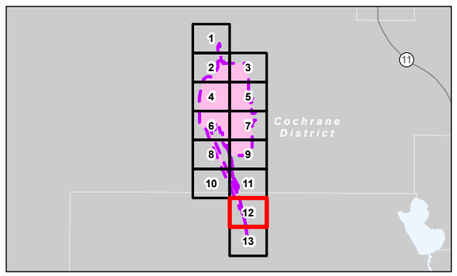

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.12

Title
Northern Pike Spawning/Rearing Habitat

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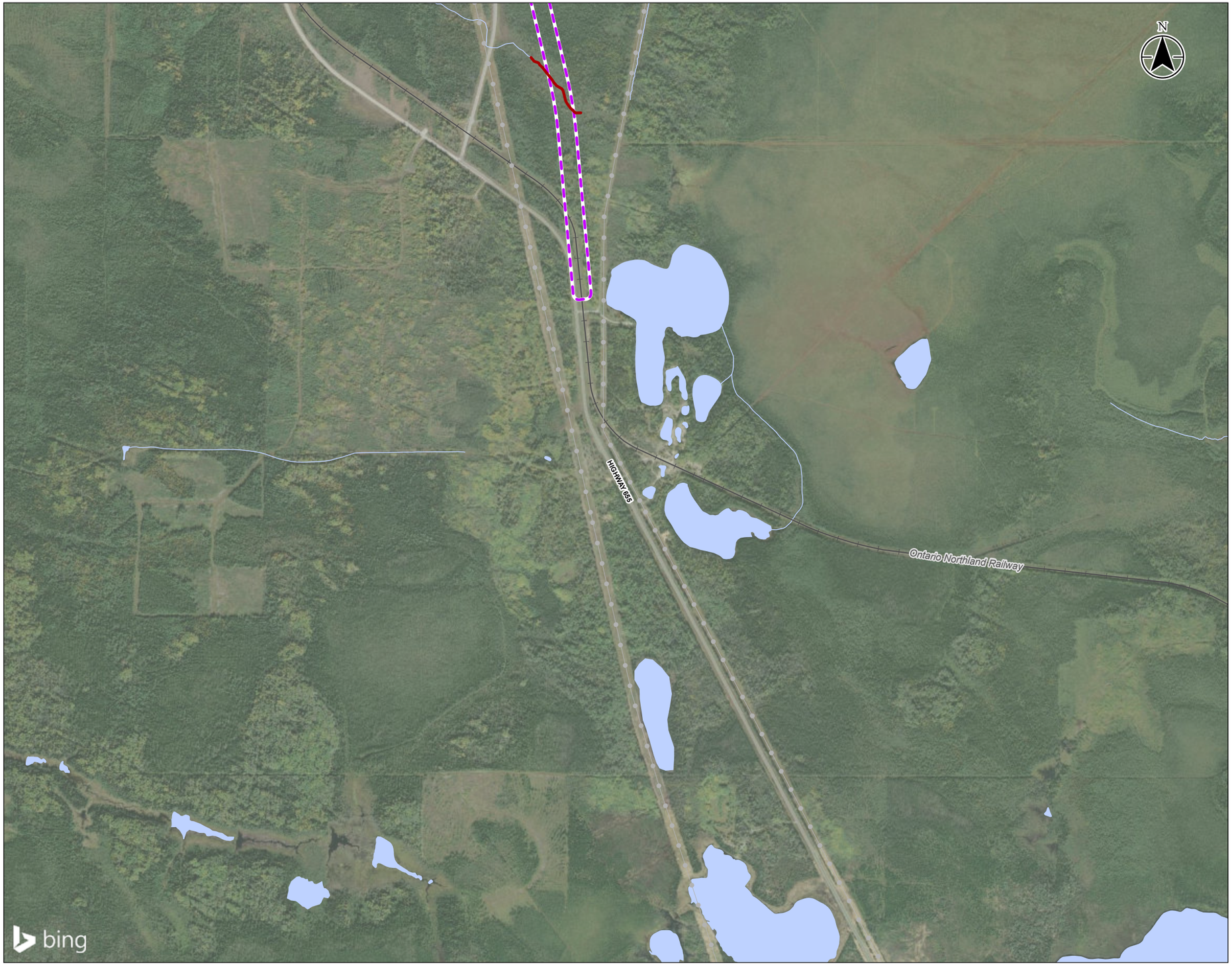

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Municipal Boundary - Lower Tier
- Waterbody
- Watercourse

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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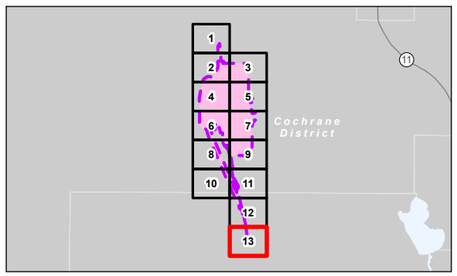

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.12.13

Title
Northern Pike Spawning/Rearing Habitat

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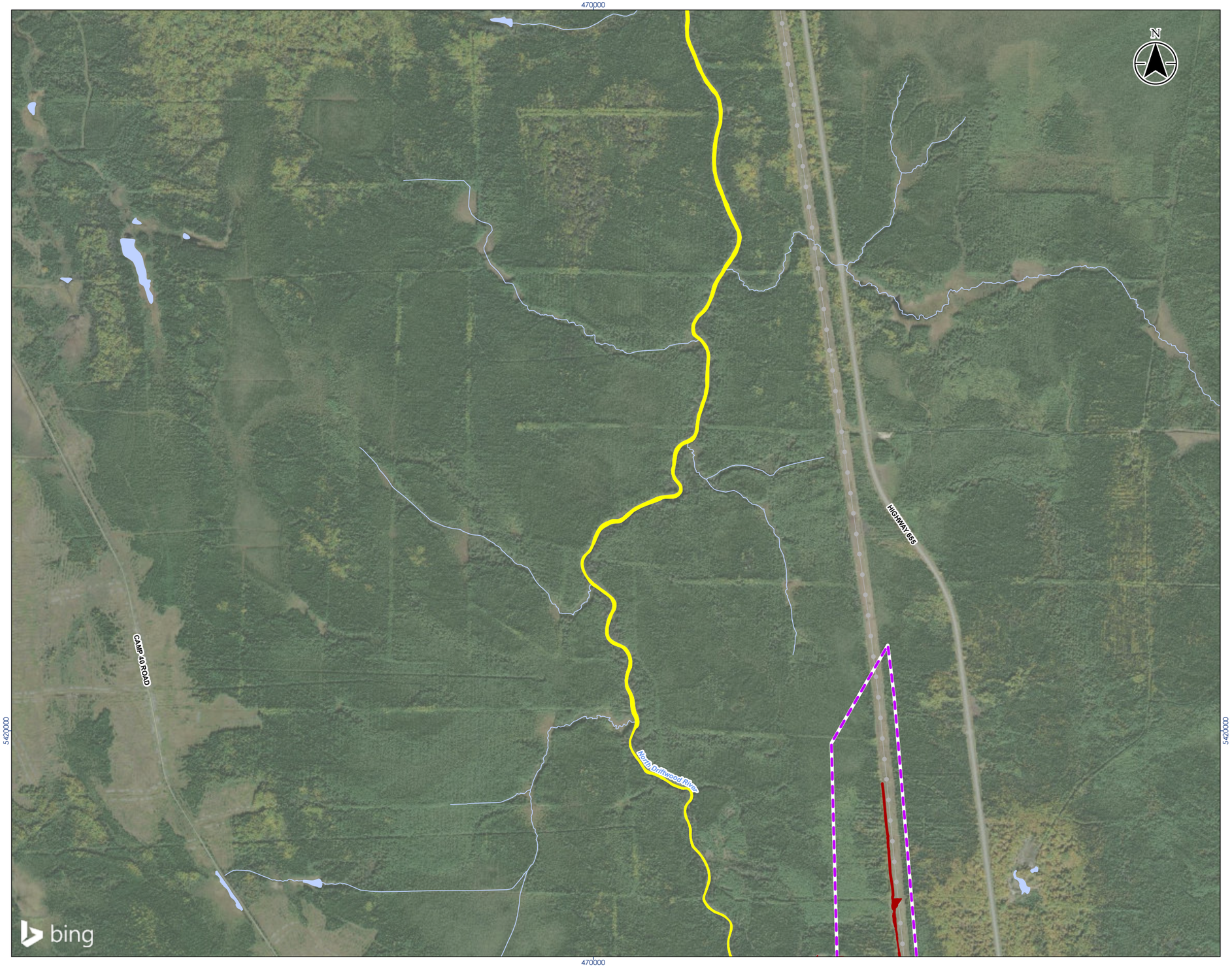

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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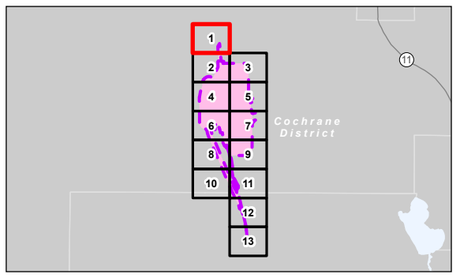

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.1

Title
Northern Pike Overwintering Habitat

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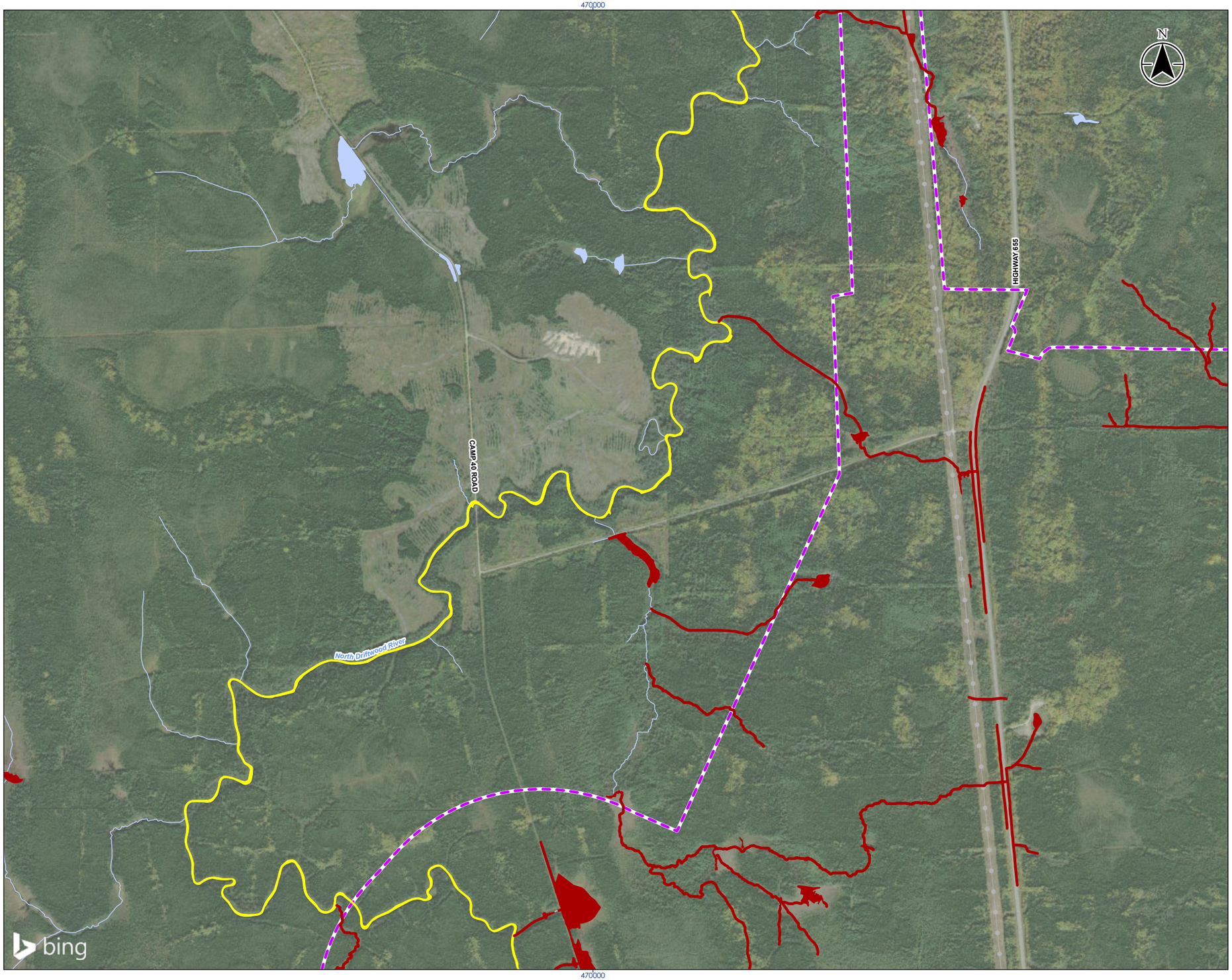

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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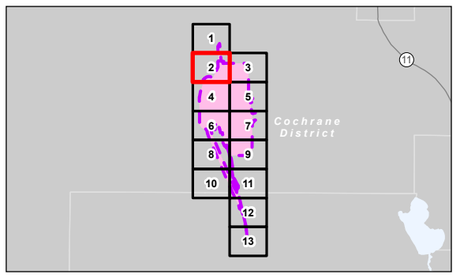

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.2

Title
Northern Pike Overwintering Habitat

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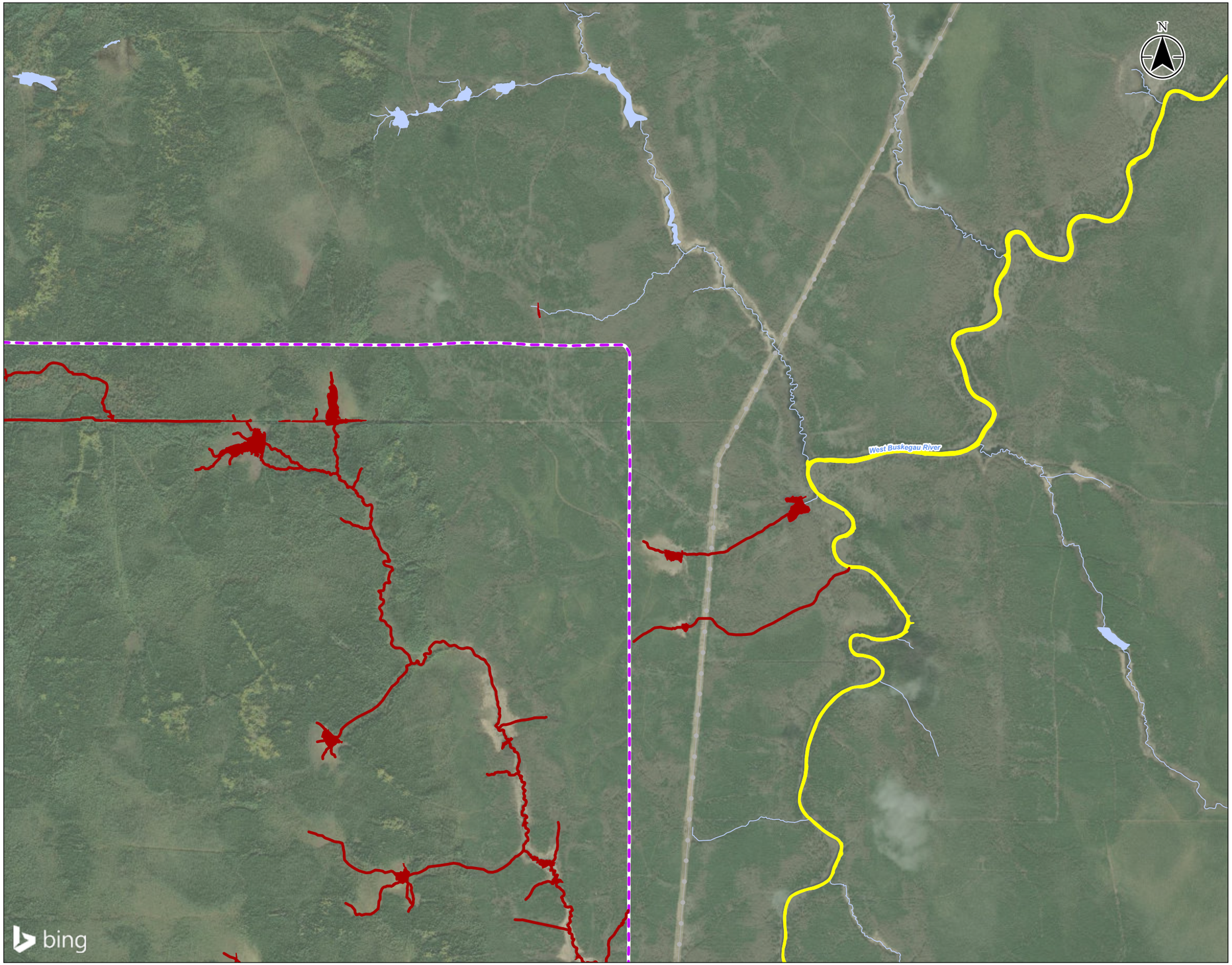
\\ca1001-f01\01\active\160930456\gis\mxd\160930456_crawford_nickel_project\160930456_A.13_Fish_Fish_Habitat_Overwintering_Northern_Pike_Overwintering_Rev6.mxd



Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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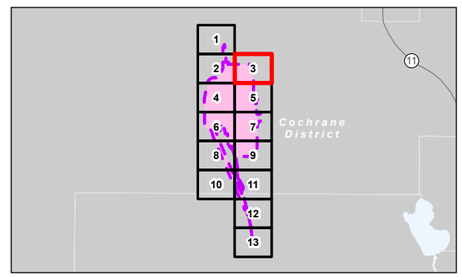

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.3

Title
Northern Pike Overwintering Habitat

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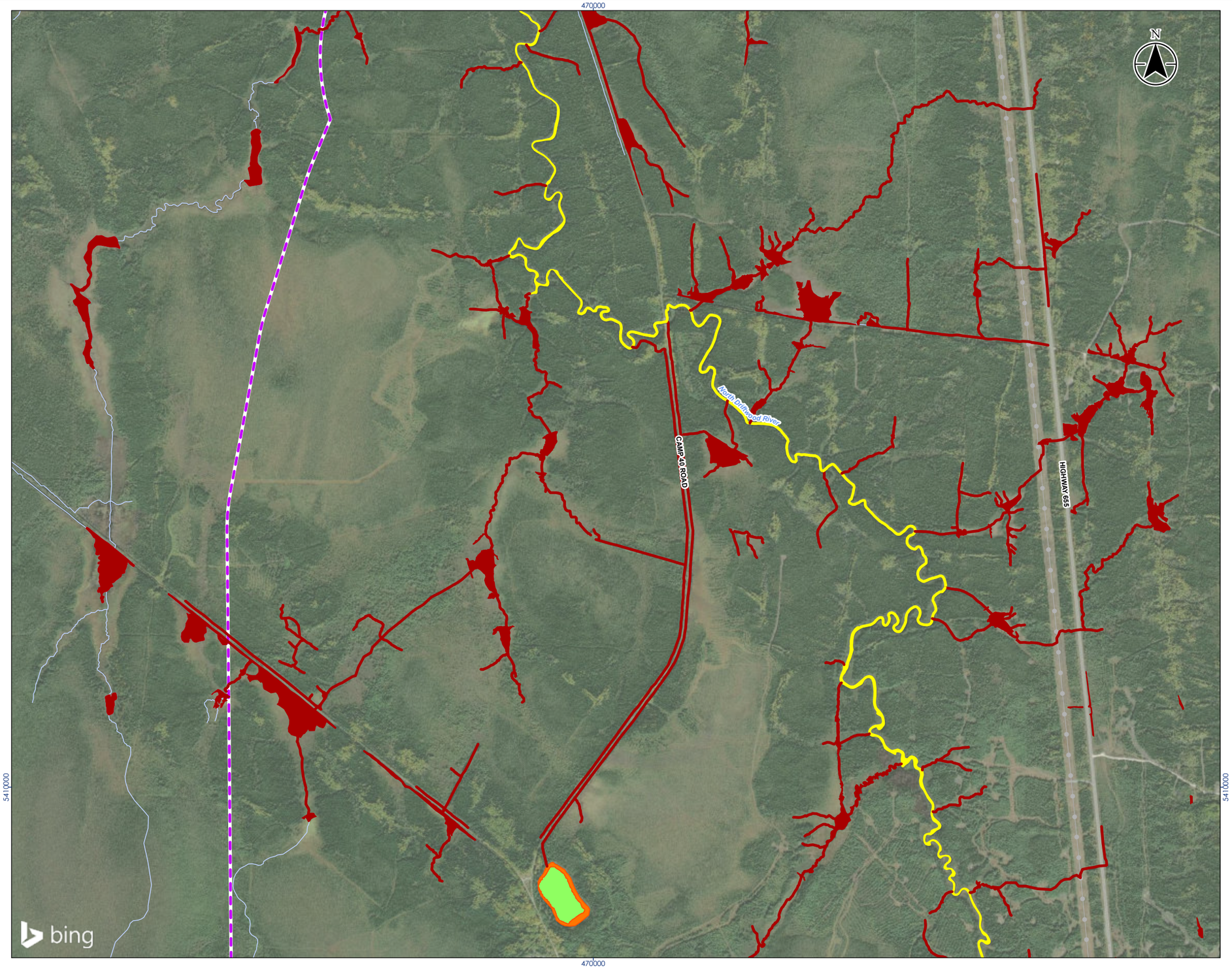

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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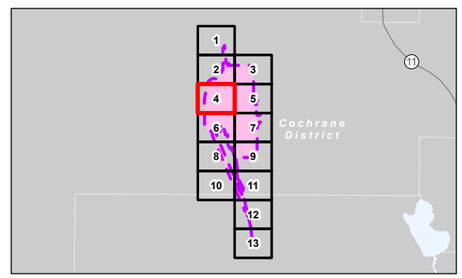

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.4

Title
Northern Pike Overwintering Habitat

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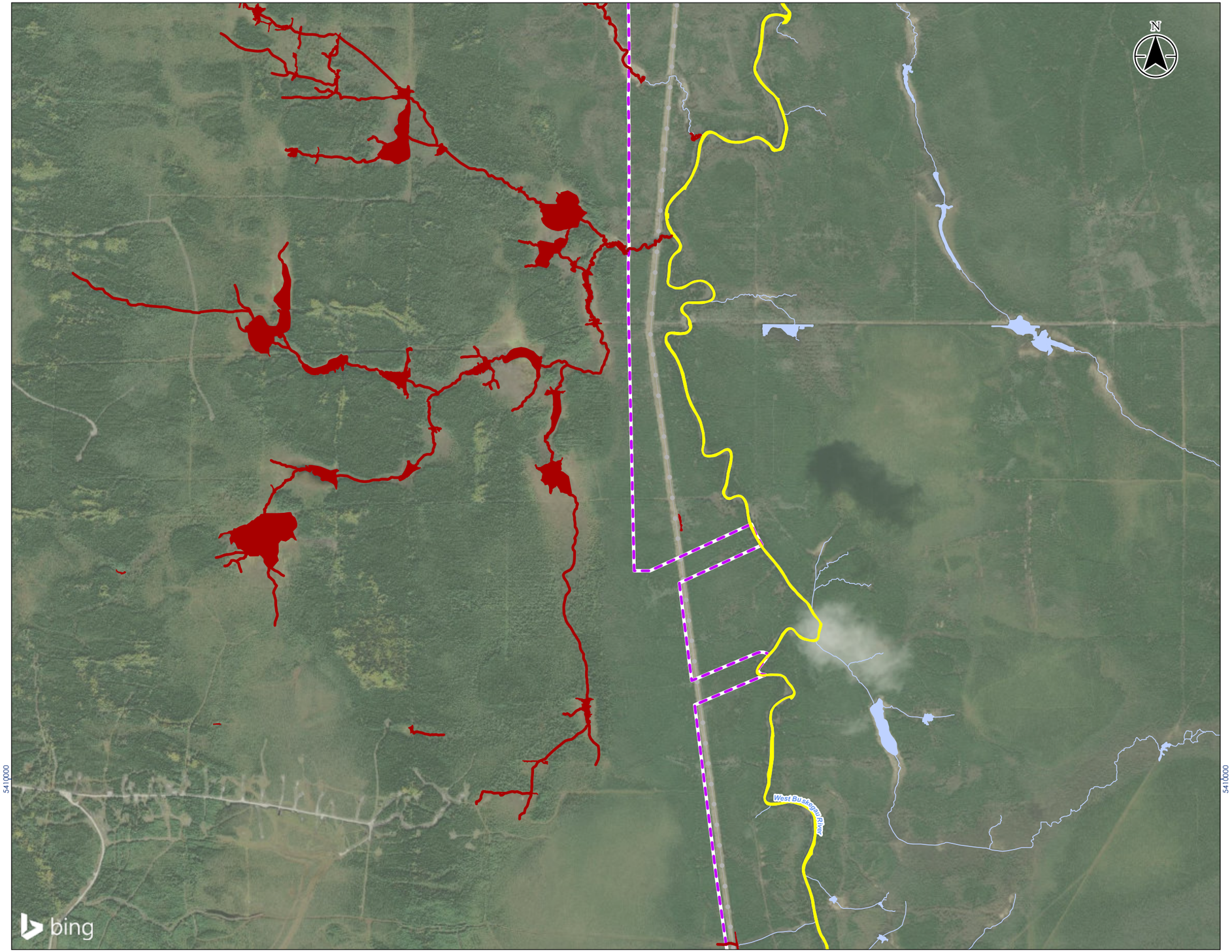

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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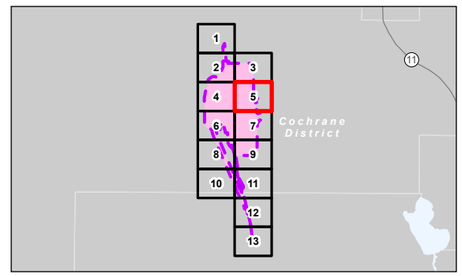

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.5

Title
Northern Pike Overwintering Habitat

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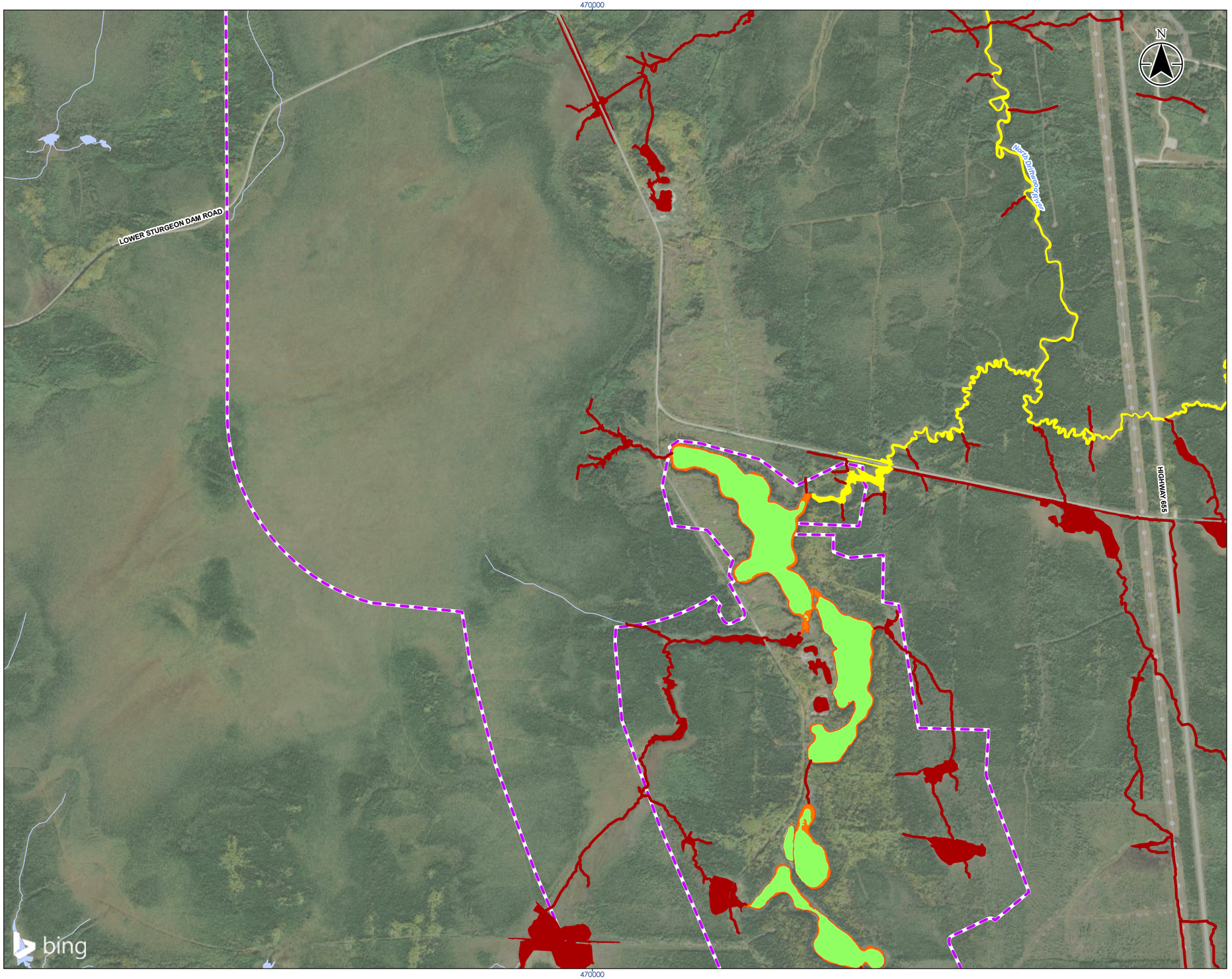

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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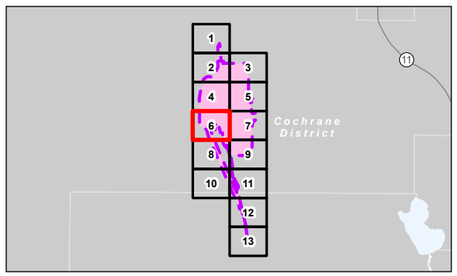

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.6

Title
Northern Pike Overwintering Habitat

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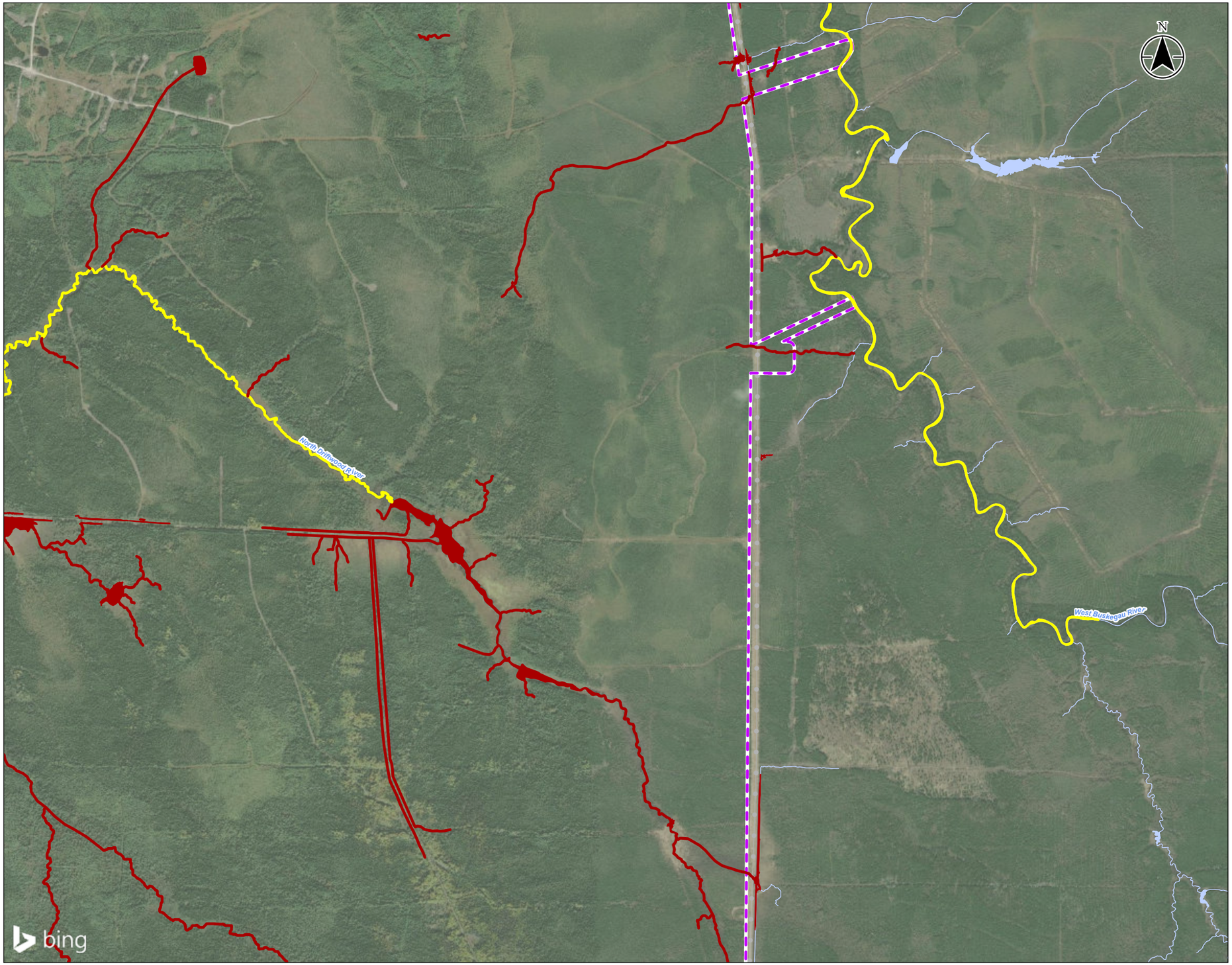

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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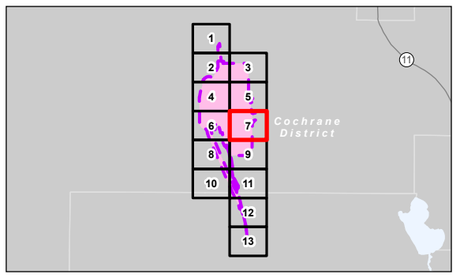

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.7

Title
Northern Pike Overwintering Habitat

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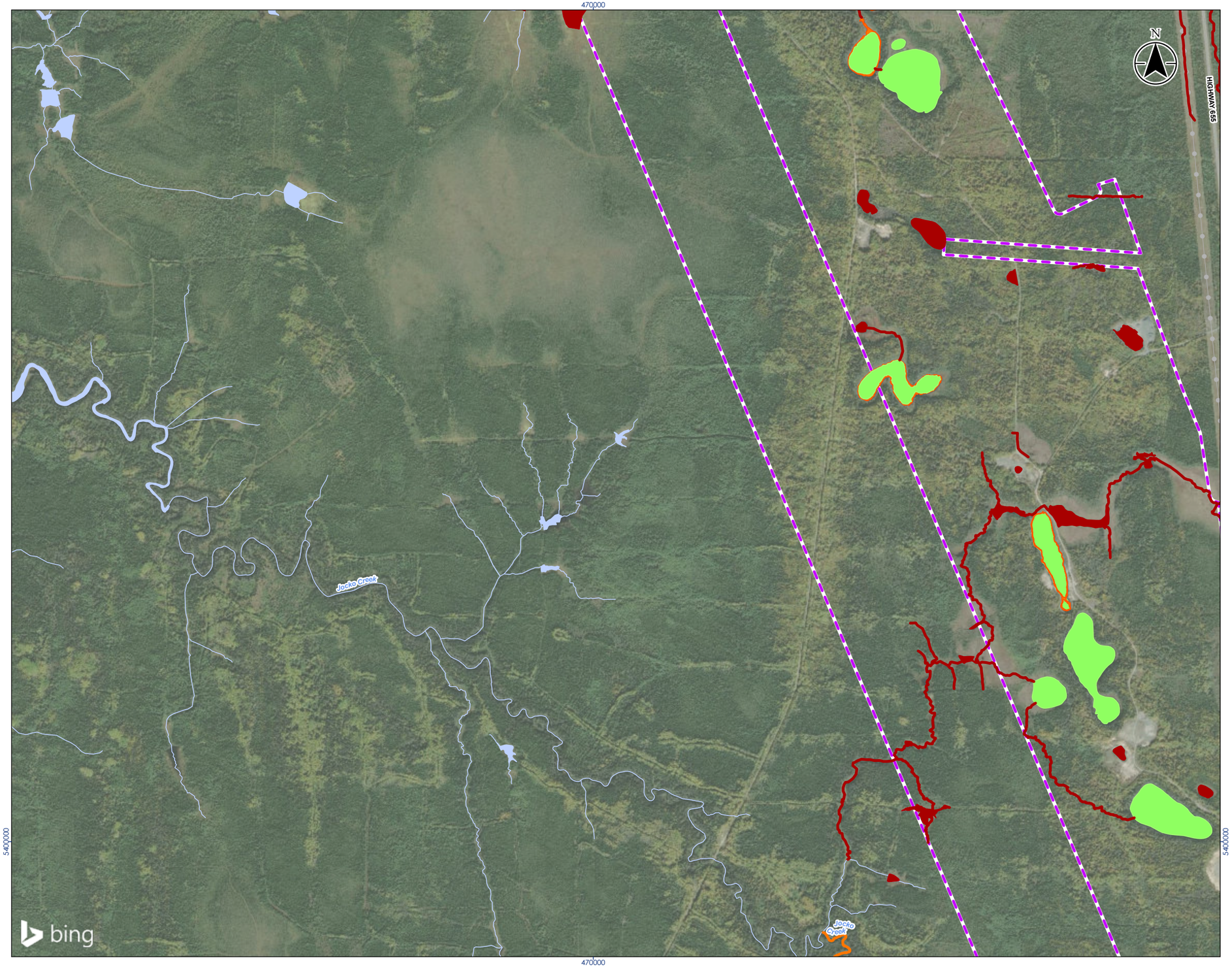

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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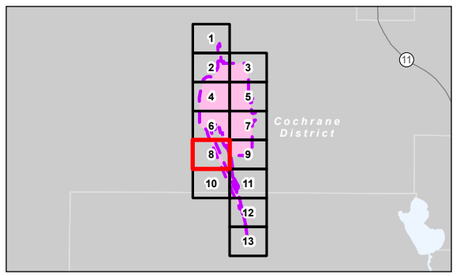

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.8

Title
Northern Pike Overwintering Habitat

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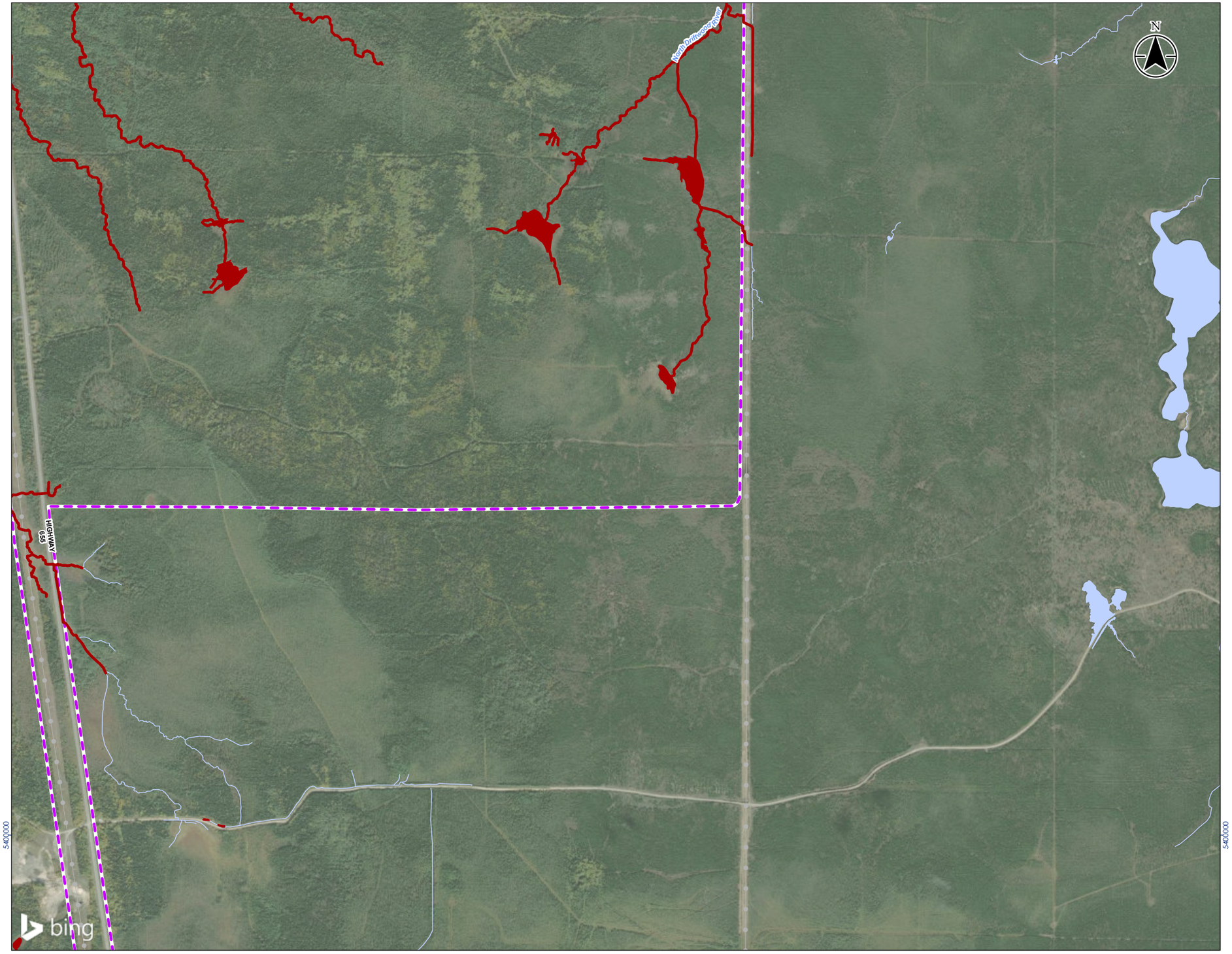

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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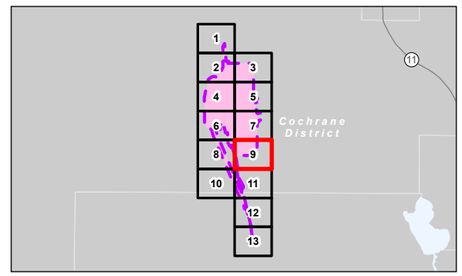

Project Location
Timmins, Ontario

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Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.9

Title
Northern Pike Overwintering Habitat

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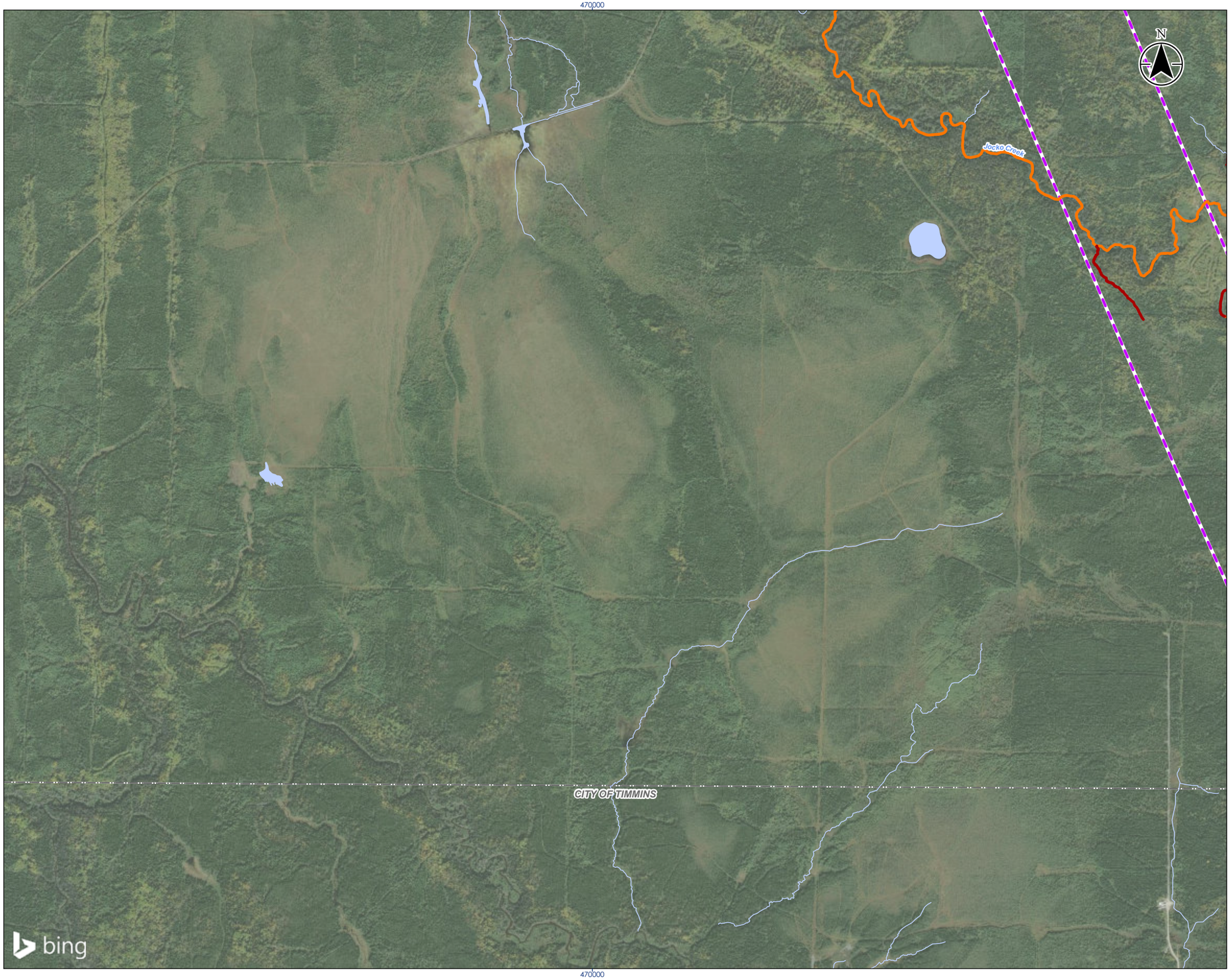

Stantec

Legend

- Project Area
- Municipal Boundary - Lower Tier
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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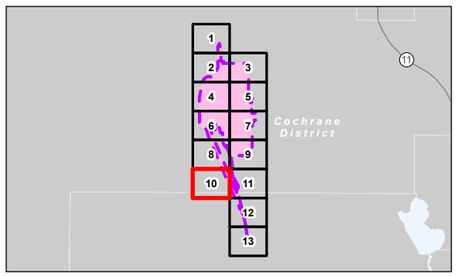

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.10

Title
Northern Pike Overwintering Habitat

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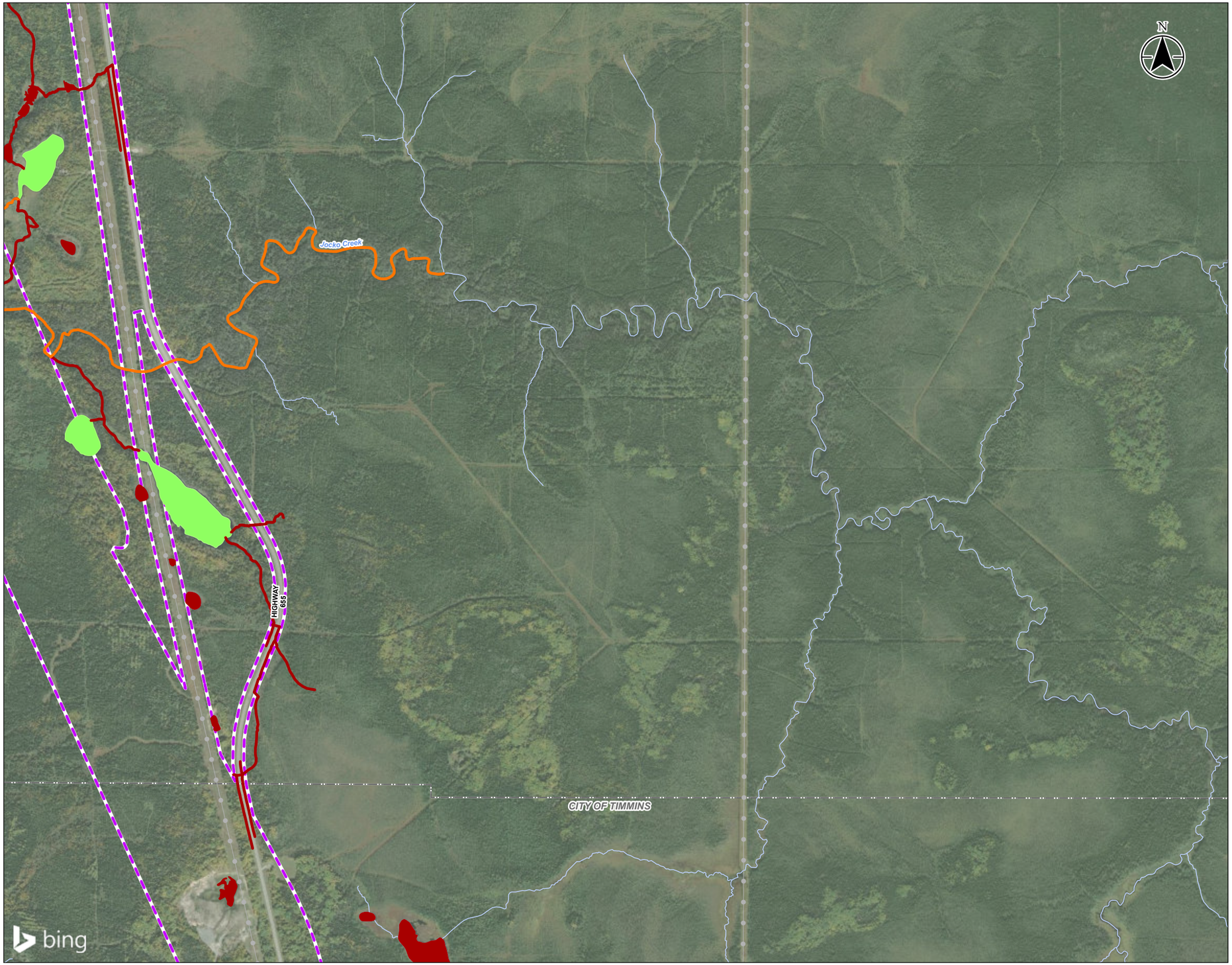

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Municipal Boundary - Lower Tier
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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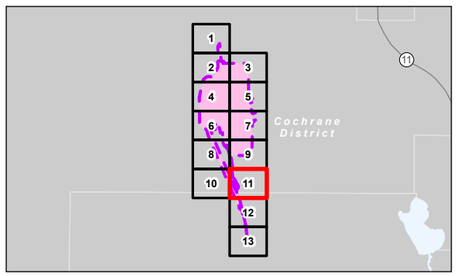

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.11

Title
Northern Pike Overwintering Habitat

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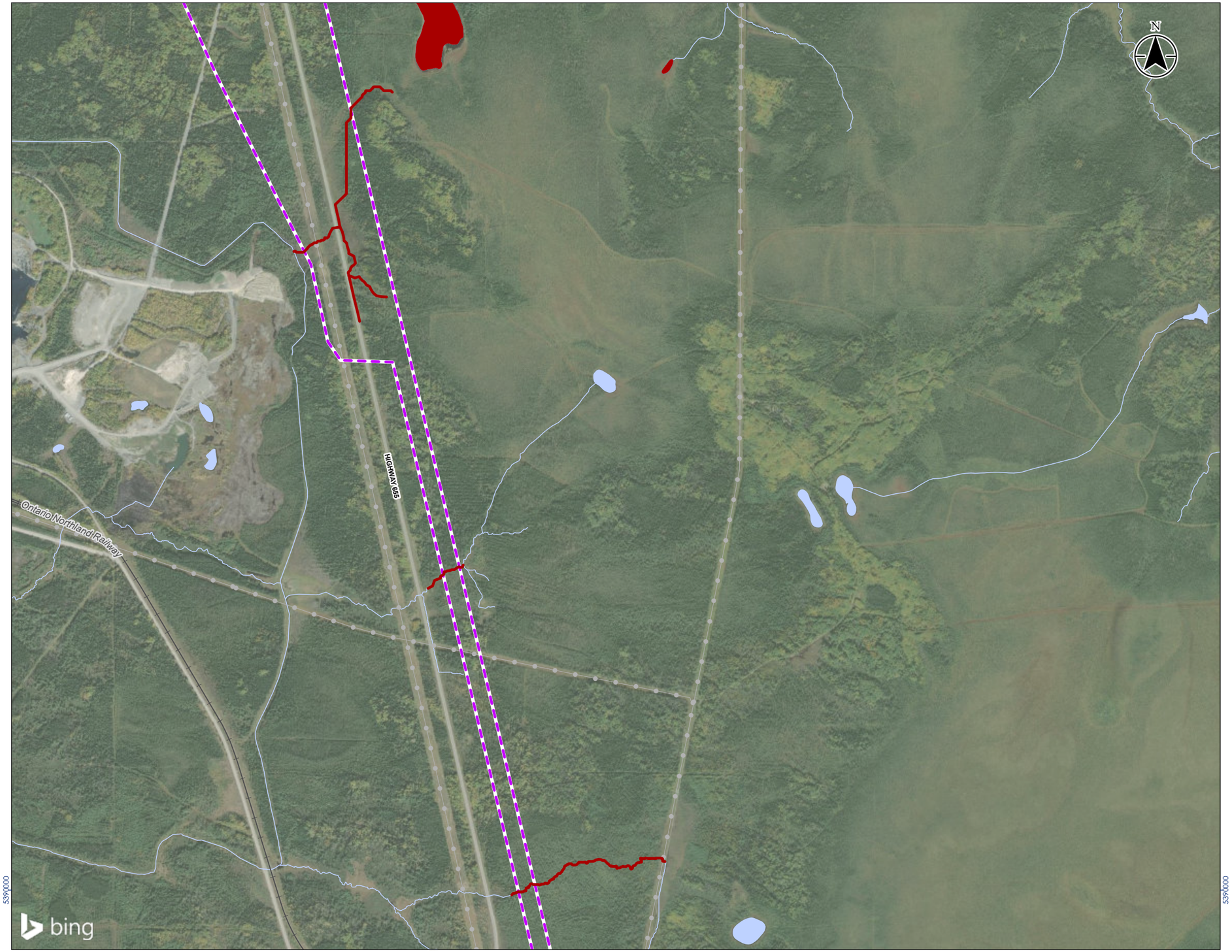

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Municipal Boundary - Lower Tier
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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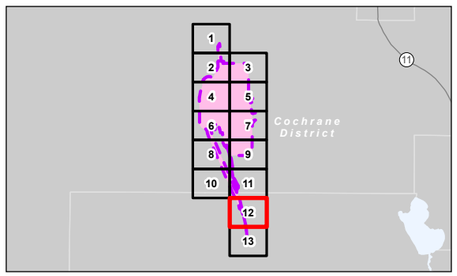

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.12

Title
Northern Pike Overwintering Habitat

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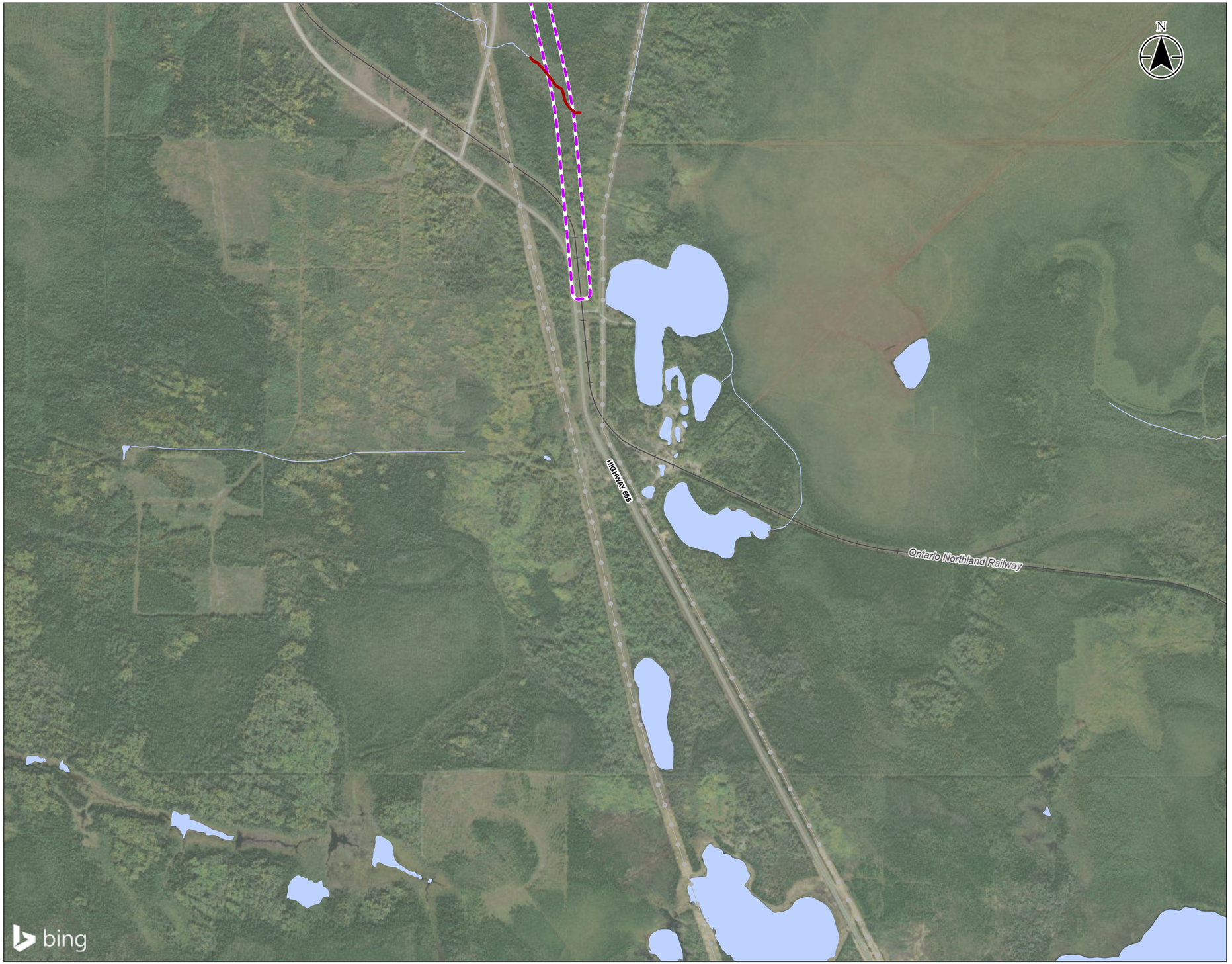

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Municipal Boundary - Lower Tier
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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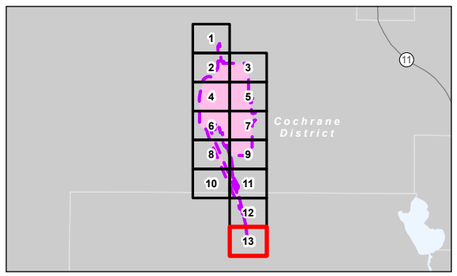

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.13.13

Title
Northern Pike Overwintering Habitat

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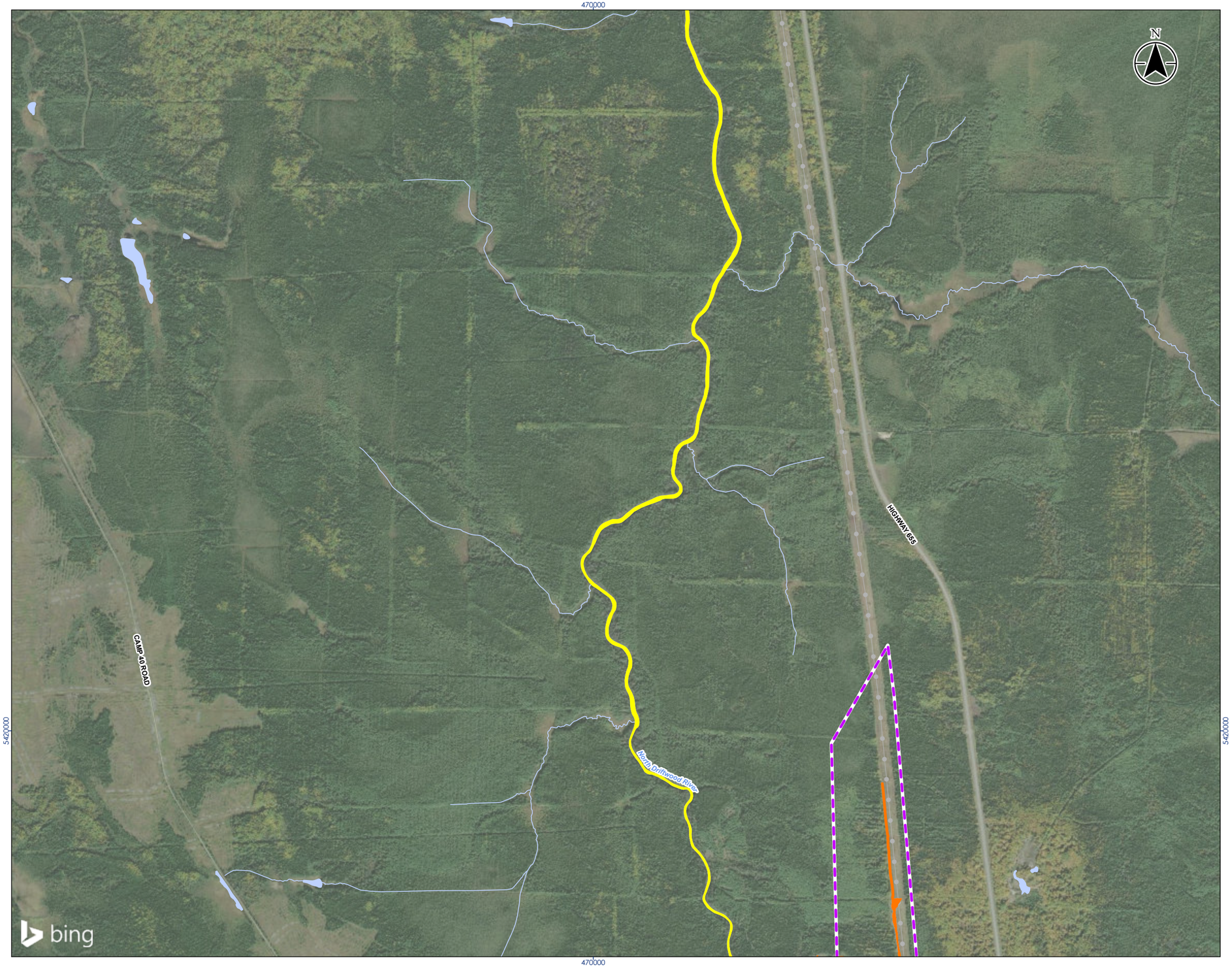

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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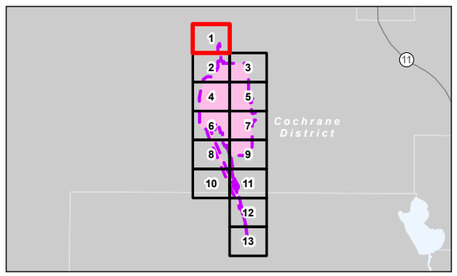

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.1

Title
White Sucker Adult Habitat

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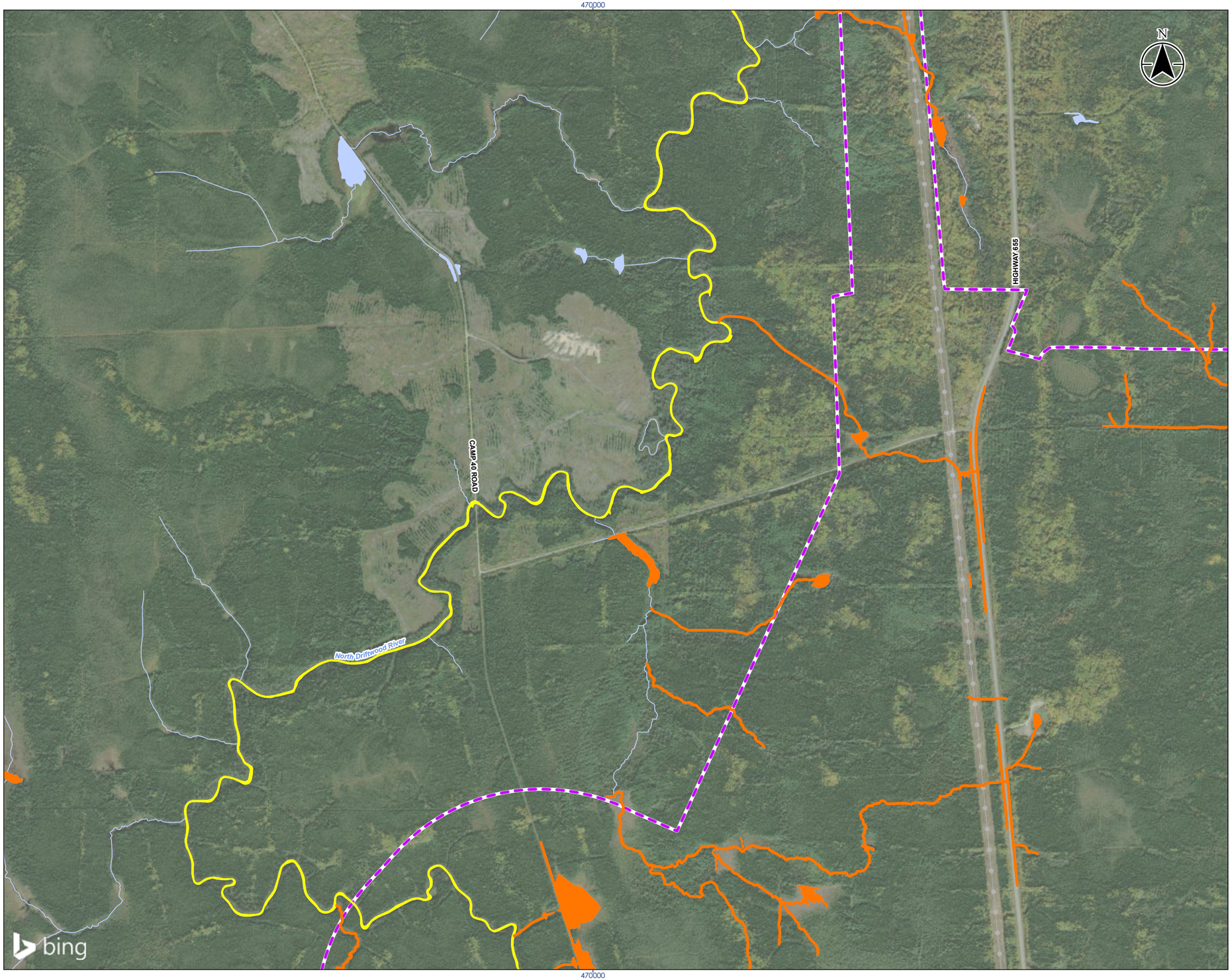

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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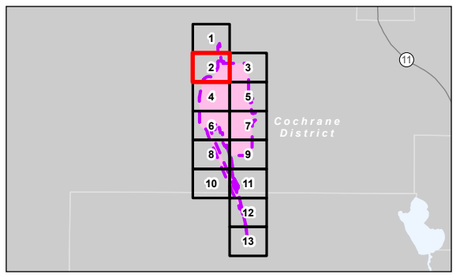

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.2

Title
White Sucker Adult Habitat

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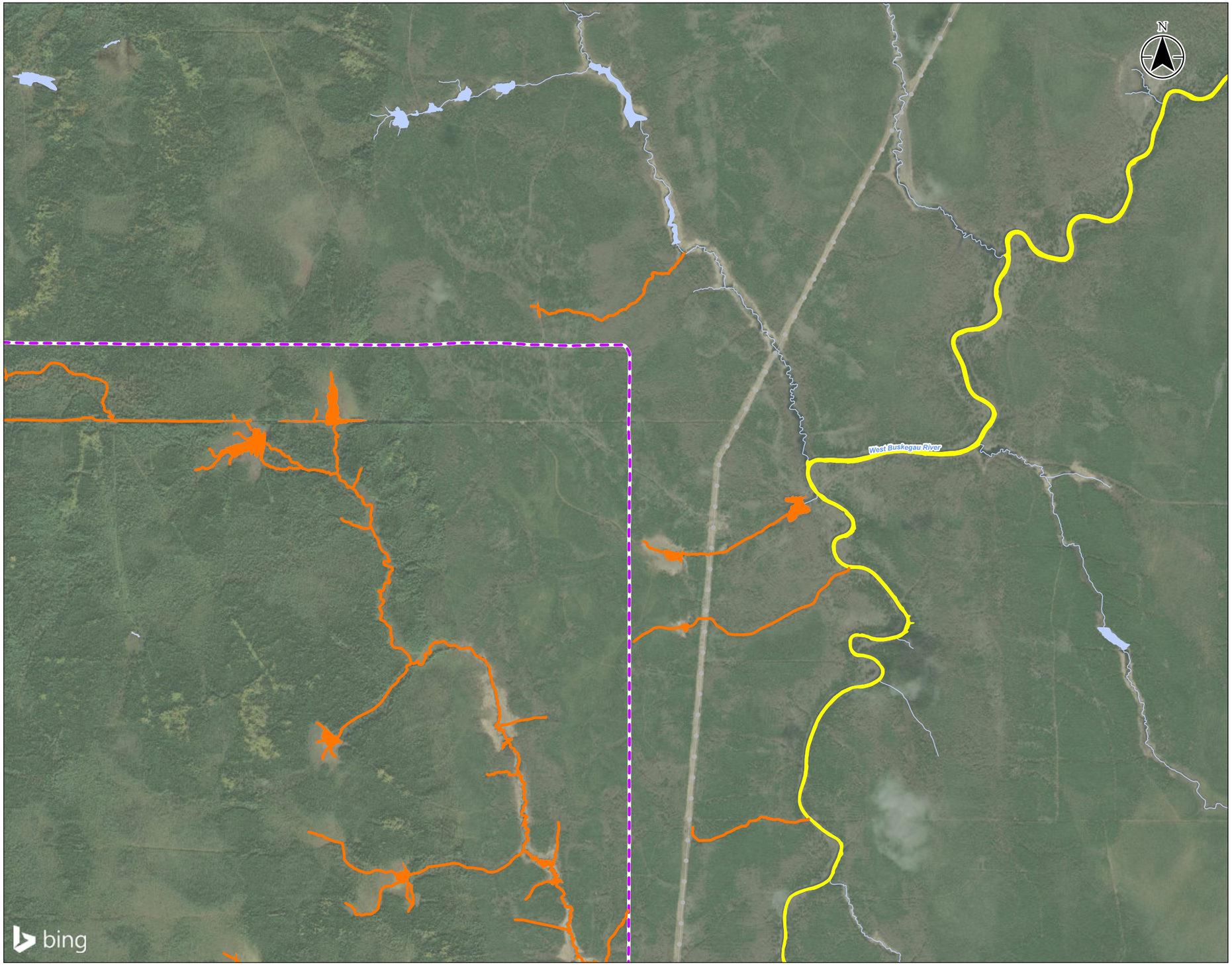

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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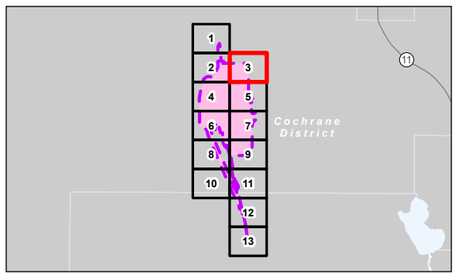

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.3

Title
White Sucker Adult Habitat

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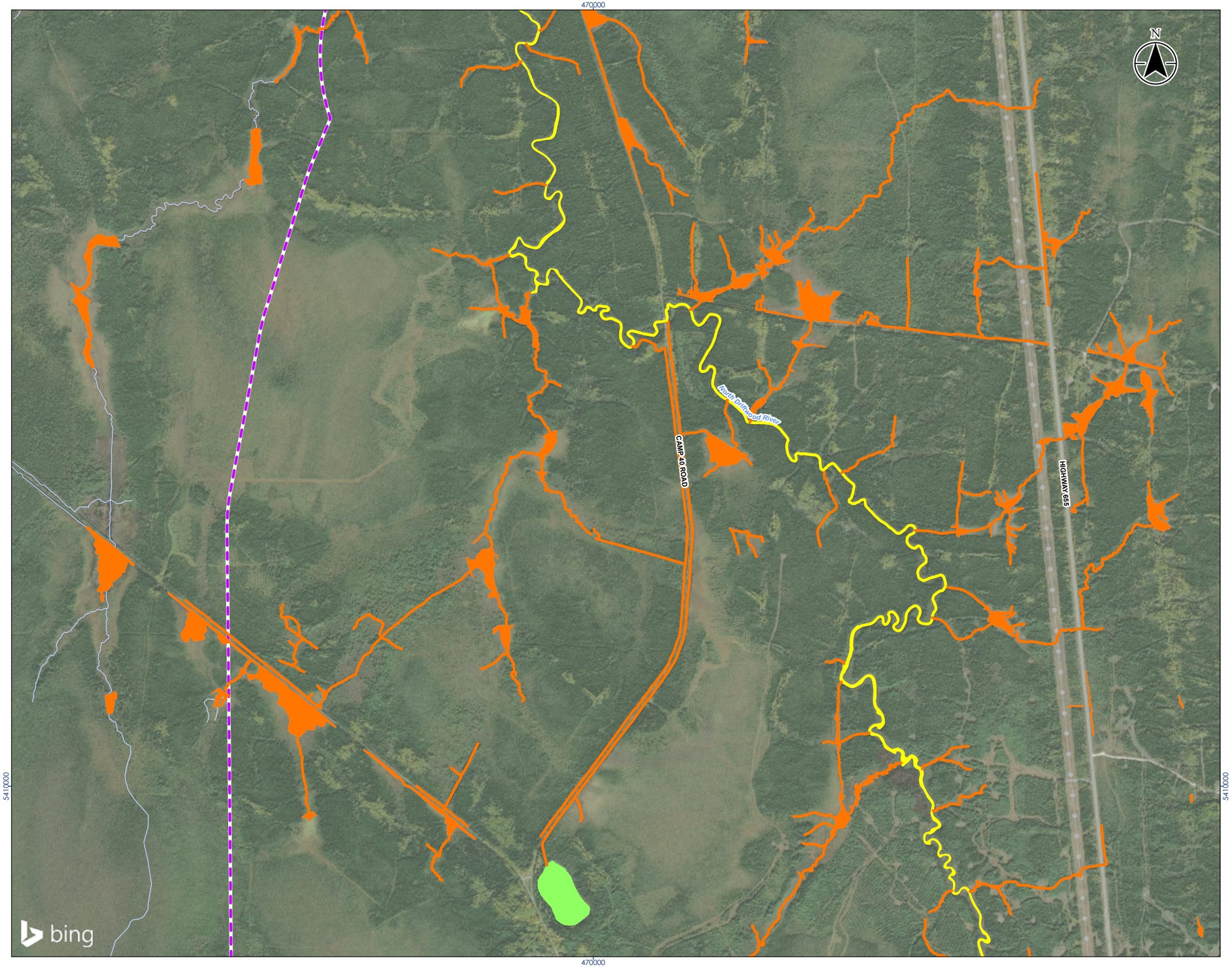

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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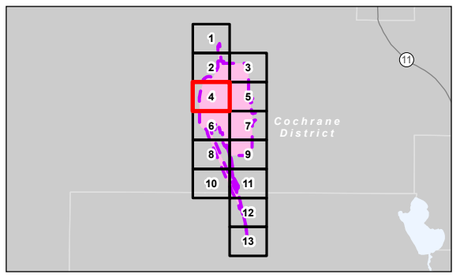

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.4

Title
White Sucker Adult Habitat

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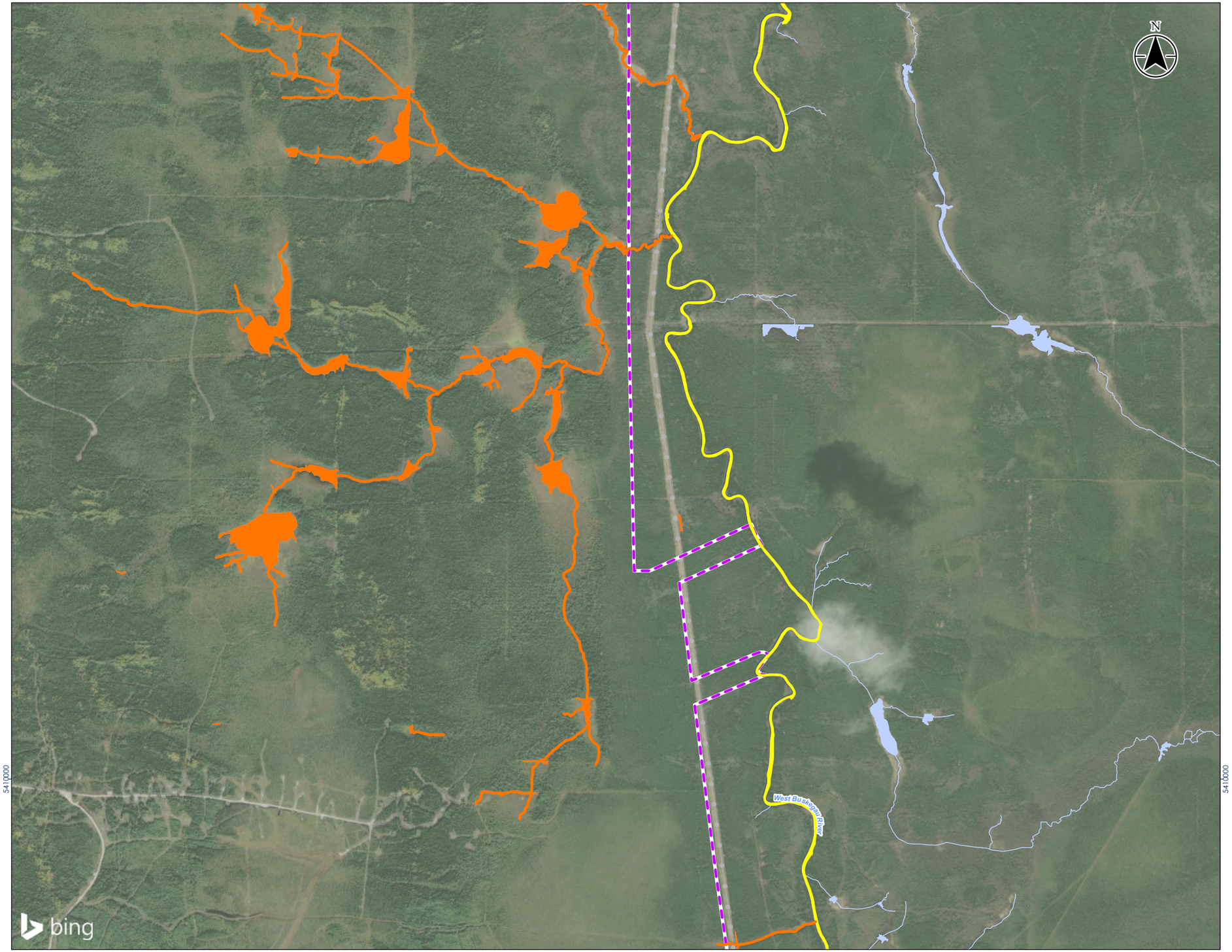

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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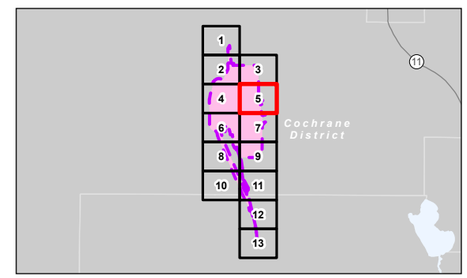

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.5

Title
White Sucker Adult Habitat

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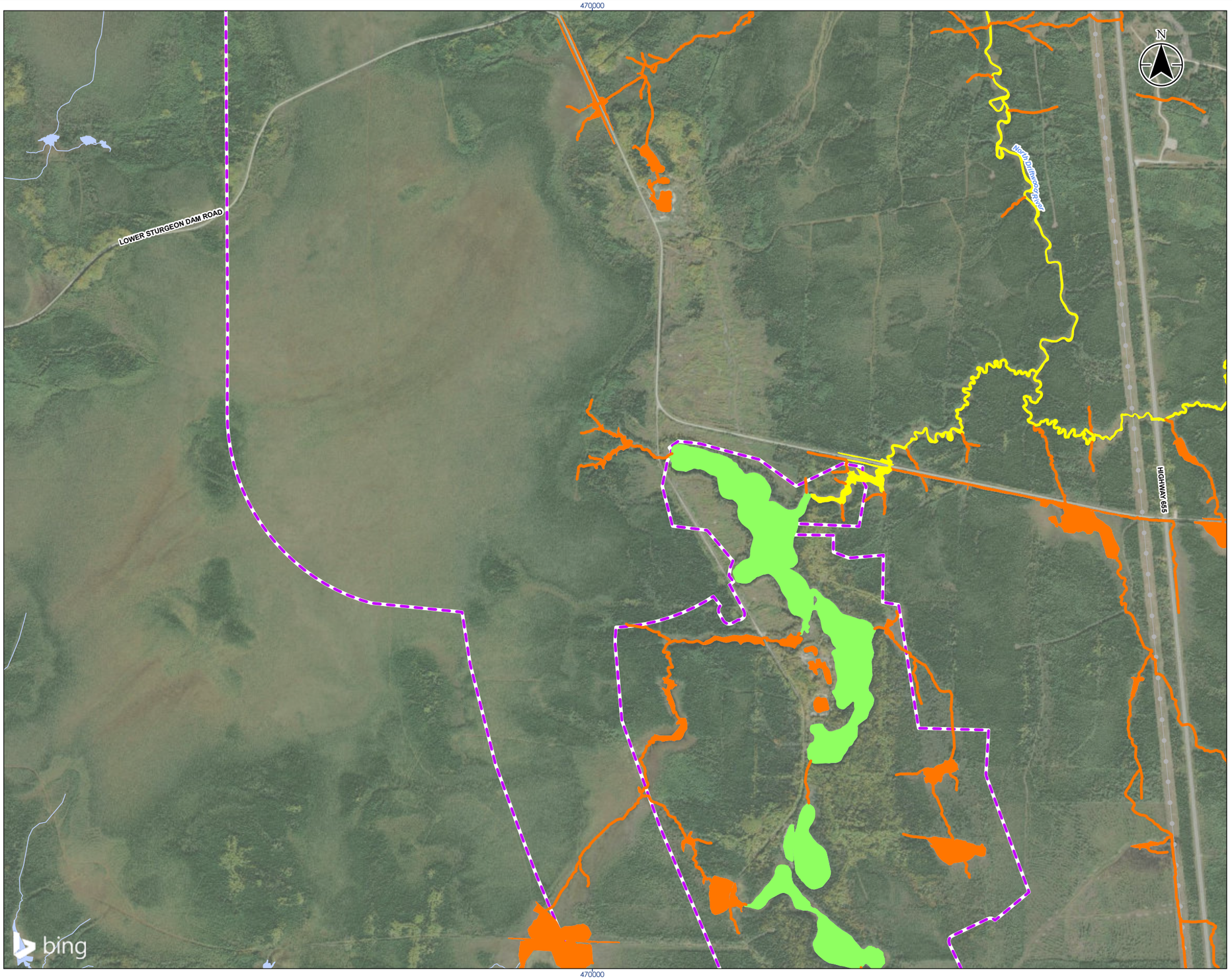

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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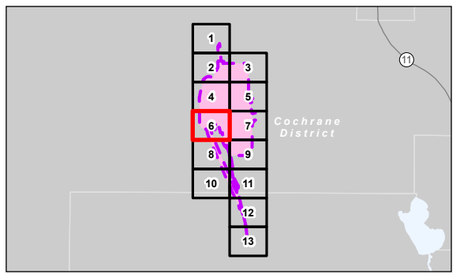

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.6

Title
White Sucker Adult Habitat

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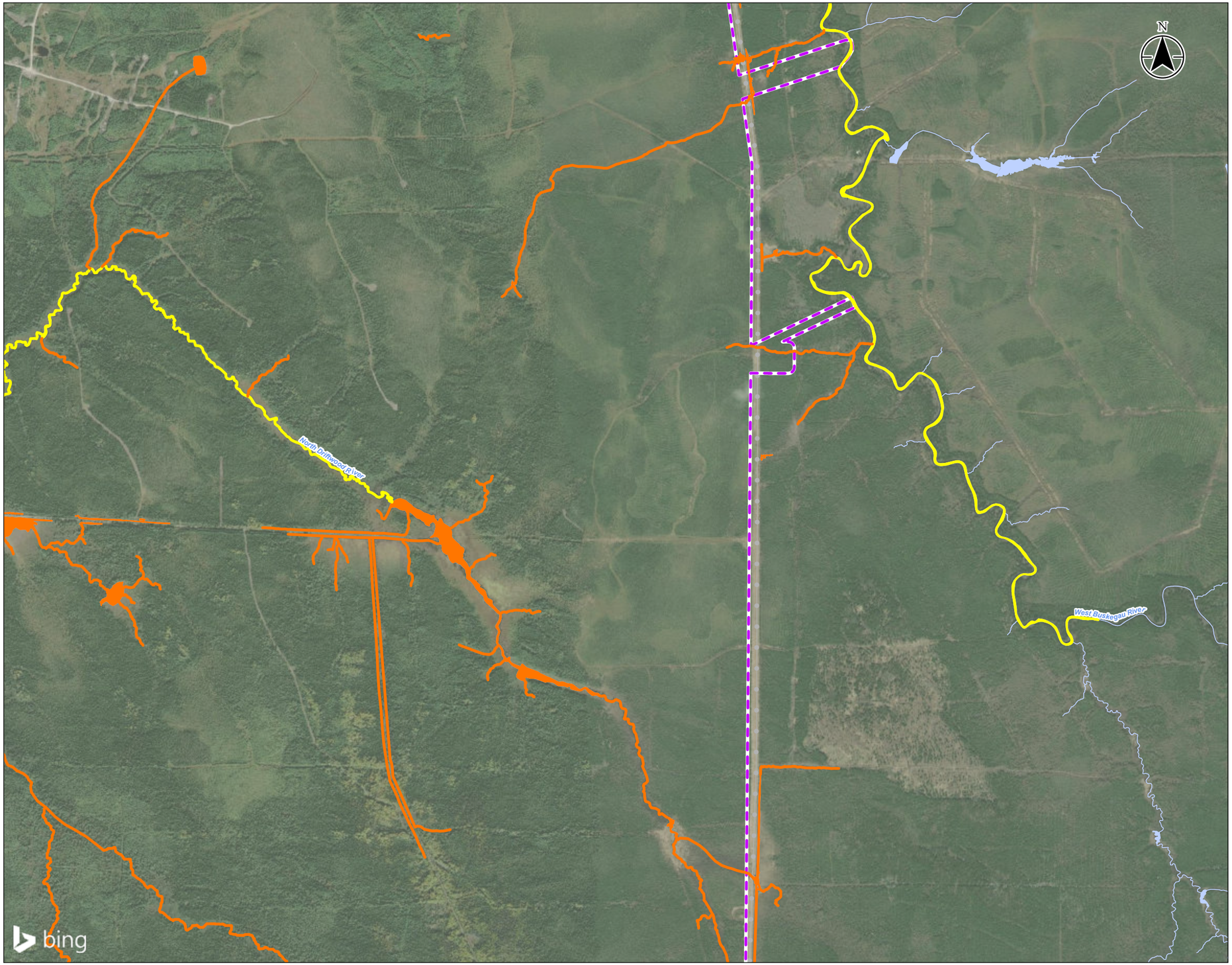

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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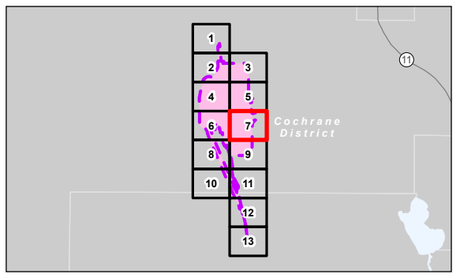

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.7

Title
White Sucker Adult Habitat

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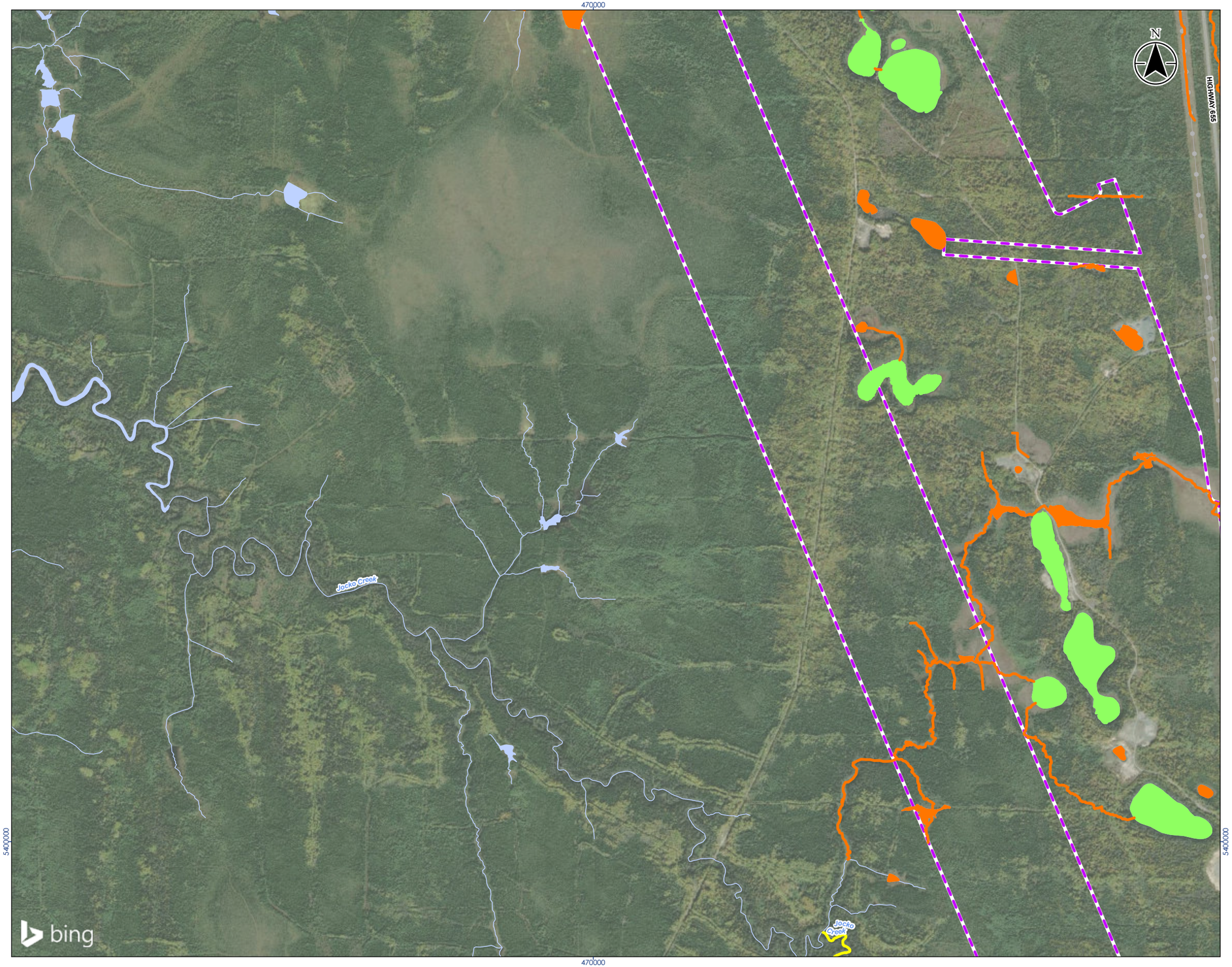

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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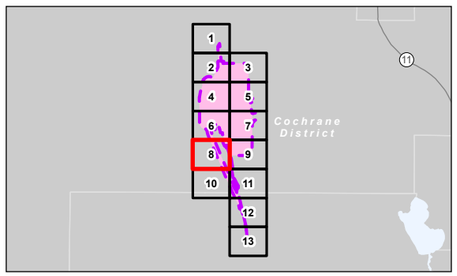

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.8

Title
White Sucker Adult Habitat

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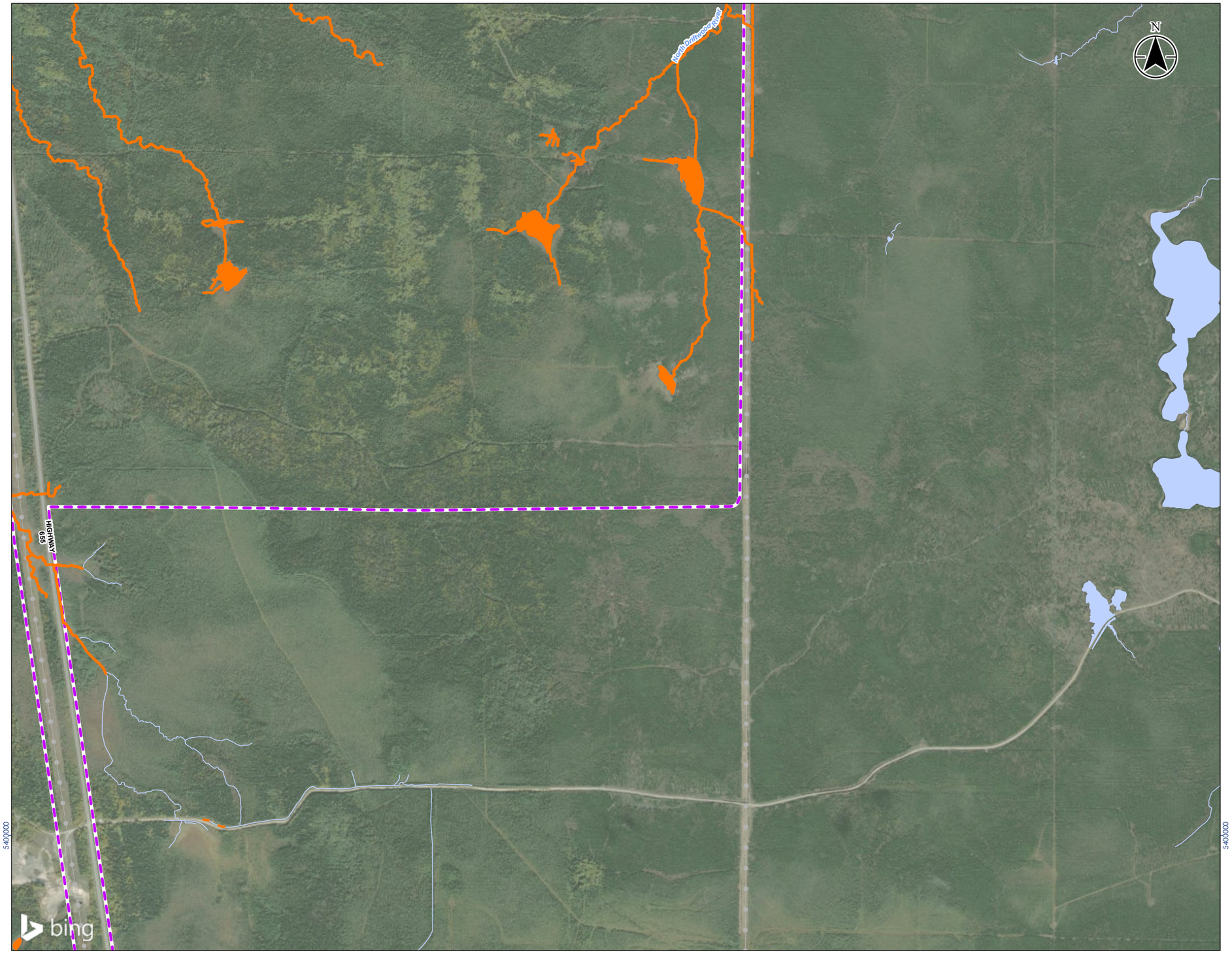

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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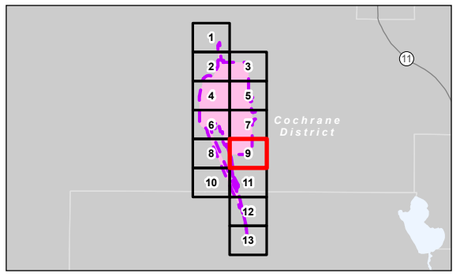

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.9

Title
White Sucker Adult Habitat

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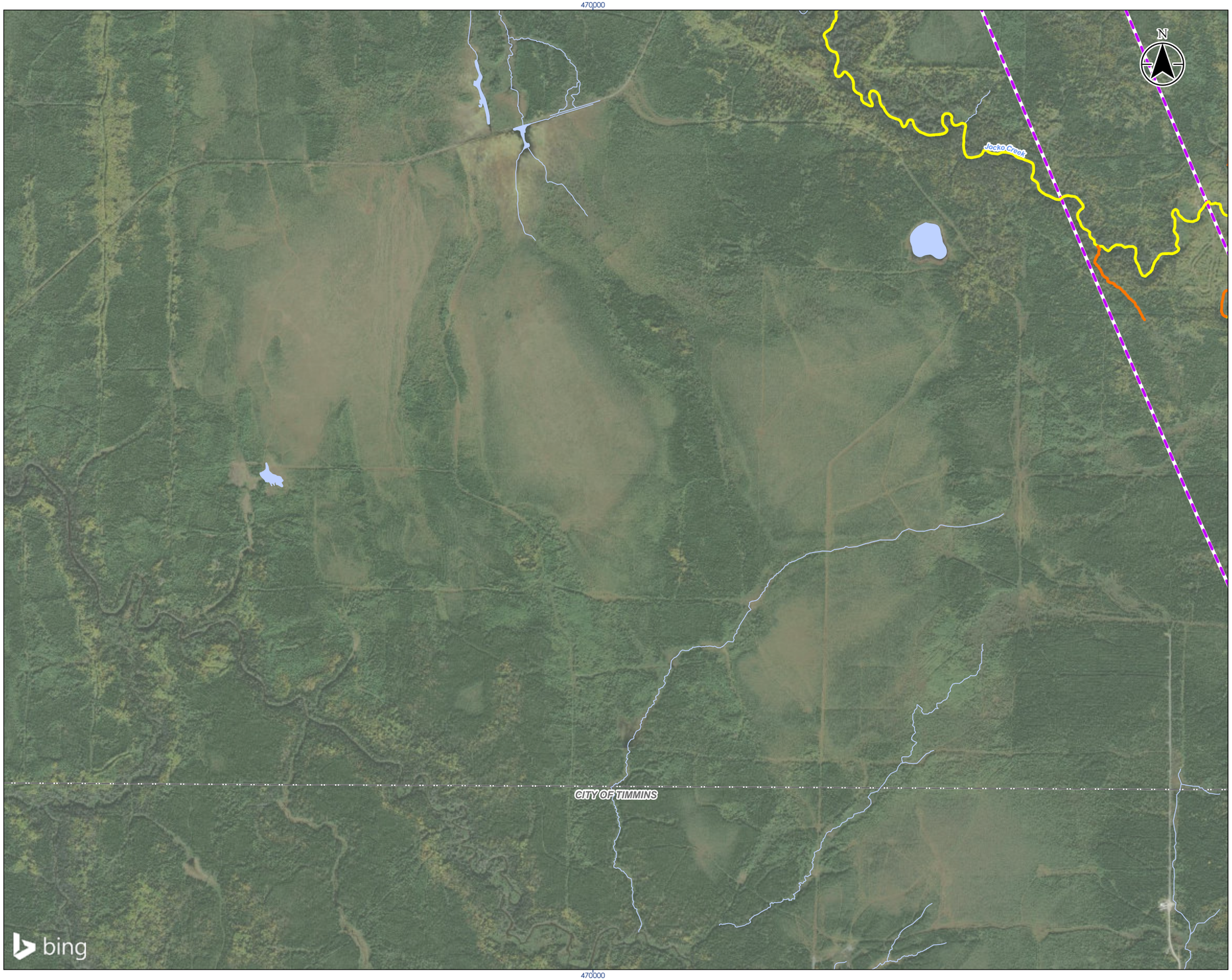

Stantec

Legend

- Project Area
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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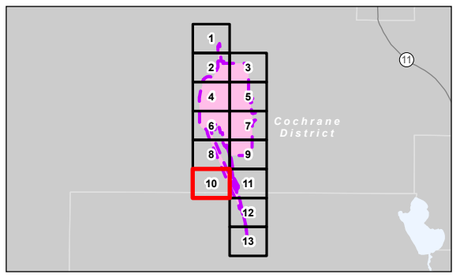

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.10

Title
White Sucker Adult Habitat

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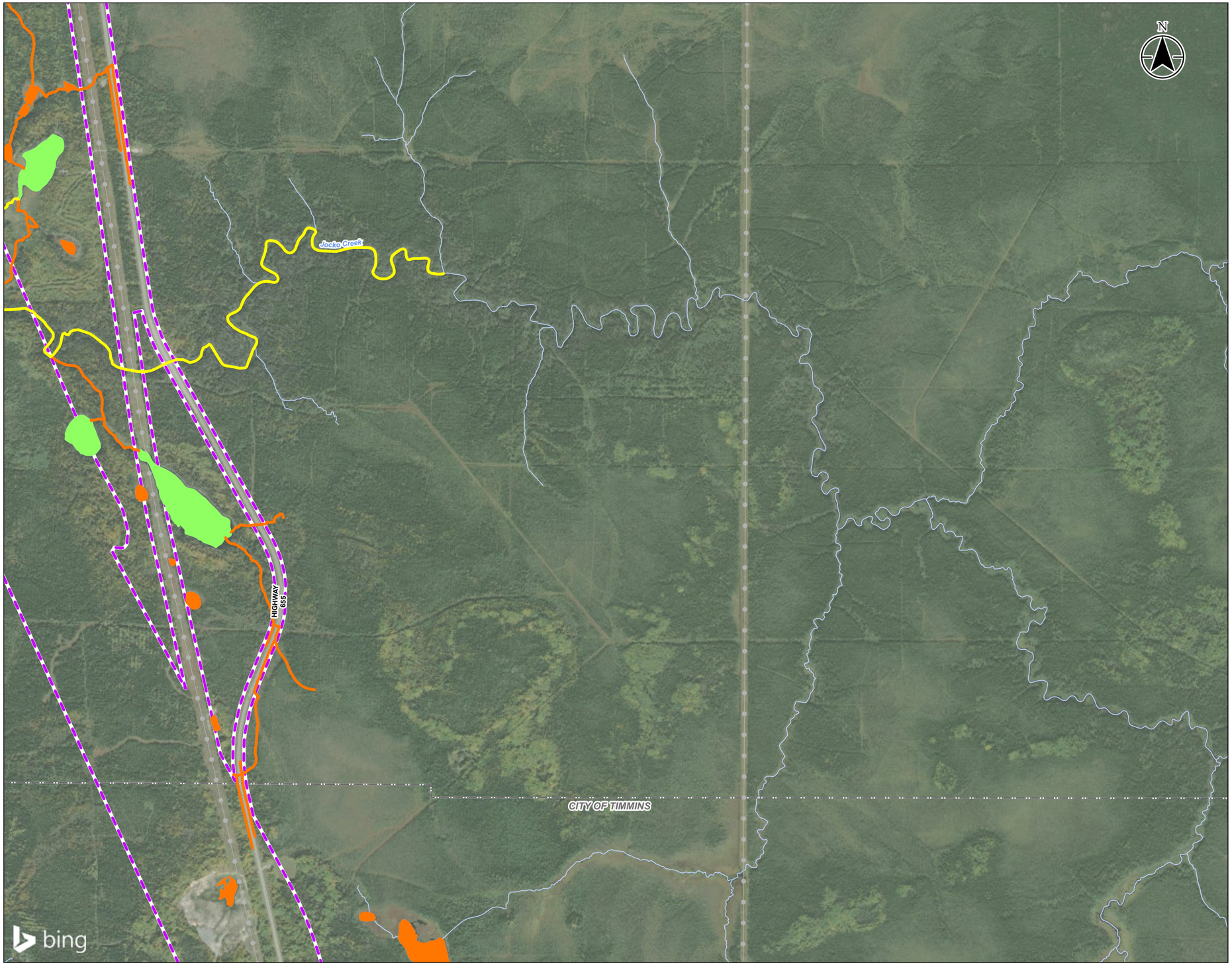

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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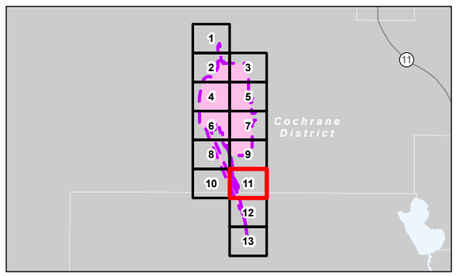

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.11

Title
White Sucker Adult Habitat

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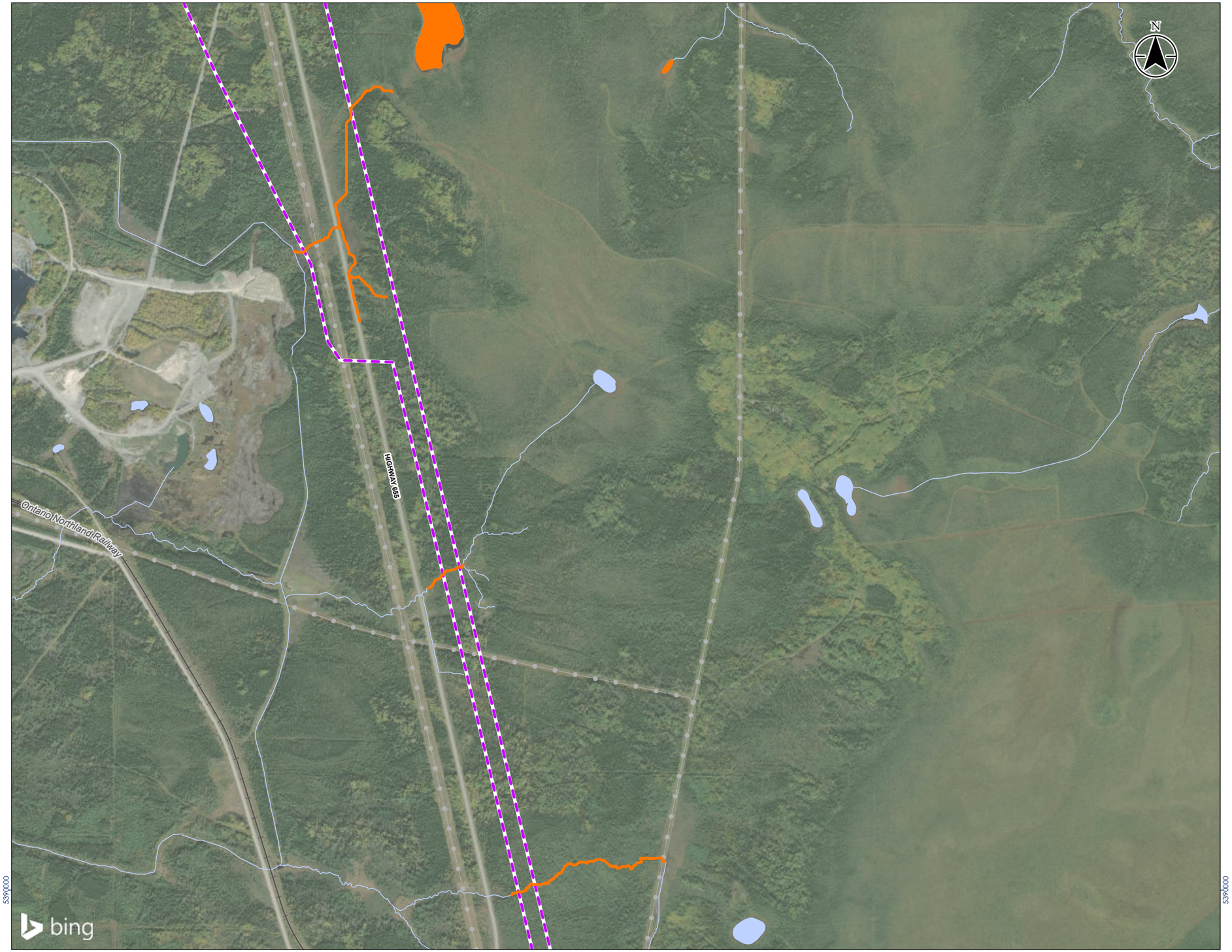

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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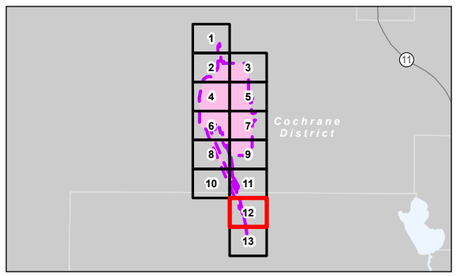

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.12

Title
White Sucker Adult Habitat

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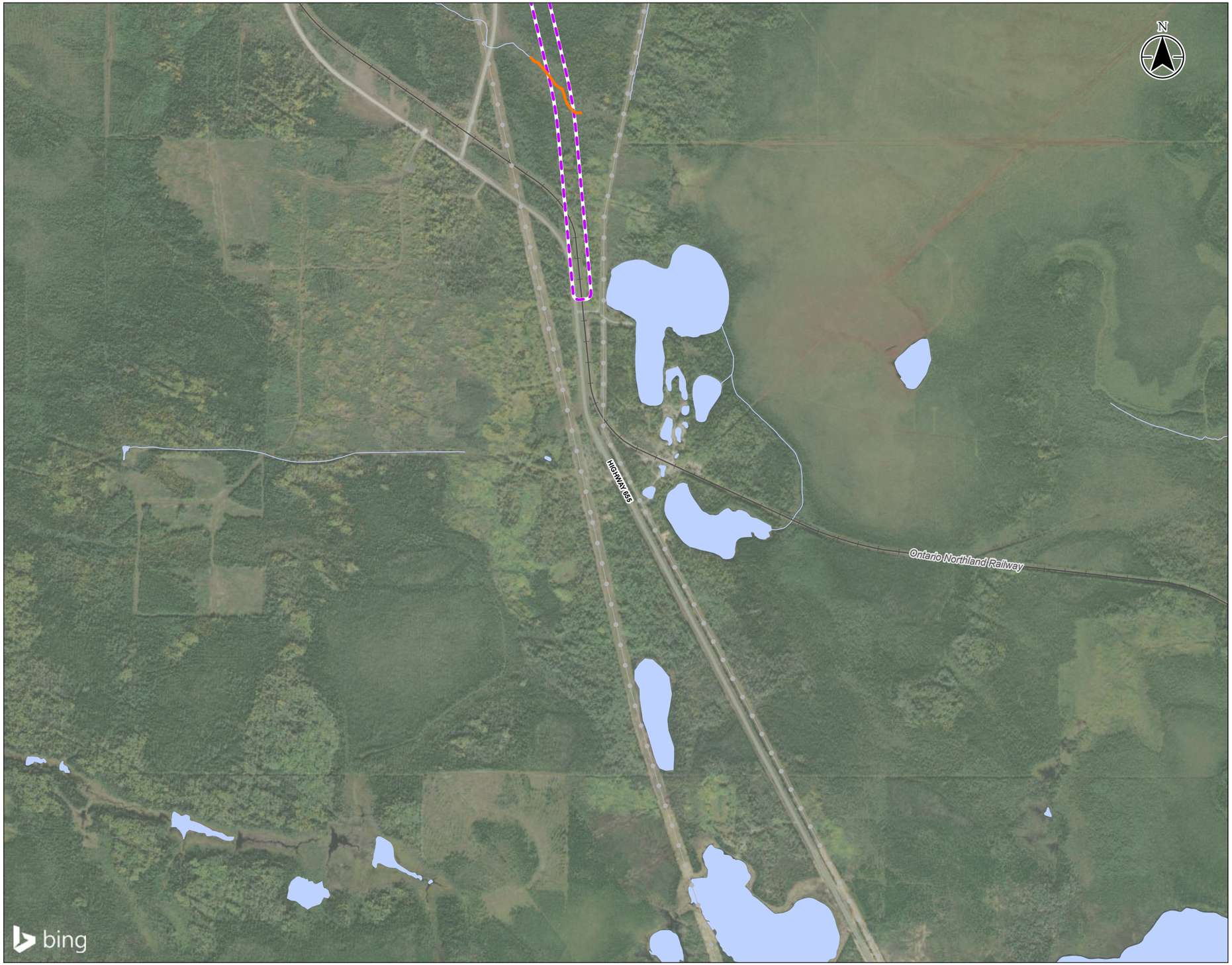

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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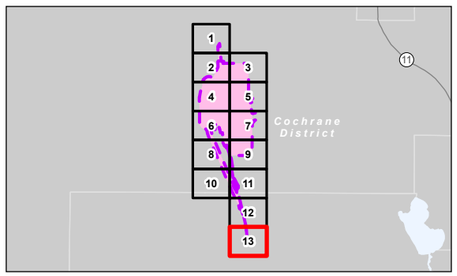

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.14.13

Title
White Sucker Adult Habitat

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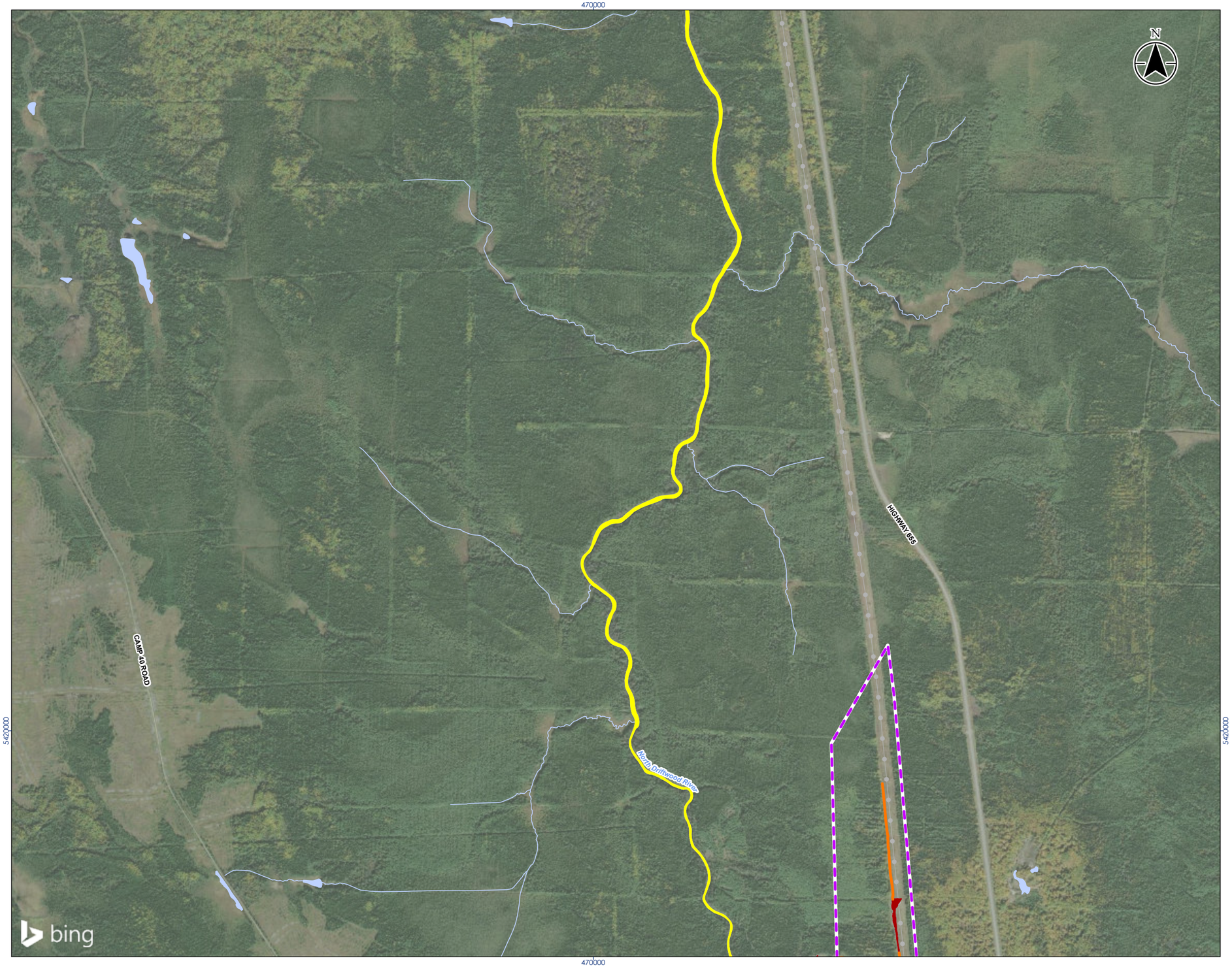

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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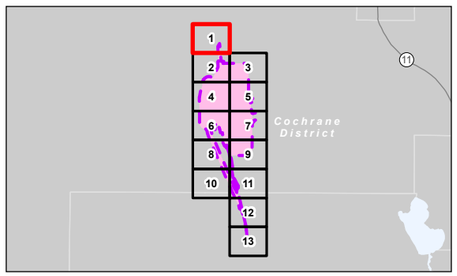

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.1

Title
White Sucker Spawning/Rearing Habitat

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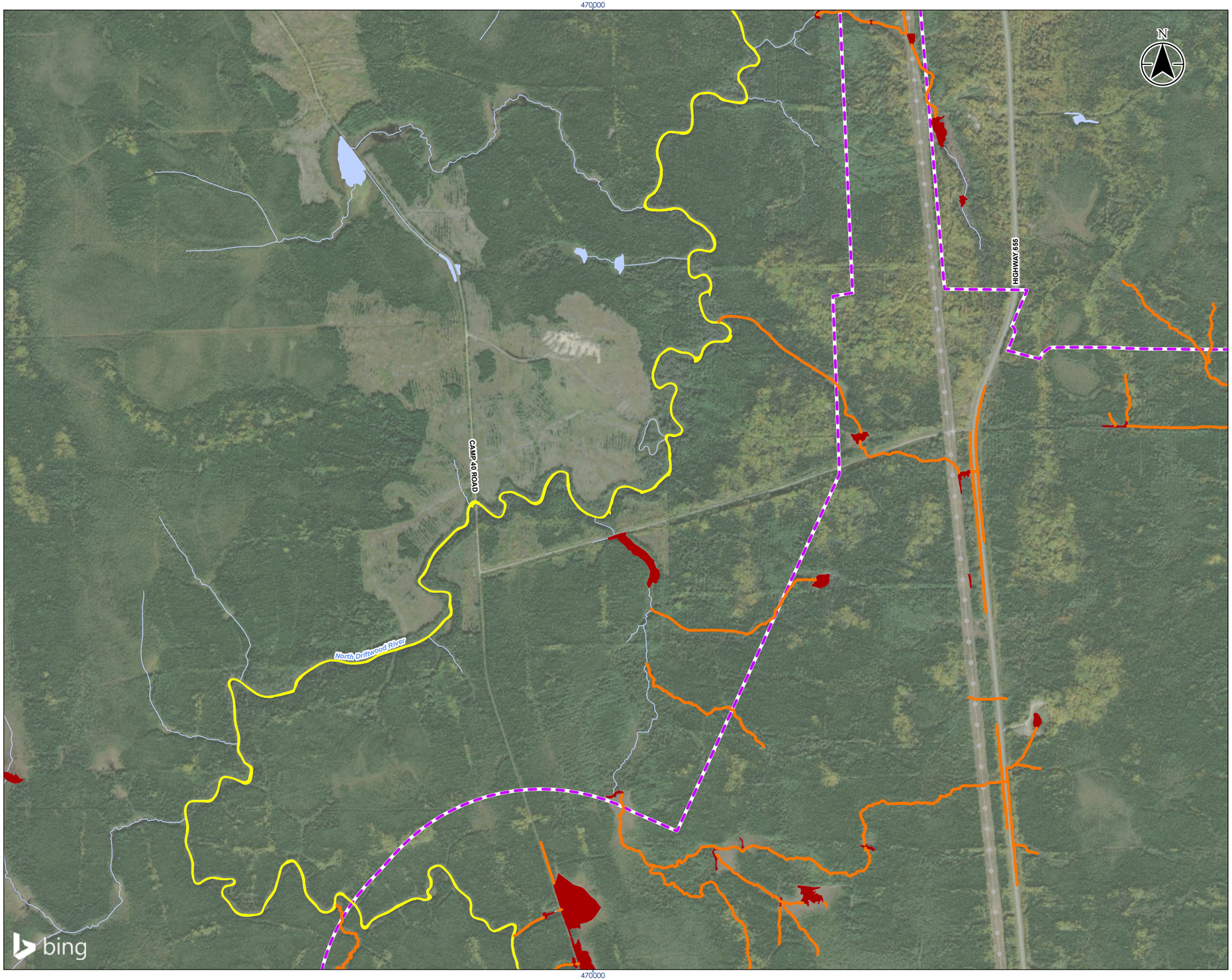

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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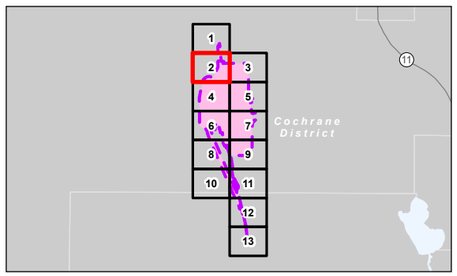

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.2

Title
White Sucker Spawning/Rearing Habitat

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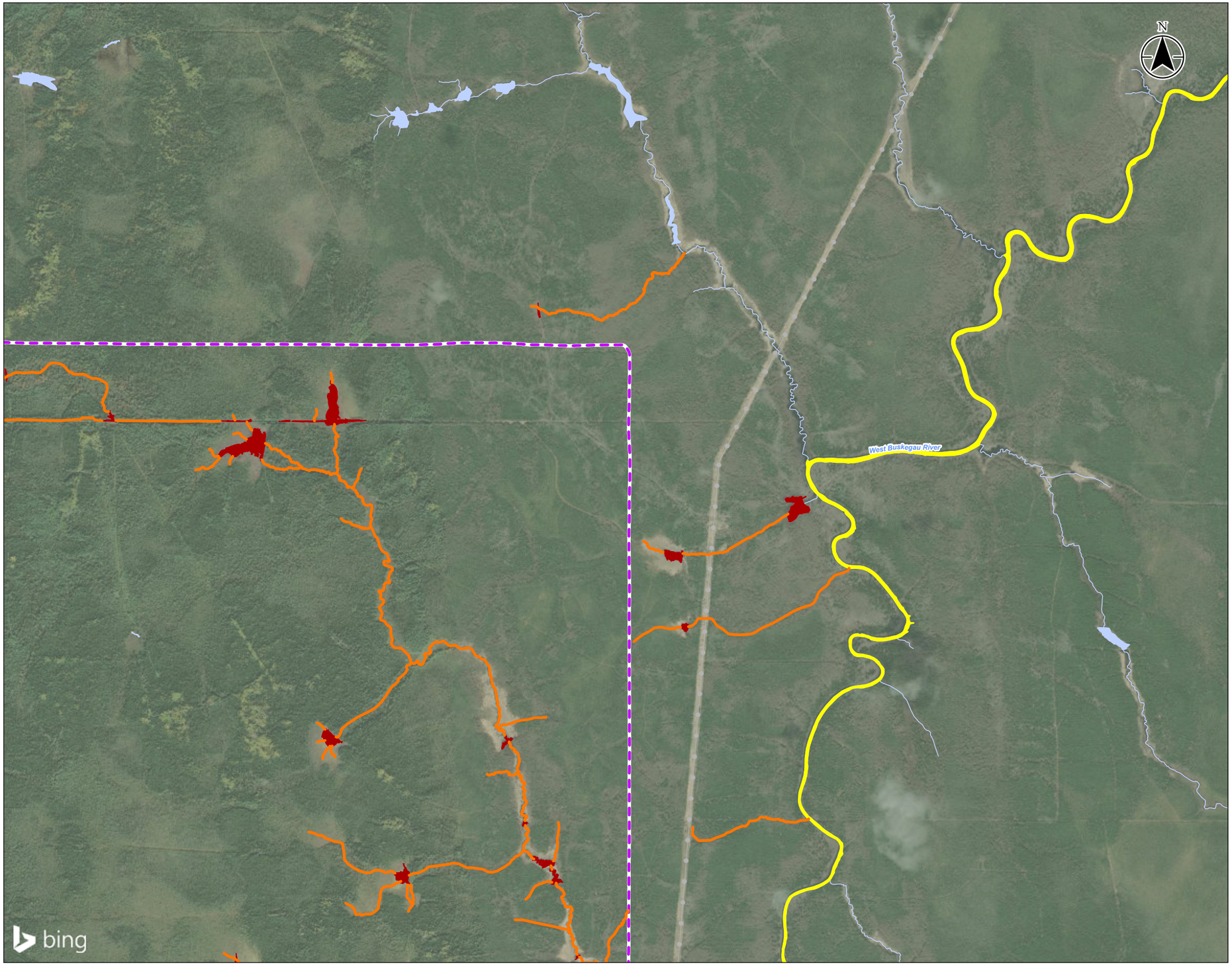

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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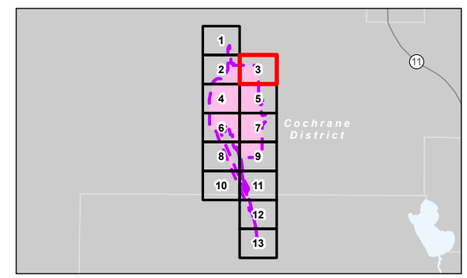

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.3

Title
White Sucker Spawning/Rearing Habitat

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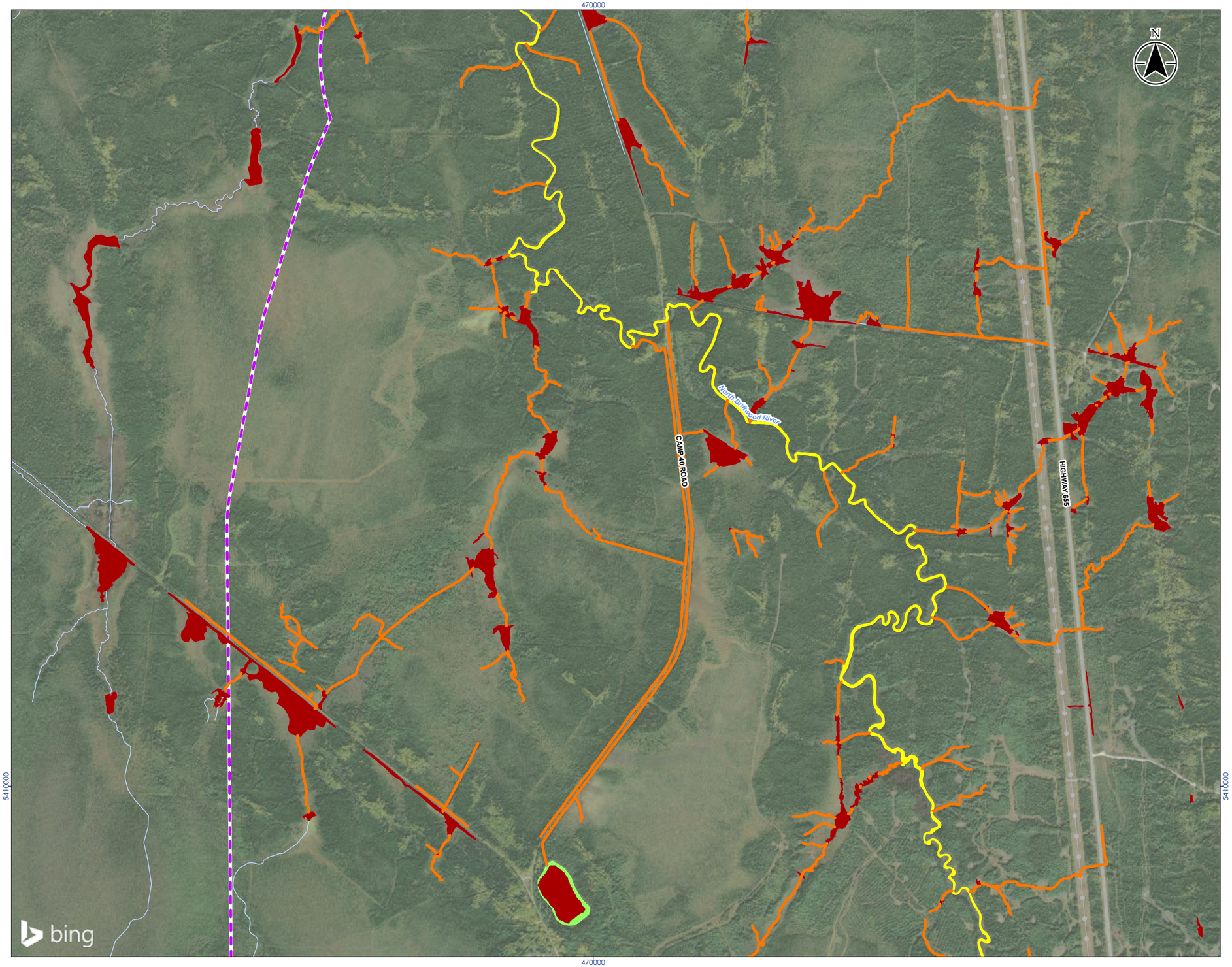

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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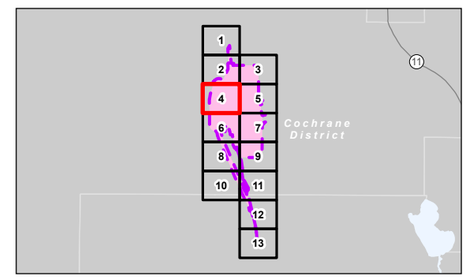

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.4

Title
White Sucker Spawning/Rearing Habitat

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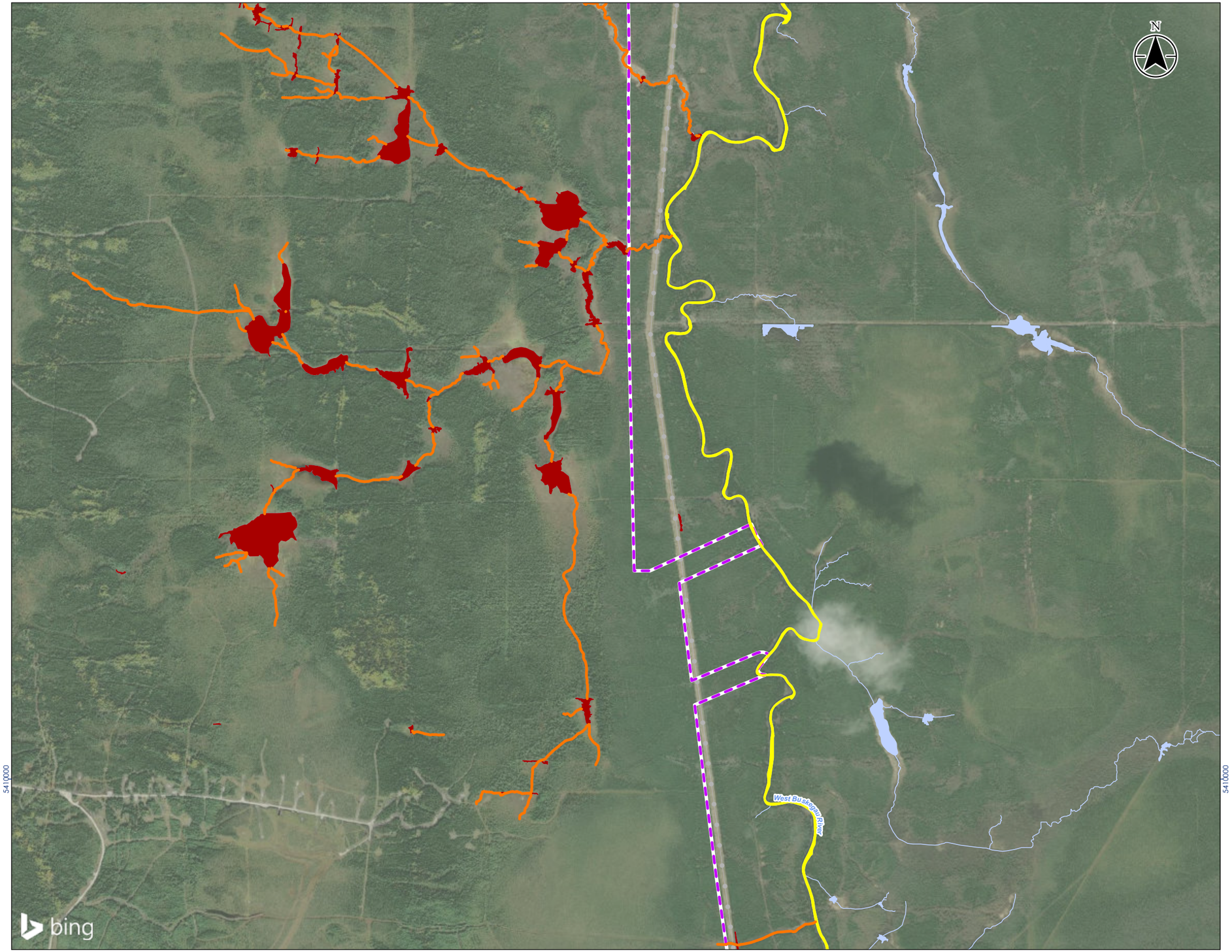

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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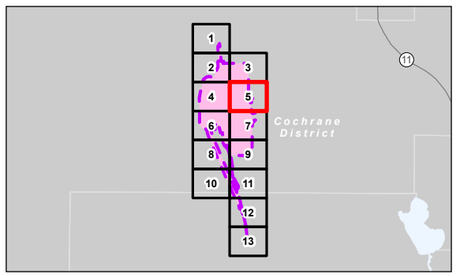

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.5

Title
White Sucker Spawning/Rearing Habitat

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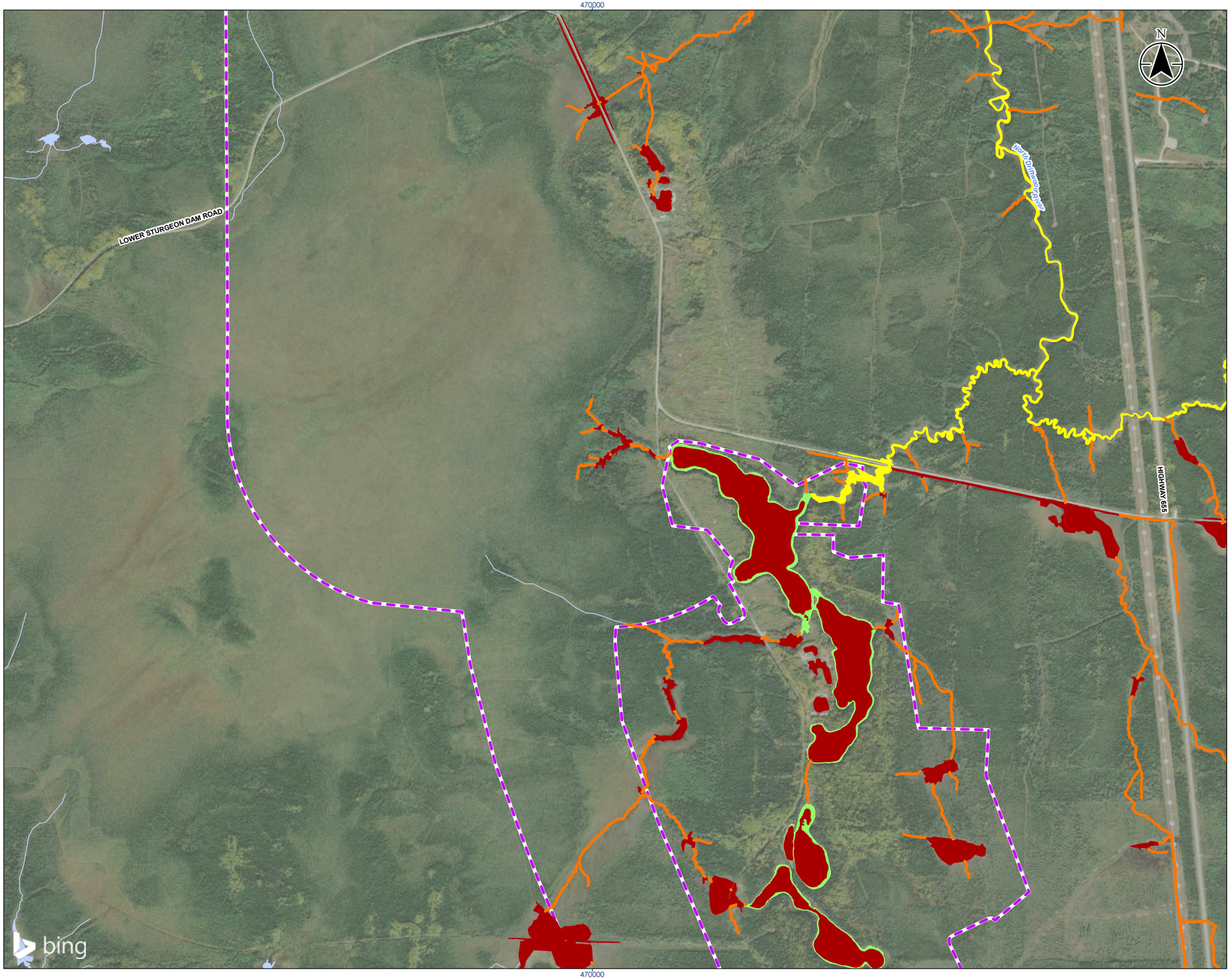

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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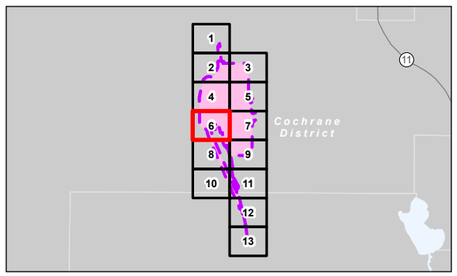

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.6

Title
White Sucker Spawning/Rearing Habitat

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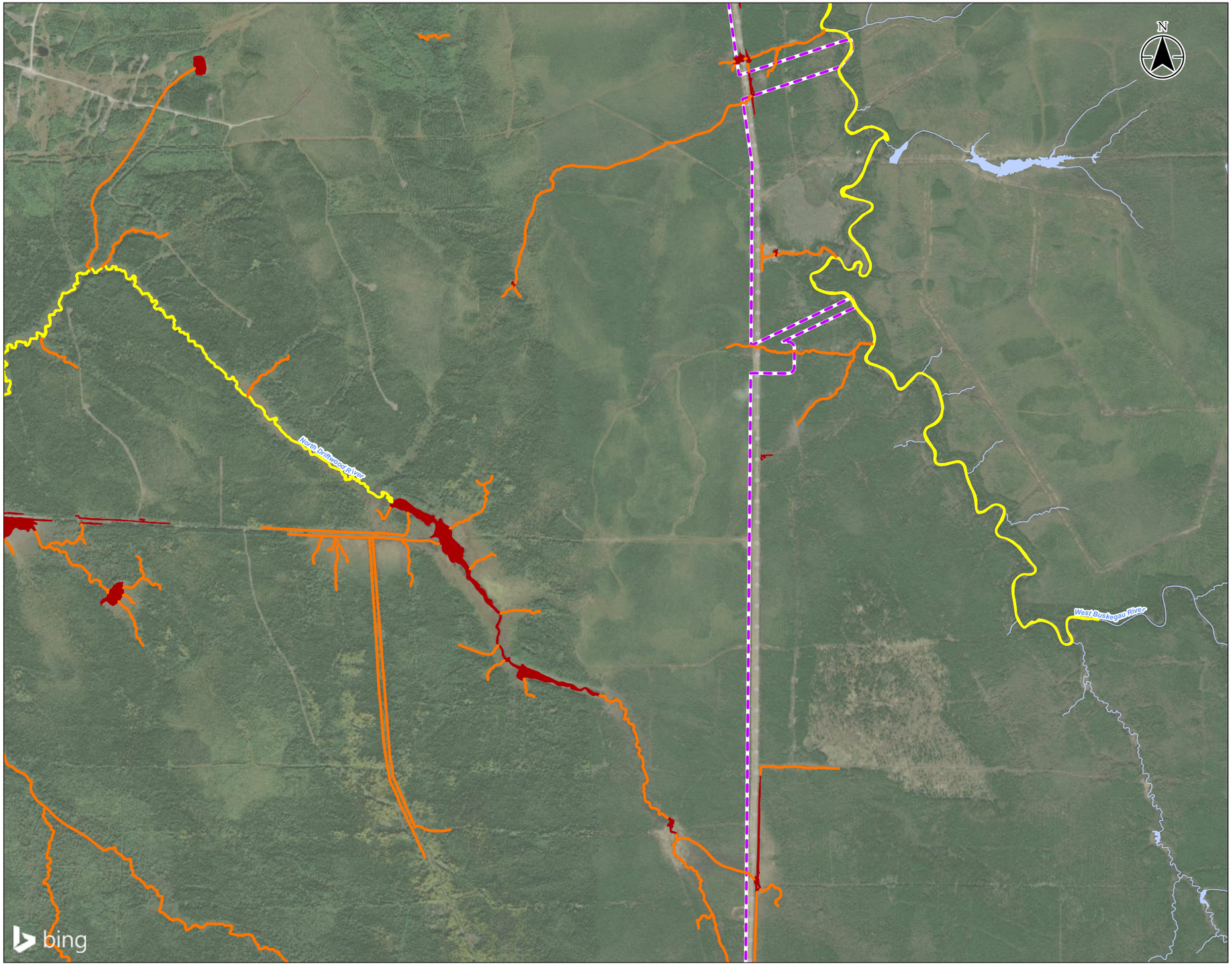

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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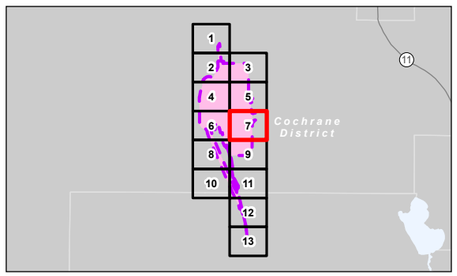

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.7

Title
White Sucker Spawning/Rearing Habitat

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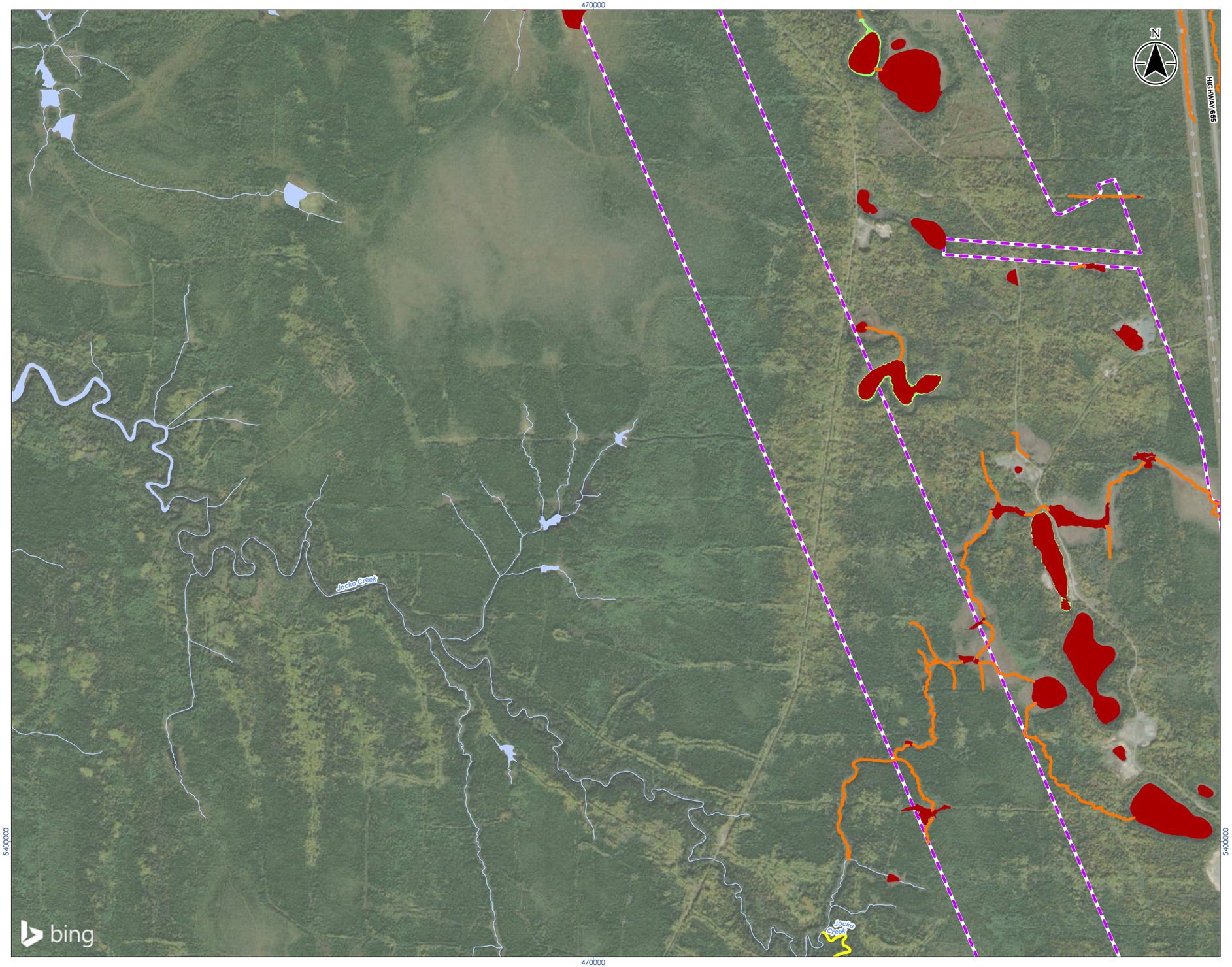

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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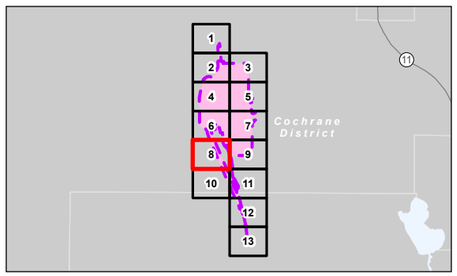

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.8

Title
White Sucker Spawning/Rearing Habitat

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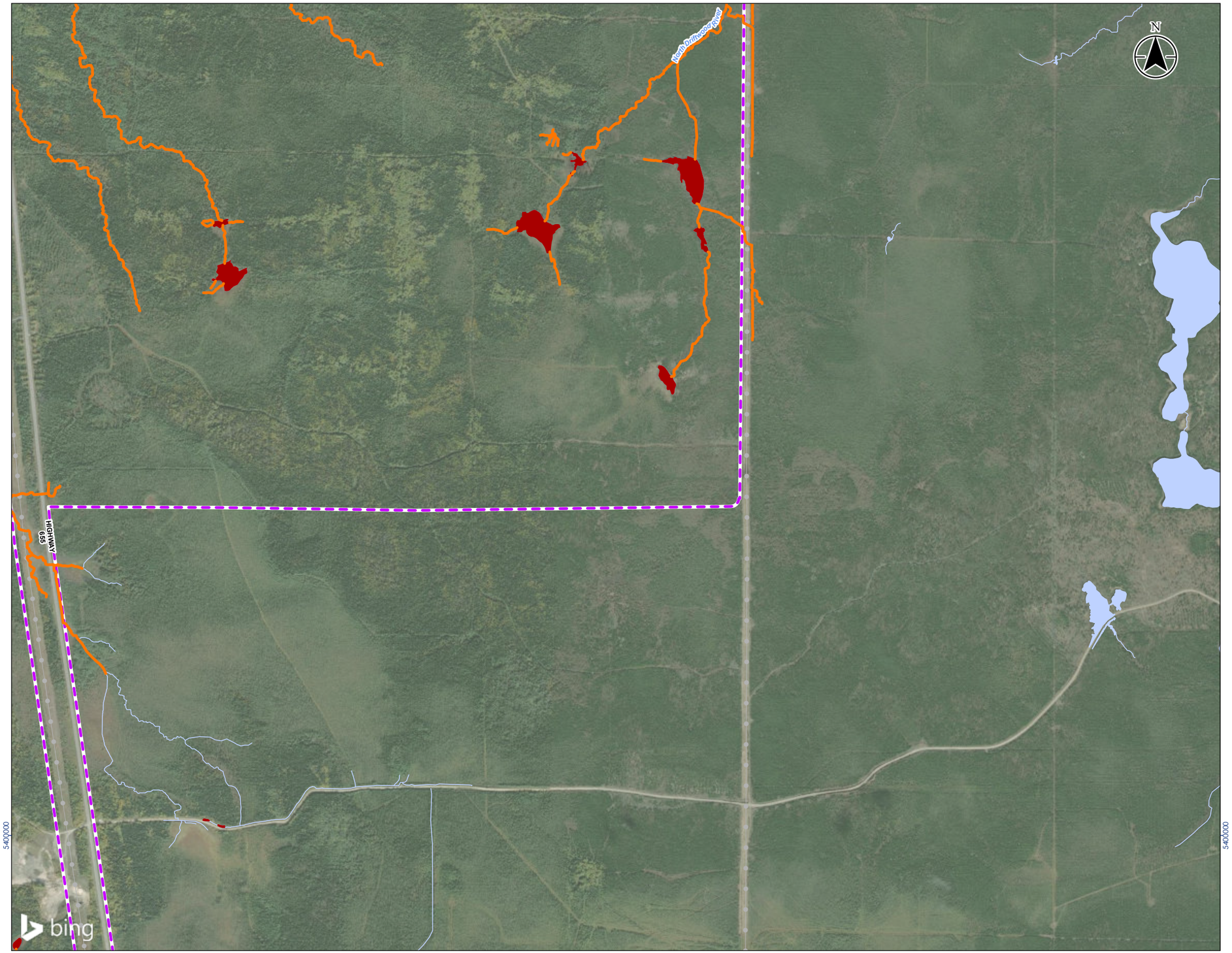

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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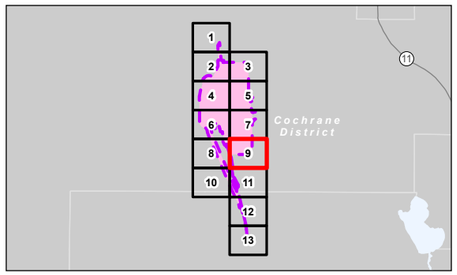

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.9

Title
White Sucker Spawning/Rearing Habitat

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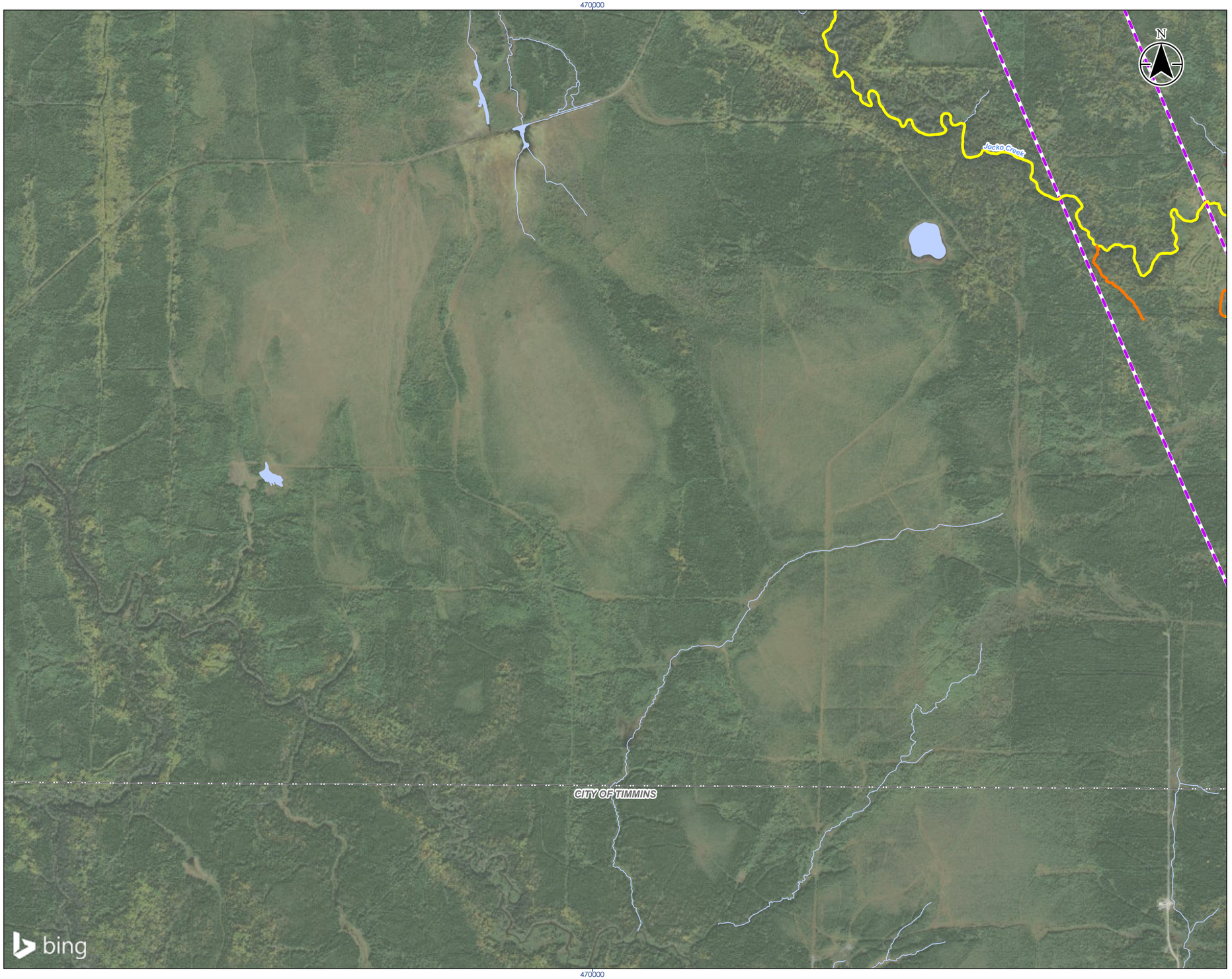

Stantec

Legend

- Project Area
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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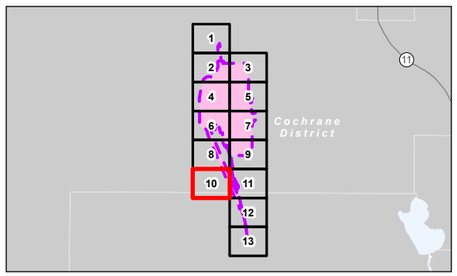

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.10

Title
White Sucker Spawning/Rearing Habitat

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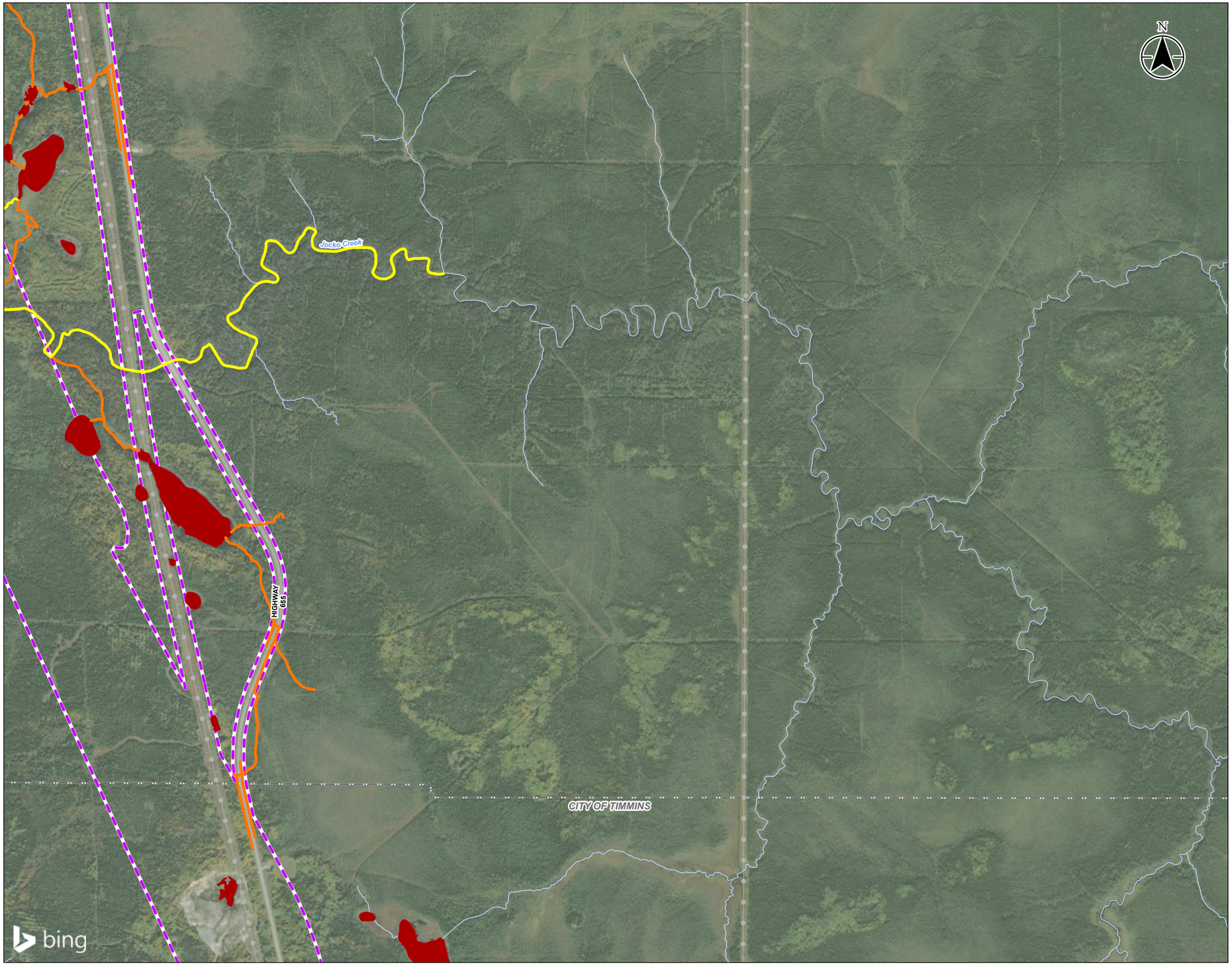

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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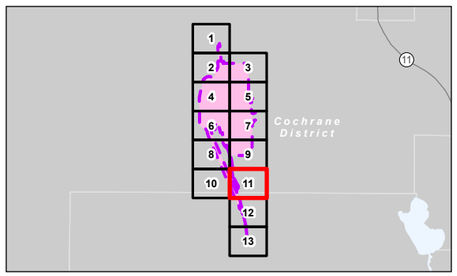

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.11

Title
White Sucker Spawning/Rearing Habitat

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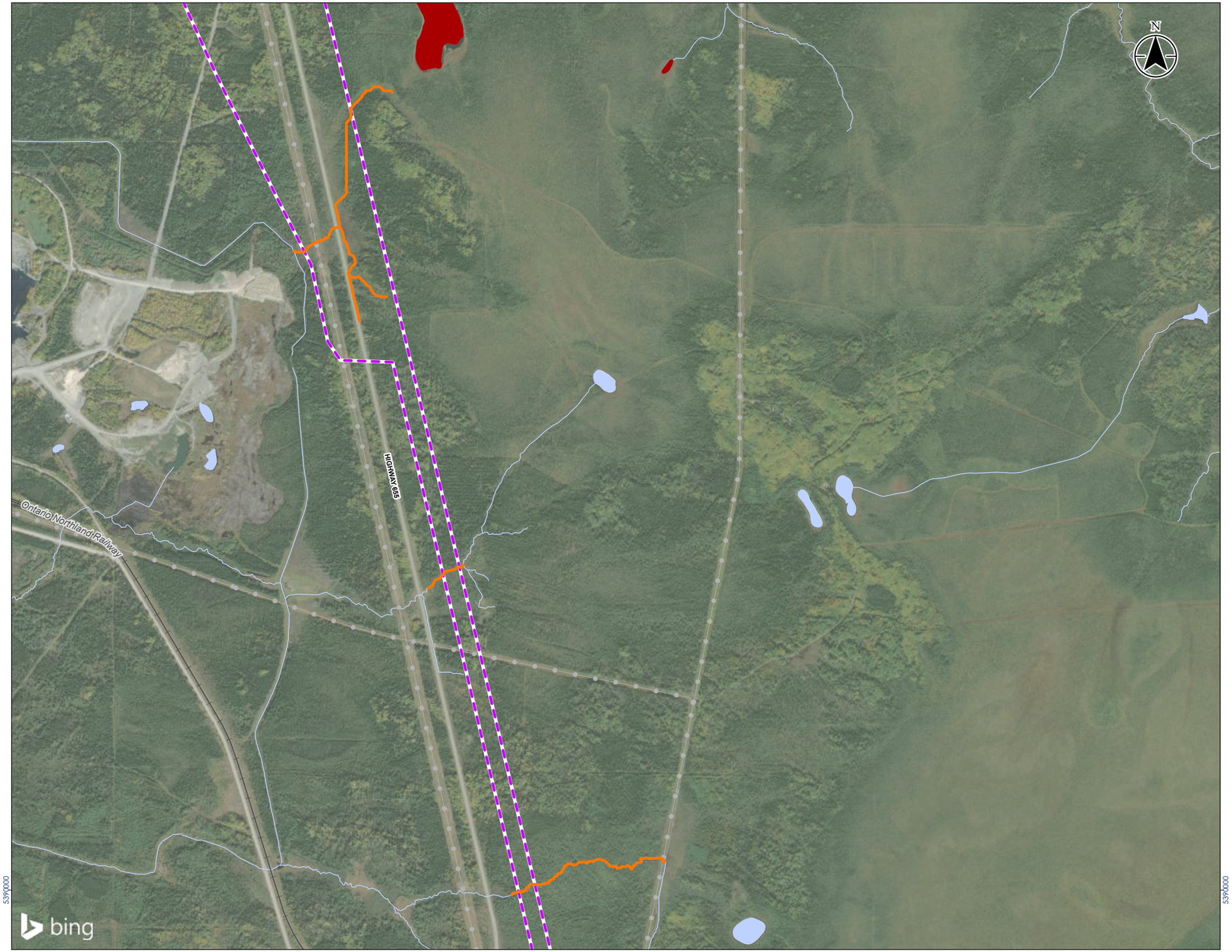

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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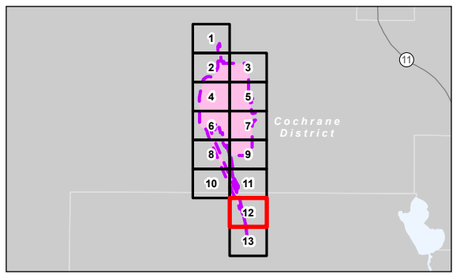

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.12

Title
White Sucker Spawning/Rearing Habitat

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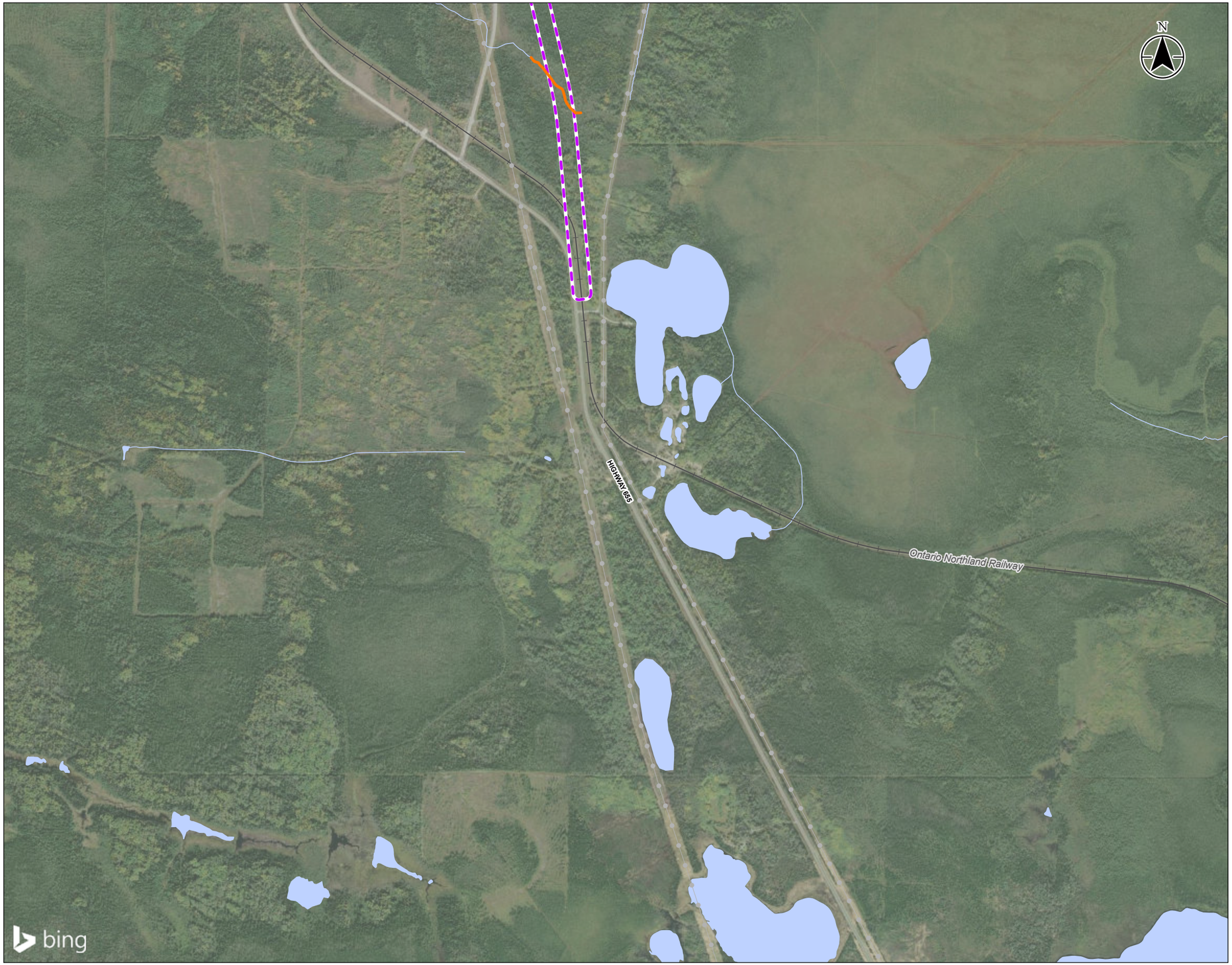

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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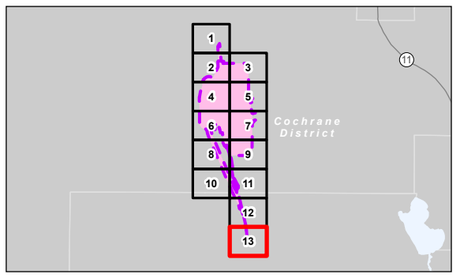

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.15.13

Title
White Sucker Spawning/Rearing Habitat

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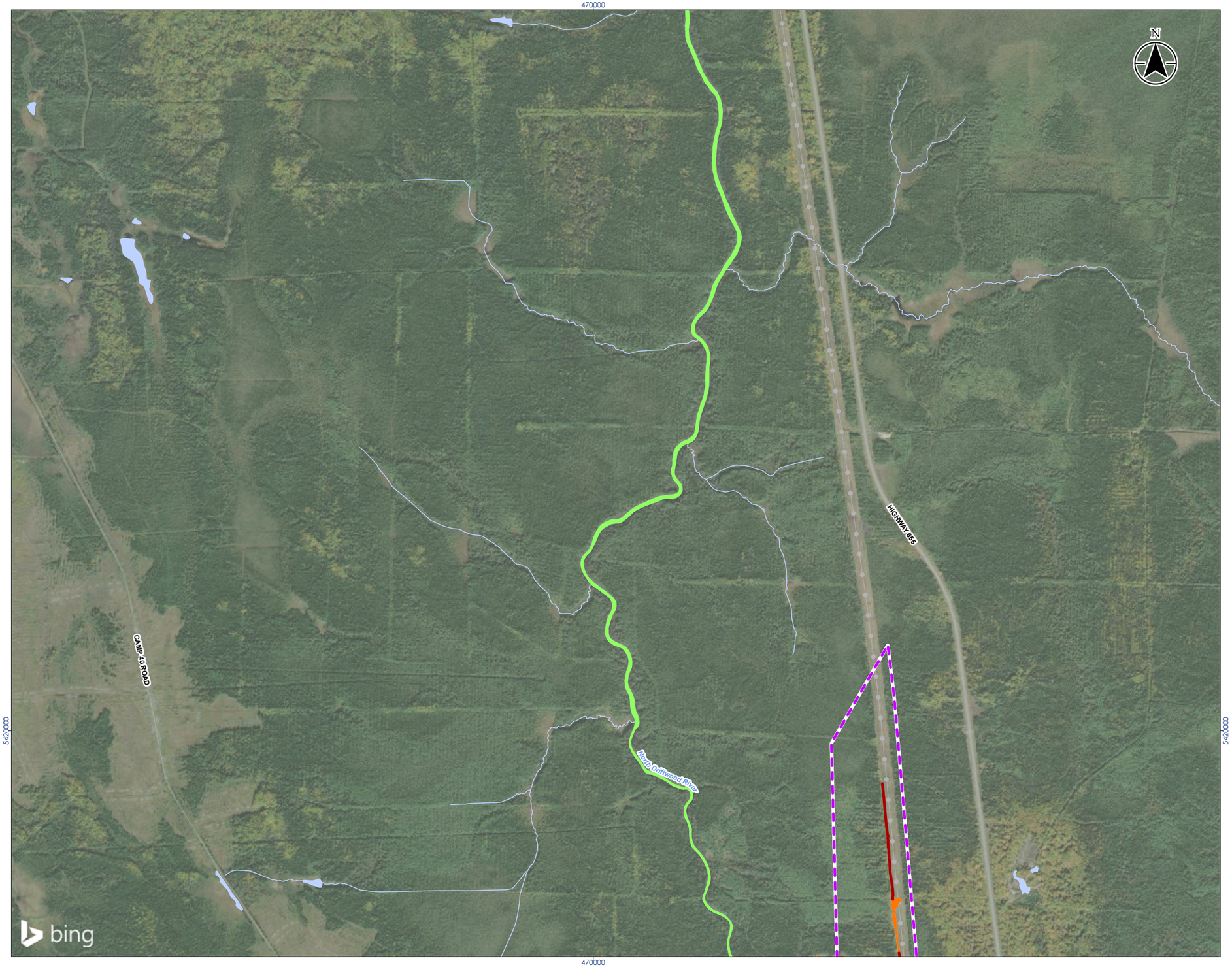

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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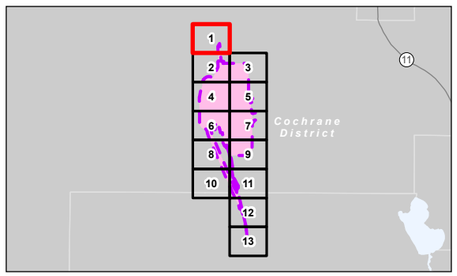

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.1

Title
White Sucker Overwintering Habitat

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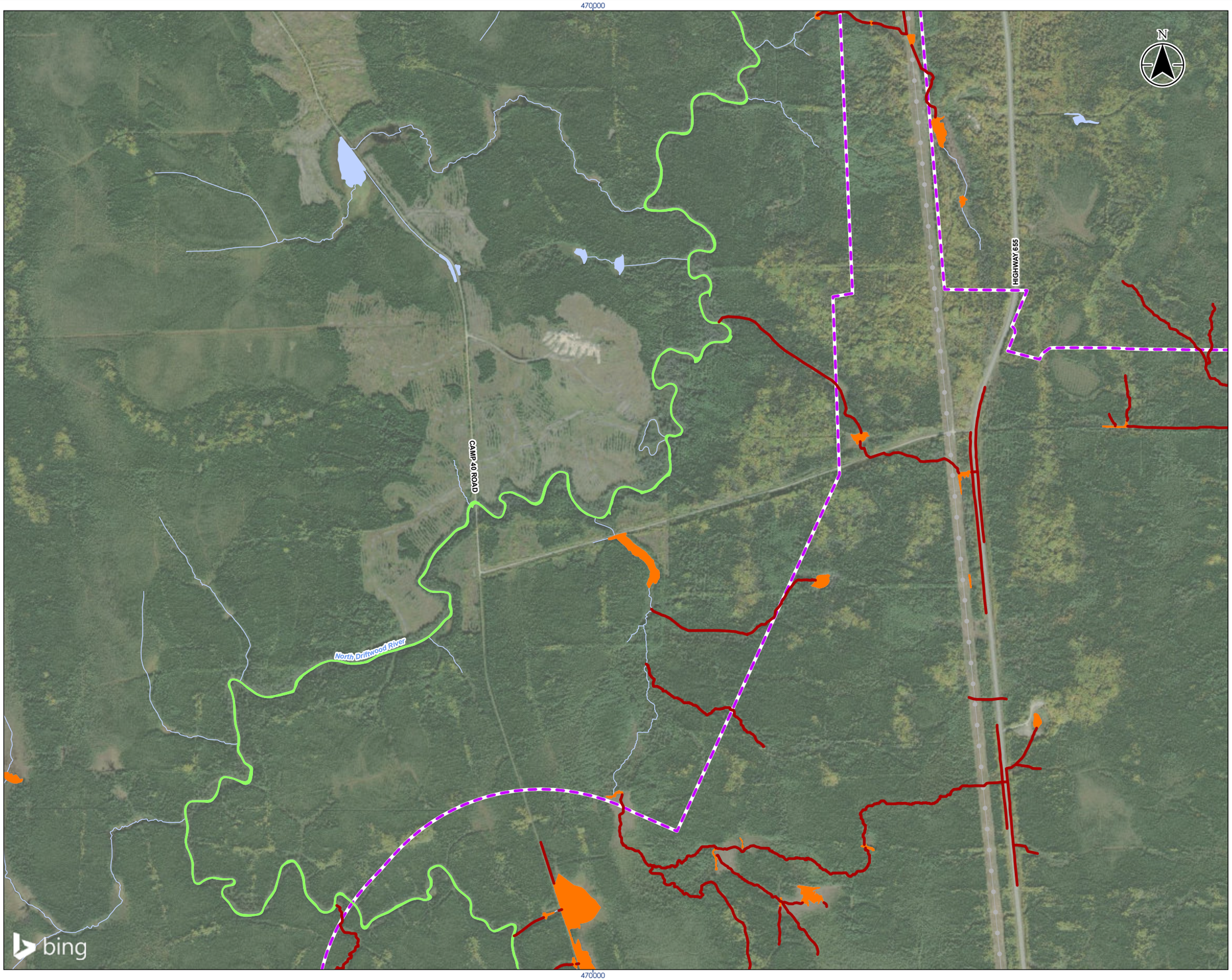

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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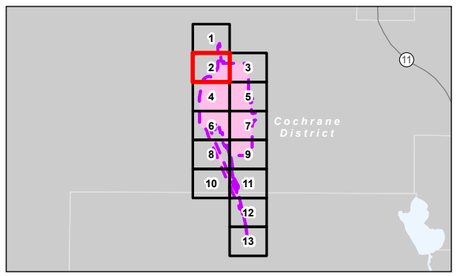

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.2

Title
White Sucker Overwintering Habitat

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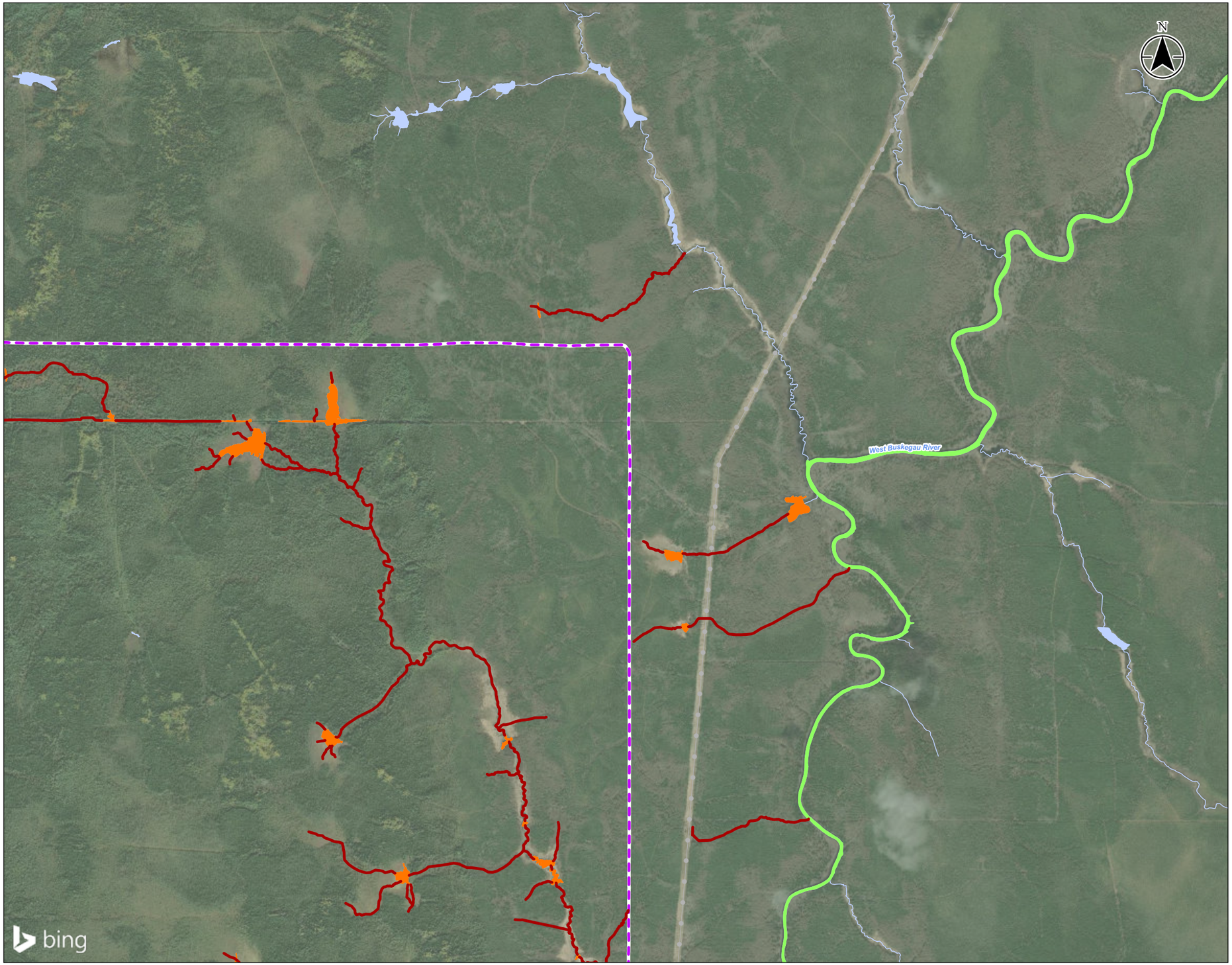

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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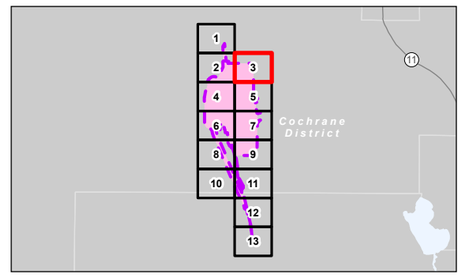

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.3

Title
White Sucker Overwintering Habitat

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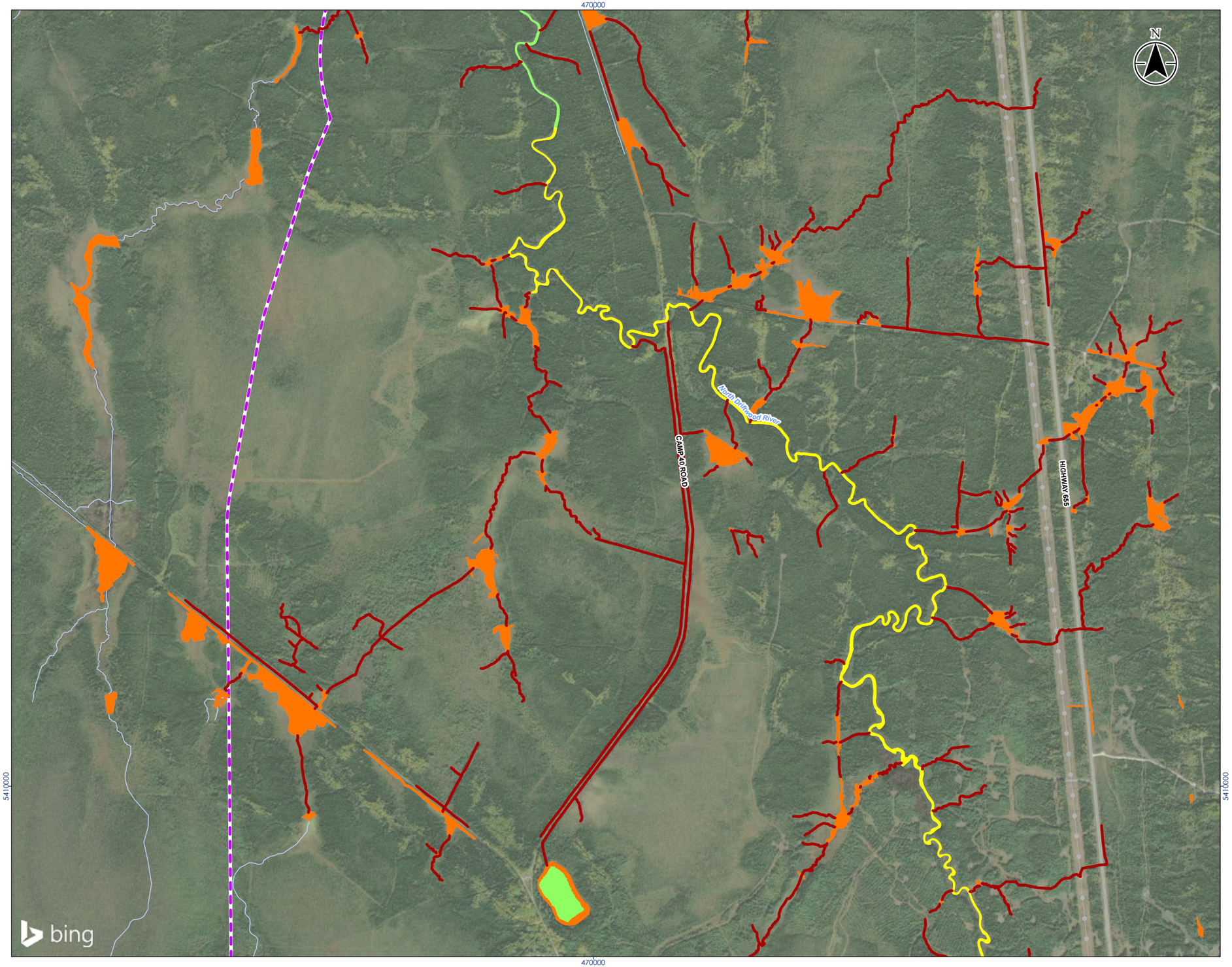

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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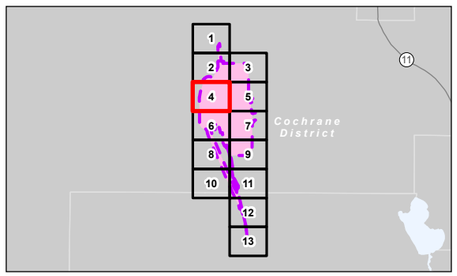

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.4

Title
White Sucker Overwintering Habitat

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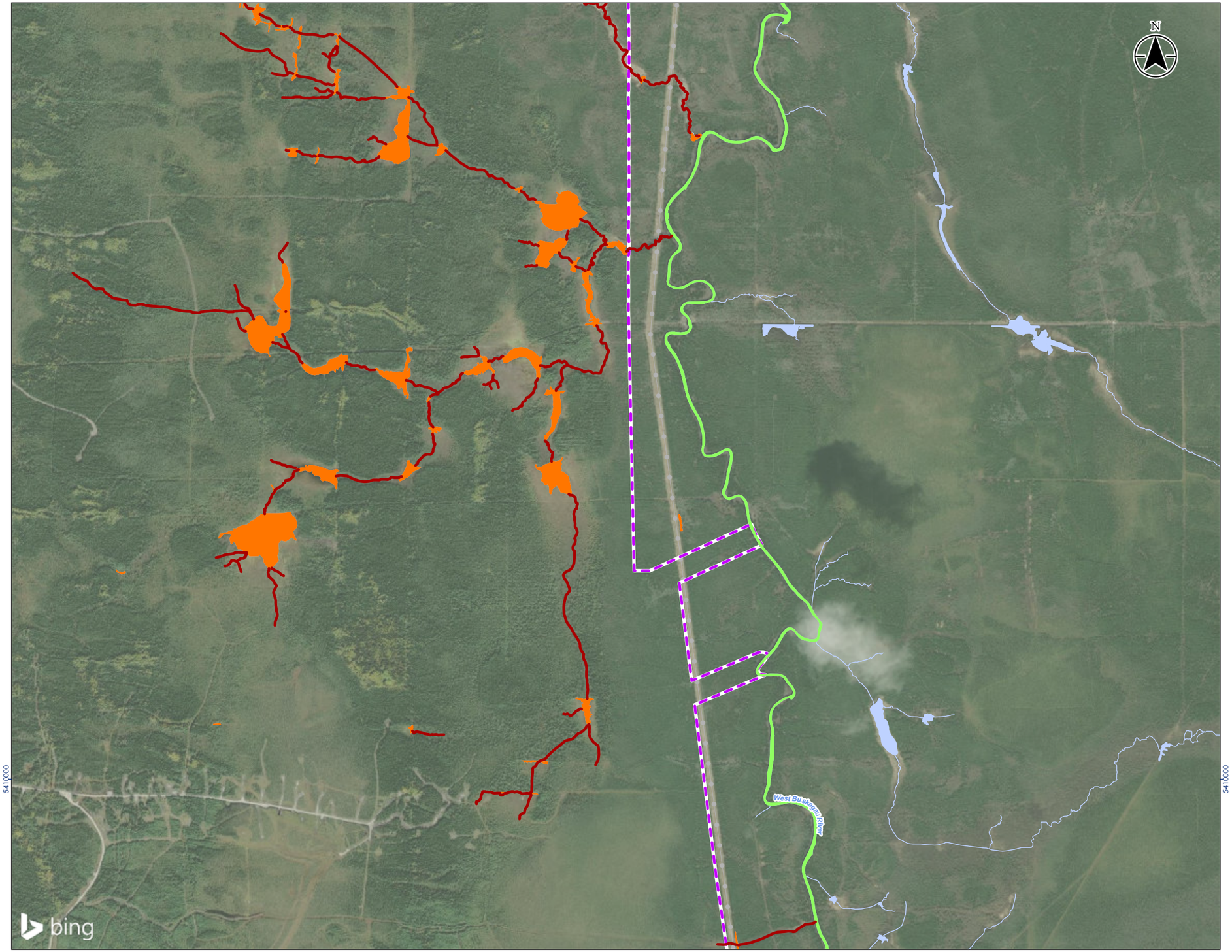

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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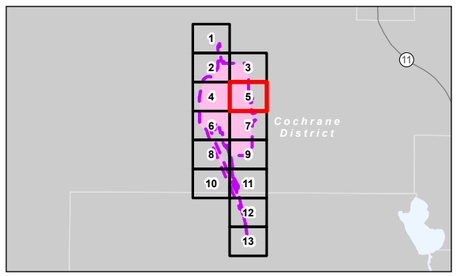

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.5

Title
White Sucker Overwintering Habitat

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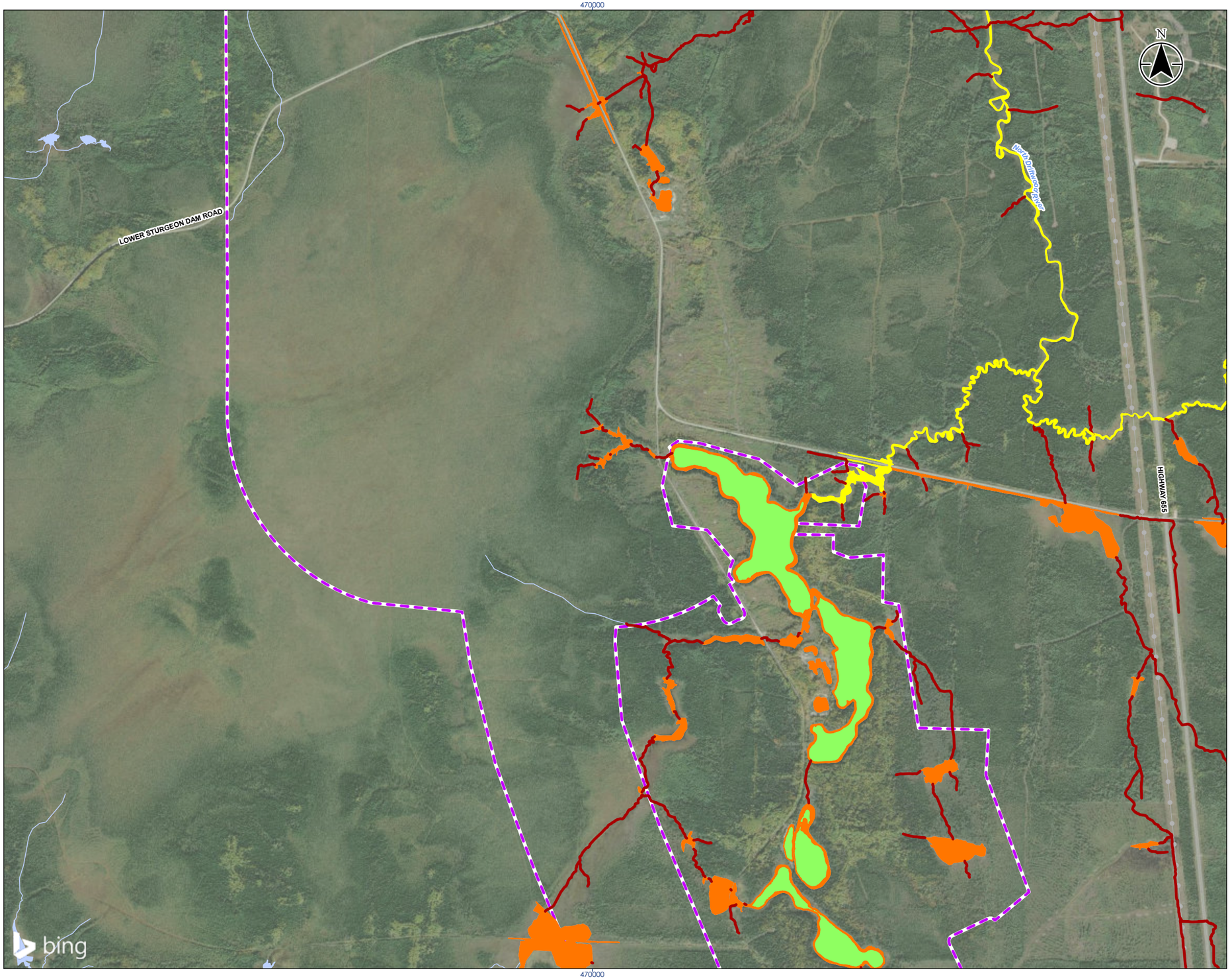

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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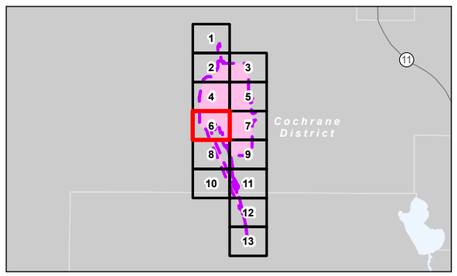

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.6

Title
White Sucker Overwintering Habitat

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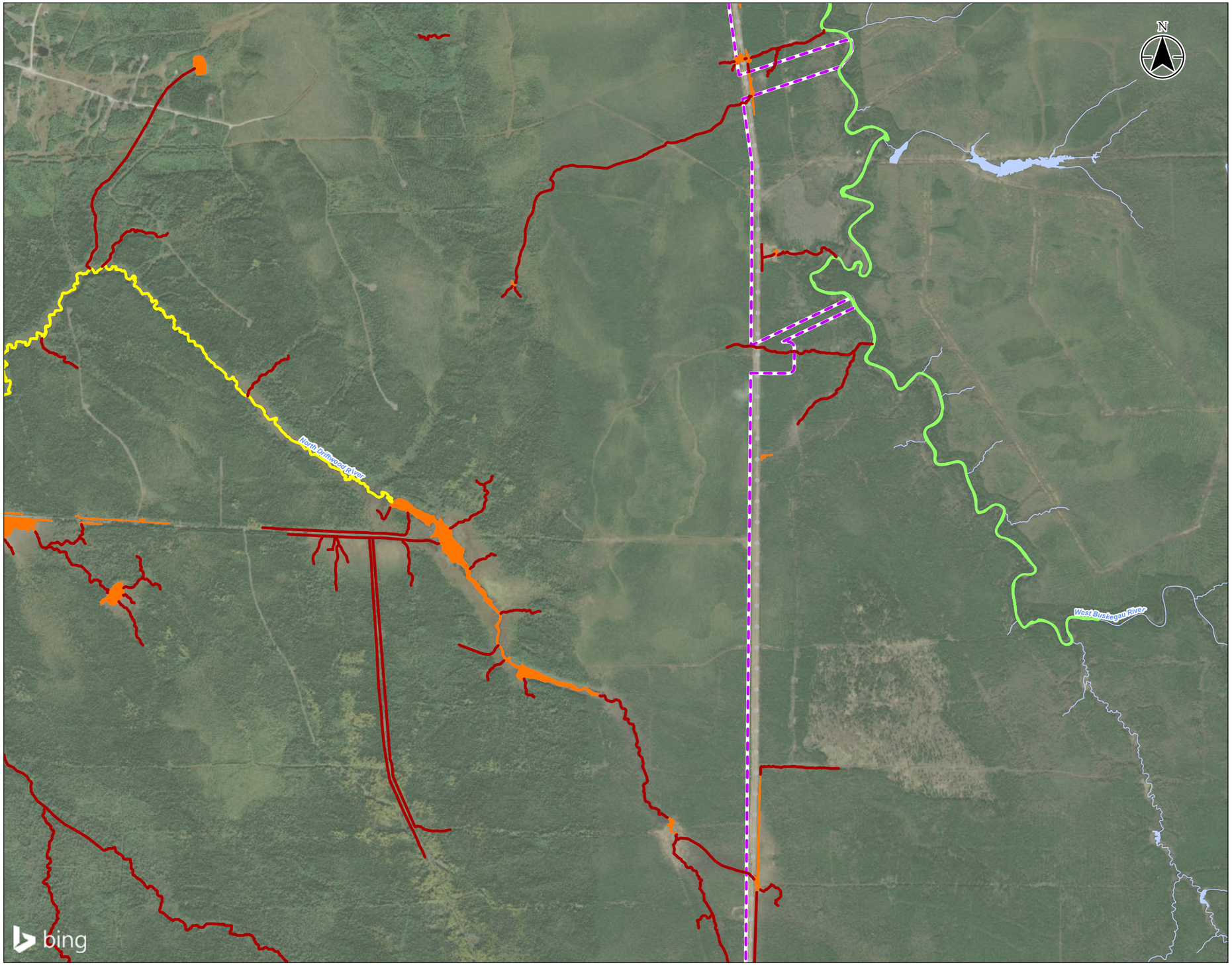

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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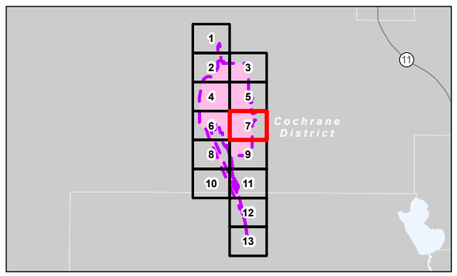

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.7

Title
White Sucker Overwintering Habitat

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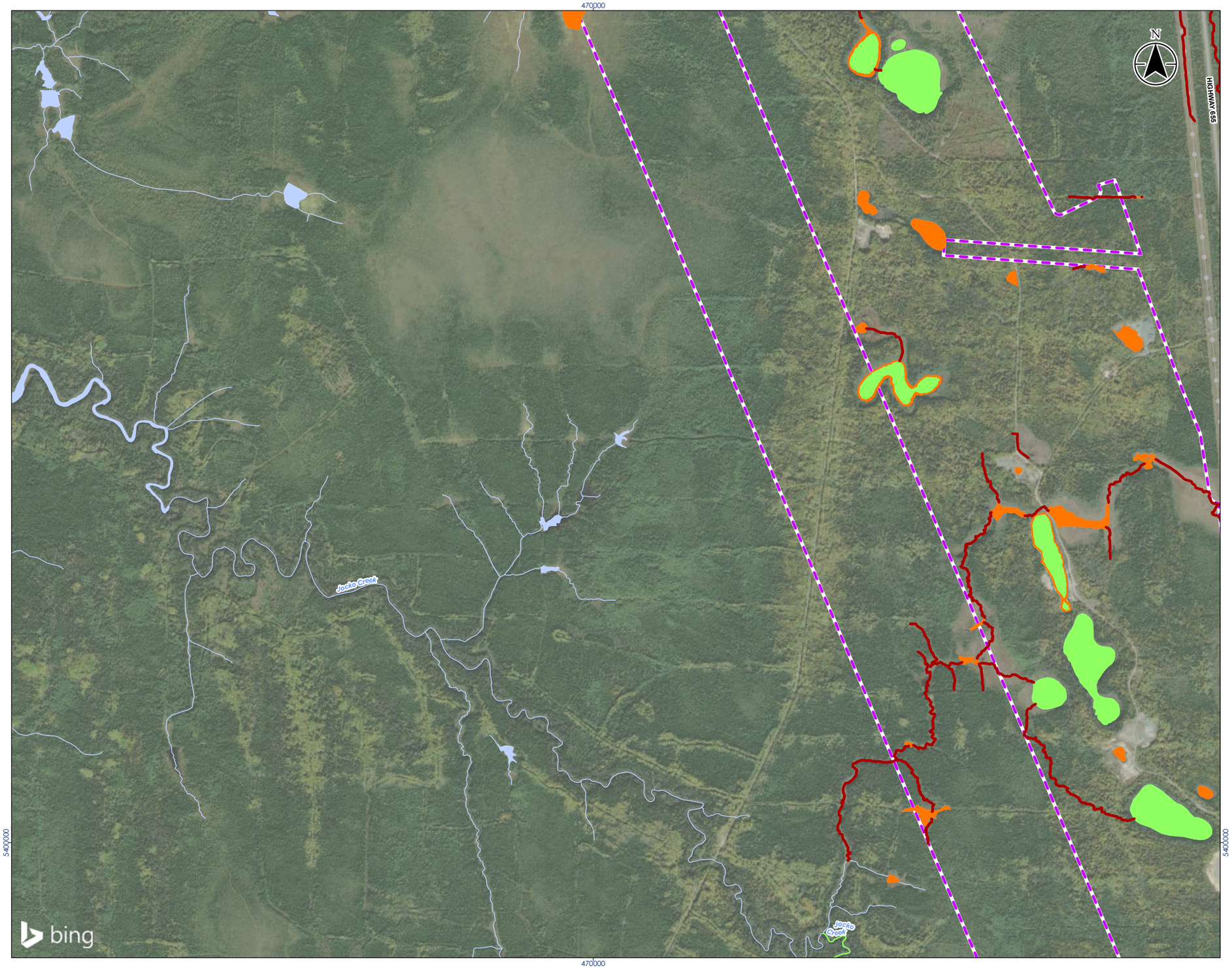

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

1:20,000 (At original document size of 11x17)

Notes

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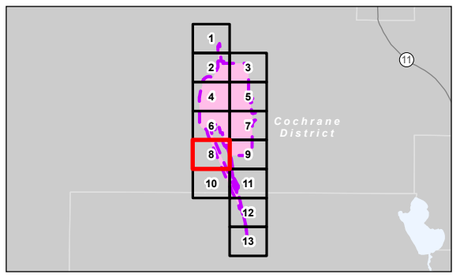

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.8

Title
White Sucker Overwintering Habitat

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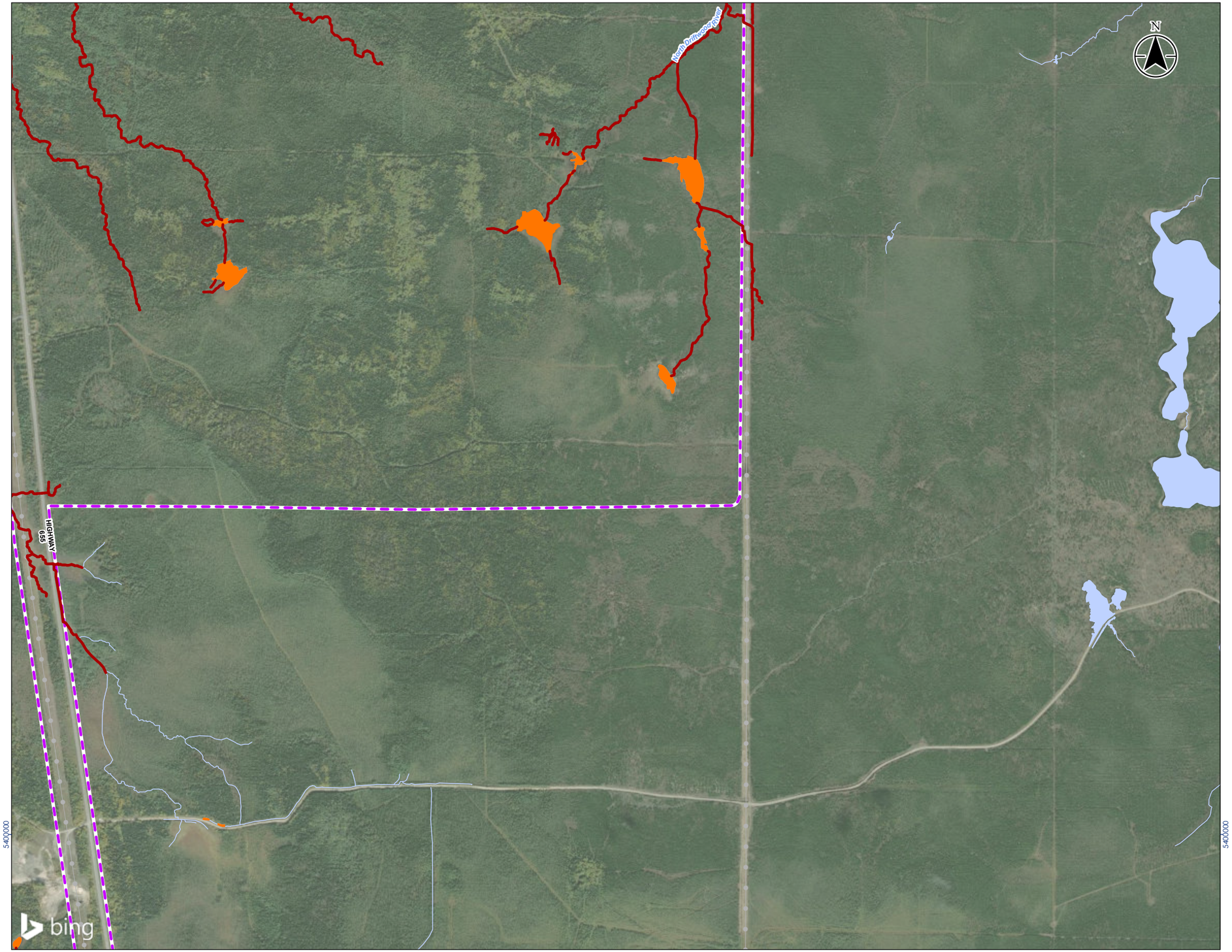

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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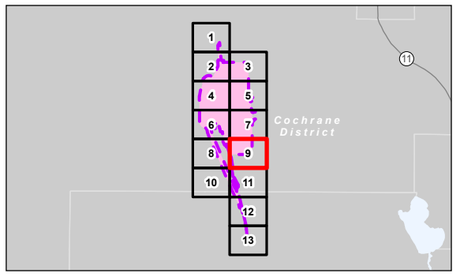

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.9

Title
White Sucker Overwintering Habitat

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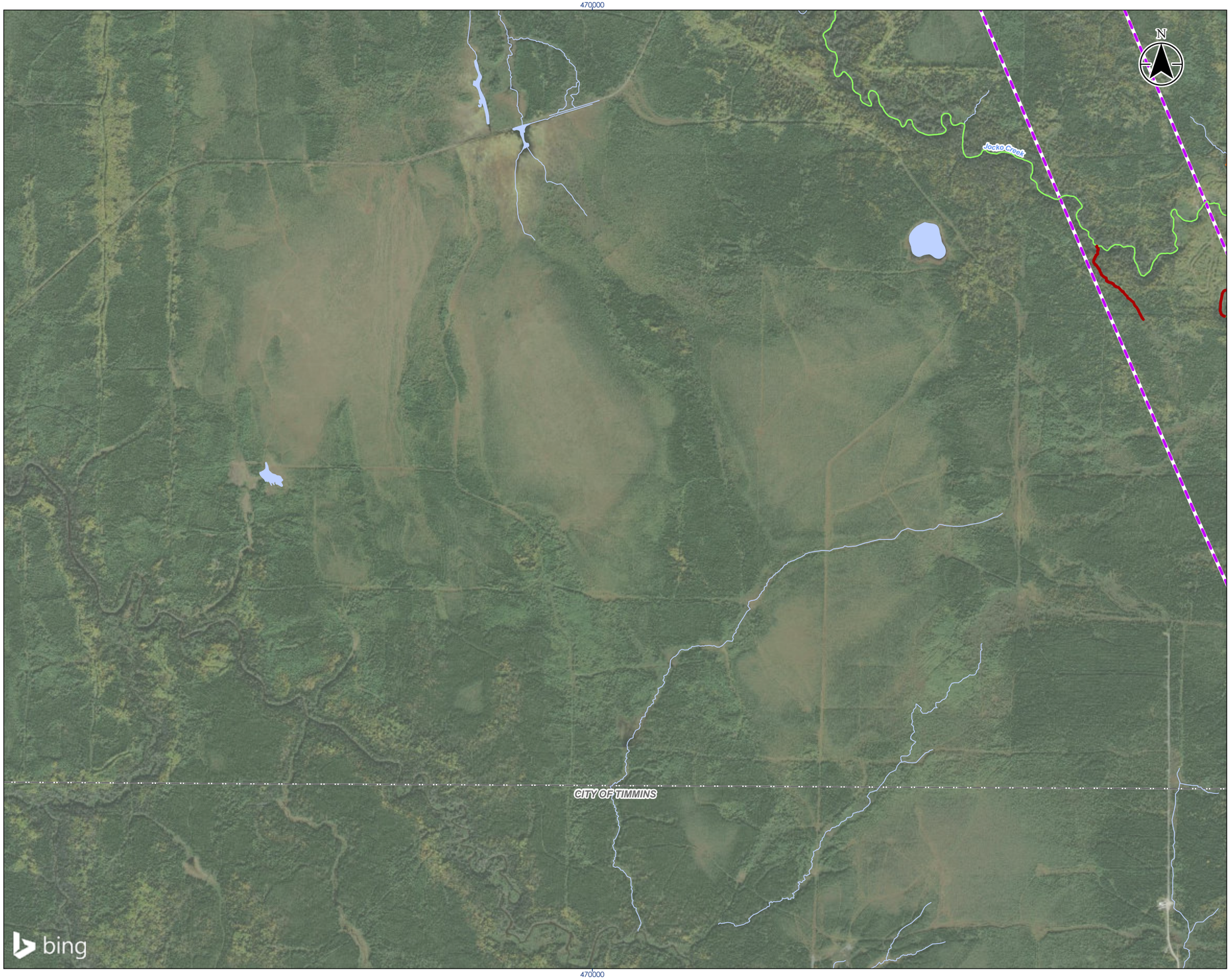

Stantec

Legend

- Project Area
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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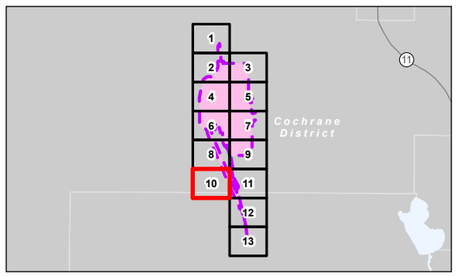

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.10

Title
White Sucker Overwintering Habitat

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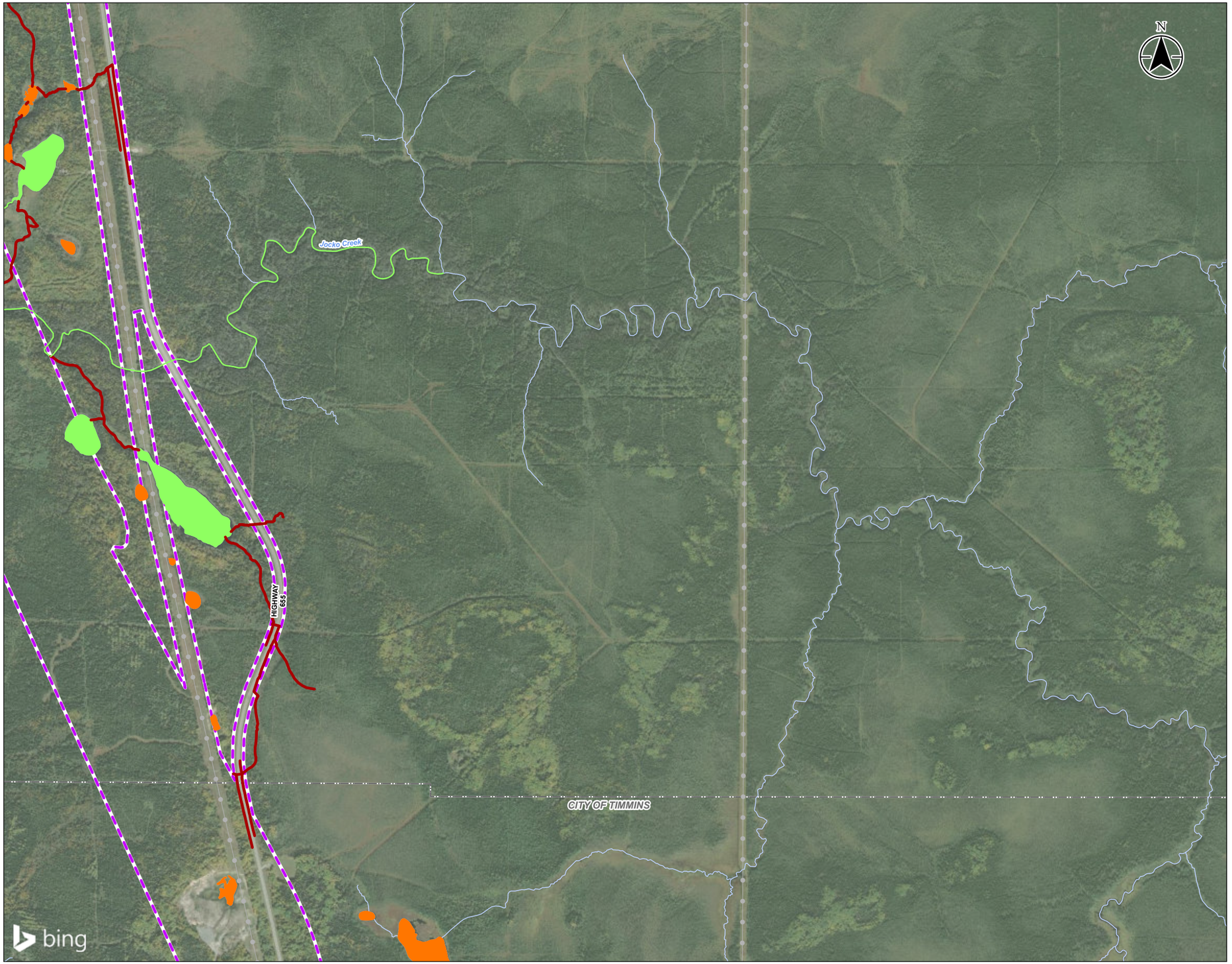

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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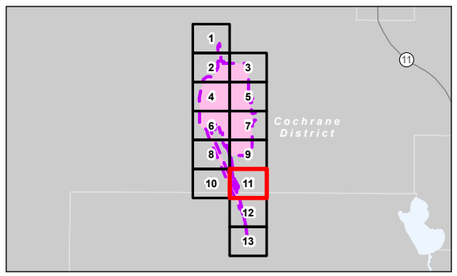

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.11

Title
White Sucker Overwintering Habitat

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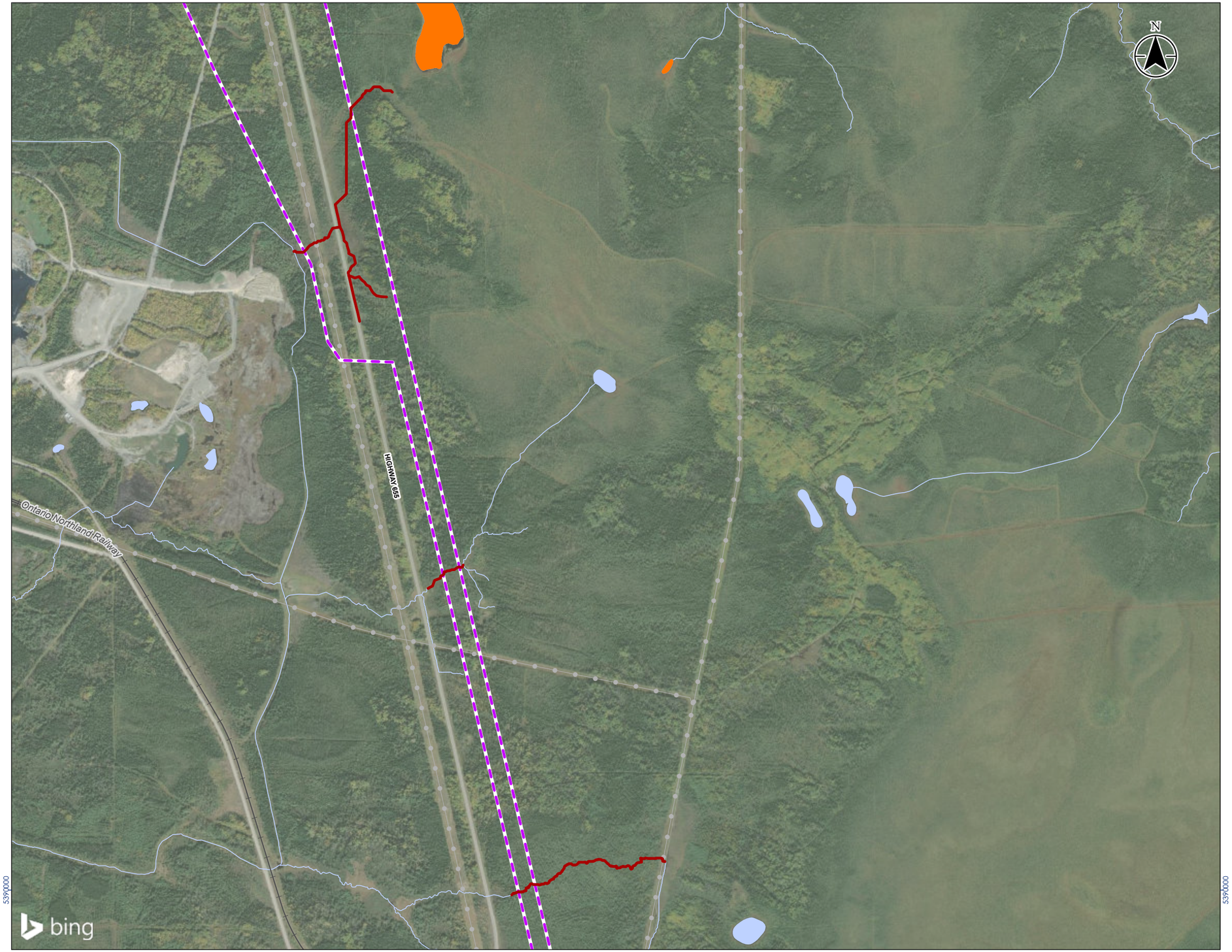

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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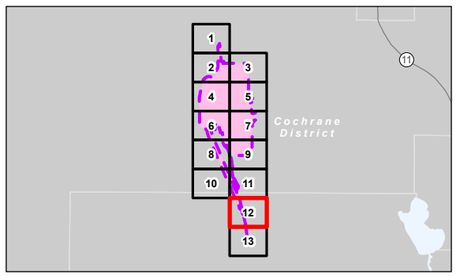

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.12

Title
White Sucker Overwintering Habitat

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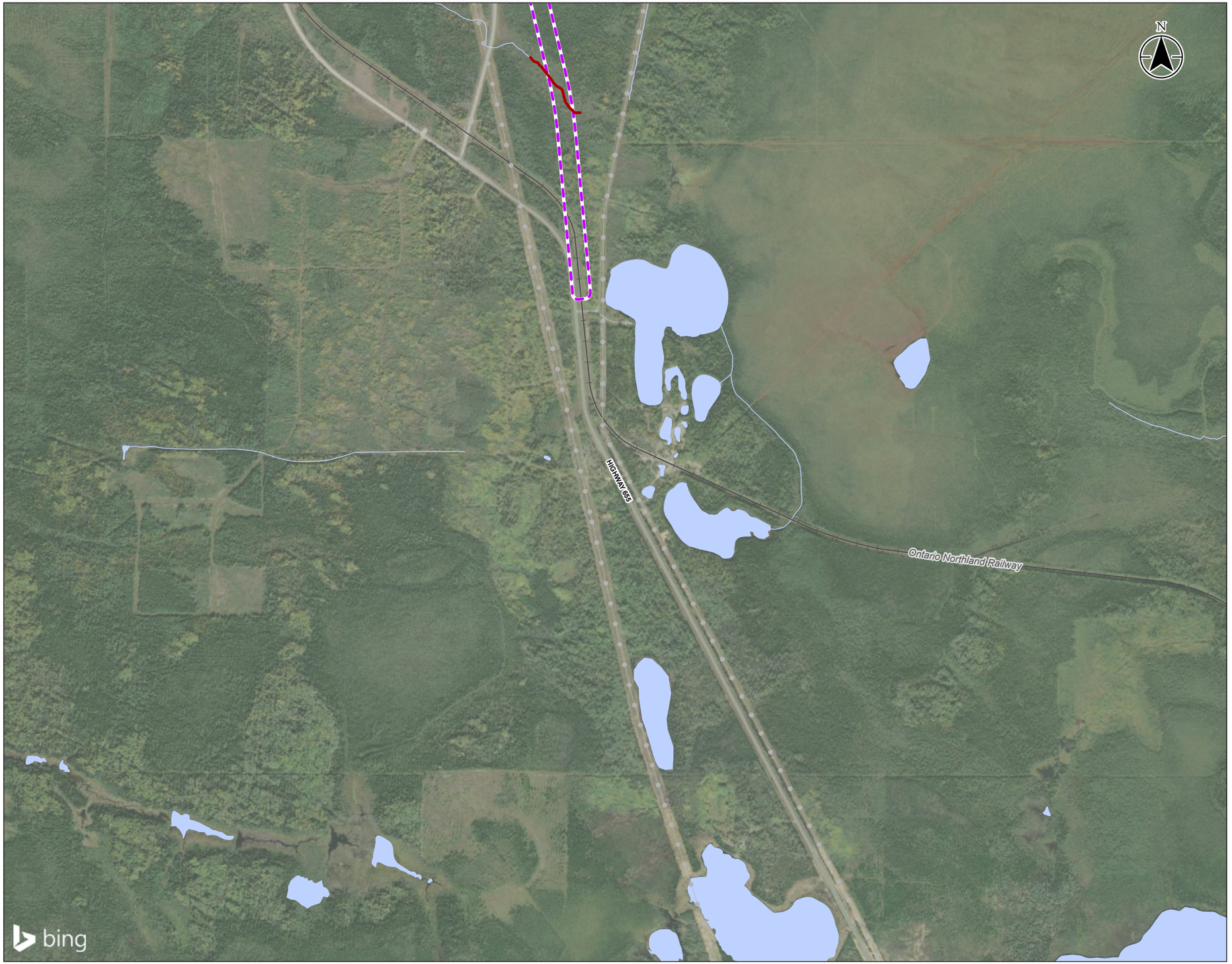

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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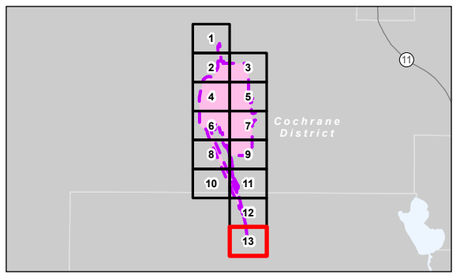

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.16.13

Title
White Sucker Overwintering Habitat

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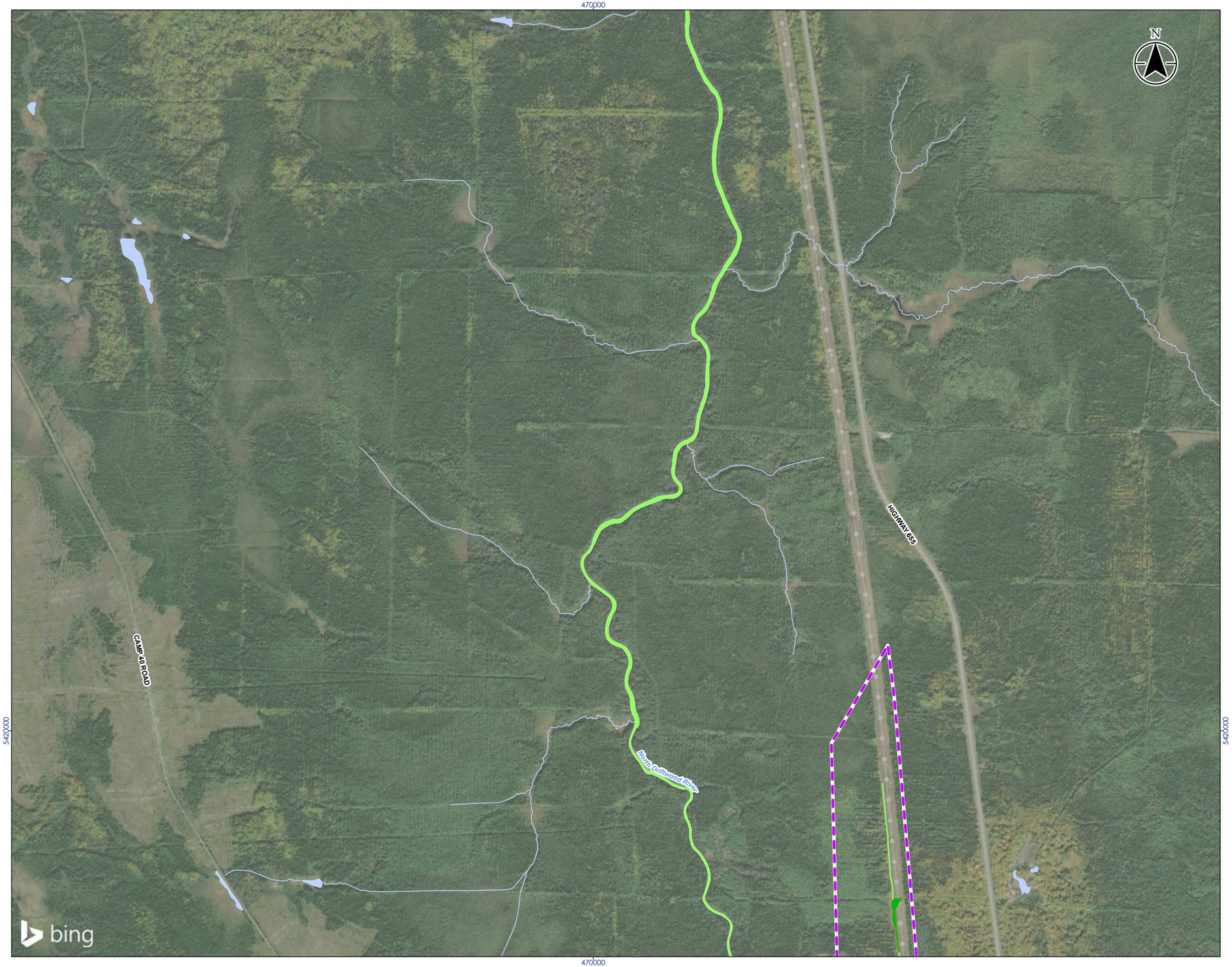

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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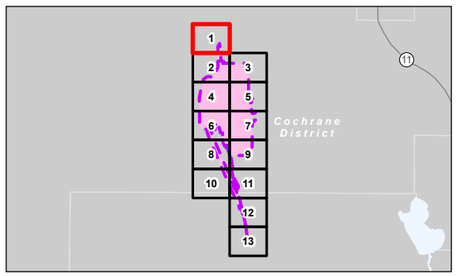

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.1

Title
Forage Species Guild Adult Habitat

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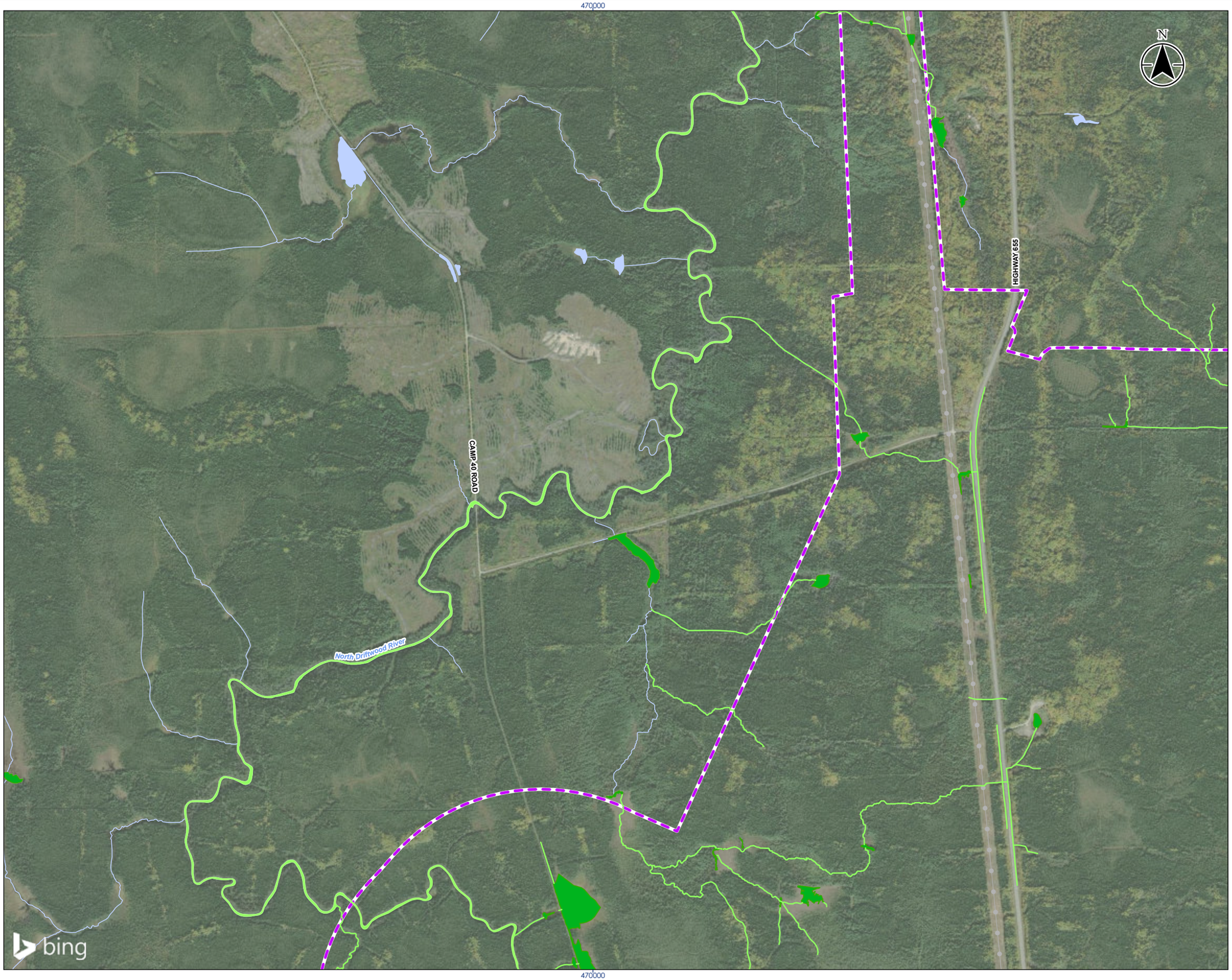

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

1:20,000 (At original document size of 11x17)

Notes

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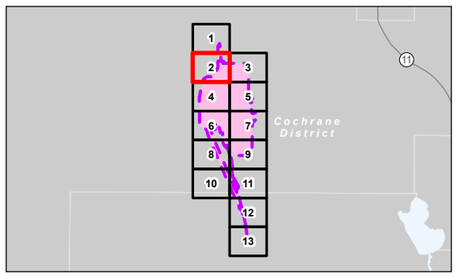

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.2

Title
Forage Species Guild Adult Habitat

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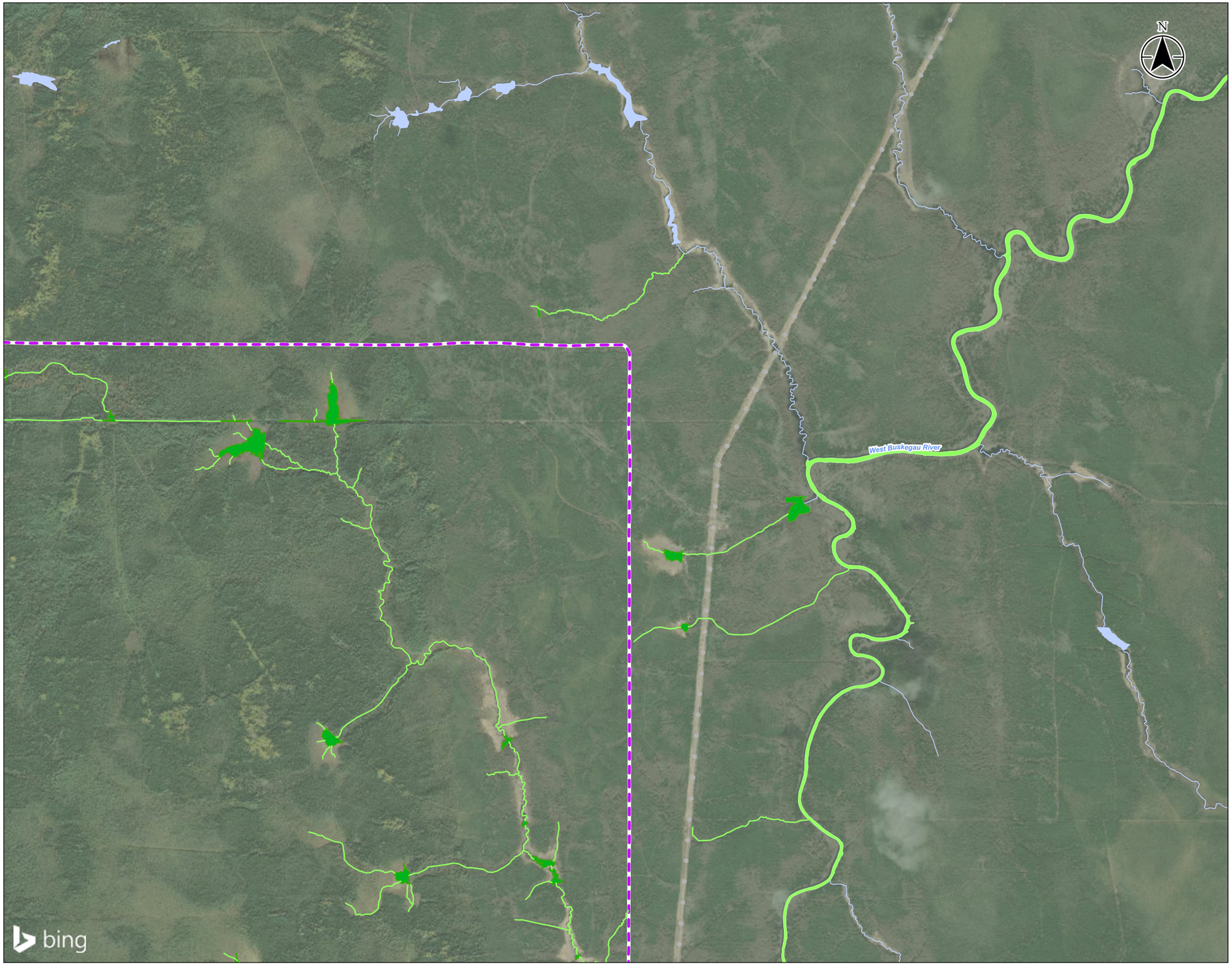

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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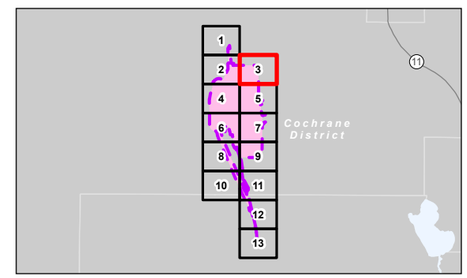

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.3

Title
Forage Species Guild Adult Habitat

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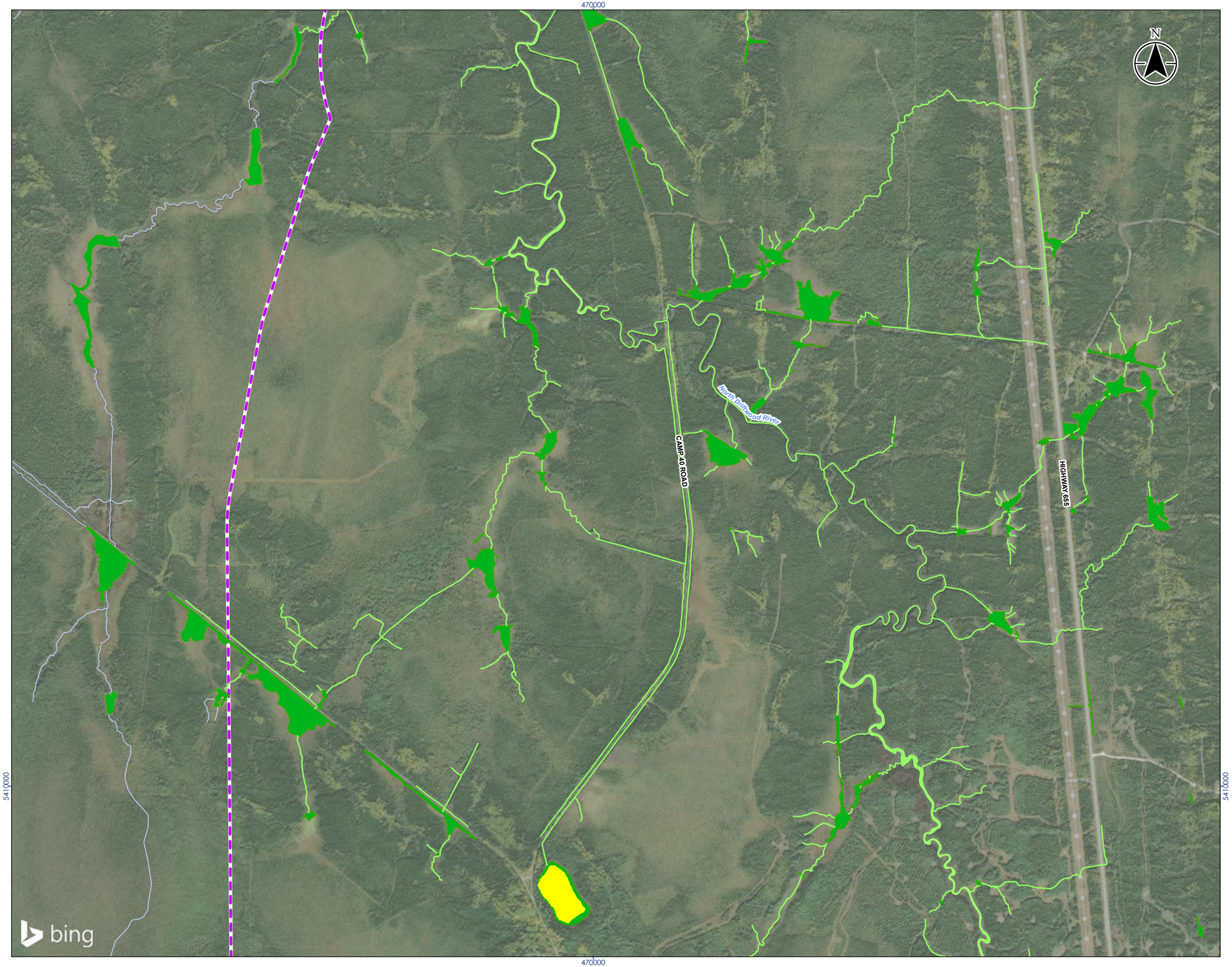

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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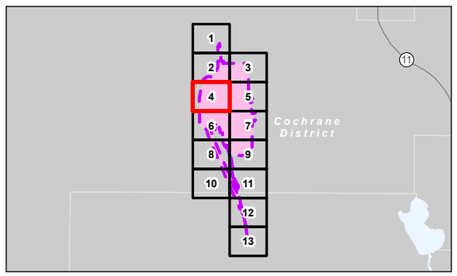

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.4

Title
Forage Species Guild Adult Habitat

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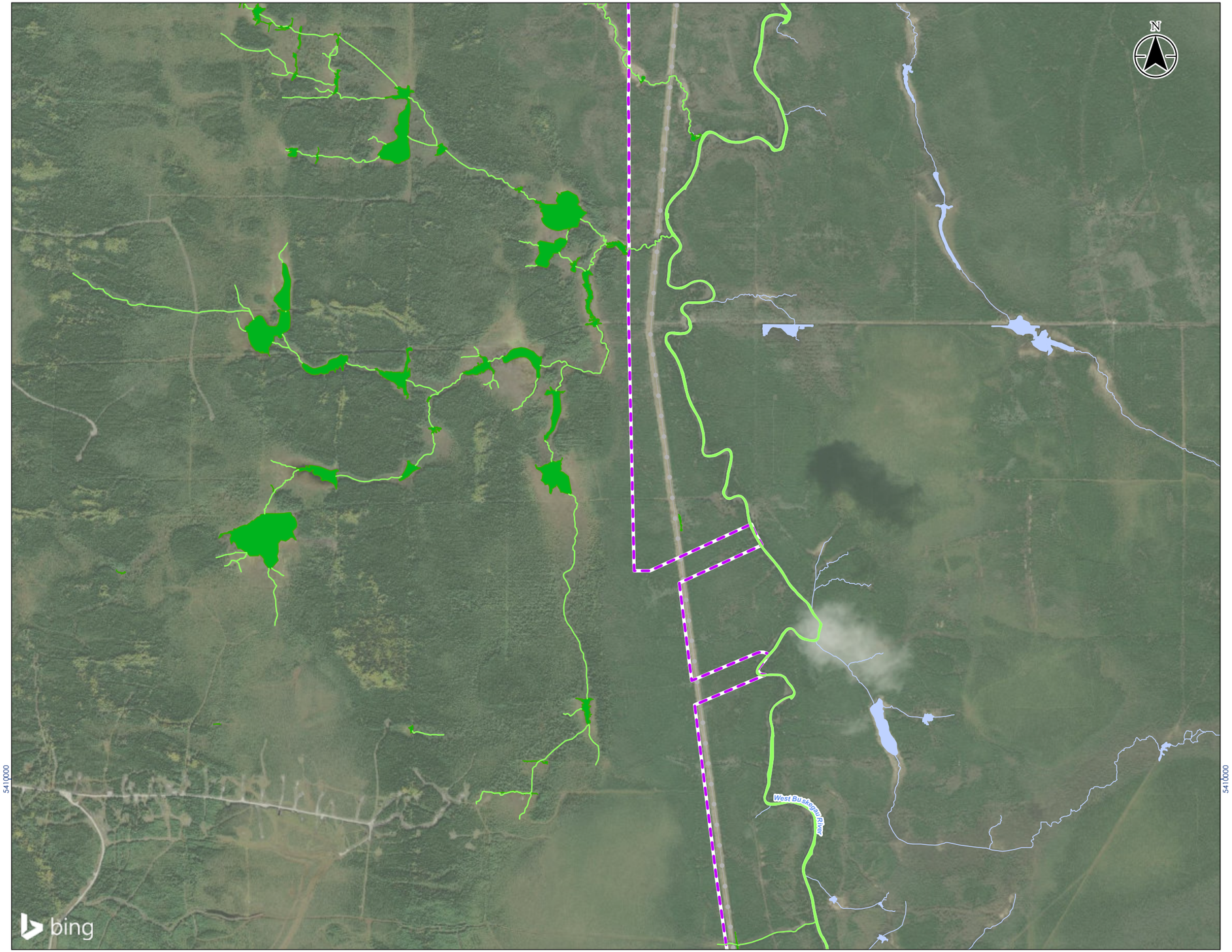

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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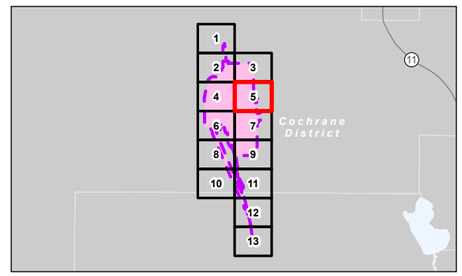

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.5

Title
Forage Species Guild Adult Habitat

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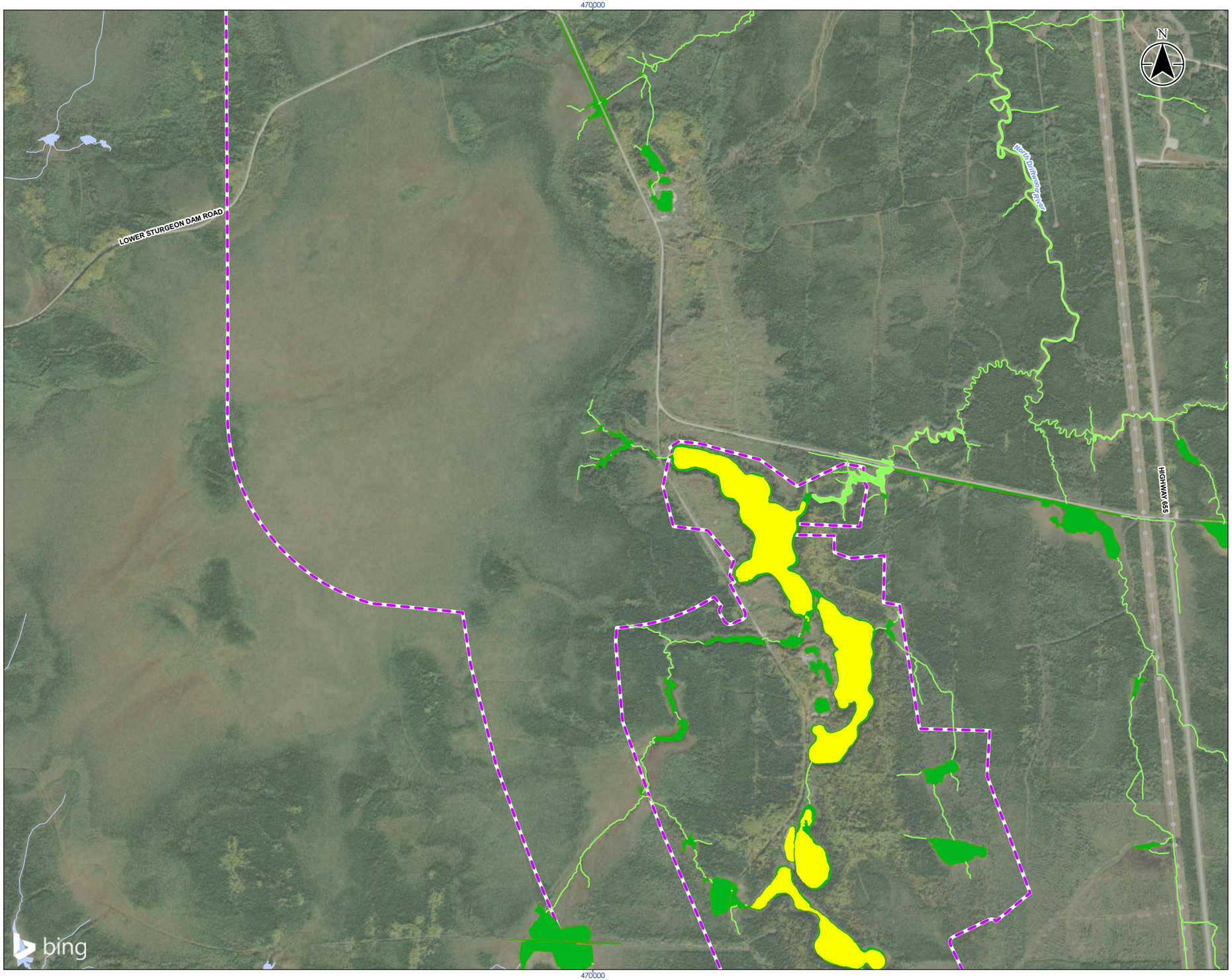

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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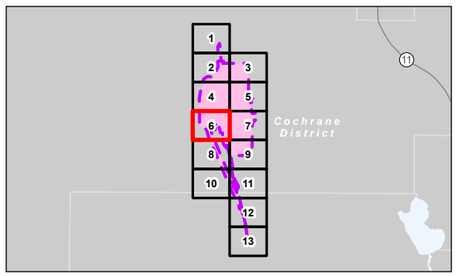

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.6

Title
Forage Species Guild Adult Habitat

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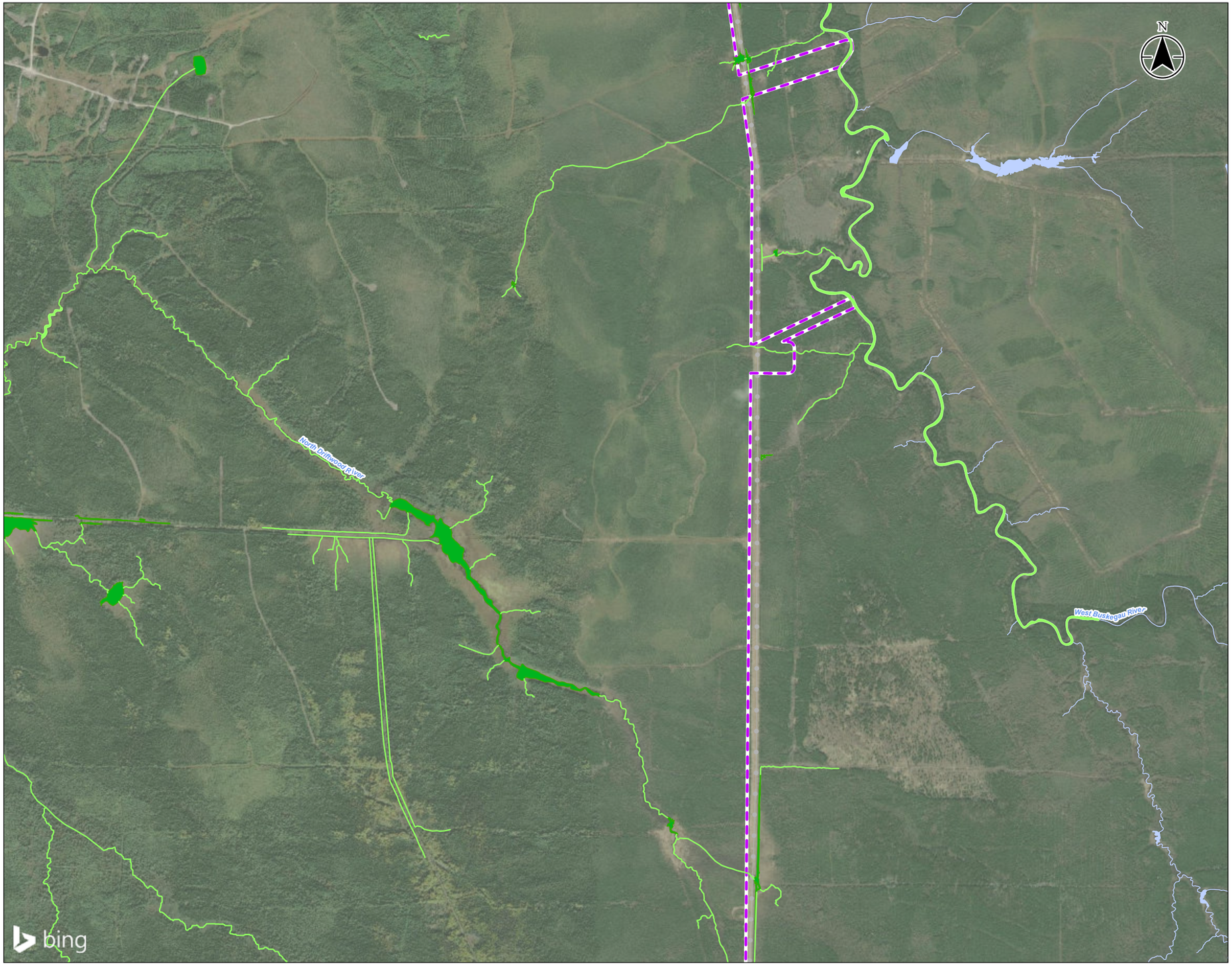

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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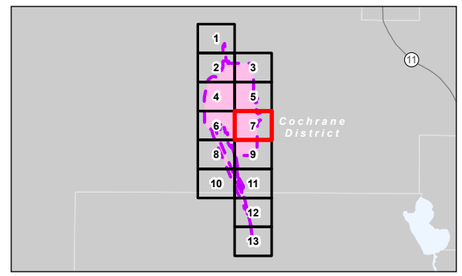

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.7

Title
Forage Species Guild Adult Habitat

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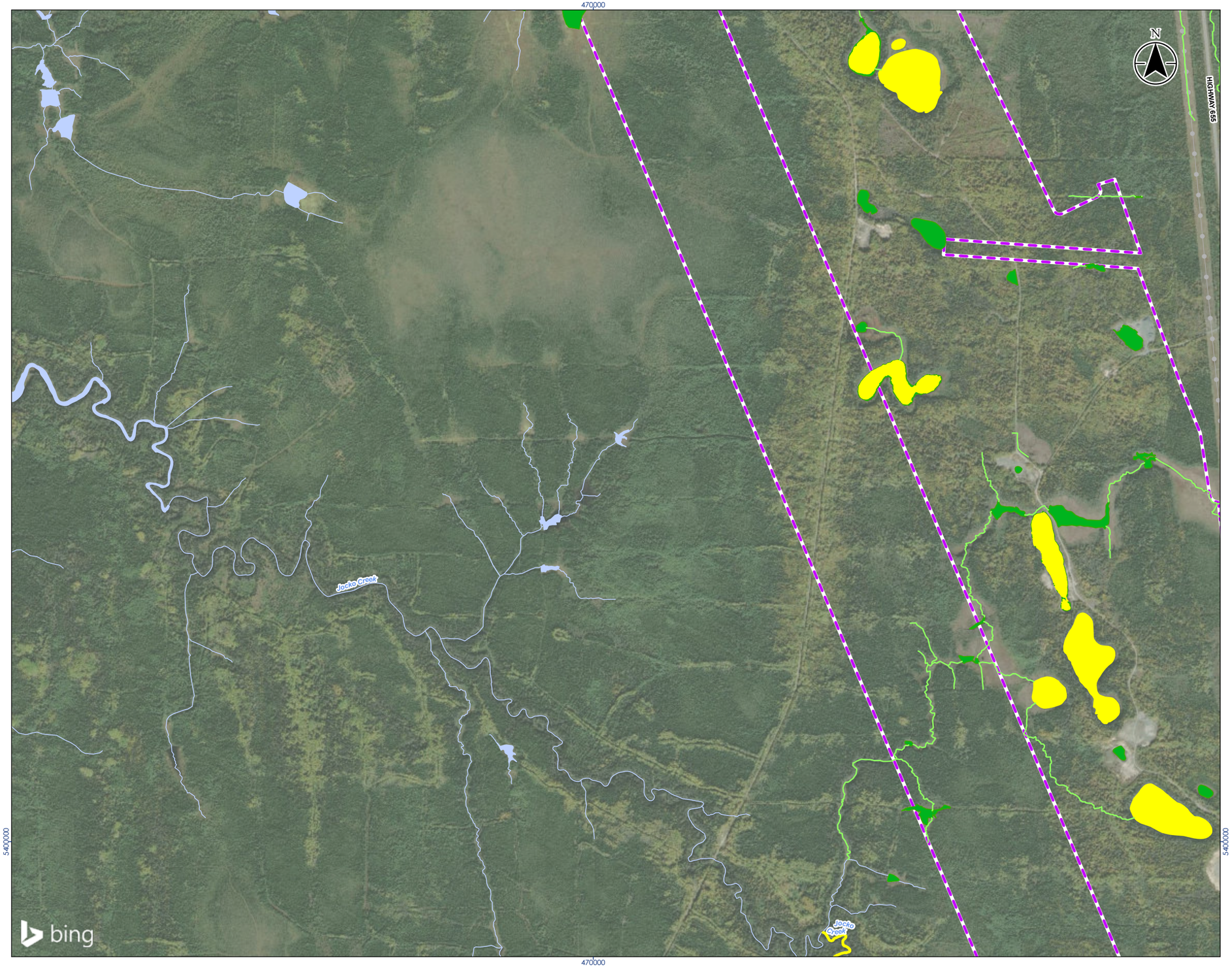

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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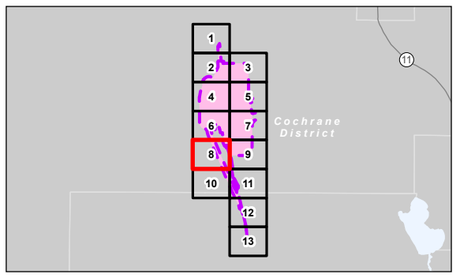

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.8

Title
Forage Species Guild Adult Habitat

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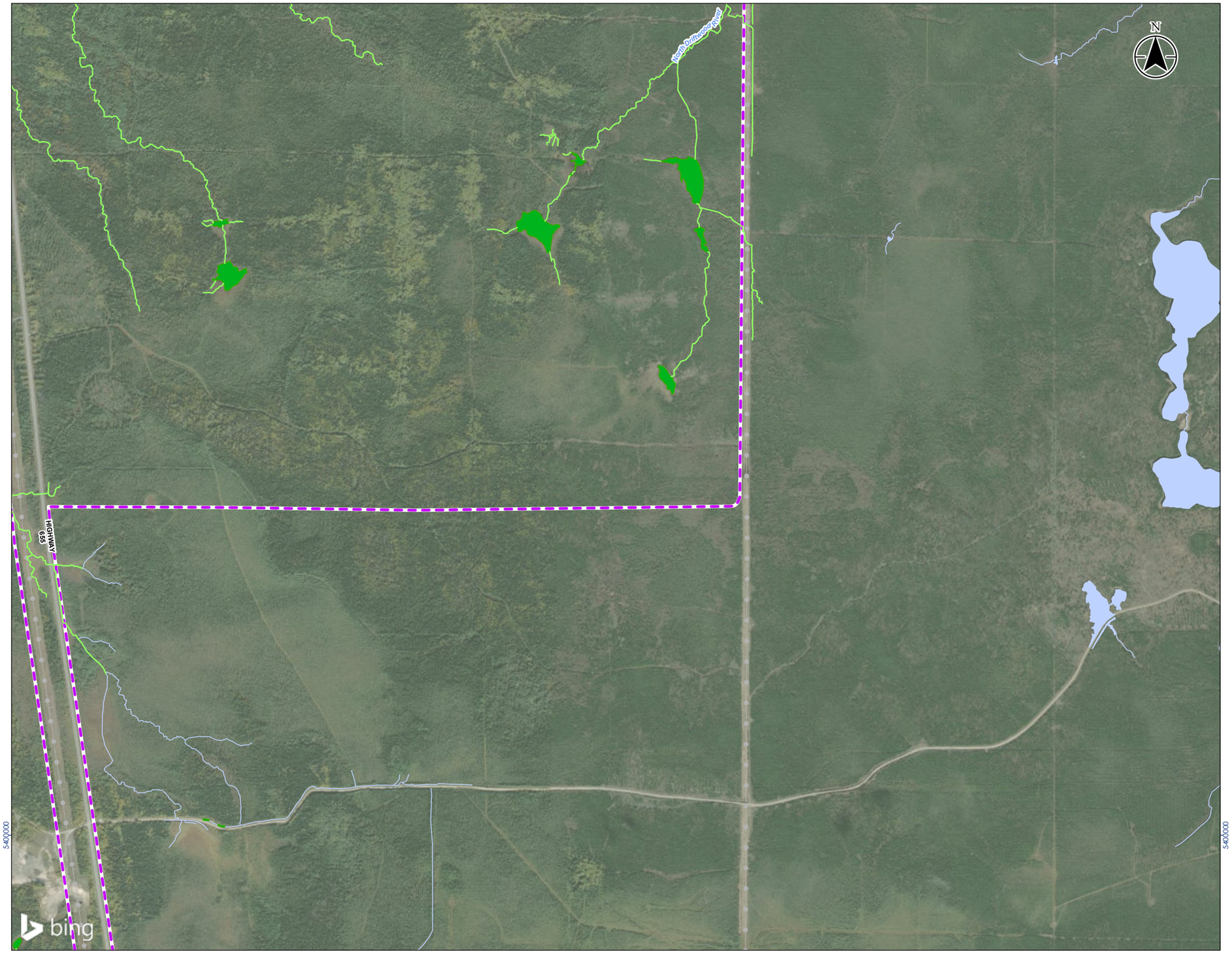

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Adult Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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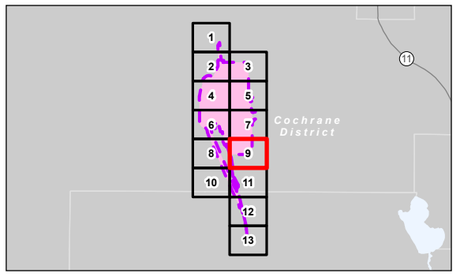

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.9

Title
Forage Species Guild Adult Habitat

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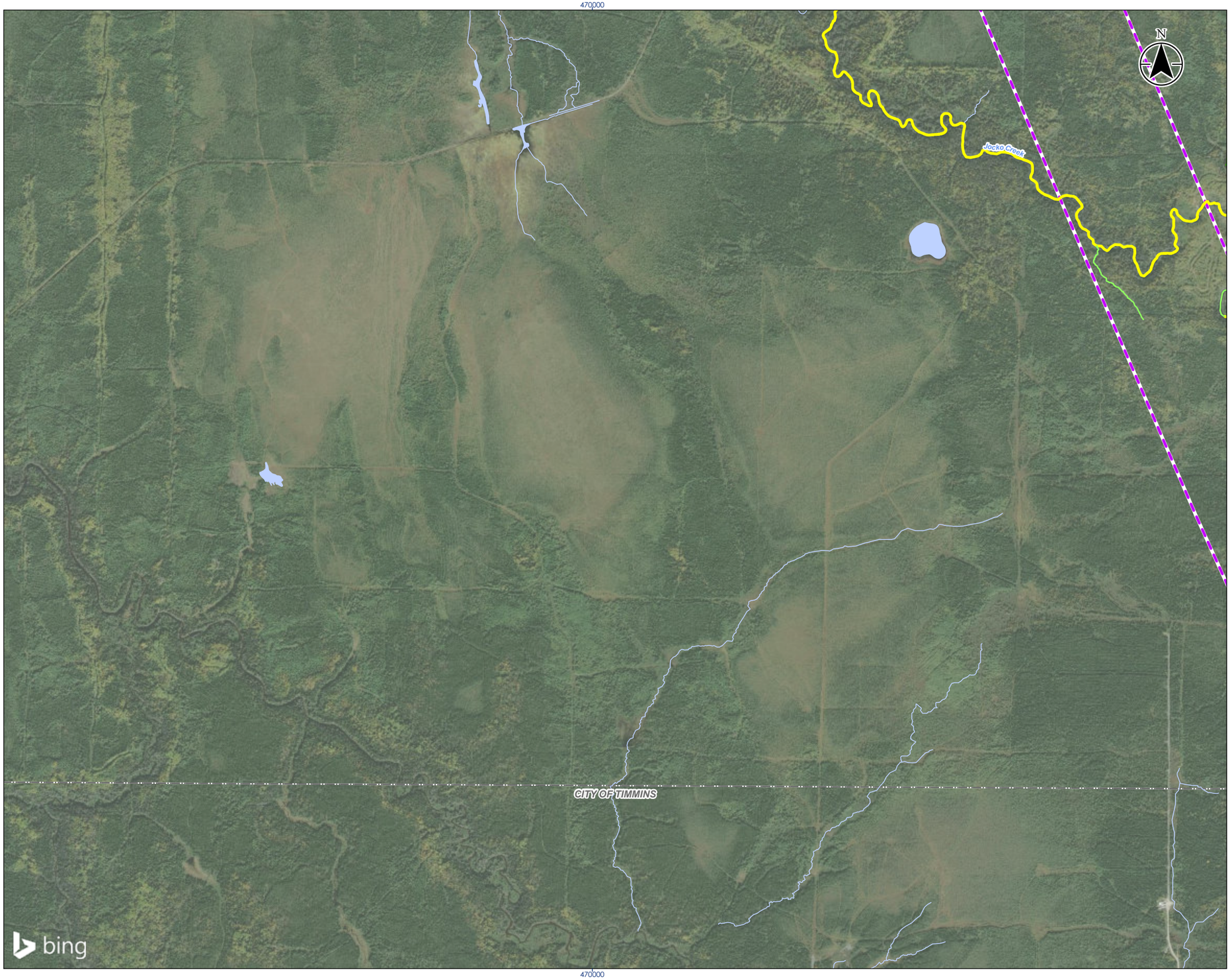

Stantec

Legend

- Project Area
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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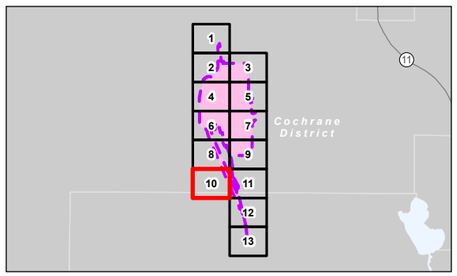

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.10

Title
Forage Species Guild Adult Habitat

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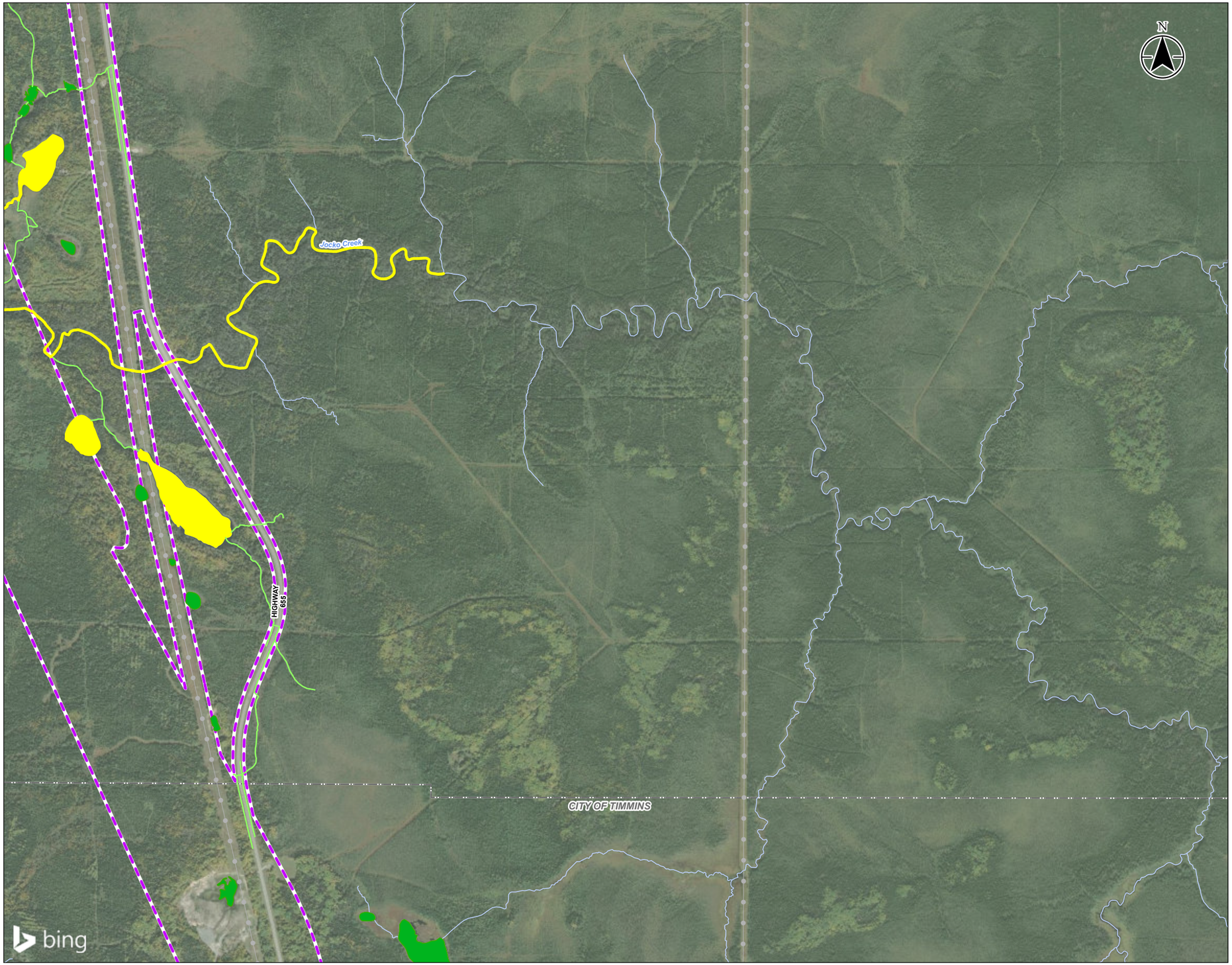

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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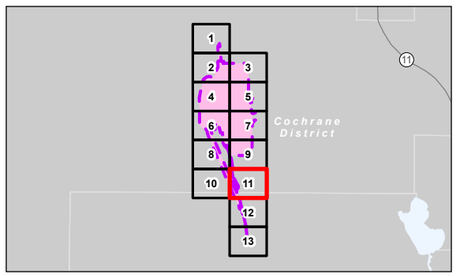

Project Location
Timmins, Ontario

160930456 REV6
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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.11

Title
Forage Species Guild Adult Habitat

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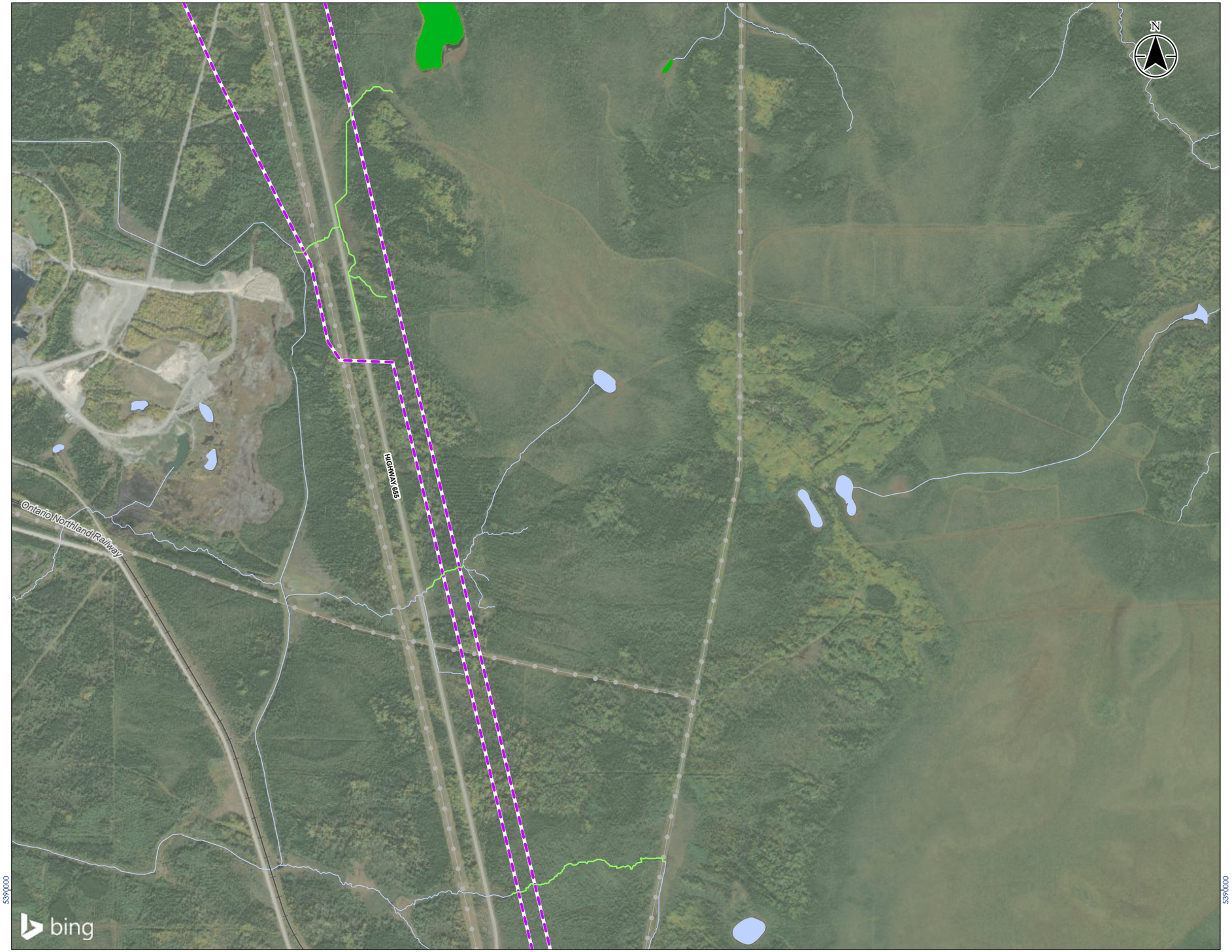

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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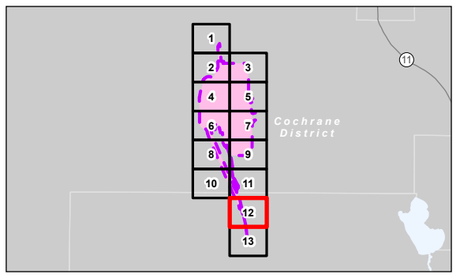

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.12

Title
Forage Species Guild Adult Habitat

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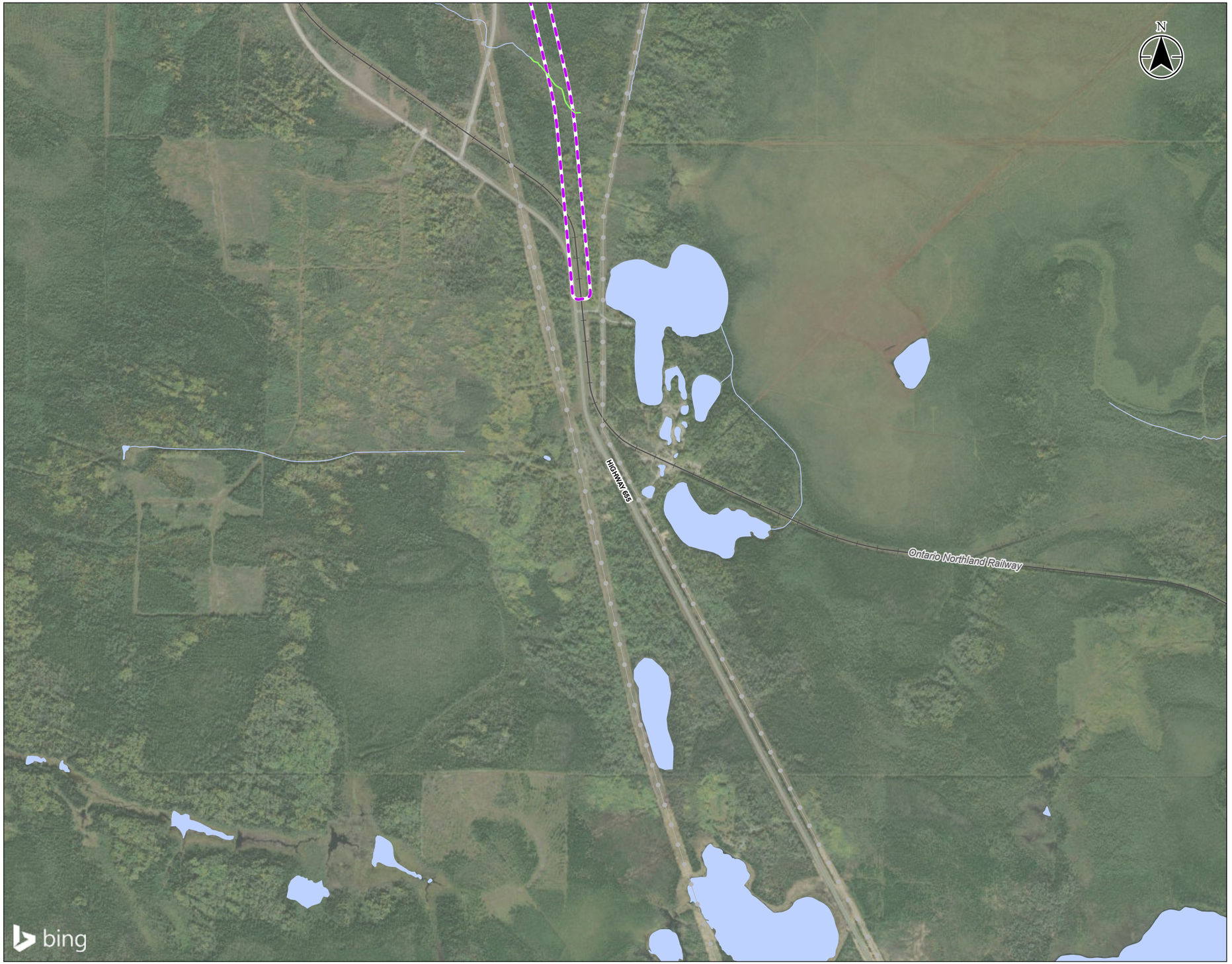

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Adult Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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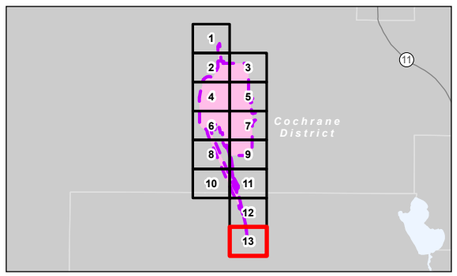

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17.13

Title
Forage Species Guild Adult Habitat

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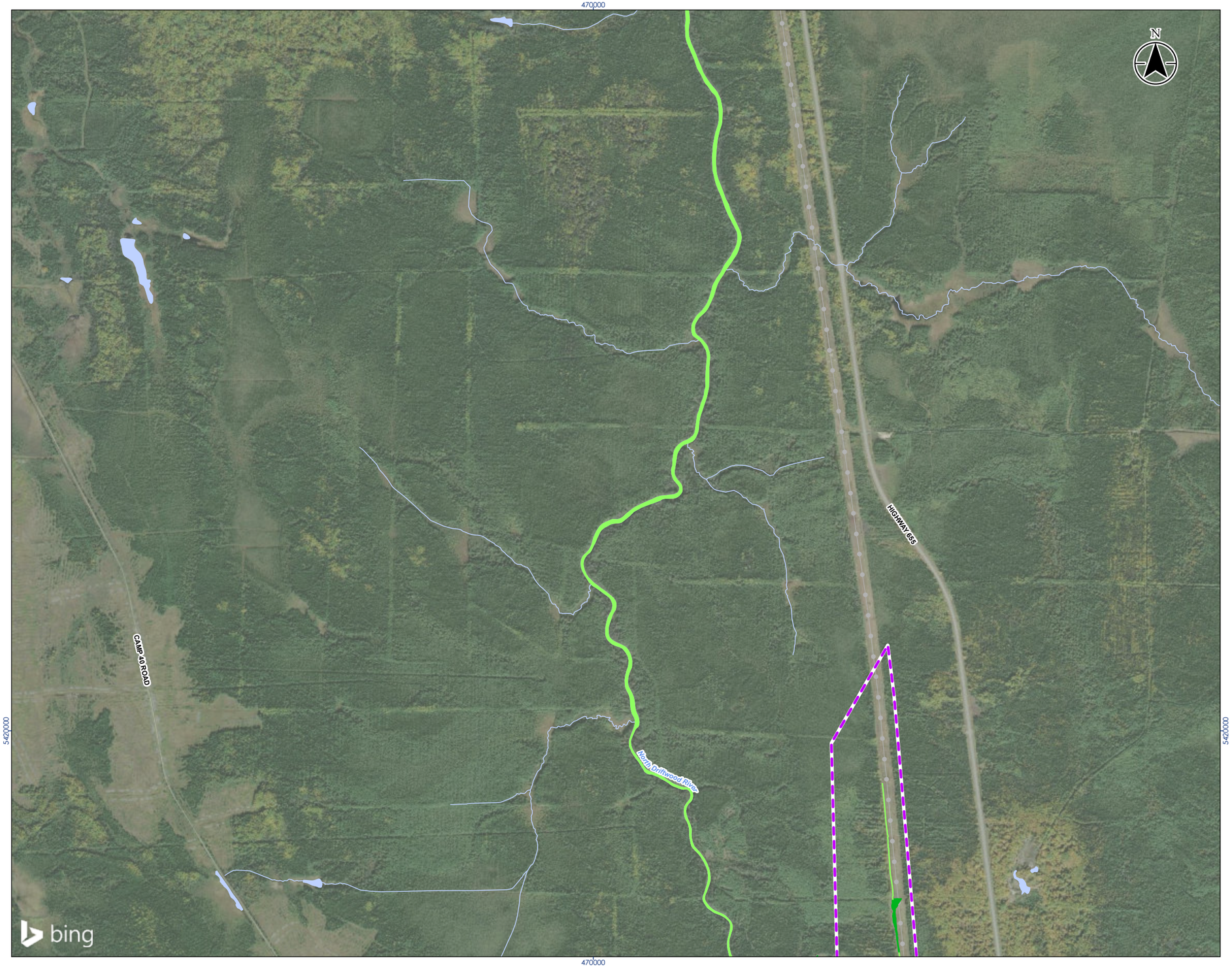

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

1:20,000 (At original document size of 11x17)

Notes

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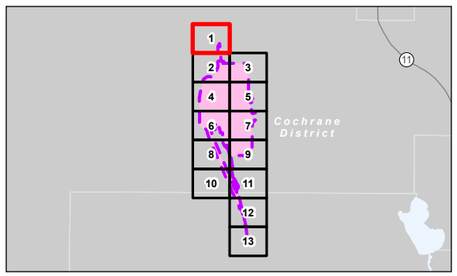

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.1

Title
Forage Species Guild Spawning/Rearing Habitat

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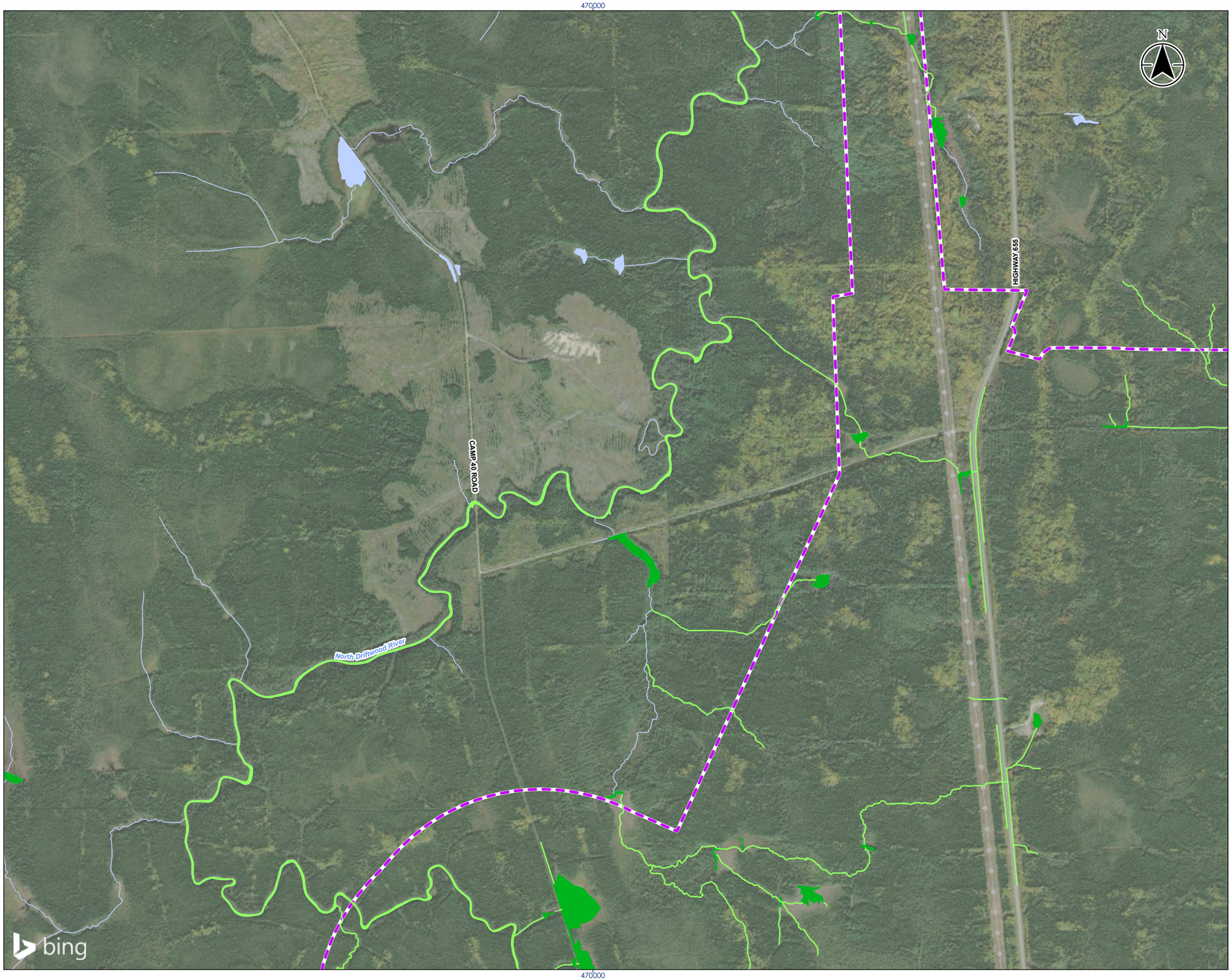

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

1:20,000 (At original document size of 11x17)

Notes

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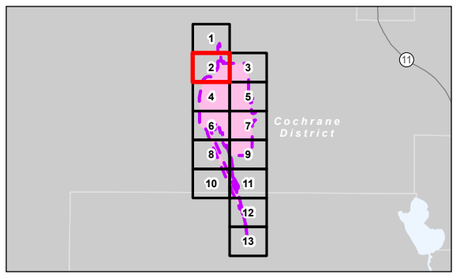

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.2

Title
Forage Species Guild Spawning/Rearing Habitat

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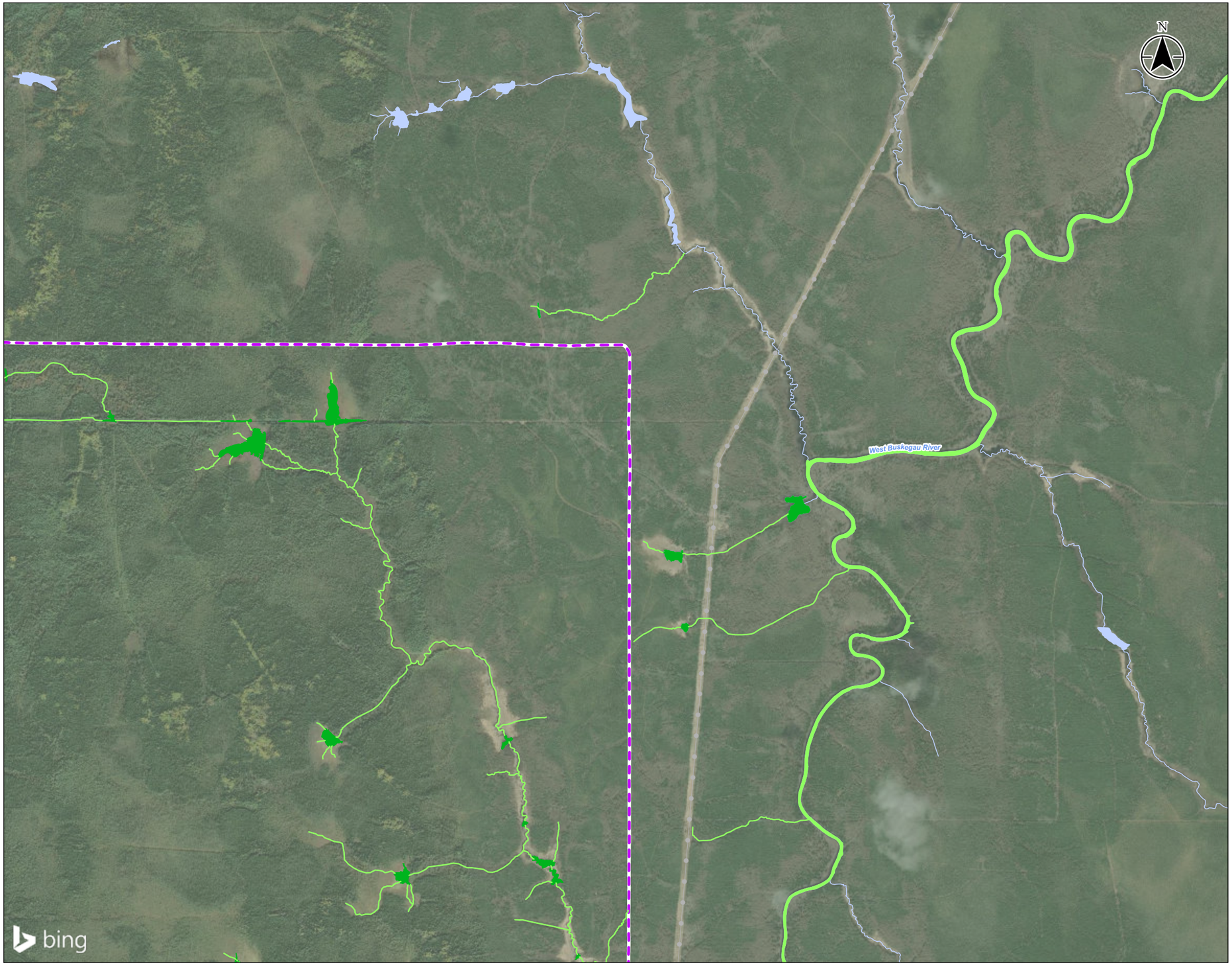

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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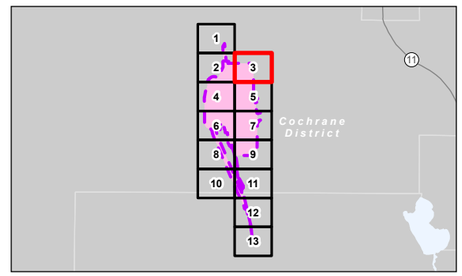

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.3

Title
Forage Species Guild Spawning/Rearing Habitat

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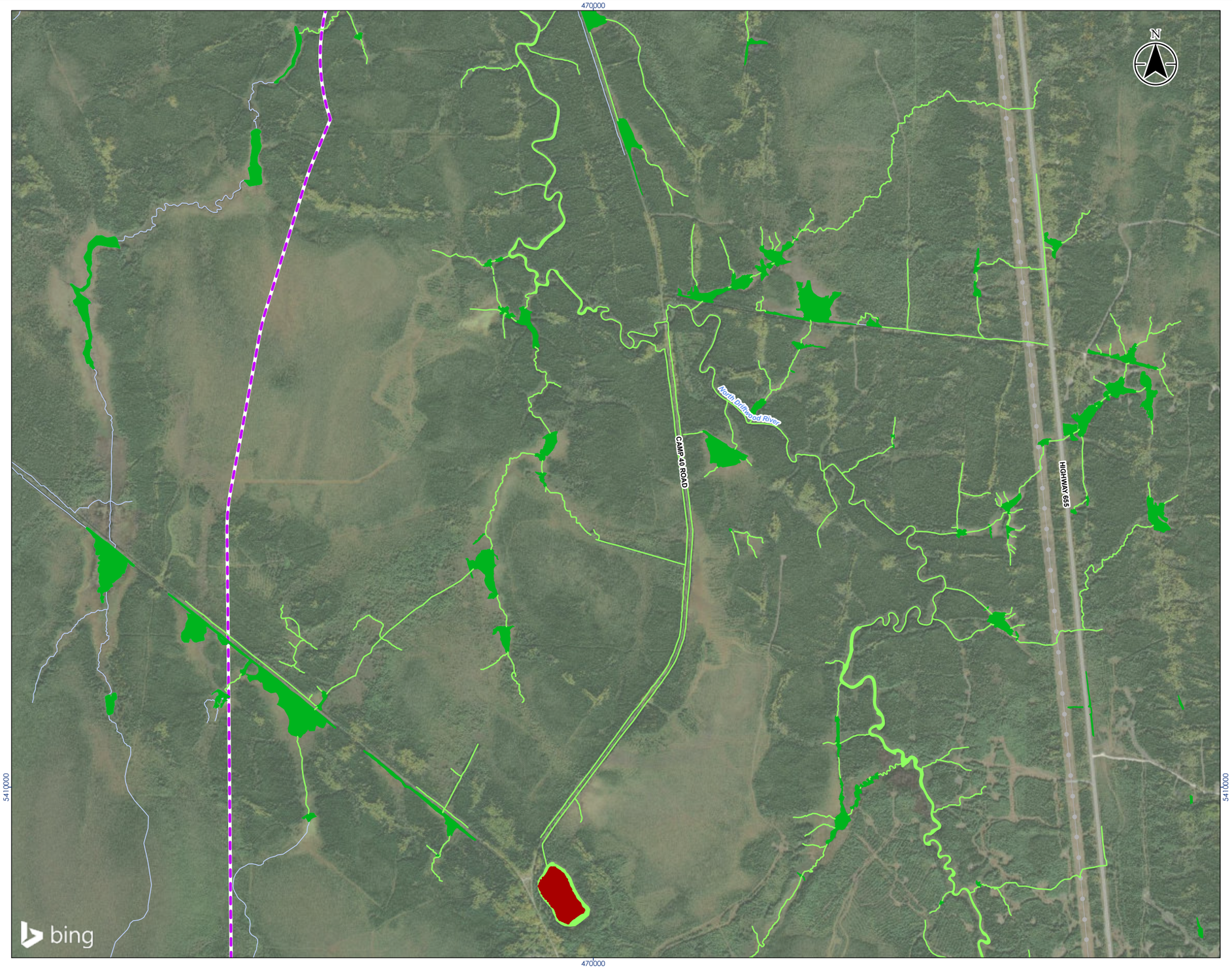

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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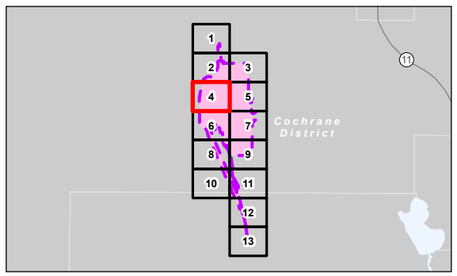

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.4

Title
Forage Species Guild Spawning/Rearing Habitat

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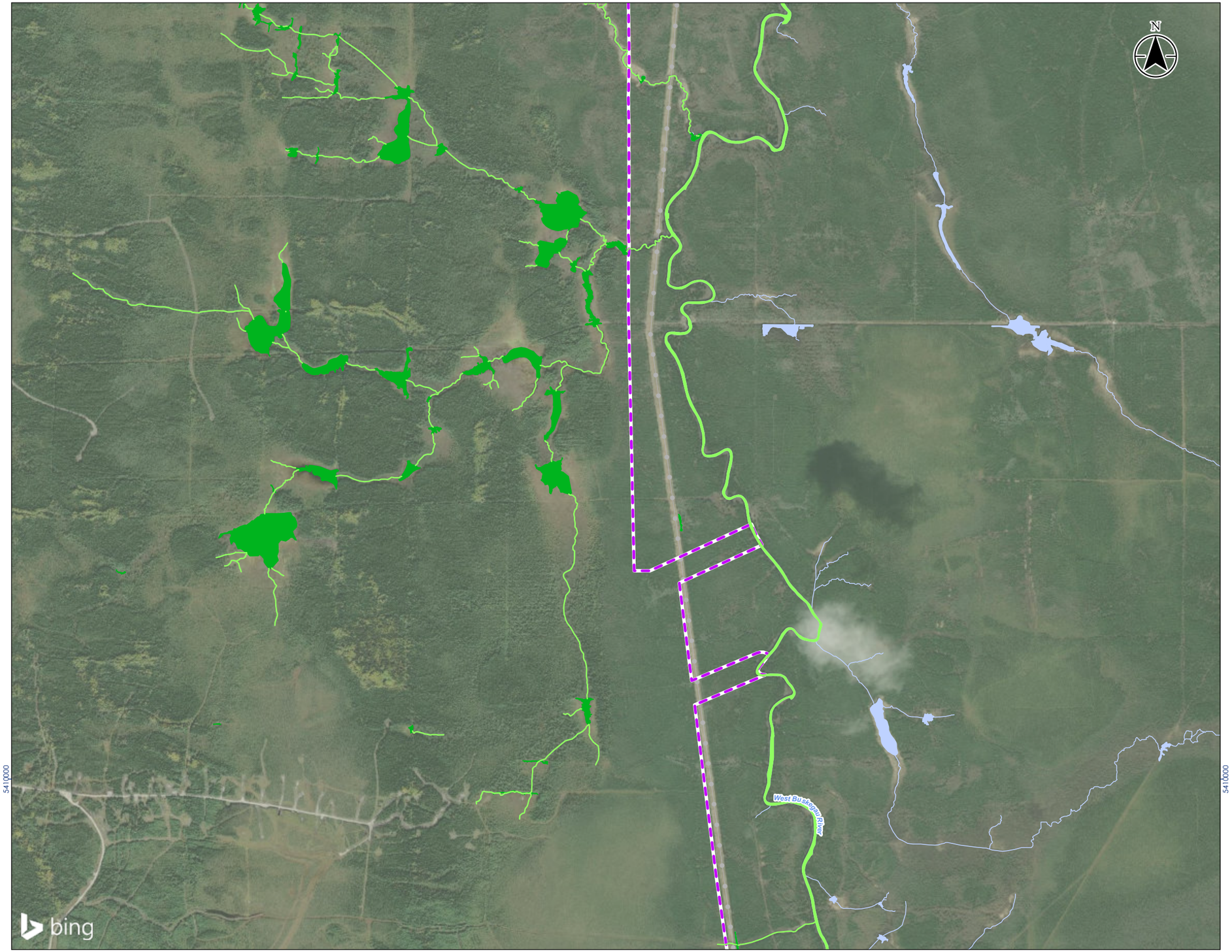

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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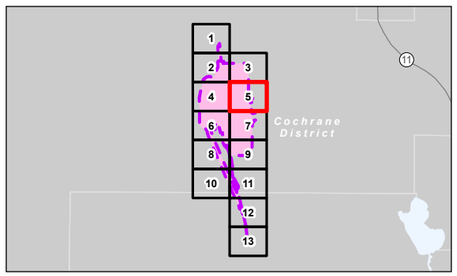

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.5

Title
Forage Species Guild Spawning/Rearing Habitat

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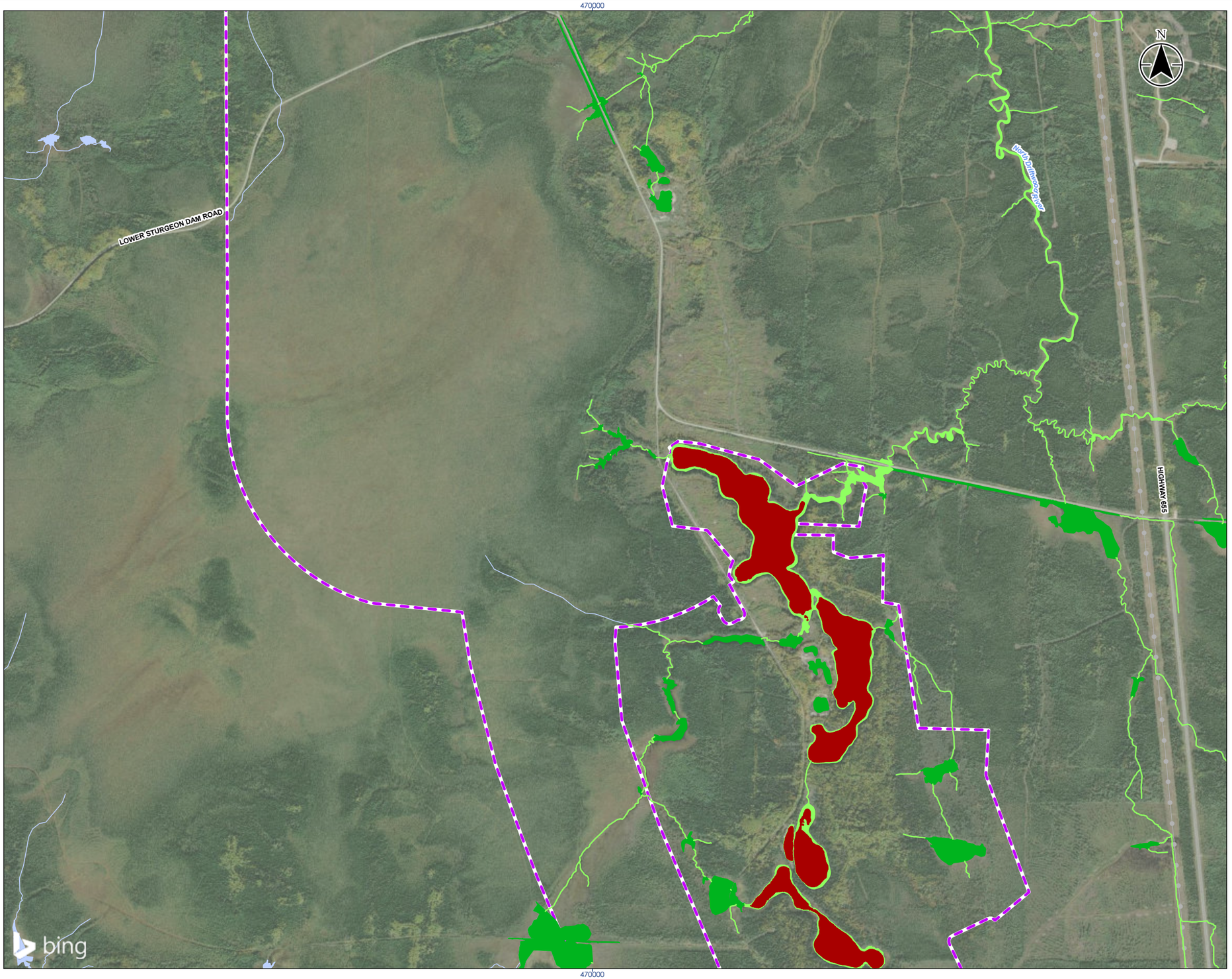

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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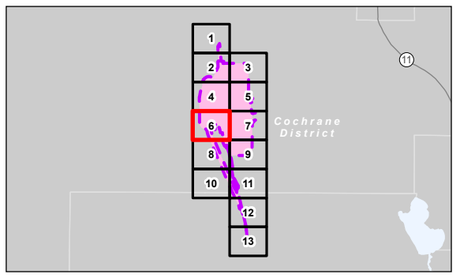

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.6

Title
Forage Species Guild Spawning/Rearing Habitat

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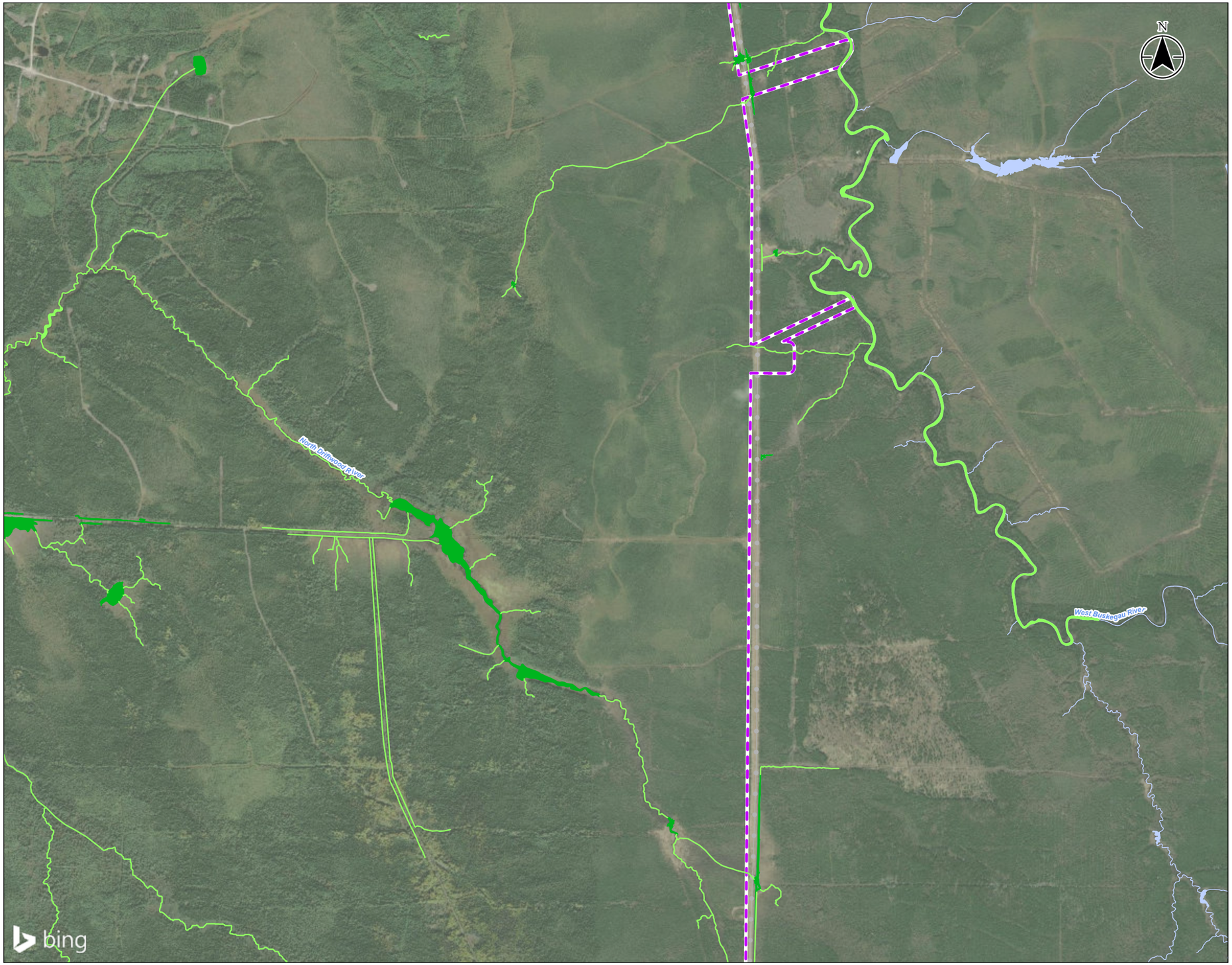

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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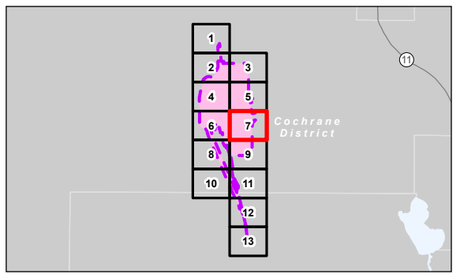

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.7

Title
Forage Species Guild Spawning/Rearing Habitat

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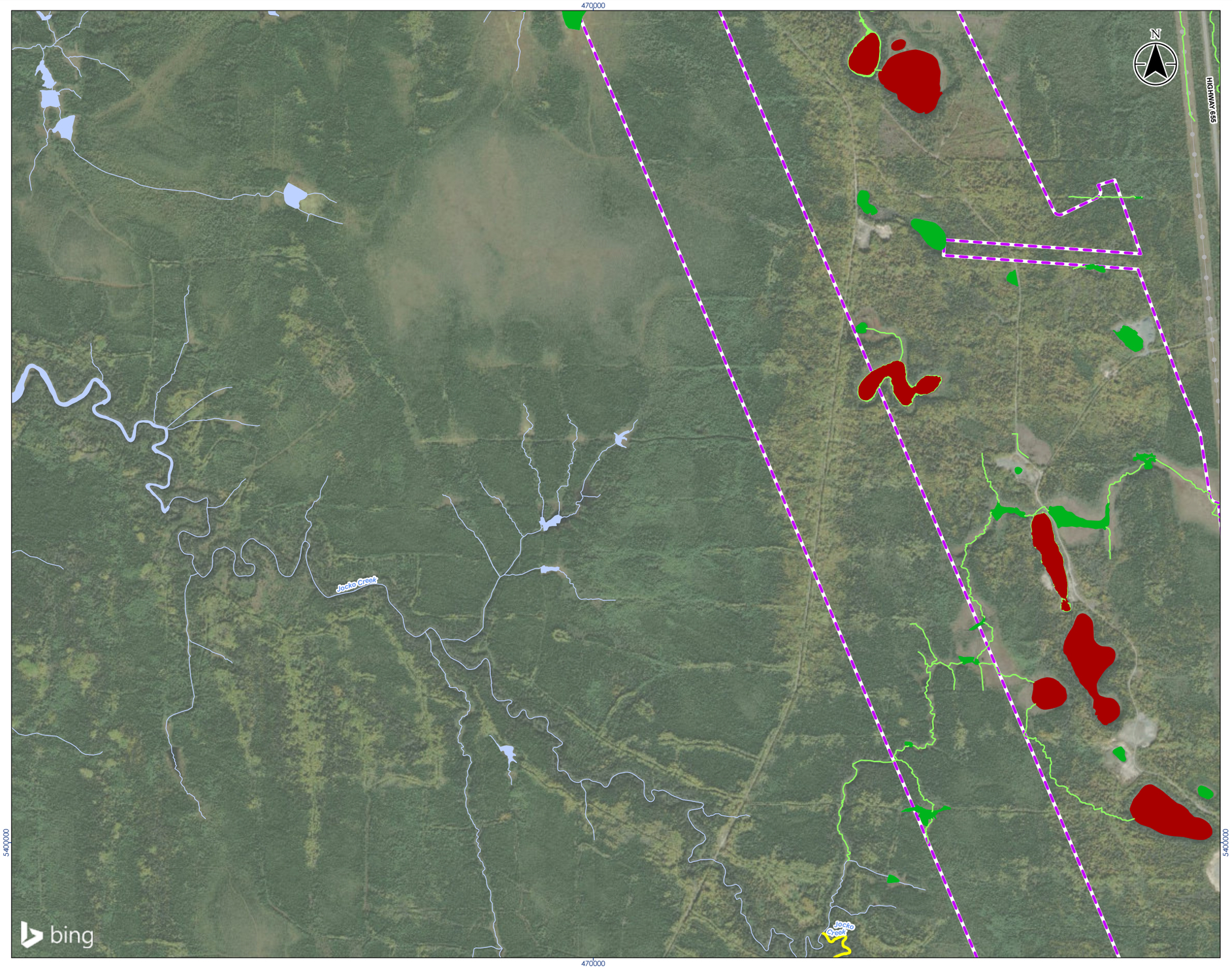

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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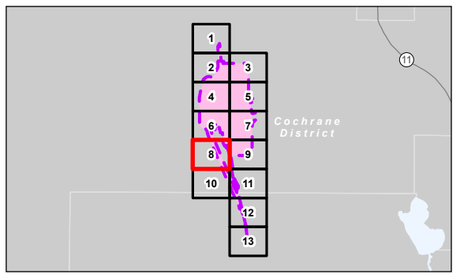

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.8

Title
Forage Species Guild Spawning/Rearing Habitat

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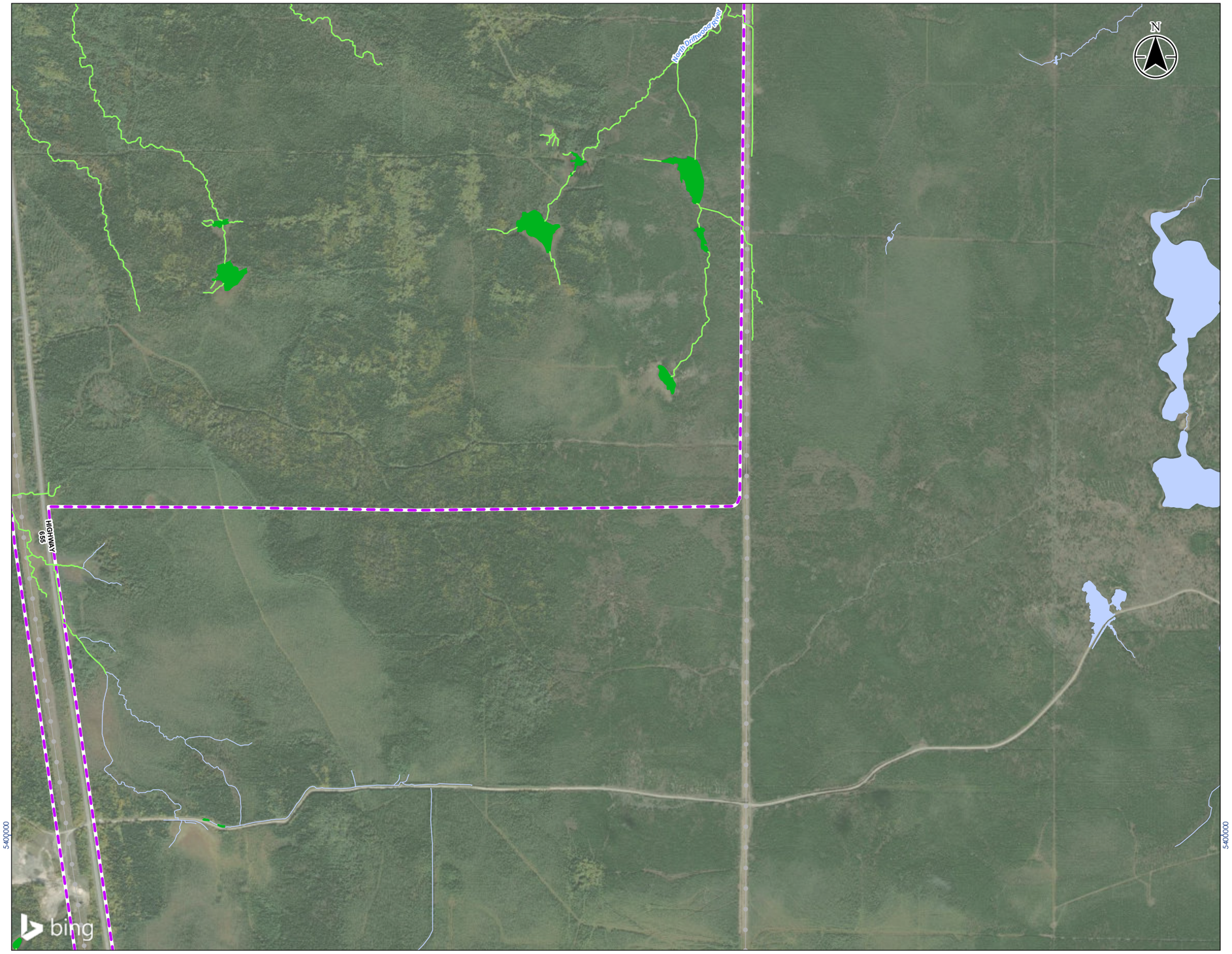

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Waterbody

Watercourse

Spawning/Rearing Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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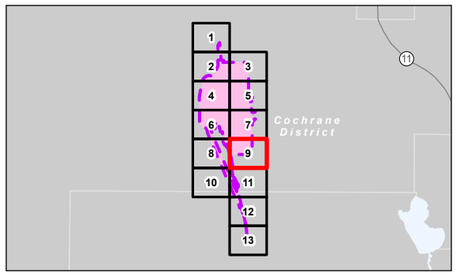

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.9

Title
Forage Species Guild Spawning/Rearing Habitat

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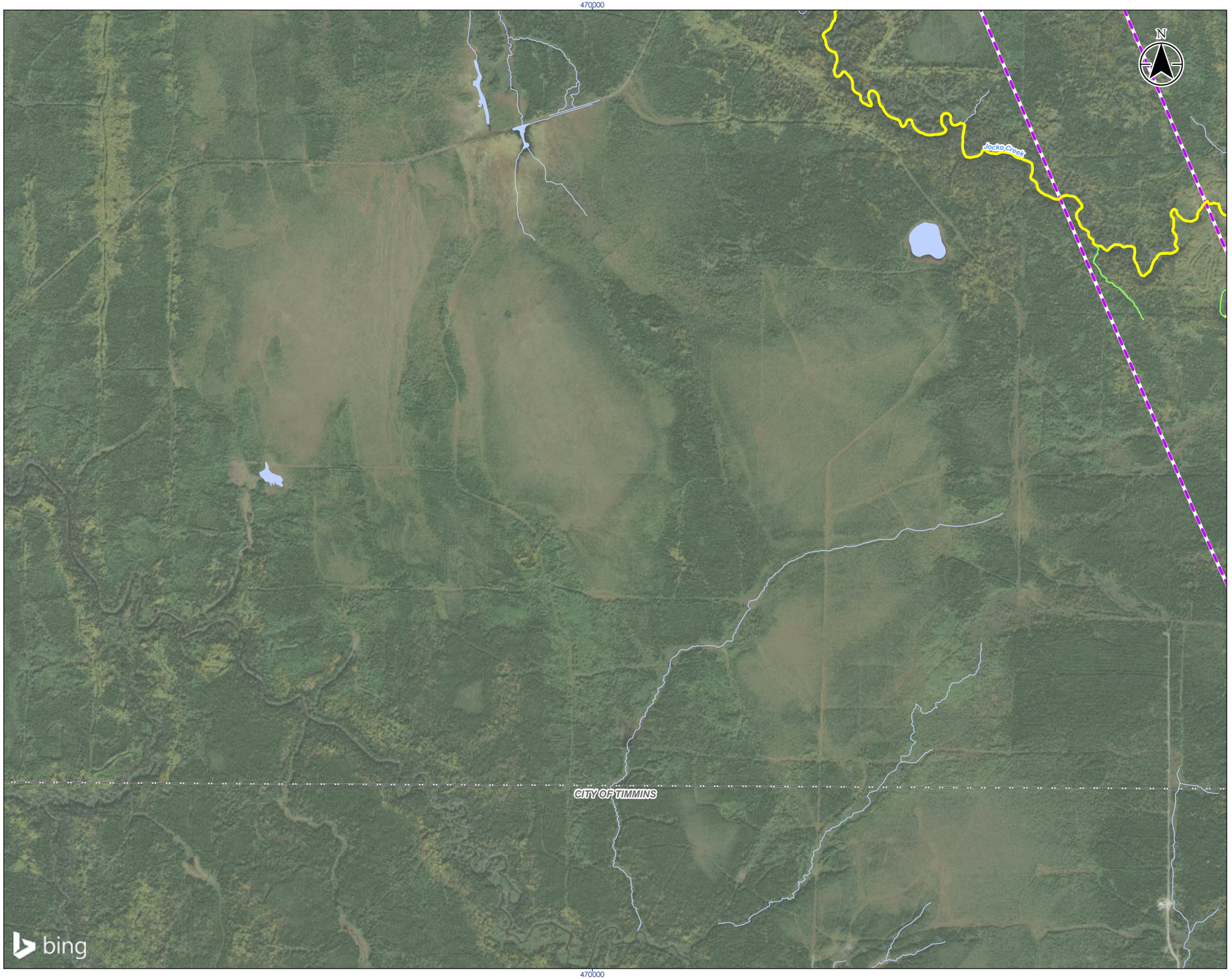

Stantec

Legend

- Project Area
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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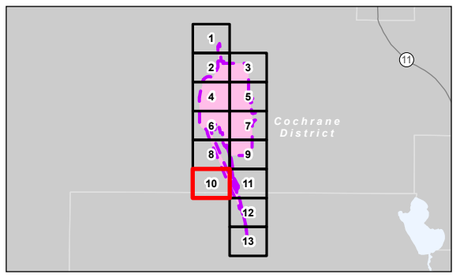

Project Location
Timmins, Ontario

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Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.10

Title
Forage Species Guild Spawning/Rearing Habitat

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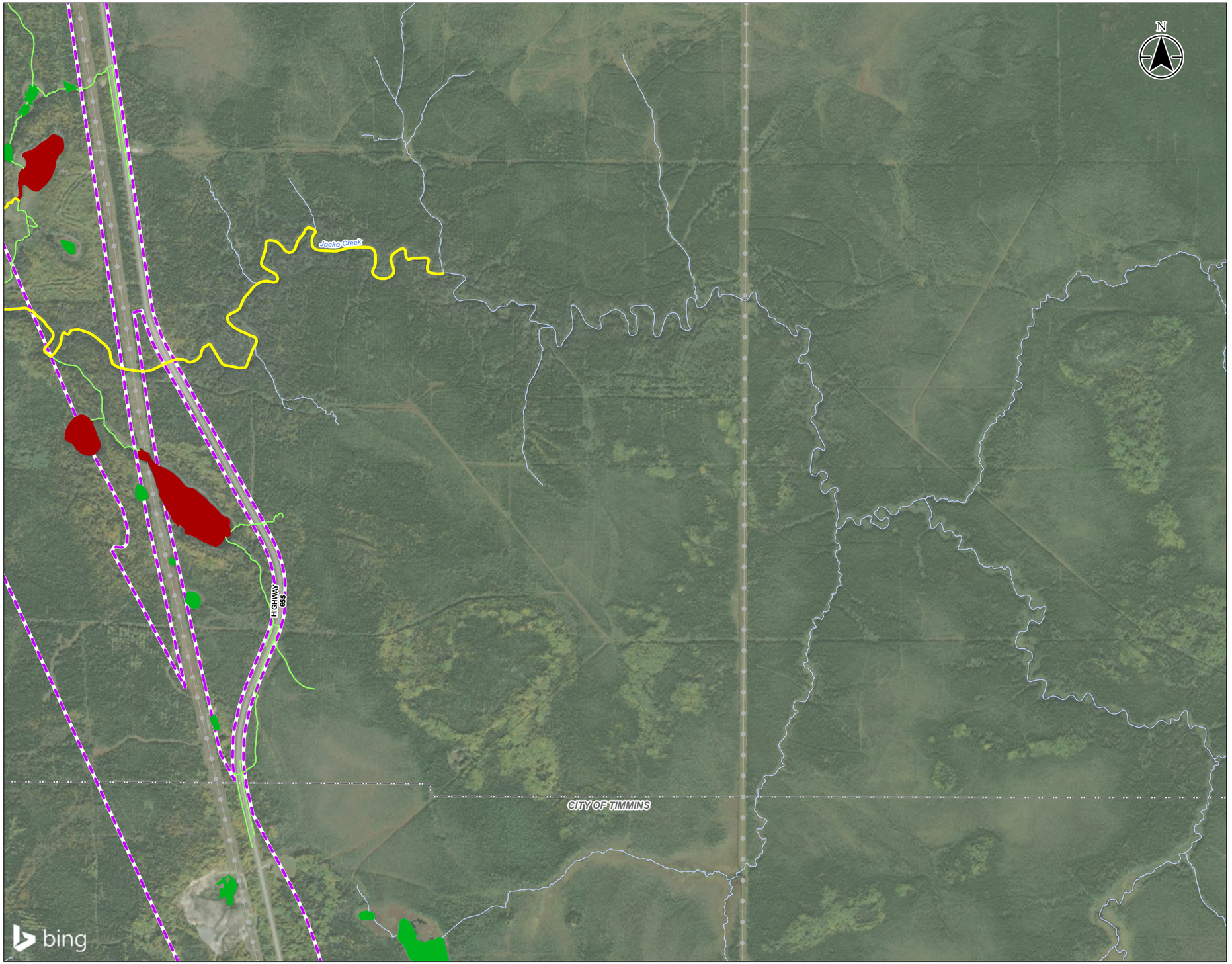

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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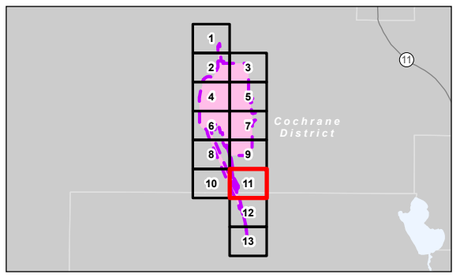

Project Location
Timmins, Ontario

160930456 REV6
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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.11

Title
Forage Species Guild Spawning/Rearing Habitat

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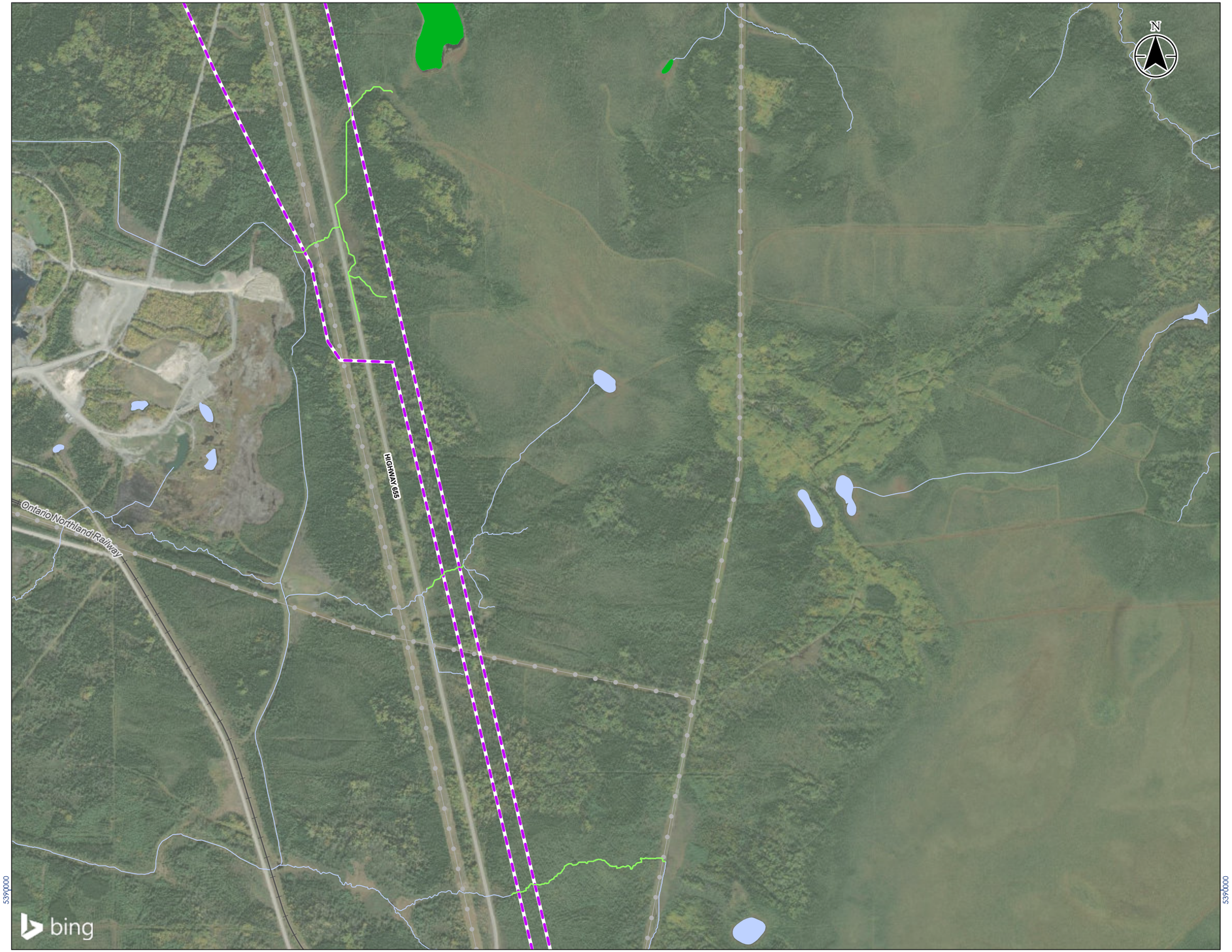

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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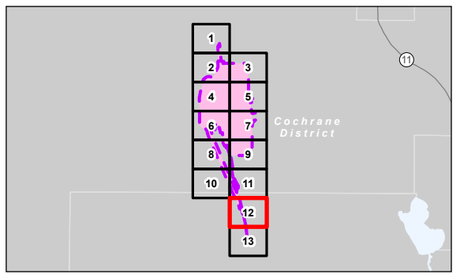

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.12

Title
Forage Species Guild Spawning/Rearing Habitat

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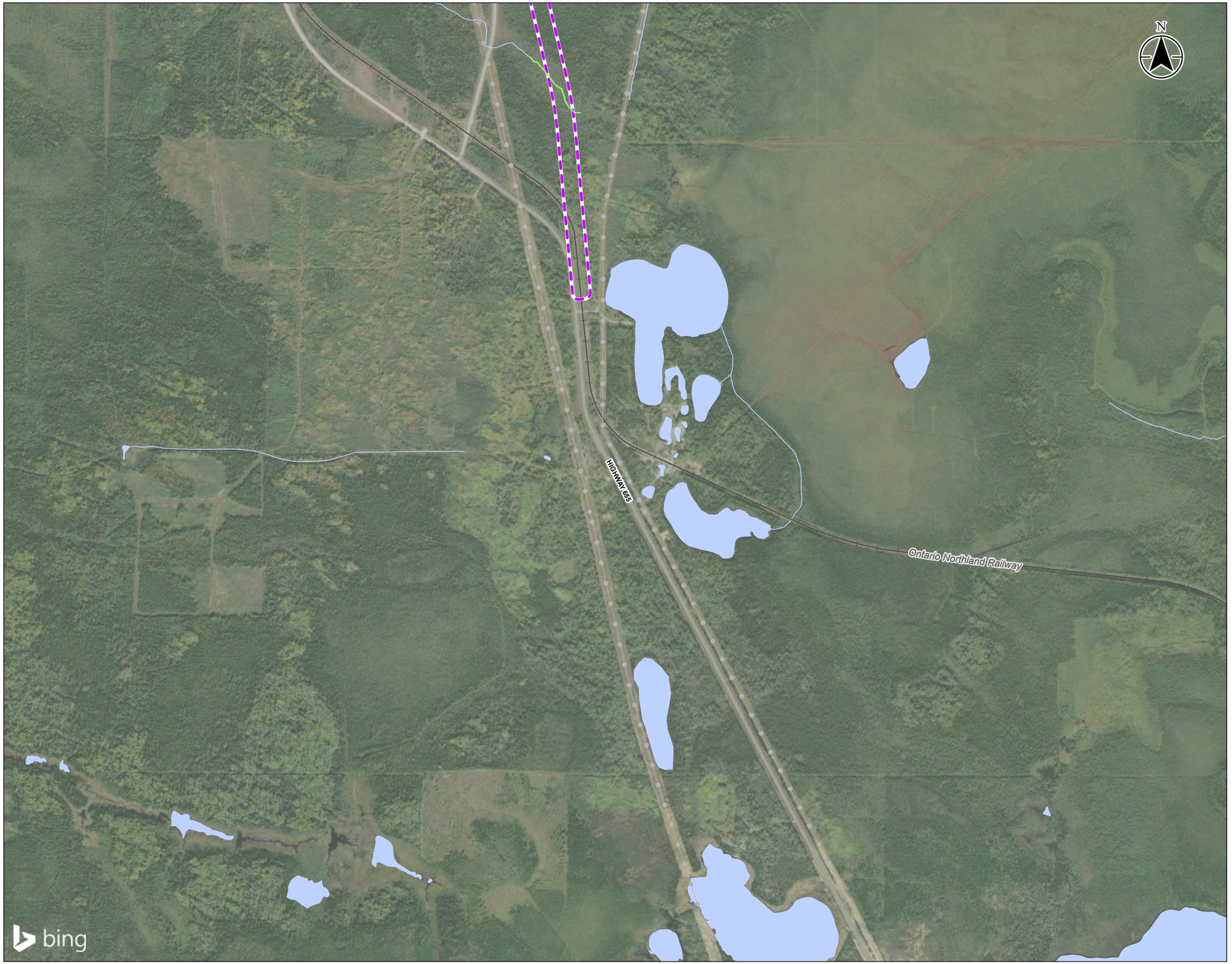

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Waterbody
- Watercourse
- Municipal Boundary - Lower Tier

Spawning/Rearing Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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Notes

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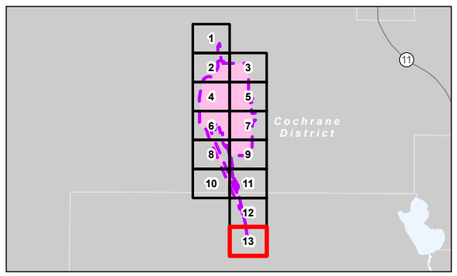

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.18.13

Title
Forage Species Guild Spawning/Rearing Habitat

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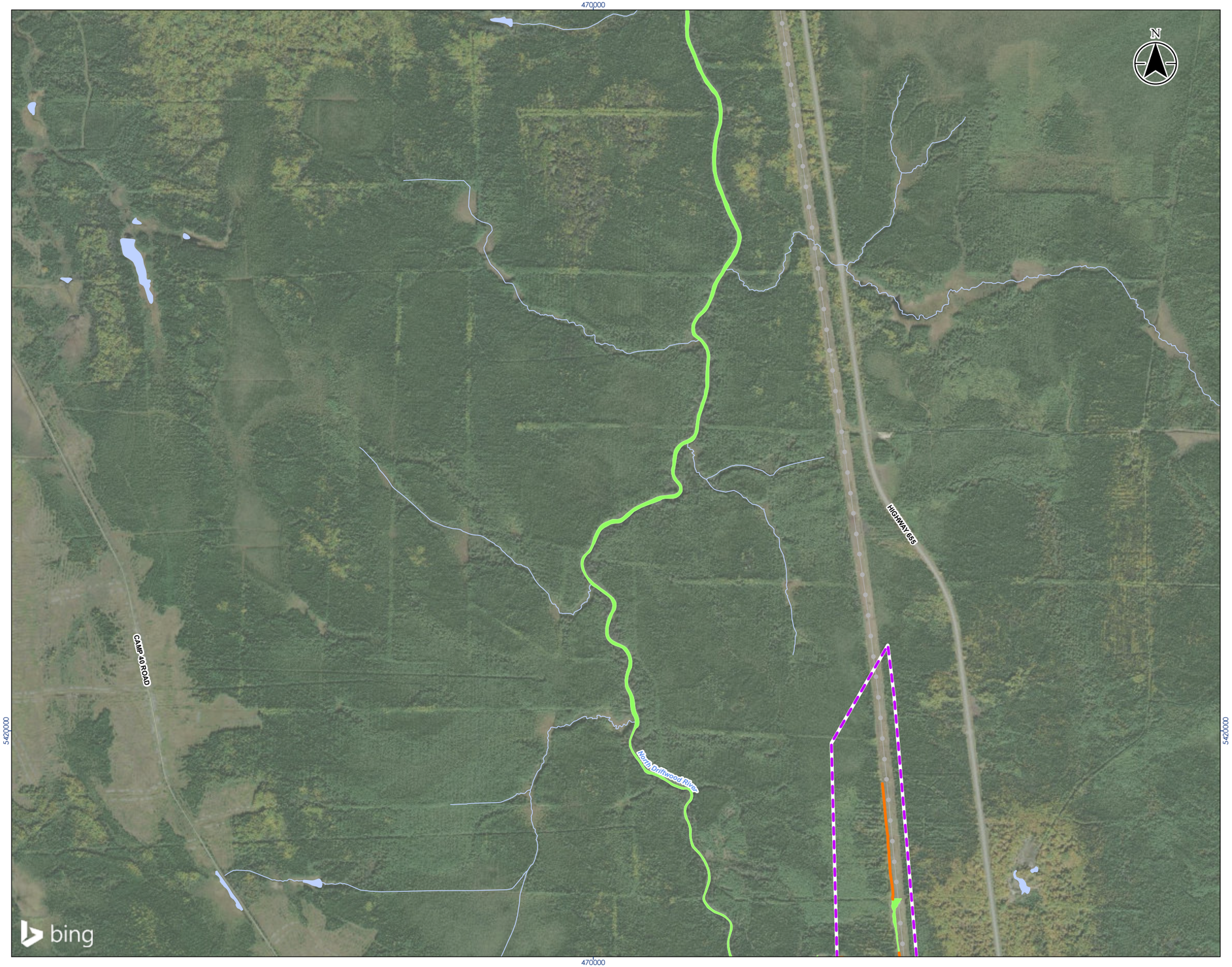

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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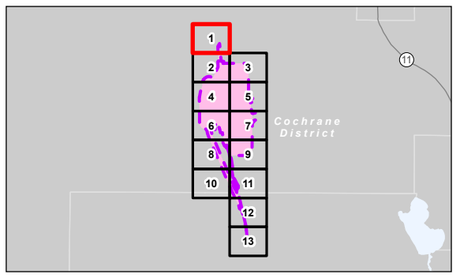

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.19.1

Title
Forage Species Guild Overwintering Habitat

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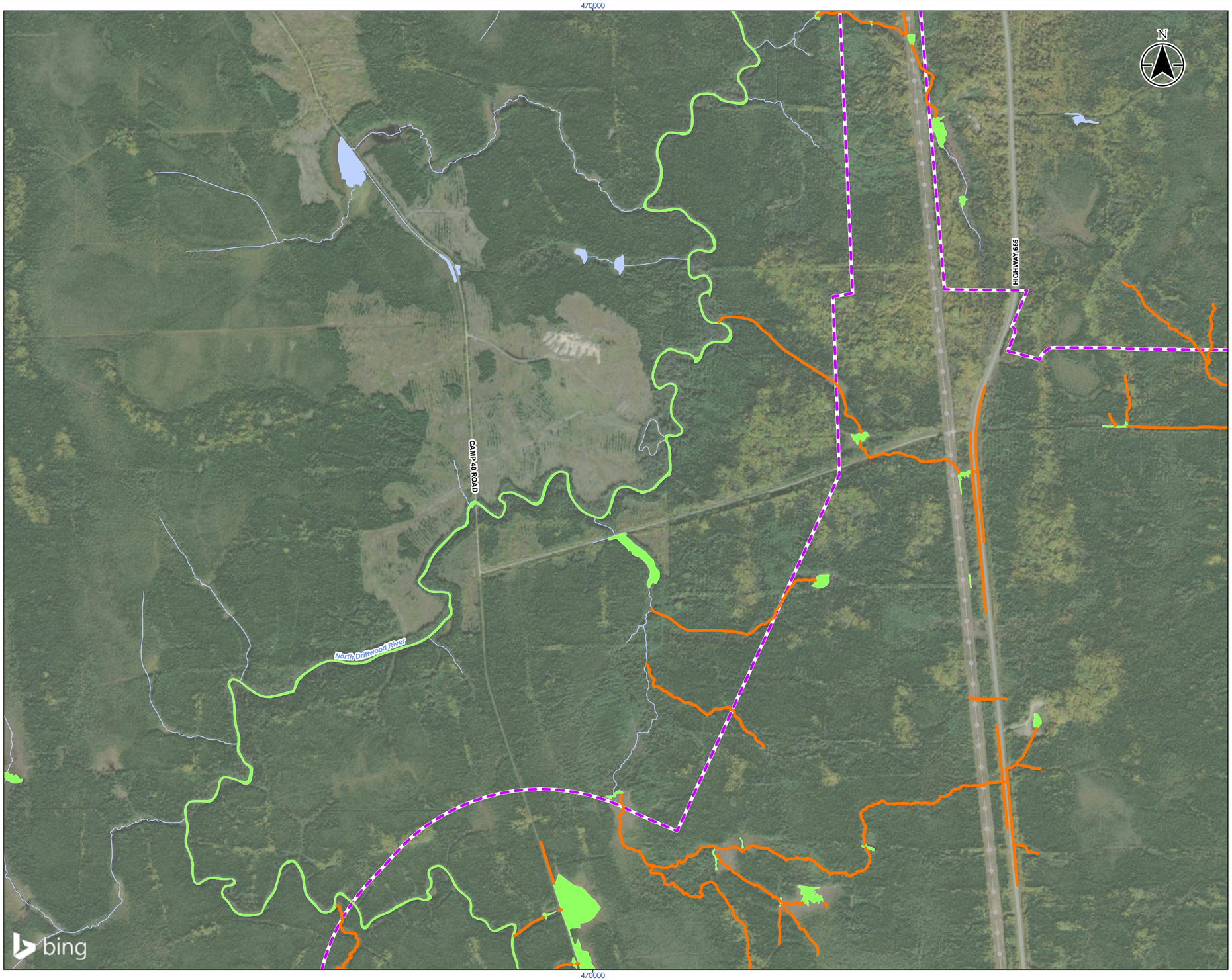

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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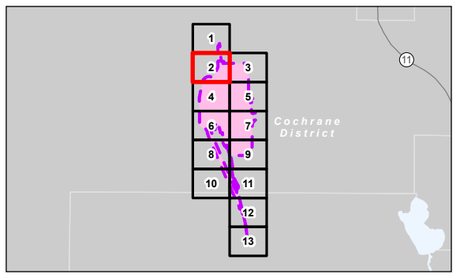

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.19.2

Title
Forage Species Guild Overwintering Habitat

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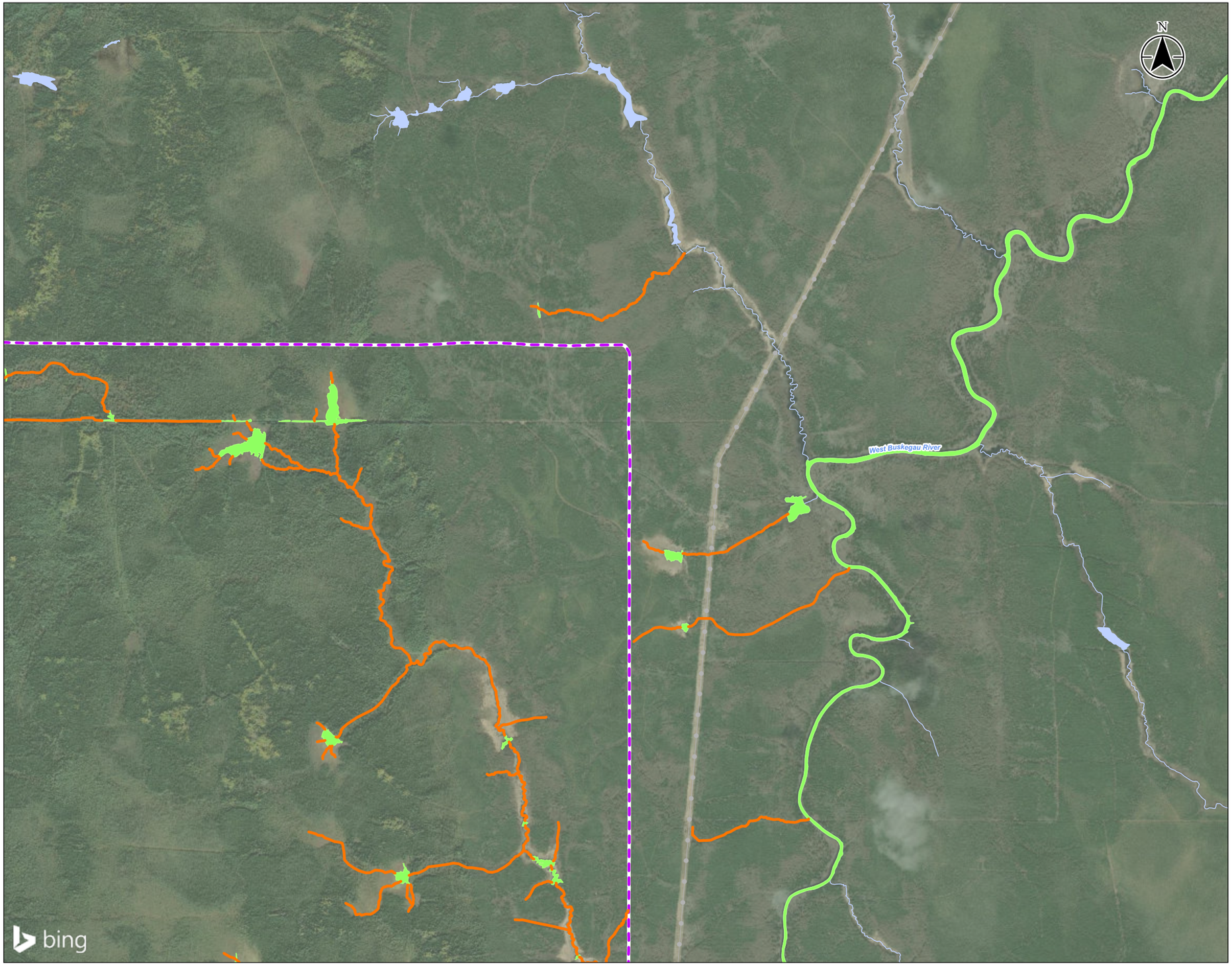

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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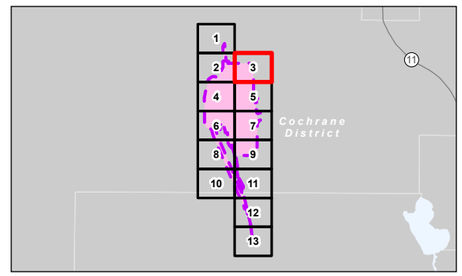

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.19.3

Title
Forage Species Guild Overwintering Habitat

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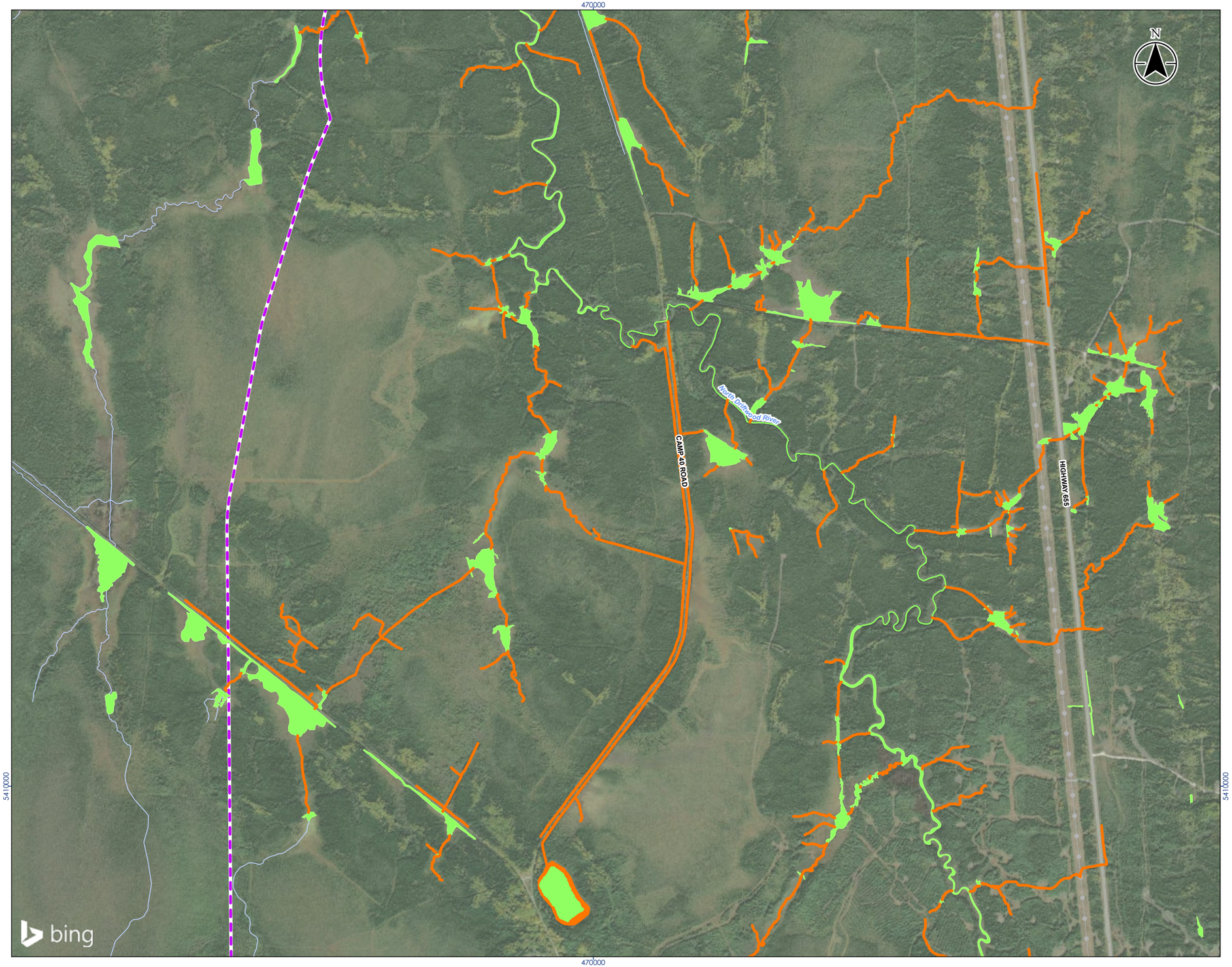

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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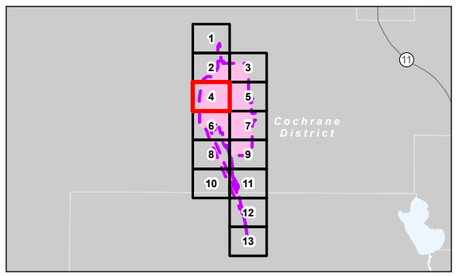

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.19.4

Title
Forage Species Guild Overwintering Habitat

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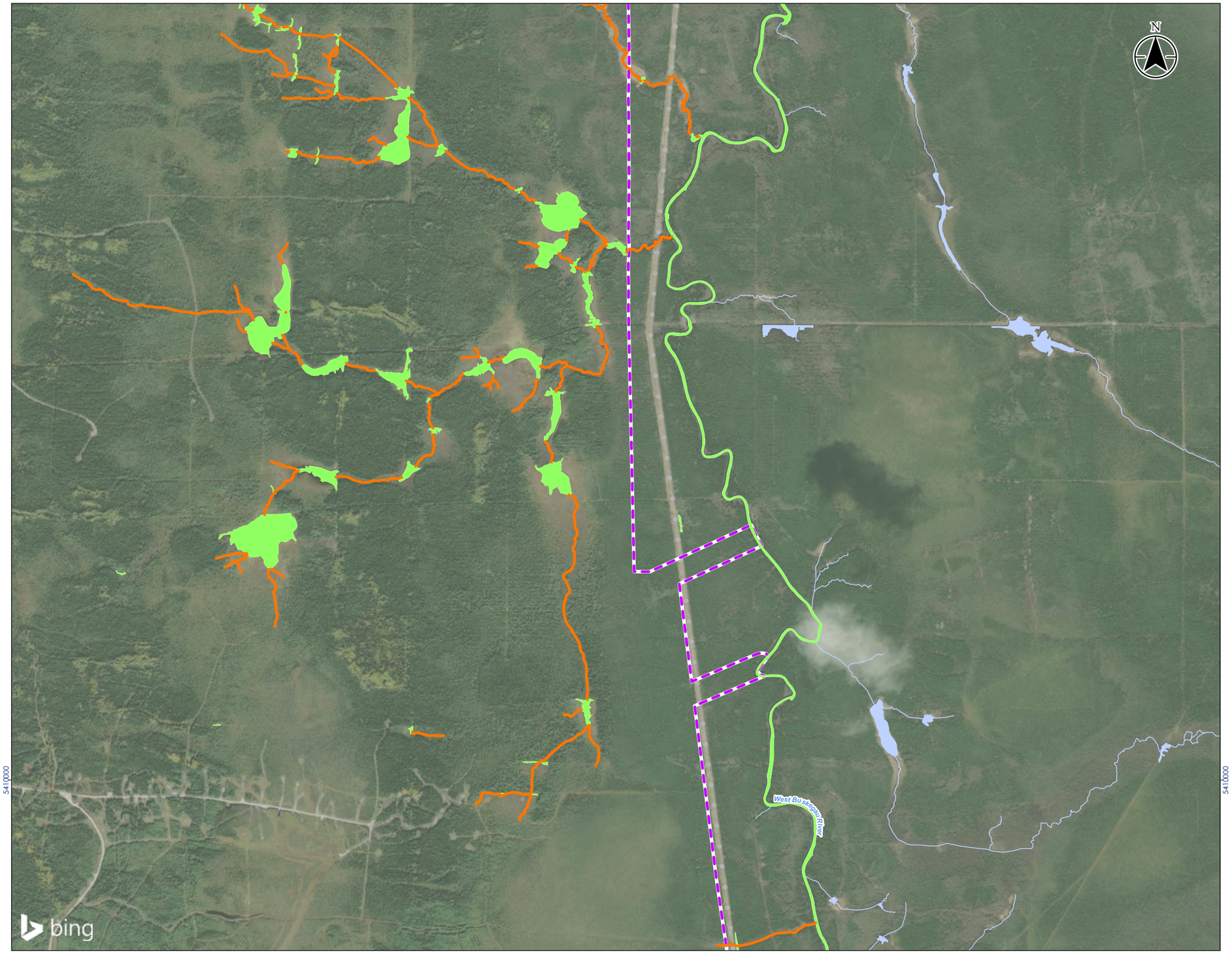

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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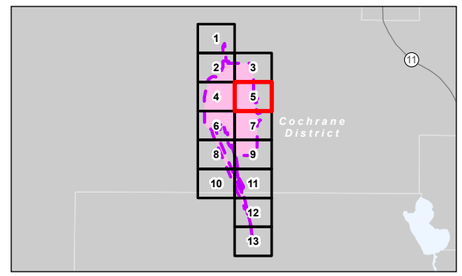

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.19.5

Title
Forage Species Guild Overwintering Habitat

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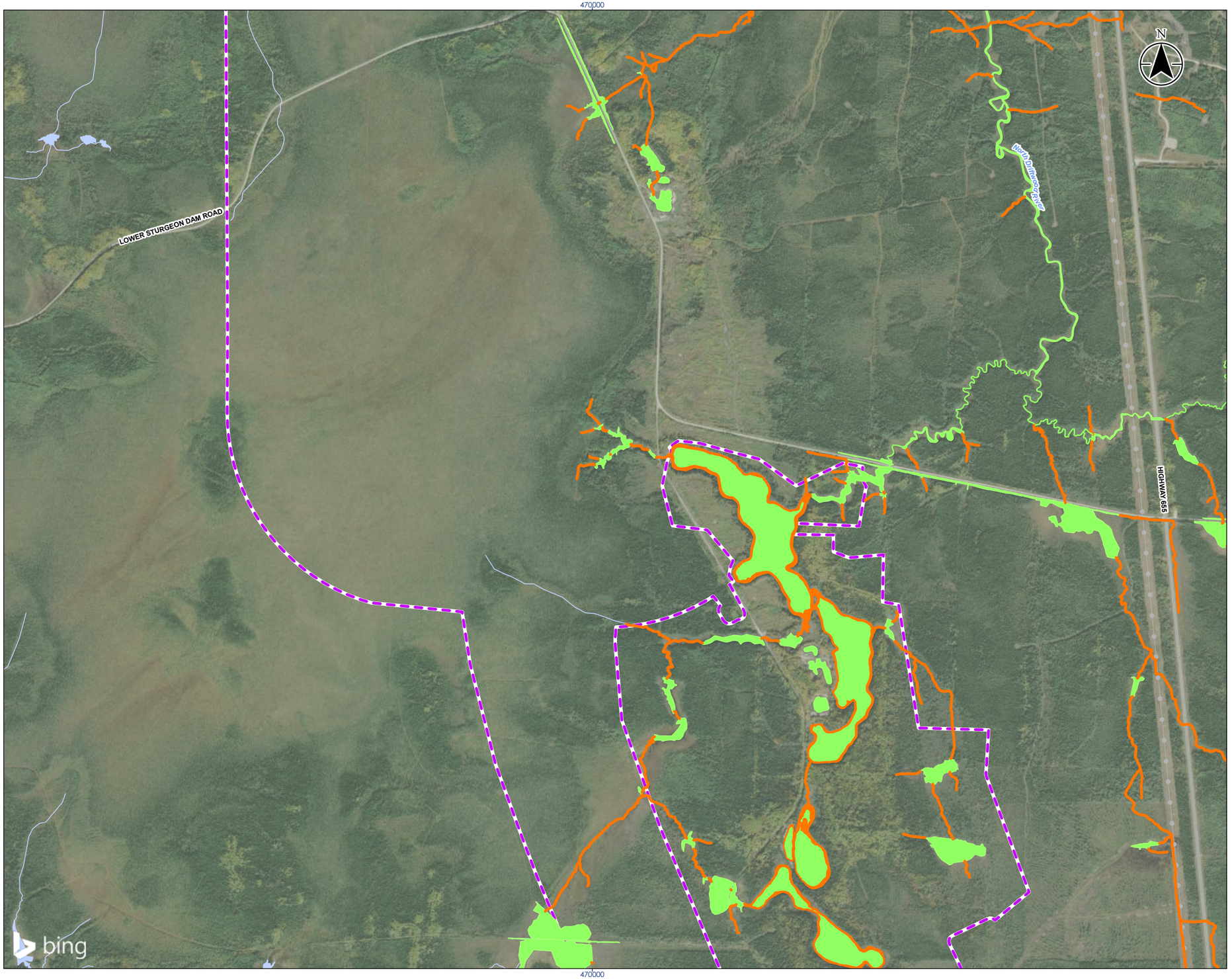

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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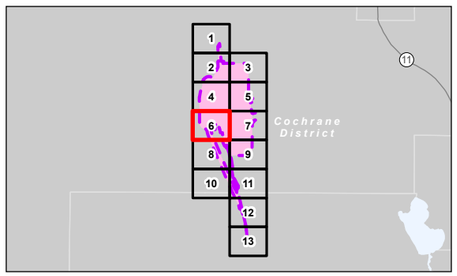

Project Location
Timmins, Ontario

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Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.19.6

Title
Forage Species Guild Overwintering Habitat

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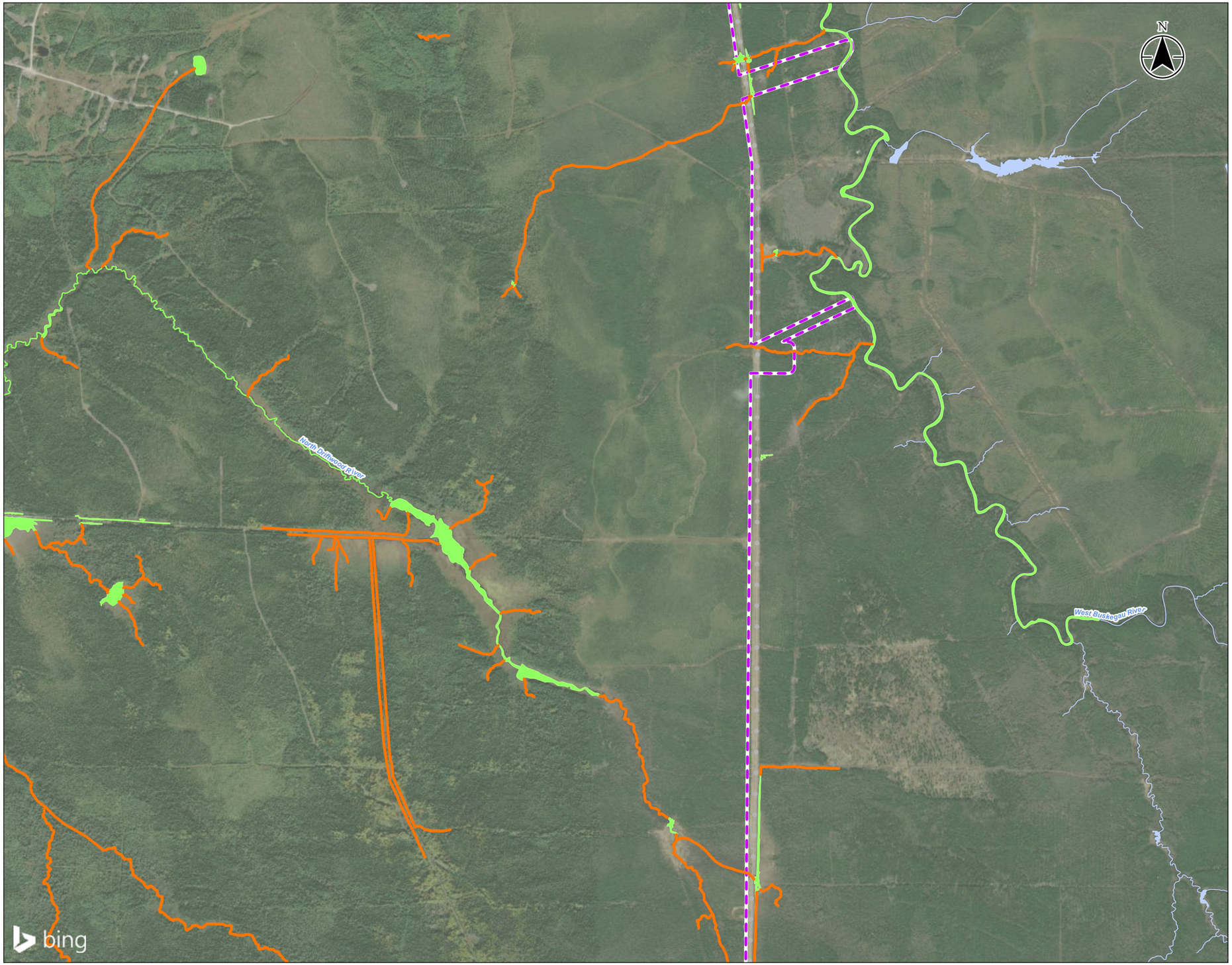

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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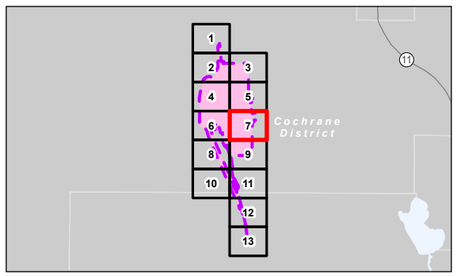

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.19.7

Title
Forage Species Guild Overwintering Habitat

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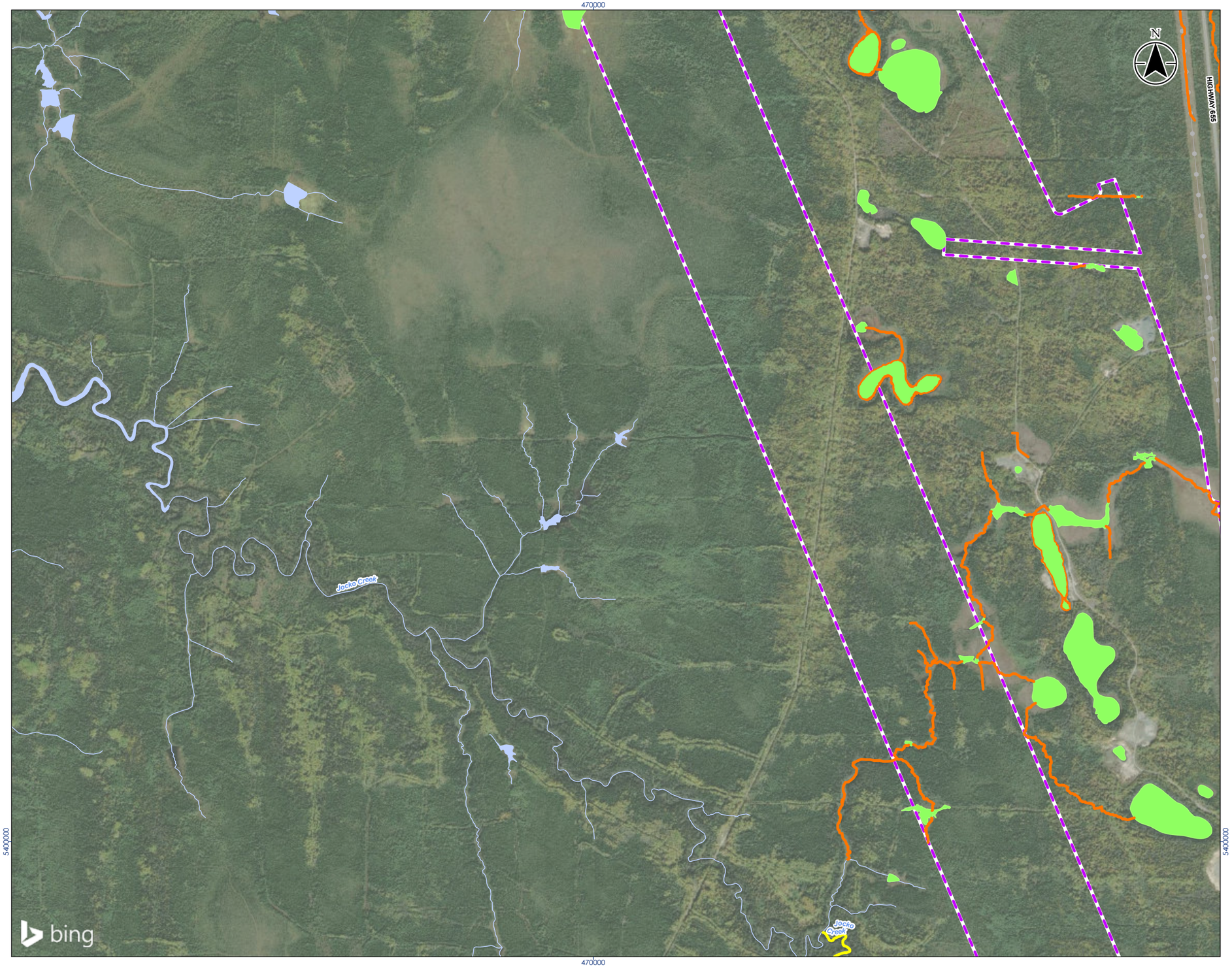

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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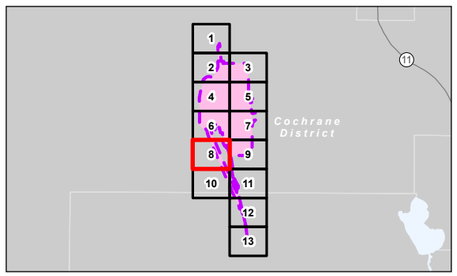

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.19.8

Title
Forage Species Guild Overwintering Habitat

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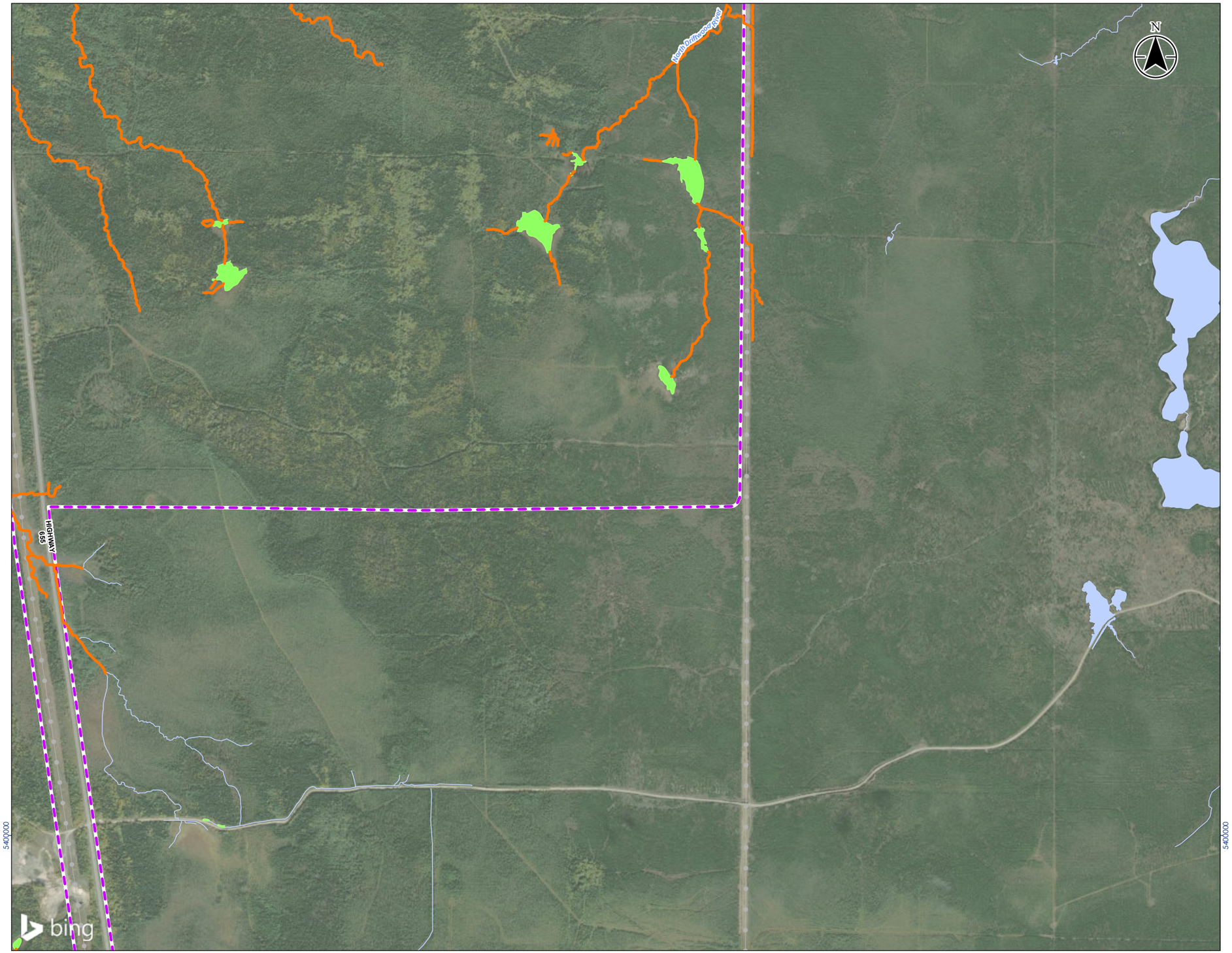

Stantec

Legend

Project Area

Base Features

Existing Transmission Line

Watercourse

Waterbody

Overwintering Habitat Suitability Category

Excellent

Above Average

Average

Below Average

Unsuitable

0 0.5 1 km

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Notes

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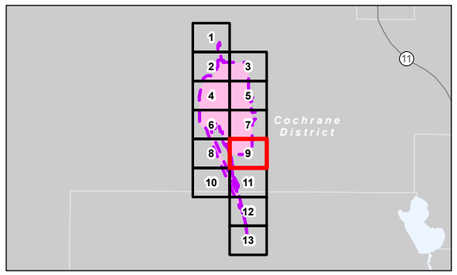

Project Location
Timmins, Ontario

160930456 REV6
Prepared by malcazaren on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.19.9

Title
Forage Species Guild Overwintering Habitat

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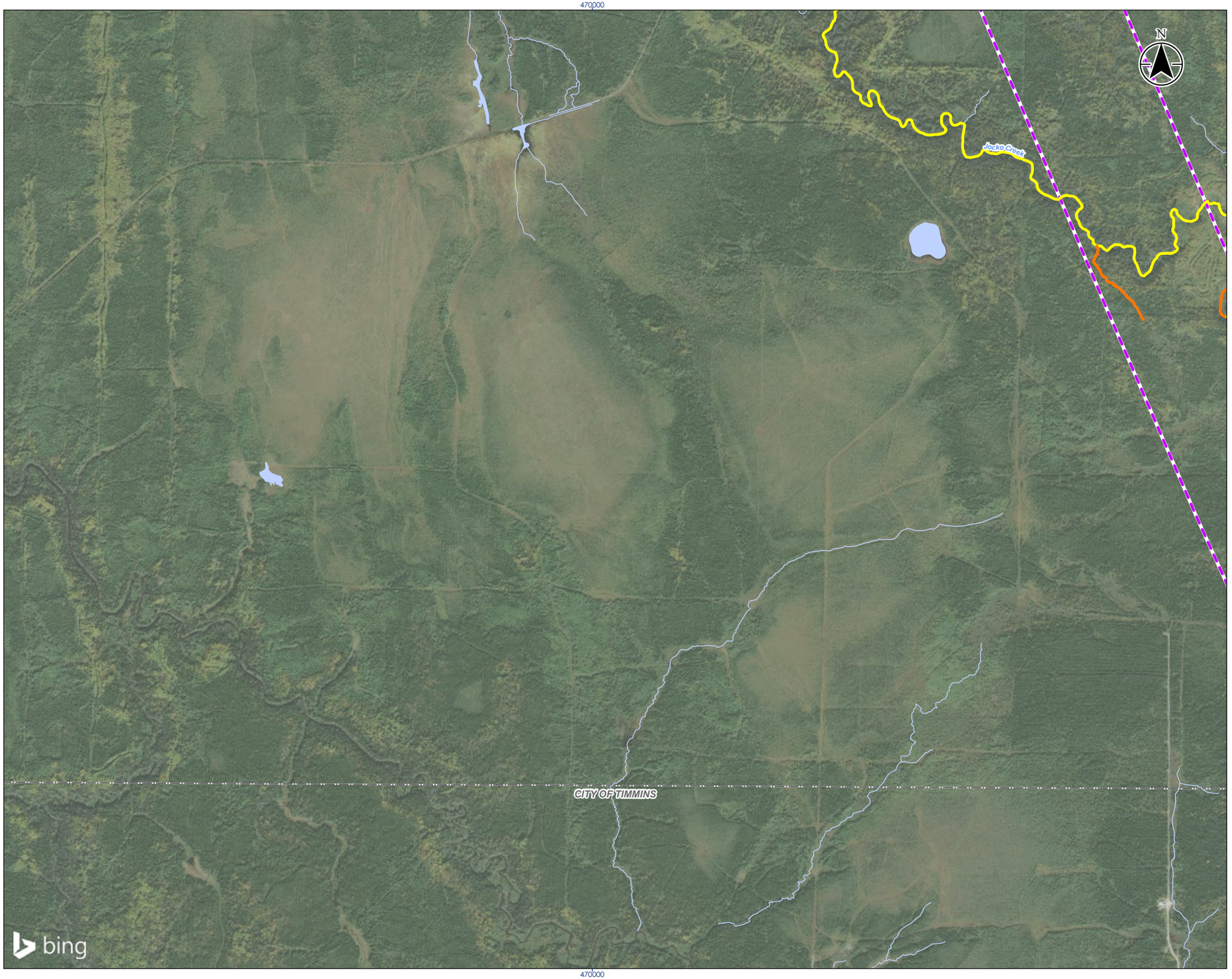

Stantec

Legend

- Project Area
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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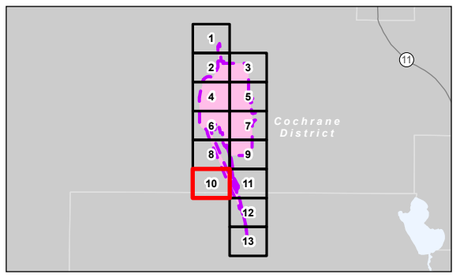

Project Location
Timmins, Ontario

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Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.19.10

Title
Forage Species Guild Overwintering Habitat

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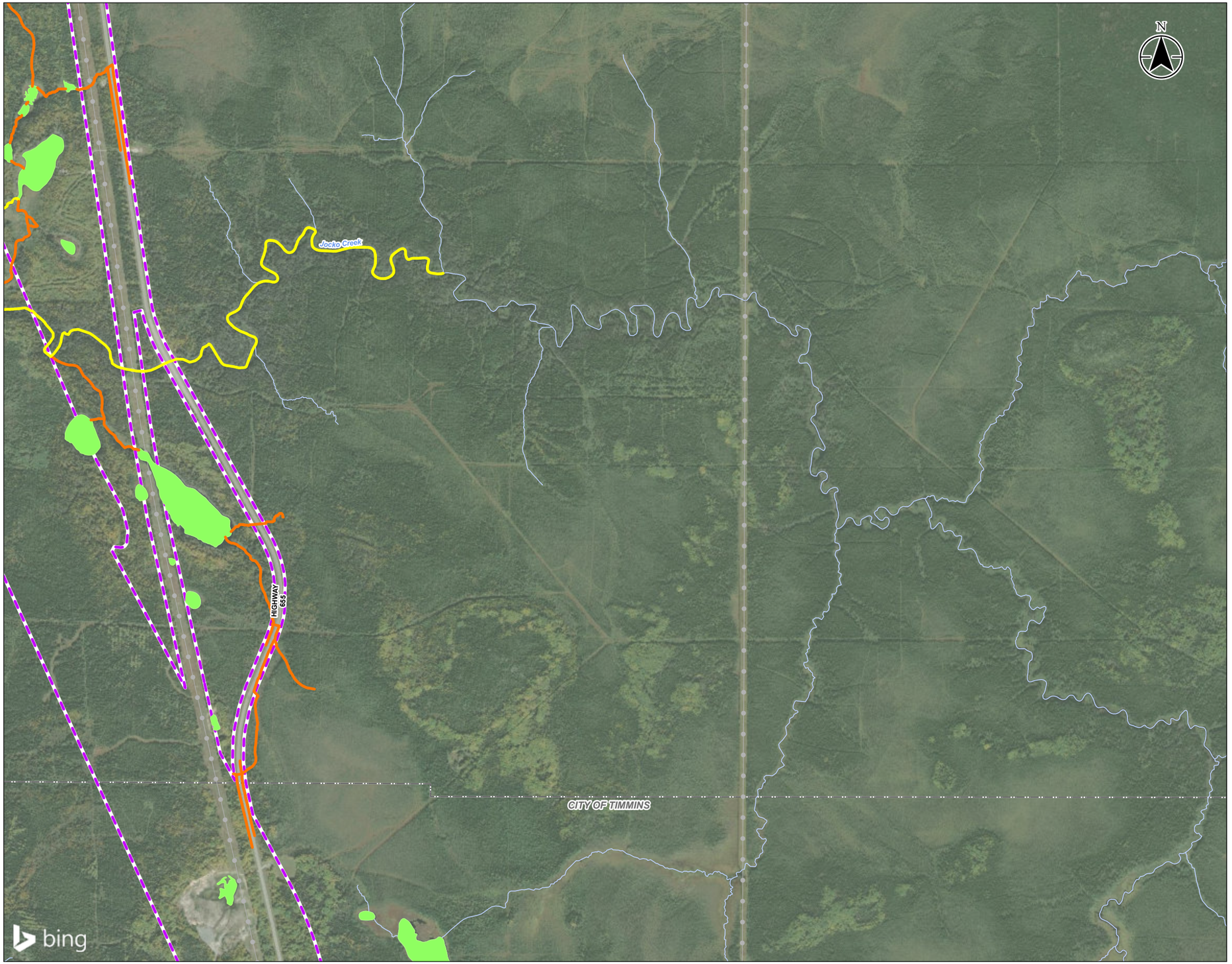

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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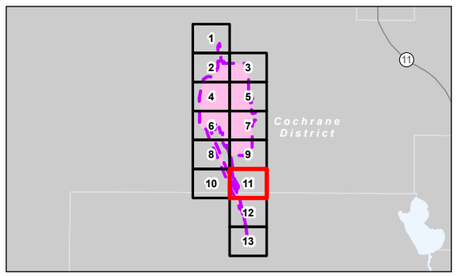

Project Location
Timmins, Ontario

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Crawford Nickel Project

Figure No.
A.19.11

Title
Forage Species Guild Overwintering Habitat

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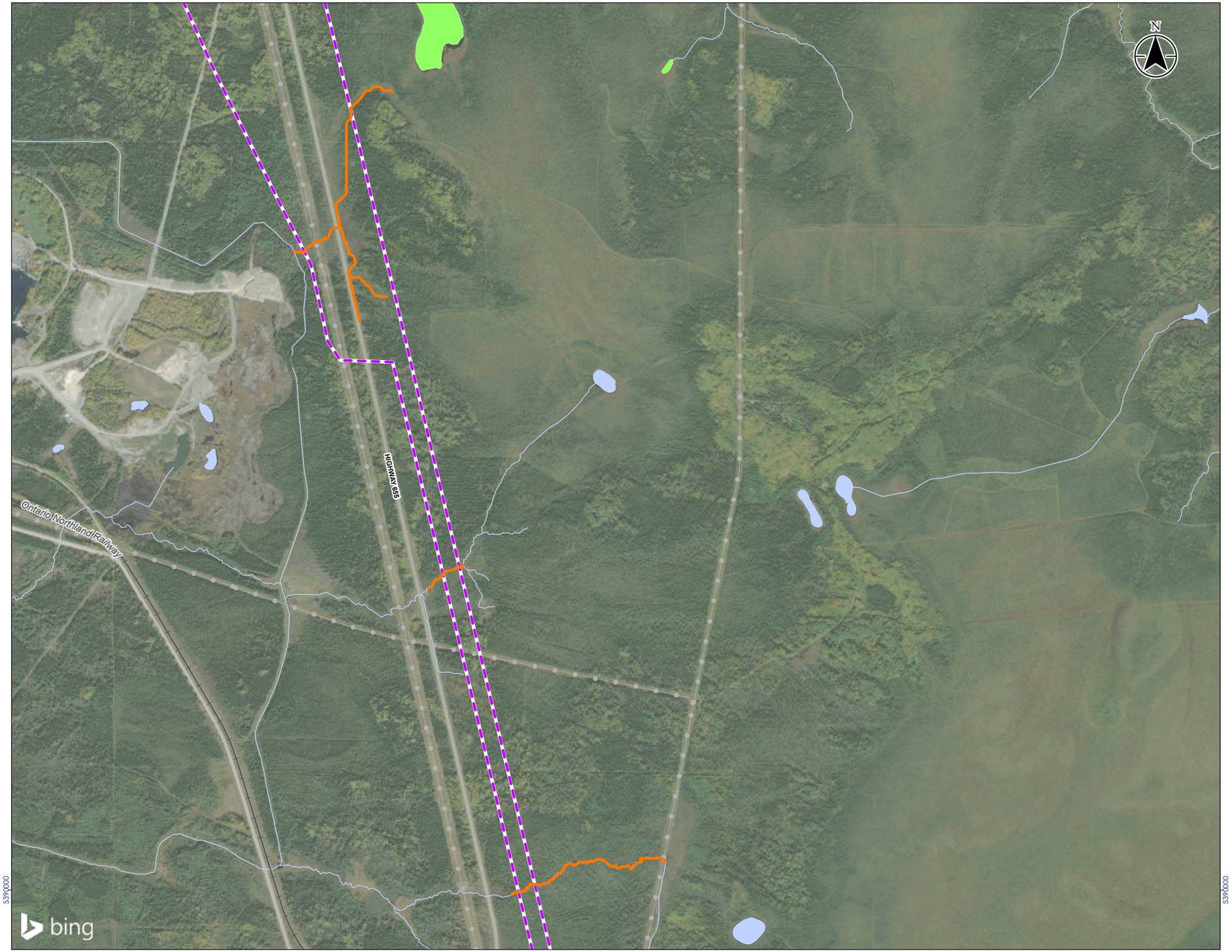

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

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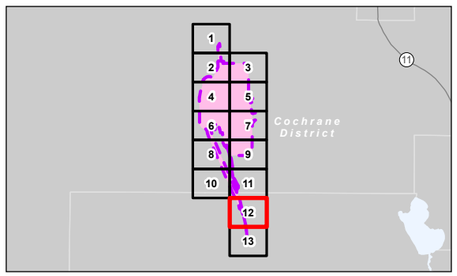

Project Location
Timmins, Ontario

160930456 REV6
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Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.19.12

Title
Forage Species Guild Overwintering Habitat

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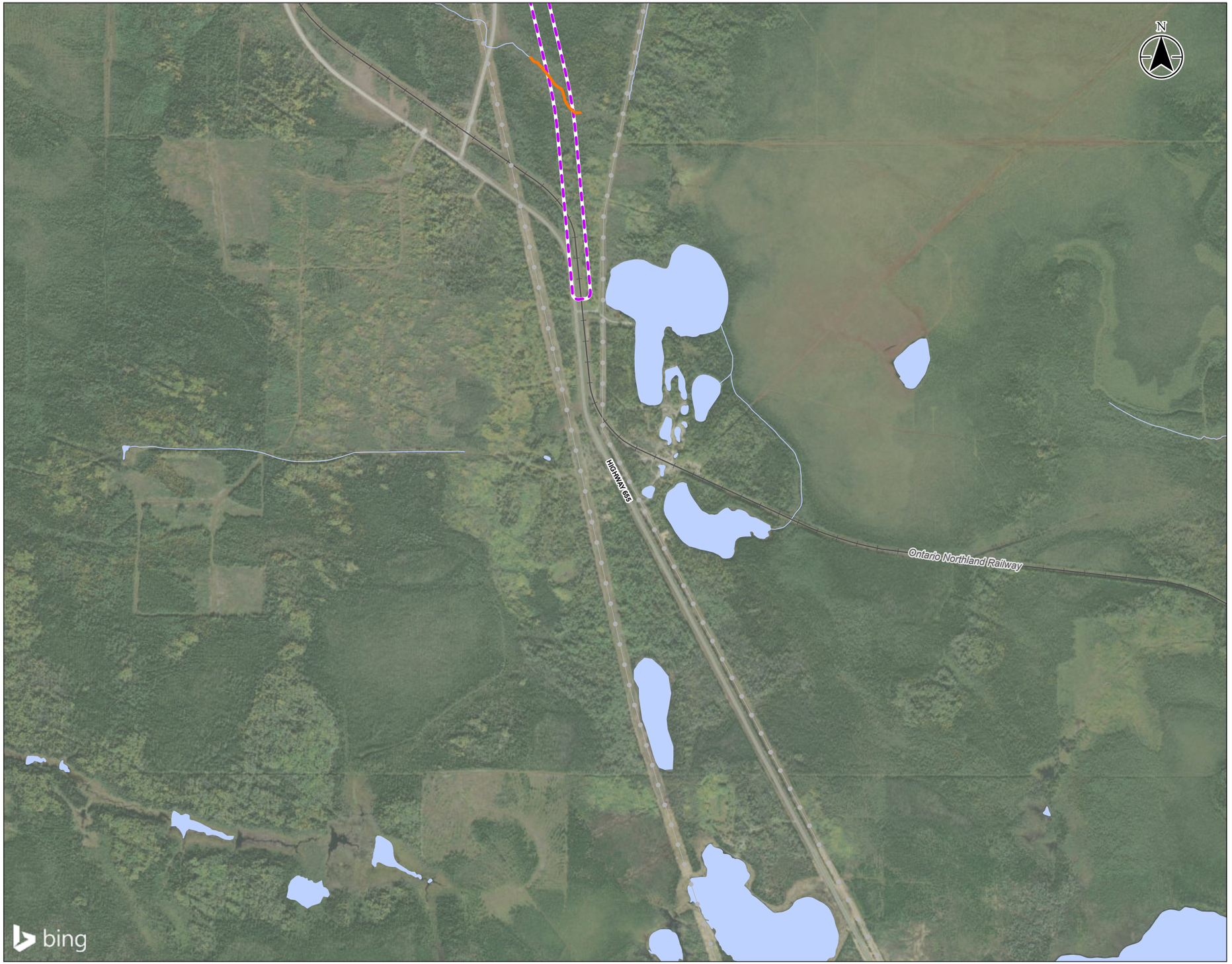

Stantec

Legend

Project Area

Base Features

- Existing Transmission Line
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Overwintering Habitat Suitability Category

- Excellent
- Above Average
- Average
- Below Average
- Unsuitable

0 0.5 1 km

1:20,000 (At original document size of 11x17)

Notes

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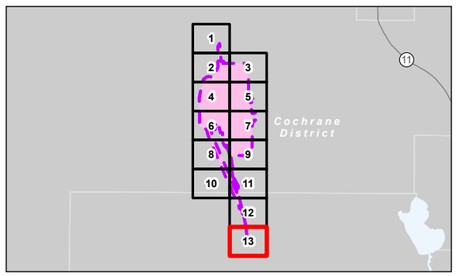

Project Location
Timmins, Ontario

160930456 REV6
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Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.19.13

Title
Forage Species Guild Overwintering Habitat

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Appendix B Fish Habitat Survey Data

Table B.1 **Summary of Modified OSAP Protocol Channel Morphology Data for Watercourses in North Driftwood River, West Buskegau River and Jocko Creek Watersheds 2021-2023 (Summarized from WSP [2024] field data sheets)**

Date	Site Code	Watershed	Zone	Easting	Northing	Channel Structure								Instream Cover						Substrate Types				Bank Stability				Comments
						Pools (Hydraulic Head = 0-3 mm)		Glides (Hydraulic Head = 4-7 mm)		Slow Riffles (Hydraulic Head = 8-17 mm)		Fast Riffles (Hydraulic Head >17 mm)		Flat Rock	Round Rock	Wood	Macraphytes	Bank	Other	Fines (<2 mm)	Gravel (2-100 mm)	Cobbles (100-1000 mm)	Bedrock (>1000 mm)	Eroding Bank (Angle > °45, erodible soil, undercut or bare)	Vulnerable Bank (Angle > 45°, erodible soil, sign of recent erosion)	Protected Bank (Angle > 45°, non-erodible material/soil)	Deposition Zone (Angle < 45°, gradual slope from river, fine grained sediments)	
						No Cover (%)	Cover Present (%)	No Cover (%)	Cover Present (%)	No Cover (%)	Cover Present (%)	No Cover (%)	Cover Present (%)															
6-Aug-21	NDR-S-04	North Driftwood River	17U	470,370	5,412,387	13.33%	86.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	19.35%	3.23%	25.81%	48.39%	3.23%	0.00%	39.34%	40.98%	19.67%	0.00%	60.00%	20.00%	20.00%	0.00%	5 transects of 6 observation points = ~ 50 m reach, T1-DS of beaver dam, T3 - Placed stone at crossing
11-Aug-21	NDR-Trib-02	North Driftwood River	17U	471,050	5,409,487	25.00%	75.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	23.08%	30.77%	46.15%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	3 observations at 3 transects
4-Jun-22	WBR-S-01	West Buskegau River	17U	478,570 478,568 478,557 478,559 478,564	5,405,899 5,405,909 5,465,928 5,405,936 5,405,914	33.33%	6.67%	26.67%	0.00%	33.33%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	40.82%	51.02%	8.16%	0.00%	40.00%	60.00%	0.00%	0.00%	Substrate assessed by foot, cobble encountered was on the smaller size
10-Aug-21	WBR-S-01	West Buskegau River	17U	478,677	5,405,872	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	38.89%	0.00%	61.11%	0.00%	100.00%	0.00%	0.00%	0.00%	66.67%	0.00%	0.00%	33.33%	3 transects of 4 observations = 20
10-Aug-21	WBR-S-02	West Buskegau River	17U	478,566	5,405,888	30.00%	70.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	6.06%	18.18%	39.39%	33.33%	3.03%	0.00%	61.11%	29.63%	9.26%	0.00%	80.00%	0.00%	0.00%	20.00%	5 transects of 6 obervations
10-Aug-21	WBR-S-03	West Buskegau River	17U	476,696	5,412,340	10.00%	90.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.00%	42.00%	46.00%	8.00%	0.00%	75.47%	22.64%	1.89%	0.00%	50.00%	0.00%	0.00%	50.00%	5 transects of 8 observations
11-Aug-21	NDR-S-02	North Driftwood River	17U	472,050	5,408,748	30.00%	70.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	20.69%	68.97%	10.34%	0.00%	88.33%	11.67%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	5 transects of 6 observation points
9-Aug-21	WBR-S-04	West Buskegau River	17U	476,574	5,412,898	23.33%	76.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	12.12%	3.03%	36.36%	33.33%	15.15%	0.00%	48.33%	41.67%	10.00%	0.00%	60.00%	0.00%	0.00%	40.00%	6 observation points, with 5 transets, transect 2 = same as diagnostic channel stability location
4-Jun-22	WBR-S-03	West Buskegau River	17U	476,666 476,676 476,682 476,690 476,694	5,412,393 5,412,383 5,415,369 5,412,353 5,412,336	16.67%	13.33%	13.33%	0.00%	26.67%	0.00%	26.67%	3.33%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	61.67%	38.33%	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	Left bank undercut additional 35 cm, substrate assessed by foot, transets same as 2021. Slump on right bank, line across stream of logs that created a riffle (T1).
6-Jun-22	WBR-S-04	West Buskegau River	17U	476,578 476,776 476,572 476,575 476,576	5,412,924 5,412,906 5,412,893 5,412,875 5,412,862	23.33%	0.00%	20.00%	0.00%	56.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	50.85%	37.29%	11.86%	0.00%	100.00%	0.00%	0.00%	0.00%	substrate assessed by foot, max cobble size approximately 100-200 mm
5-Jun-22	JC-S-01	Jocko Creek	17U	473,310 473,345 473,301 473,247 473,246	5,401,567 5,401,502 5,401,499 5,421,497 5,401,487	63.33%	10.00%	26.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	70.00%	30.00%	0.00%	Substrate assessed by foot

Note: "DS" = downstream

Table B.2 Summary of Watercourse Measurement Data for North Driftwood River, West Buskegau River and Jocko Creek Watersheds 2021-2023 (Summarized from WSP [2024] field data sheets)

Date sampled	Site Code	Watershed	Stream Order	Average Wetted Depth (m)	Wetted Width(s) (m)	Bankfull Depth(s) (m)	Entrenchment Width (m)	Bankfull width (m)	Active Channel Width(s) (m)	Avg. Active Channel Width (m)
02-Jun-23	JCRK-S-01	Jocko Creek	3	0.24	-	1.07, 0.92, 0.74	>40	2.36	2.08, 2.59	2.34
13-Jul-23	JCRK-S-01	Jocko Creek	3	0.40	-	0.9, 0.53, 0.6	-	-	-	-
05-Jun-22	JOC-S-01	Jocko Creek	3	0.36	-	1.36	>40	2.15	1.95	1.95
03-Jun-23	RDAL-02	Jocko Creek	3	0.88	-	-	-	2.8 (mean)	-	-
03-Jun-23	JCRK-S-03	Jocko Creek	4	0.51	-	1.64	-	-	6.9,8.1,6.73	7.24
12-Jul-23	JCRK-S-03	Jocko Creek	4	0.56	-	-	-	-	-	-
11-Jul-23	NDR-S-06b	North Driftwood River	2	0.42	-	0.57, 0.56, 0.92	-	-	1.4,1.7,1.6	1.57
11-Aug-21	NDR-Trib-02	North Driftwood River	2	0.11	-	0.114	-	1.4	1.4	1.40
01-Jun-23	NDR-S-06b	North Driftwood River	2	0.43	-	1.5	>60	-	4.49, 4.58	4.54
11-Aug-21	NDR-Trib-01	North Driftwood River	3	-	6,12	-	-	-	-	-
31-May-23	RDAL-06	North Driftwood River	3	0.56-1.36 (DS), 0.7-1.36 (US)	-	1.1	-	1.8	-	-
11-Aug-21	NDR-S-02	North Driftwood River	4	0.63	-	0.93	40	11.66	9.53	9.53
06-Aug-21	NDR-S-04	North Driftwood River	4	0.27	-	0.84	-	8.24	6.68	6.68
29-Aug-22	NDR-S-04	North Driftwood River	4	-	-	-	-	-	-	-
12-Jul-23	NDR-S-04	North Driftwood River	4	0.48	-	1.04	-	-	8.87	8.87
09-Jun-23	NDR-S-06	North Driftwood River	4	0.43	-	1.14	12	-	10.9	10.90
31-May-23	NDR-S-04	North Driftwood River	4	0.37	-	1.46	>15.1	-	9.2,8.1	8.65
10-Aug-21	WBR-S-01	West Buskegau River	2	0.23	-	0.74	-	3.2	2.34	2.34
04-Jun-22	WBR-S-01	West Buskegau River	4	0.68	-	1.35	-	-	9.8	9.80
10-Aug-21	WBR-S-02	West Buskegau River	4	0.43	-	0.95	26.56	10.36	9.2	9.20
10-Aug-21	WBR-S-03	West Buskegau River	4	0.28	-	0.87	10.56	9.9	8.05	8.05
02-Jun-22	WBR-S-03	West Buskegau River	4	0.69	-	1.34	-	-	13.9	13.90
04-Jun-23	WBR-S-06	West Buskegau River	4	0.28	-	1.7	5.5	17	-	-
04-Jun-23	WBR-S-06	West Buskegau River	4	0.27	-	1.7	5.5	-	12.1, 11.0	11.55
15-Jul-23	WBR-S-06	West Buskegau River	4	0.28	-	1.22	-	-	11.25, 10.65, 10.55	10.82
09-Aug-21	WBR-S-04	West Buskegau River	5	0.46	-	0.98	13.68	12	11.14	11.14
04-Jun-22	WBR-S-04	West Buskegau River	5	0.55	-	-	-	-	10.3	10.30
04-Jun-23	WBR-S-04	West Buskegau River	5	0.36	-	-	-	-	12	12.00
14-Jul-23	WBR-S-04	West Buskegau River	5	0.47	-	-	-	18.5, 18.75	-	-
17-Jul-23	WBR-S-07	West Buskegau River	5	0.33	-	2.49	-	-	13.6, 14.8, 17.05	15.15

Notes: “-“ not applicable; "DS" = downstream; "US" = upstream

Table B.3 Summary of MTO Protocol Fish Habitat Assessments for Watercourses in North Driftwood River, West Buskegau River and Jocko Creek Watersheds 2021-2023 (Summarized from WSP [2024] field data sheets)

Date	Site Code	Watershed	Stream Order	Habitat Notes
16-Oct-22	NDR - S-05	North Driftwood River	2	**Habitat** - narrow trail along road, width approximately 3 m - 13 m, T intersection, water flowing out, beaver activity, dogwood, grasses, horsetails, cattails, alders, tamarack, spruces, fen flood plan, soft organic bottom
29-Aug-22	NDR-S-04	North Driftwood River	4	**Habitat Assessment** - Joe pye weed, horsetail, arrowhead, poison hemlock, tape grass, alder spruce
12-Oct-22	NDR-S-04	North Driftwood River	4	**Sediment Quality** - Sand, gravel, cobble-substrate, not many depositional zones, hard bottom, road used to travel over river, large rocks along banks. Right bank possible depositional zone. **Fish Habitat** - Gravel/Cobble bottom, active beaver dam, alders, low shrubs, grasses along shoreline, some visible erosion, old road crossing, summer vegetation dead, large rocks, slow flow, water levels appoximately the same as spring.
23-Oct-22	NDR-S-01	North Driftwood River	3	**Habitat** - beaver activity, more of a beaver pond, flows into stream, floating fen mats, trees/ twigs in water/along shoreline, cattails, rushes reeds, alders, flood plain shoreline, tree line tamarck/spruces approximately 100 m back from main wetted pond, relatively shallow 0.6 - 1.3 m, small tribuatary flow in
18-Oct-22	NDR-Trib-01	North Driftwood River	3	**Habitat** - Approximately 13 m wide, meandering tributary, tamarack, spruces for tree line, grassses, alders, flood plain like shoreline, beaver activity present, dam dug out, increasing flow upstream
16-Oct-22	NDR-Trib-02	North Driftwood River	2	**Habitat** - narrow tributary, over 1 m deep, approximately 2 m wide flood plain shoreline grasses, horsetails alders, tamarack, spruces flooded over edge, about 30 cm water to treeline
16-Oct-22	NDR - S-02	North Driftwood River	4	**Habitat** - slow/low flow, exposed banks, water levels low, alders, grasses,small tributary flowing in flood plain like habitat, spruce, tamarack, dark tea coloured water
18-Oct-22	NDR-JC-S-01	Jocko Creek	3	**Habitat** - flood plain, water over bankfull, grasses, deep narrow channels, below powerlines spruce/tamarack on edge of flood plain, highway 100 m away from site, high flow
24-Oct-22	WBR-S-05	West Buskegau River	2	**Habitat** - grasses, rushes, small alder shoreline, narrow stream approximately 3.2 m wide, algae, beaver dam upstream, beaver pond downstream, woody debris, low flow, low canopy cover, pine, spruce treeline, large logs in stream, flows over trail and down into stream and WBR-P-03, black/tea stain water, flood plain
09-Jun-23	NDR-S-06	North Driftwood River	4	**Observation** - slow moving water, perdominatly coniferous forest surrounds channel, deciduous trees a long banks, erosion visible, under cutting observed no slumping observed, lots of tree trucks built up along upstream abutments, bridge wood supports are deteriorated and not touching bottom of bridge anymore, bridge not maintained.
13-Jun-23	RDAL-04	North Driftwood River	2	**Observation** - flow north, lots of small woody debris, channel, bog, swamp, water depth 40-50 cm, channel bottom sometimes spongey, lots of fishes(TSS), channel in open wet area, tamarack, alders, irises, ferns, peat, little beaver dam south of Rox's waypoint, water attop of bank, becomes brided
14-Jun-23	RDAL-03	North Driftwood River	-	**Observation** - coniferous forest, no watercourse, peat, labrador tea, black spruce, few alder
15-Jul-23	WBR-S-06	West Buskegau River	4	**Habitat** - mid-sized river, river very shallow, tape grass, arrowhead, yellow pond lily, sandy gravel substrate, mussels, low flow, **Banks** - alder, grasses, rushes, swamp, milkweed, lots of woody debris interupting flow, fallen logs, some boulders **Left Bank** - deeply cut **Right Bank** - gradual, mature conifers upland, tea stained water
16-Jul-23	MATR-02	Mattagami River	Unknown	**Habitat** - large river - flow dependent on dams (low today), pondweed, arrowhead, horsetail, rushes, floating and emergent macrophytes **Banks** - lined with rushes, sedges, grasses, willows, dogwood, slightly turbid, low woody dbris, upland dominated by birch , poplar, some coniferous, moderately entrenched banks **Species** - walleye, pike, perch, sturgen, trout (local knowledge, sherp operator), rocky substrate with clay, dead white sucker observed in water
16-Jul-23	MATR-01	Mattagami River	Unknown	**Habitat** - horsetail dominate dam zone, some arrowhead, cedar dominat upland, clay, silt substrate with some boulders, unstable banks, little macrophyte growth **Left Bank** - shoreline boulder dominated, just down stream of riffle **Right** - riparian zone sedges, fern vegetation
03-Jun-23	RDAL-02	Jocko Creek	2	**Habitat** - floodplain, no active channels, floodplain dominated by grasses, rushes, some woody debris and shags, upland area dominated by alder and coniferous
17-Jul-23	WBR-S-07	West Buskegau River	5	**Habitat** - Primarily shallow run at time of site visit, infrequent riffles, immediate riparian margins an overstory of alder with ferns below. Moderately steep banks ~20-40°, but up to 2 m high above wetted width. Upland vegetation along left bank is black spruce and tamarack. IV is tape grass and yellow pond lily, star duckweed, arrowhead. Total cover available to fish ~14%, comprising of IV (65%), large woody debris (25%) ov alder (10%), lowflow, very minor patches of small cobbles, large and small gravel. Primarily silty sand bed. Several large fish observed darting away.

Note: "-" not applicable

Table B.4 Summary of MTO Protocol Fish Habitat Assessments for Ponds in North Driftwood River and West Buskegau River Watersheds 2021-2023 (Summarized from WSP [2024] field data sheets)

Sample Date	Site Code	Watershed	Land Use and Pollution		Waterbody Type and Morphology		Shore Coverage (% shaded)	Underwater Cover (% surface area)						VegetationType							Migratory Obstructions		Potential Significant Habitat
			Surrounding Land Use/Terrain	Sources of Pollution	Waterbody Type	Morphology		Boulders (%)	Cobbles (%)	Woody Debris (%)	Organic Debris (%)	Vascular Macrophytes (%)	Other (%)	Submerged (%)	Predominant Species	Floating (%)	Predominant Species	Emergent (%)	Predominant Species	None	Type	Comments	
08-Aug-21	NDR-P-01	North Driftwood River	meadow/wetland	overland flow	pond	in-stream	1-29	-	-	30	-	70	-	40	millfoil	-	-	60	horsetail	-	seasonal	beaver dam at culvert, at 6J5	1 young-of-year finescale dace in dip net
07-Aug-21	NDR-P-02	North Driftwood River	forest/meadow	overland flow	dug-out	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Dry, not fish habitat, manmade, seasonally wet, low lying
08-Aug-21	NDR-S-01	North Driftwood River	meadow/wetlands	-	pond	in-stream	1-29	-	-	40	-	60	-	30	millfoil	-	-	70	lilly pad, cattails	-	seasonal	beaver dam	Large beaver dam, mid stream cresting larger ponded habitat meadow/wetland surrounding typical beaver habitat
04-Aug-21	NDR-P-02A	North Driftwood River	meadow/forest	overland flow	pond	-	1-29	-	-	-	-	100	-	60	millfoil, stonewort, alge	-	-	40	cattails, horsetails	-	seasonal	-	Potentially manmade, leeches/frogs, no fish observed, no flow in/out
04-Aug-21	NDR-P-02-C	North Driftwood River	-	-	pond, dug-out	run-off, spring-fed	30-50	-	-	10	-	90	-	60	millfoil, stonewort	10	pondweed	30	cattails	-	seasonal	-	Potential spring fed / 2 cell pond, potentially manmade, heavy veg/aquatic veg cover, backfill height +/- 0.5 m, backfill width +/- 1.0 m, leeches & frogs, no fish observed, 4 minnos traps
05-Aug-21	NDR-P-03	North Driftwood River	forest (coniferous)	overland flow	lake	-	1-29	-	-	20	-	80	-	50	stonewort, Richarson pondweed	-	-	50	white water lilly	-	seasonal	beaver dam	Uniform habitat throughout pond, margins lined with aquatic vegetation, open water through the center of pond, fish observed cyprinidae), loons and frogs
04-Aug-21	NDR-P-04	North Driftwood River	-	-	pond	-	1-29	-	-	100	-	-	-	-	millfoil	-	water lilly	-	grasses	-	-	-	Deep (30 ft) at center of pond, potential spring fed? Historic beaver activity, leaches, aquatic inverts, 1 frog
30-Aug-22	NDR-P-06	North Driftwood River	-	-	pond	-	1-29	-	-	-	-	-	-	59-30	-	-	-	-	-	-	-	-	Arrowhead, cattails, rushes, reeds, alders, dogwoodsoft mucky bottom >1m deep, channel flowing out some deadheads, 3 m wide
07-Aug-21	WBR-P-01	West Buskegeau River	meadow/wetland	-	pond	in-stream	1-29	-	-	40	-	60	-	30	millfoil	-	-	70	lilly pad cattails	-	seasonal	beaver dam	Large, active beaver pond, fish observed (pearl dace and frescale dace) captured in 12 minnow traps
07-Aug-21	WBR-P-02	West Buskegeau River	-	-	pond	in-stream	1-29	-	-	30	-	70	-	30	millfoil	-	-	70	white lilly aquatic grasses	-	season	-	NRD captured (adult /young-of-year), active beaver den/pond

Note: "-" not applicable

Appendix C Aerial Survey Report

Stantec

Memo

To:	Mathieu Boucher, Environmental Manager	From:	Michel La Haye Erica Padvaiskas
	Canada Nickel Company Inc.		Stantec Consulting Ltd
Project/File:	160930456	Date:	August 12, 2024

Reference: Lake Sturgeon Aerial Habitat Survey and eDNA Sampling, Spring 2024

1 Introduction

Lake Sturgeon (*Acipenser fulvescens*) are the only aquatic species at risk in the vicinity of the Crawford Nickel Project. This species is known to inhabit the Mattagami River, the Abitibi River, and the Frederick House River (COSEWIC, 2017). Lake sturgeons in these rivers are part of the Southern Hudson Bay-James Bay populations, populations listed as "special concern" on Schedule 1[1] of the *Species at Risk Act*.

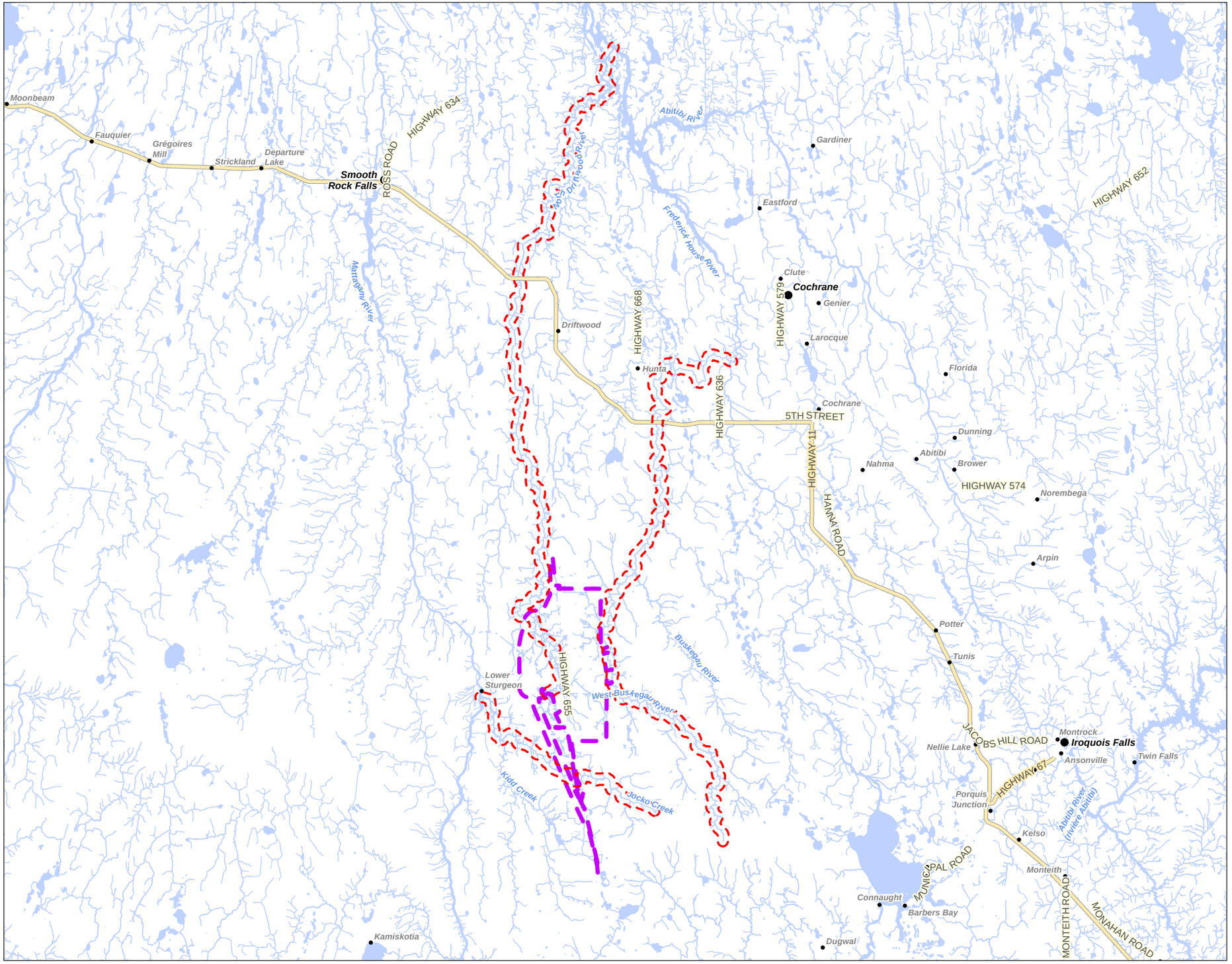
Environmental DNA (eDNA) surveys conducted in 2023 confirmed the presence of Lake Sturgeon in the Mattagami River. However, none of the eDNA samples collected in the North Driftwood River (NDR) downstream of the Project detected any Lake Sturgeon DNA. Lake Sturgeon eDNA surveys were not conducted in the West Buskegau River (WBR) or in Jocko Creek in 2023. The NDR, WBR, and Jocko Creek are tributaries of the Abitibi, Frederick House, and Mattagami rivers, respectively, and may be affected by construction, operation, and closure of the Crawford Nickel Project (Figure 1).

This memo summarizes the methods and results of an aerial survey and eDNA survey conducted in the NDR and WBR in spring 2024. The purpose of these surveys was to determine the likely upstream distribution of Lake Sturgeon in the NDR and WBR so that potential effects of the Crawford Nickel Project on habitat, stream flows, and water quality could be assessed.

The objectives of these surveys were to:

1. Document the location of barriers to upstream migration of Lake Sturgeon in the NDR and WBR
2. Document the location of suitable Lake Sturgeon spawning habitat in the NDR and WBR
3. Determine the upstream extent of Lake Sturgeon in the NDR and WBR using direct observations and presence of Lake Sturgeon eDNA.

[1] Species at Risk Act Public Registry (Species search - Species at risk registry (canada.ca)) accessed on July 21, 2024



Stantec

CANADA NICKEL COMPANY

Legend

- Study Area
- Project Area (PA)

Base Features

- Highway
- Watercourse
- Waterbody

N

0 10 20 km

1:400,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.
3. Orthoimagery:

Project Location
Timmins, Ontario

160930456 REVA
Prepared by malcazaren on 2024-09-30

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
1

Title
Location of the Crawford Nickel Project in Relation to the North Driftwood and West Buskegau Rivers and Jocko Creek

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2 Methods

2.1 Office Methods

2.1.1 Map Book Preparation

Map books of the NDR and WBR were created in a geographic information system (GIS) from interpretation of Google Earth imagery and on-line maps available from the Ontario Ministry of Natural Resources and Forests (MNRF). The purpose of these map books was to identify:

1. kilometer points (KP) upstream from the confluences with the Abitibi and Frederick House rivers, respectively, to the Crawford Nickel Project area
2. Potential barriers to upstream fish passage
3. Rocky riffles and rapids with fast flowing water that have the potential for Lake Sturgeon spawning and other fish species known to use rocky riffles for spawning (e.g., Walleye, White Sucker)
4. planned eDNA sampling sites.

Two senior fish biologists did the photo interpretation and gathered the information in an Excel spreadsheet containing the KPs, falls, riffles and rapids, eDNA sampling location, links to Google Earth, geographic coordinates, and images of each point of interest in each river.

2.1.2 Environmental DNA Sample Site Identification

Sites for eDNA sampling were selected in the NDR and WBR between each potential barrier to upstream fish passage identified during photo interpretation. Additional sites were added in sections of river greater than 30 km long between potential barriers to lower the risk of false negatives due to decomposition of Lake Sturgeon eDNA. From this analysis, five eDNA sample sites were selected in the NDR (KPs 11.75, 21.8, 25.75, 58.95 and 62.25 upstream from the confluence with the Abitibi River) and four eDNA sample sites were selected in the WBR (KP 0.0, 3.5, 27.5 and 42.8 upstream from the confluence with the Frederick House River).

2.2 Field Methods

2.2.1 Aerial Surveys

Aerial surveys of the NDR and WBR were conducted by two fish biologists from a helicopter flying upstream from the confluences with the Abitibi and Frederick House rivers on May 30 and 31, 2024. During the surveys, one fish biologist took photos and confirmed the geographic coordinates of each point of interest using a customized Field Map application. The second fish biologist confirmed the potential barriers (e.g., falls or cascades) and potential spawning habitat for Lake Sturgeon and other spring spawning fish species known to utilize similar fast-flowing rocky riffle/rapids for spawning as Lake Sturgeon (e.g., Walleye and White Sucker) that was identified in the office and identified any new barriers or potential spawning areas that were missed during the photo interpretation.

The potential barriers to upstream fish passage were classified into four categories derived from criteria established for Atlantic Salmon (*Salmo salar*) in Quebec (Boudreault 1984):

- Impassable without reservation: major obstacle whose height and/or configuration prevents upstream fish passage under all flow conditions
- Impassable with reservation: major obstacle whose height and/or configuration prevents upstream fish passage under most flow conditions; maybe passage during high flows only
- Passable with reservation: impediment to upstream fish passage under most flow conditions but a potential barrier to upstream fish passage during certain hydrological conditions (e.g. low flow).
- Passable without reservation: impediment to upstream fish passage but passable under all flow conditions.

These classifications were applied during the aerial survey after observing the vertical height, gradient, substrate type and configurations, and flow conditions in the rivers at potential barrier locations.

Lake Sturgeon spawn in rapids between 0.3 m and 2.0 m deep, with rocky substrate ranging from gravel to boulders with moderately fast, non-turbulent flow (COSEWIC, 2006, Desroches and Picard, 2013). Potential Lake Sturgeon spawning locations were identified by observing areas with this type of habitat from the helicopter. Substrate classes and habitat types, as defined in the Ontario Stream Assessment Protocol (OMNR 2017), were recorded at each site.

2.2.2 eDNA Sampling

eDNA samples were collected from five sites in the NDR and four sites in the WBR during the May 29 and 30 aerial surveys. A positive control sample was collected on May 30 from the Mattagami River near the boat launch in Timmins, Ontario, a site known to be used by juvenile Lake Sturgeon. One negative control sample was collected each day by filtering distilled water. At each site, the helicopter landed as close as possible to the river to allow the fish biologists to safely access the sites.

Three replicate water samples were collected at each site in pre-labeled (i.e., river name, date, KP and replicate number), 2 Litre plastic containers following the “Supplemental Fish and Fish Habitat Collection-Environmental DNA” protocol (Attachment A). Water samples were collected by pointing the bottles upstream to avoid contamination from chest waders. Water samples were kept on ice in a cooler during transport and then placed in a refrigerator at camp while waiting to be filtered.

At camp, samples were filtered through Smith-Root Self-Preserving Filter (PES 1.2 µM mesh size) using a Smith-Root eDNA Citizen Science Sampler. A minimum of 600 ml from the 2 L samples were filtered from each replicate sample collected at each site of both rivers. The exceptions were replicate samples from two sites in the WBR (i.e., WBR-03-Rep03 and WBR-04-Rep01_02_03) which could only be filtered after allowing high suspended solid concentrations to settle overnight. Work areas were cleaned with a 10% bleach solution and fresh nitrile gloves were used between each sample filtering to avoid cross-contamination. Sample filters were kept in cool in a refrigerator or cooler for delivery to the analytical laboratory (Nature Metrics, Guelph, Ontario Canada Office).

eDNA sample sheets were prepared for each replicate sample with project information, eDNA lab name, waterbody, sampling date, sampler name, site and replicate number, habitat description, geographic coordinates, and volume filtered.

2.3 Data Analysis

Data collected on the map books and the Field map application were compared to data created from the photo interpretation. Map books were adjusted, and new features were added, as necessary, based on field results. Discreet rapids suitable for Lake Sturgeon spawning were identified as points in the map books. Continuous series of riffles suitable for Lake Sturgeon spawning were grouped into sets in the map books with an upstream and downstream location.

3 Results

3.1 Aerial Surveys

3.1.1 North Driftwood River

3.1.1.1 Barriers to Lake Sturgeon Upstream Passage

Five barriers or impediments to upstream passage of Lake Sturgeon were observed in the NDR between the confluence with the Abitibi River and the Crawford Nickel Project during the aerial survey (Table 1 and Attachment 2. An impassable barrier to upstream passage under all flow conditions was present in the NDR at KP 21.80. This barrier is a series of bedrock waterfalls.

Three barriers were identified at KPs 12.20, 25.75, and 32.40 upstream from the confluence with the Abitibi River (Table 1). These barriers are located 72.88, 59.21 and 52.61 km downstream of the Project area, respectively. All three barriers were classified as “impassable with reservation”, meaning they are likely passable only at extreme high flows. An impediment to upstream fish passage was identified at KP 11.75 upstream from the Abitibi River (i.e., KP 73.27 downstream from the Project area). This impediment was classified as “passable with reservation”, meaning it was likely passable during high flows (Table 1).

Table 1 Location, Passability Level, and Conditions for Upstream Passage of Lake Sturgeon at Potential Barriers in the North Driftwood River, May 2024

Kilometre Point upstream from confluence with Abitibi River	Kilometre Point downstream of the Project Area	Photolog ID	Passability Category	Conditions for Passage
11.75	73.27	1	Passable with reservation	High flow
12.20	72.88	2	Impassable with reservation	High flow

Kilometre Point upstream from confluence with Abitibi River	Kilometre Point downstream of the Project Area	Photolog ID	Passability Category	Conditions for Passage
21.80	63.30-63.35	6	Impassable without reservation	None
25.75	59.21	7	Impassable with reservation	High flow
32.40	52.61	11	Impassable with reservation	High flow

3.1.1.2 Potential Lake Sturgeon Spawning Sites

Thirty-four riffles and rapids were observed in the NDR during the aerial survey (Attachment 2). Two potential Lake Sturgeon spawning sites identified from photo interpretation were not observed as riffles or rapids during the aerial survey (KP 32.40 and 58.95).

Seven riffles or rapids having high potential for Lake Sturgeon spawning were observed in the NDR between KP 22.70 and KP 54.85 downstream of the Project area (Attachment 2). All these riffles and rapids were located upstream of the impassable barrier at KP 63.30 and, therefore, inaccessible to Lake Sturgeon in the Abitibi River.

Six riffles or rapids having low to fair potential for Lake Sturgeon spawning were observed in the NDR between KP 22.63 and KP 49.90 downstream of the Project area (Attachment 2). These riffles are also inaccessible to Lake Sturgeon in the Abitibi River due to their location upstream of the impassable barrier at KP 63.30. There was one riffle with low to fair potential for Lake Sturgeon spawning at KP 73.27 downstream of the impassable barrier (Attachment 2).

Seventeen of the 34 riffles and rapids identified in the NDR had no potential for Lake Sturgeon spawning due to the absence of suitable gravel, cobble, or boulder substrates or the presence of waterfalls.

3.1.1.3 Potential Spawning Sites for Other Species

Twenty-four of the 34 riffles and rapids observed in the NDR between its confluence with the Abitibi River and the Project area were identified as providing potential spawning habitat for Walleye and/or White Suckers. Twenty of these riffles/rapids were located upstream of the impassable barrier at KP 63.30 (i.e., between KP 59.21 and KP 21.69 downstream of the Project area) and four were located downstream of the impassable barrier (i.e., between KP 63.30 and KP 73.27 downstream of the Project area). There were no riffles suitable for Walleye and/or White Sucker spawning identified closer than 21 km downstream from the Project area in the NDR. Ten riffles had no spawning potential for Walleye or White Sucker due to the lack of rocky substrates or because of too high a gradient.

3.1.2 West Buskegau River

3.1.2.1 Barriers to Lake Sturgeon Upstream Passage

There are no barriers to upstream passage of Lake Sturgeon in the West Buskegau River or Buskegau River that would prevent Lake Sturgeon in the Frederick House River from migrating upstream into habitat near the Project area. However, there are three impediments to upstream passage at KPs 61.54, 59.51 and 57.11 downstream from the Project area (

Table 2 and Attachment 3). These three impediments are passable by Lake Sturgeon at moderate to high flow conditions.

Table 2 Location and Conditions for Passage at Lake Sturgeon Potential Barriers Identified in the WBR, May 2024

Kilometre Point upstream of the mouth of the Frederick House River	Kilometre Point downstream of the Project Area	Photo ID	Passablity categories	Conditions for Passage
0.10	61.54	2	Passable with reservation	High flow
1.75	59.51	5	Passable with reservation	High flow
4.50	57.11	9	Passable with reservation	Moderate flow

3.1.2.2 Potential Lake Sturgeon Spawning Sites

There is less riffle and rapid habitat in the WBR compared to the NDR. However, there is a higher density of suitable habitat for Lake Sturgeon spawning, per river length, in the WBR than in the NDR.

Seventeen riffles or rapids were observed in the WBR during the aerial survey (Attachment 3). Two of the riffles and rapids identified from photo interpretation were not observed as riffles or rapids during the aerial survey (KP 19.17 and 34.17).

Seven riffles in the WBR and Buskegau River between the Frederick House River confluence and the Project area were identified as having high potential for Lake Sturgeon spawning (Attachment 3). All were in the Buskegau River within 16 km of the confluence with the Frederick House River (i.e., between KPs 45.21 and 61.65 downstream of the Project area). These habitats generally contained substrates ranging from gravel to boulder and with fast flow conditions suitable for Lake Sturgeon spawning.

Seven other riffles were identified with low to fair spawning potential for Lake Sturgeon. Six of these riffles are in the Buskegau River between KPs 35.81 and 60.83 downstream of the Project area (Attachment 3). Only one riffle with spawning potential for Lake Sturgeon was identified in the WBR (at KP 3.93

downstream of the Project area) but the suitability of the spawning habitat for Lake Sturgeon was low. The suitability of these riffles for Lake Sturgeon spawning was low because they were characterised by coarse substrates (mainly bedrock and boulders).

3.1.2.3 Potential Spawning Sites for Other Species

Eleven of the 14 riffles or rapids identified as providing low to good quality Lake Sturgeon spawning habitat in the Buskegau River and WBR were also identified as having suitable spawning habitat for Walleye and/or White Suckers. All 11 riffles were in the Buskegau River between KPs 37.53 and 61.65 downstream of the Project area. These riffles have rocky substrates ranging from gravel to boulder swift flow conditions in spring.

3.2 eDNA Samples

3.2.1 Collected Samples

The location of eDNA samples collected in the NDR and WBR are provided in Table 3 and

Table 4, respectively. The final number of eDNA samples sent to the lab for analysis was 38. This included the three replicates collected from the five sites in the NDR, the three replicates collected from the four sites in the WBR, the three replicates collected from the positive control site in the Mattagami River, four negative control replicates, and four additional filters necessary in the WBR due to the high suspended solid concentrations encountered during filtering.

Table 3 Location of eDNA Samples Collected in the North Driftwood River, May 2024

	NDR-01	NDR-02	NDR-03	NDR-04	NDR-05
Coordinates	49°20'09.6"N 81°21'40.0"W	49°16'27.8"N 81°22'29.4"W	49°15'34.8"N 81°23'49.4"W	49°01'34.6"N 81°25'33.0"W	49°00'16.6"N 81°25'06.6"W
KP upstream	11.75	21.80	25.75	58.95	62.25
KP downstream	73.27	63.3-63.35	59.21	26.21	22.7

Table 4 Location of eDNA Samples Collected in the West Buskegau River, May 2024

	WBR-01	WBR-02	WBR-03	WBR-04
Coordinates	49°06'52.0"N 81°08'28.9"W	49°06'58.6"N 81°10'35.1"W	49°01'12.7"N 81°14'57.6"W	48°55'16.4"N 81°16'32.2"W
KP upstream	0.0 -0.1	3.5	27.5	42.8
KP downstream	61.54	58.12	34.17	19.17

3.3 eDNA Results

Results of the eDNA analyses were not available for the preparation of this memo. This section of the memo will be updated once these data are received from the analytical lab.

A second series of eDNA sampling is planned for the summer of 2004 to verify the presence of juvenile Lake Sturgeon in pools located upstream of the impassable barrier. These data will be added to the memo once this survey is completed and results are received from the analytic lab.

4 Closing

We hope that this memorandum provides you with the information needed to progress the Crawford Nickel Project. Please contact the undersigned if you have any question regarding information provided herein.

Regards,

STANTEC CONSULTING LTD.

Digitally signed by Erica Padvaiskas
Date: 2024.09.30 15:26:25 -04'00'

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Attachments:

Attachment 1: Supplemental Fish and Fish Habitat Collection-Environmental DNA" protocol

Attachment 2: eDNA Sampling Sites, Potential Lake Sturgeon Spawning Habitat, and Barriers to Upstream Fish Passage in North Driftwood River.

Attachment 3: North Driftwood River Aerial Survey Results, May 2024.

Attachment 4: North Driftwood River Aerial Survey Photolog, May 2024.

Attachment 5: eDNA Sampling Sites, Potential Lake Sturgeon Spawning Habitat, and Barriers to Upstream Fish Passage in the Buskegau and West Buskegau Rivers

Attachment 6: West Buskegau River Aerial Survey Results, May 2024.

Attachment 7: Buskegau River/West Buskegau River Aerial Survey Photolog, May 2024.

5 References

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COSEWIC 2006. COSEWIC assessment and update status report on the Lake Sturgeon Acipenser fulvescens in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 107 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

COSEWIC. 2017. COSEWIC assessment and status report on the Lake Sturgeon *Acipenser fulvescens.* Western Hudson Bay populations. Saskatchewan – Nelson River populations. Southern Hudson Bay – James Bay populations and Great Lakes – Upper St. Lawrence populations in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxx + 153 pp. (Species at Risk Public Registry website).

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August 12, 2024
Mathieu Boucher, Environmental Manager

Reference: **Lake Sturgeon Aerial Habitat Survey and eDNA Sampling, Spring 2024**

Attachment 1 Supplemental Fish and Fish Habitat Collection-Environmental DNA protocol

Stantec

Memo

To:	Michel La Haye Stantec - Montreal	From:	Mary Murdoch and Nate Marshall Stantec – Fredericton, NB and Topsham, Maine, USA
Project/File:	160930456	Date:	August 12, 2024

Reference: Spring 2024 Supplemental Fish and Fish Habitat Data Collection – Environmental DNA

information for environmental assessment of the Crawford Nickel Project (the Project). environmental DNA (eDNA) samples will be collected from two river systems to determine the presence of Lake Sturgeon (*Acipenser fulvescens*). Sampling sites in the North Driftwood River and in the West Buskegau River will target areas downstream of rocky rapids or riffles (where they exist), which is habitat used by Lake Sturgeon for spawning. Lake Sturgeon is a spring spawner so sampling in spring will increase the likelihood of detecting the species (if present) in the North Driftwood and West Buskegau rivers.

This memo provides a summary of the eDNA sampling design which has been developed based on guidance from Fisheries and Oceans Canada (DFO 2020[1]) and Abbott et al. (2021[2]) and Stantec's experience in conducting eDNA studies for detection of fish species in river systems in North America.

Sample sites will include:

1. In the North Driftwood River at the previous eDNA site sampled by WSP in 2022 (NDR-S-06) located downstream of the Project footprint
2. In the North Driftwood River upstream of the confluence with Nesbitt Creek
3. In the North Driftwood River downstream of the confluence with Nesbitt Creek
4. In the West Buskegau River at WSP site WBR-S-07 located downstream of the Project footprint
5. In the West Buskegau River upstream of the confluence with the Buskegau River.

A known positive control site will also be sampled to confirm sampling effectiveness, and this will be in Mattagami River downstream of the Sturgeon Falls Dam.

For the study sites and the positive control site, triplicate water samples will be collected at each site. Sampling will be conducted below identified rifles of potential spawning activities for Lake Sturgeon, if present.

The negative control will be distilled or deionized water sampled once each day (i.e., one replicate per day).

---

[1] DFO. 2020. Advice on the Use of Targeted Environmental DNA (eDNA) Analysis for the Management of Aquatic Invasive Species and Species at Risk. DFO Can. Sci. Advis. Sec. Res. Doc. 2020/058. 19 p. https://publications.gc.ca/collections/collection_2021/mpo-dfo/fs70-6/Fs70-6-2020-058-eng.pdf

[2] Abbott, C., M. Coulson, N. Gagné, A. Lacoursière-Roussel, G.J. Parent, R. Bajno, C. Dietrich, S. May-McNally. Guidance on the Use of Targeted Environmental DNA (eDNA) Analysis for the Management of Aquatic Invasive Species and Species at Risk. DFO Can. Sci. Advis. Sec. Res. Doc. 2021/019. iv + 42 p. : https://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2021/2021_019-eng.html

Reference: **Spring 2024 Supplemental Fish and Fish Habitat Data Collection – Environmental DNA**

Water Sample Collection

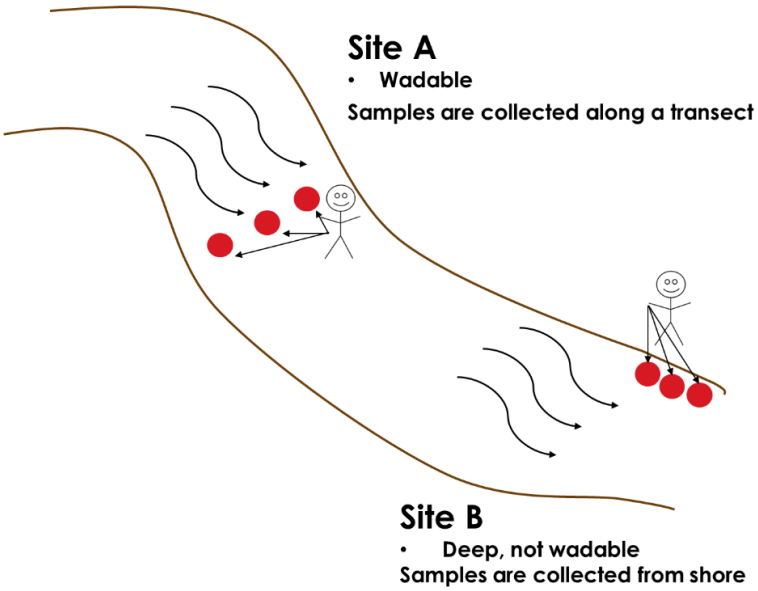
The field team will select a transect location that is ideally wadable and downstream of a riffle. Avoid deeper channels and swifter flows that may be unsafe.

- For sites that are wadable, the triplicate water samples will be collected as three discrete point samples along a transect spanning from bank to bank (see Site A from Figure 1 for an example). Sampling along a transect will optimize the probability of collecting Lake Sturgeon eDNA if it is present in the river section upstream.
- For sites that are deep and not wadable, the three replicate samples will be collected directly from the riverbank (see Site B from Figure 1 for an example).

Each water sample will be 2L in volume, which will be collected from the river using new clean 2L bottles (do not re-use). Samples will be collected facing upstream to avoid adding turbidity to the water samples. Use fresh nitrile gloves for sampling at each site and avoid touching the bottle openings and insides of bottle caps. Sample along the transect or at the riverbank, then cap and label the bottle with site ID and replicate number (e.g., NB-01-Rep1). Continue water sampling along the transect until three replicate 2L samples are collected at each site.

To collect eDNA, each water sample will be filtered onsite or back at basecamp within eight hours of collection. If filtering back at basecamp, place sample bottles into a cooler on ice as soon as sample is collected.

Figure 1 **Schematic of eDNA water sampling protocol for shallow, wadable sites (Site A) or deep, not wadable sites (Site B).**



Reference: Spring 2024 Supplemental Fish and Fish Habitat Data Collection – Environmental DNA

eDNA Water Filtration

For filtration, find a stable area to work on the ground near the sampling site. If filtering back at basecamp, set up the work surface and wipe with 10% bleach solution and clean paper towel before and after filtration of each sample to avoid cross-contamination of samples.

Use fresh nitrile gloves for filtering each sample, taking care not to cross-contaminate samples.

Using the Smith-Root eDNA Citizen Science Sampler, filter each water sample through a Smith-Root Self-Preserving Filter (PES 1.2 µM mesh size). Video instructions for using the pump and filters can be found here: https://www.smith-root.com/edna/edna-citizen-scientist-sampler. Instructions for use of this filter can be found at https://www.smith-root.com/support/downloads/self-preserving-filter-pack-instructions and are provided as the last page of this field plan for reference in the field.

Label each filter package with the same ID used to identify each water sample.

For filtering a water sample, set up the tubing from each sample package with the pump and place into intake end into the water sample bottle. Place the outlet tubing from the pump into an empty 2L bottle. Turn on the pump and filter the full sample volume (2L) or until the filtration has slowed to a stop for 30 seconds. Collect the output water to measure the volume filtered from each sample, then discard the output water.

Once filtration is complete[3], elevate the filter housing to clear the suction hose and filter all remaining water in the housing. IMPORTANT: crack the seal (do not open) of the filter housing and continue to run the pump for one full minute to air dry the filter membrane. Flip the seal back down and reduce excess water on outside of the filter casing (light shake or dab with clean paper towel).

Record the volume filtered per sample on the eDNA Sample Sheet.

Place the completed filter back in its packing bag and label the packing bag with the sample ID. Place filters into a cooler with ice and discard the used suction tubing into field waste container (do not re-use).

Before filtering the next sample, wipe the work surface with 10% bleach and clean paper towel, and change gloves.

Collect one negative control per day of sampling. After completing eDNA sample collection and filtration for the last site for the day, collect the negative control sample using 2L of fresh distilled or deionzed water from a bottle purchased from a convenience or grocery store. Label the sample using the last site ID and “T-0” (example: NB-02 T-0; representing a negative control sample taken at site NB-02).

Between sampling sites and away from the watercourse, spray waders and equipment that have come in contact with previous site water with 10% bleach solution and wipe down with clean paper towel. This will avoid carry-over of eDNA from one site to the next.

After completing field work for the day and returning to base camp, transfer the filters with eDNA samples from the cooler to a refrigerator, taking care to use clean nitrile gloves and avoid contamination of filter samples. When shipping eDNA samples from the field to the home office, use a cooler with cooler packs and then store in a non-frost-free freezer until shipment to the selected eDNA laboratory.

[3] Filtration is complete if the full water sample volume has been filtered or when filtration rate has slowed down substantially (due to clogging) and has remained slow for one minute.

Safety Alert

When using 1% bleach solution, wear goggles with side shields to protect eyes, wear gloves and keep away from exposed skin, work in a well-ventilated environment. Print out and keep a copy of the Material Safety Data Sheet at hand and make note of the safe use conditions and response in event of an exposure or discomfort.

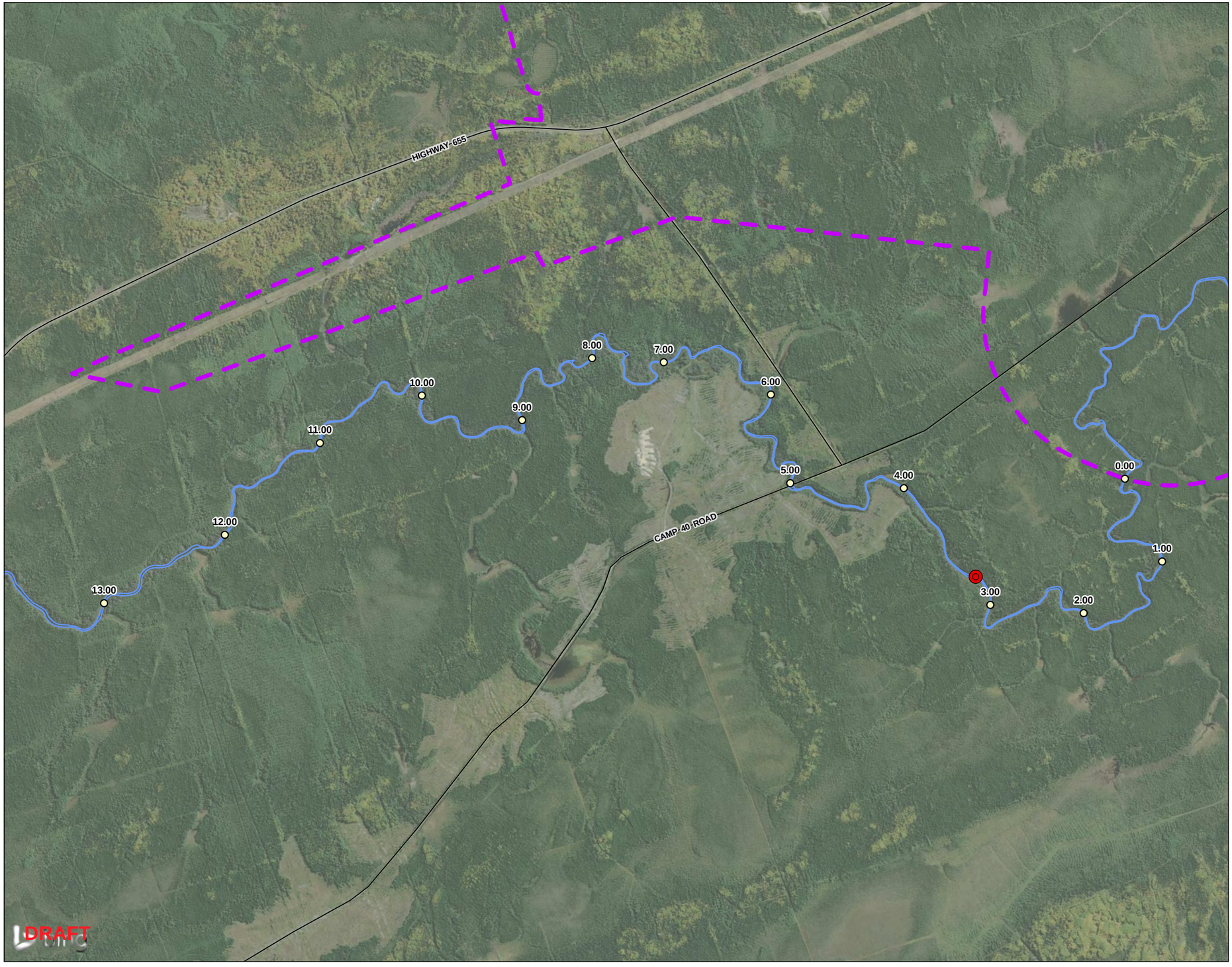
Table 1 Equipment and Supply List for eDNA Sampling

Item	Comment
Smith-Root eDNA Citizen Science Sampler	For filtration of water samples, contact Waterloo office
Smith-Root Self-Preserving Filters; 1.2 um mesh size	Order from Hoskins Scientific; three per site plus one negative control per day; take extras to the field in case additional sampling locations are identified
Distilled or Deionize Water (4x2L bottles)	Purchase from grocery or convenience store. For negative controls (one per day).
1% bleach in spray bottle (labeled and with MSDS in backpack)	For cleaning work areas before and after sample handling and filtration
Box of Ziploc bags – large	To hold sample bottles prior to filtration
2L polypropylene bottles (new) for collecting water samples for eDNA	One per water sample. Do not re-use for sampling; three per site
Nitrile gloves – clean and packed one pair to a Ziploc bag	Take 20 sets per day into the field - pack into baggies using clean nitrile gloves for handling
eDNA Sample Form and pencil or pen	Print the form on waterproof paper
Cooler and ice packs	To hold water samples and filters; clean with 1% bleach solution before and after use each day

August 12, 2024
Mathieu Boucher, Environmental Manager

Reference: **Lake Sturgeon Aerial Habitat Survey and eDNA Sampling, Spring 2024**

Attachment 2 eDNA Sampling Sites, Potential Lake Sturgeon Spawning Habitat, and Barriers to Upstream Fish Passage in North Driftwood River



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Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody

N

0 0.5 1 km

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Notes

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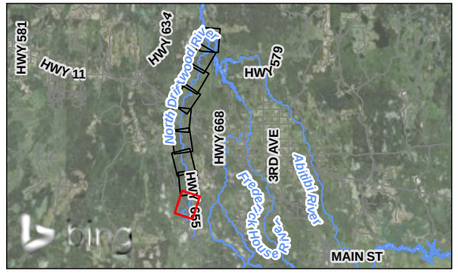

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 2.1

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and barriers to Upstream Passage in the North Driftwood River

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CANADA NICKEL COMPANY

Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody

N

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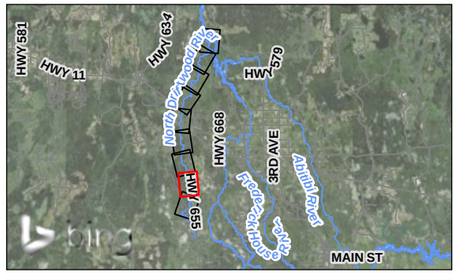

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 2.2

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and barriers to Upstream Passage in the North Driftwood River

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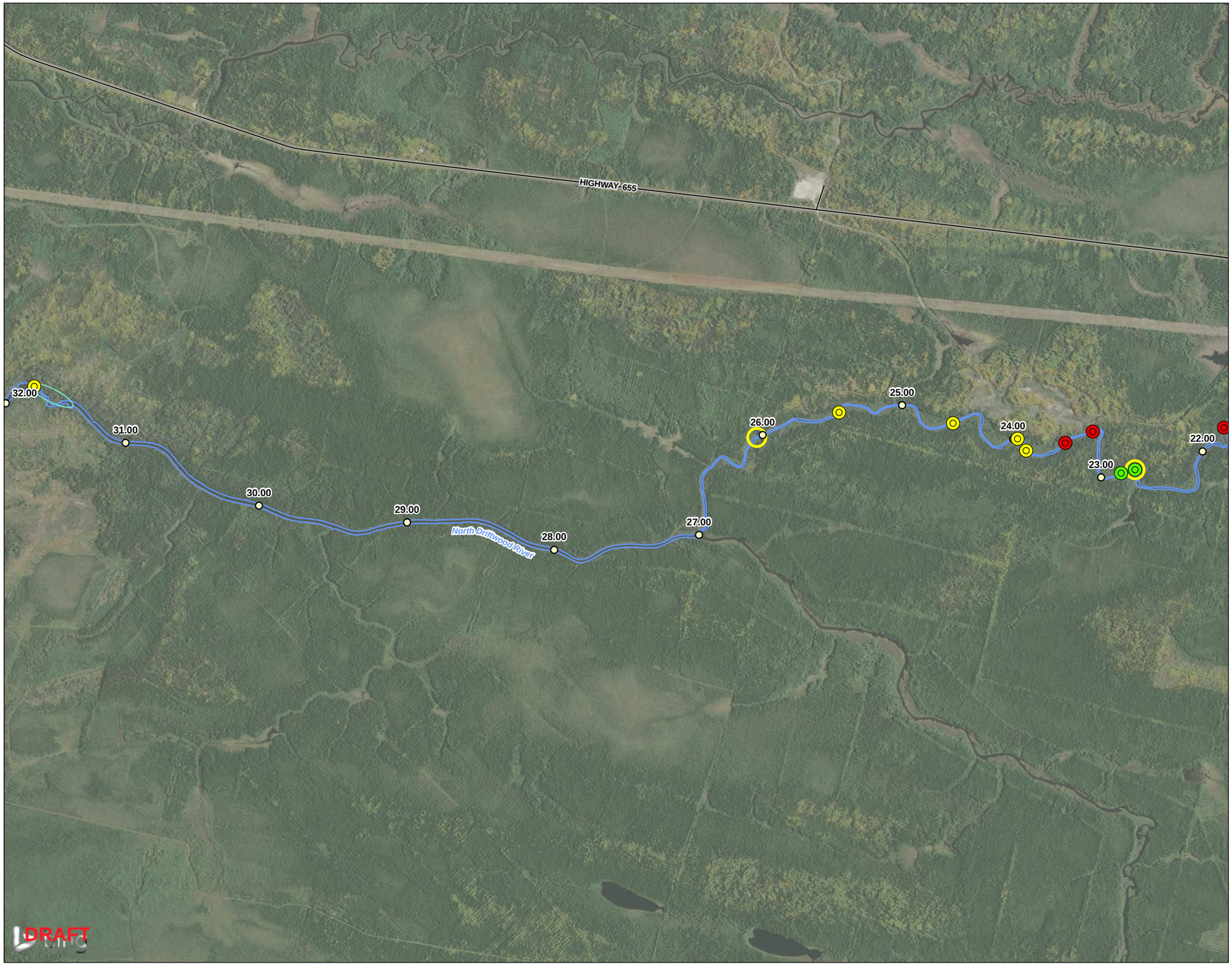

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Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody

N

0 0.5 1 km

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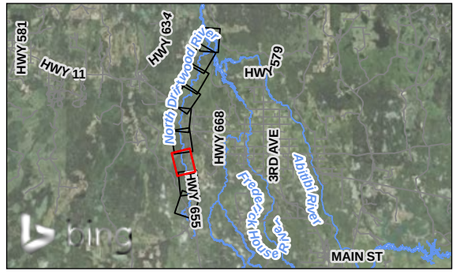

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 2.3

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and barriers to Upstream Passage in the North Driftwood River

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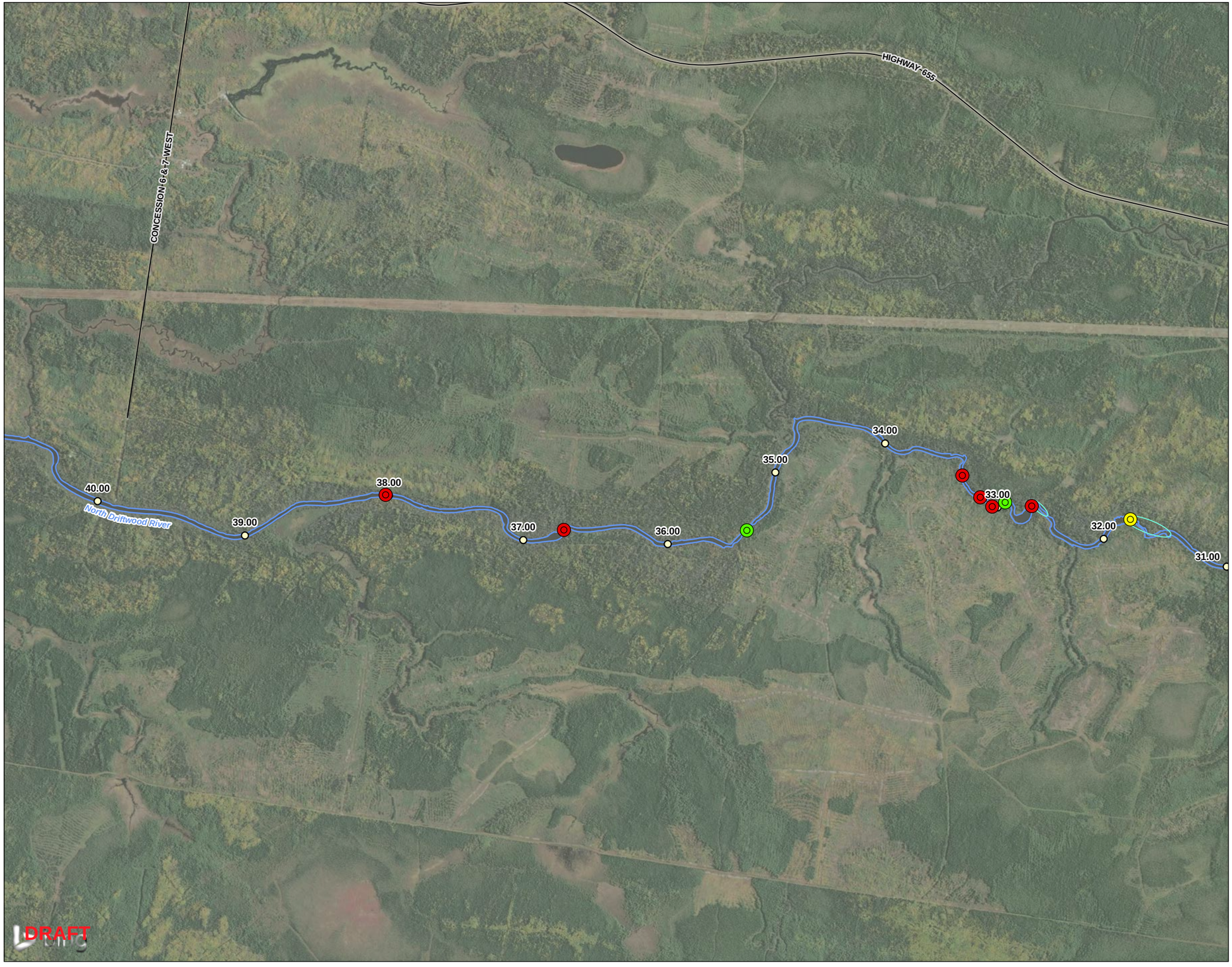

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- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

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- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
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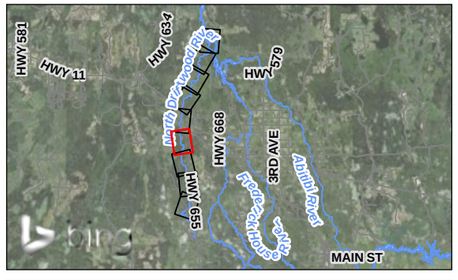

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 2.4

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and barriers to Upstream Passage in the North Driftwood River

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Stantec

CANADA NICKEL COMPANY

Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody

N

0 0.5 1 km

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Notes

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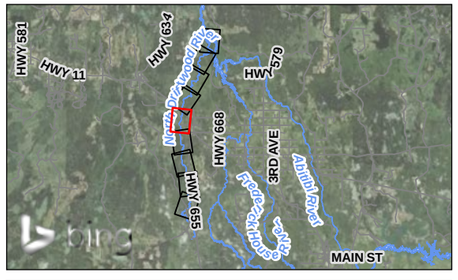

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 2.5

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and barriers to Upstream Passage in the North Driftwood River

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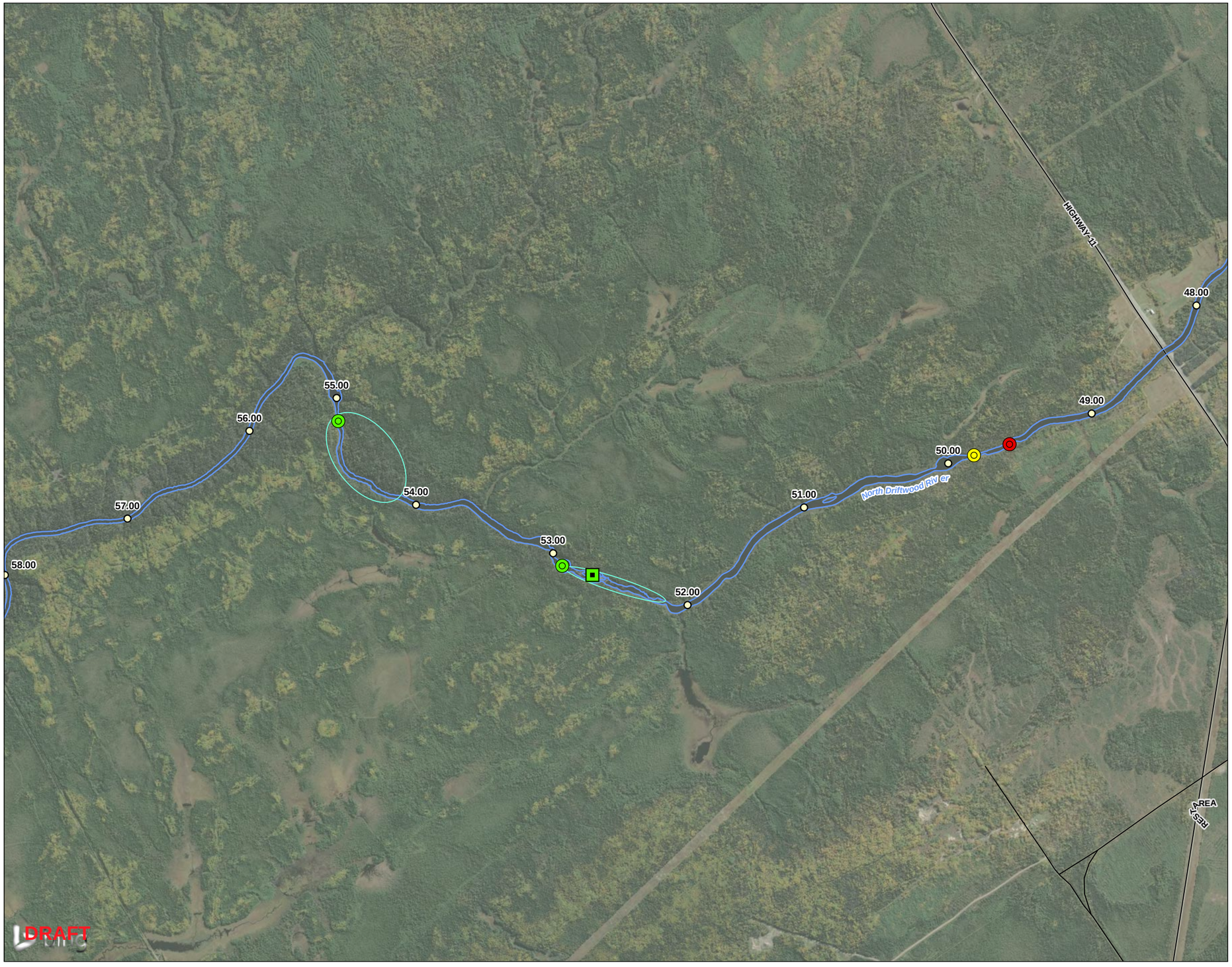

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody

0 0.5 1 km

1:25,000 (At original document size of 11x17)

Notes

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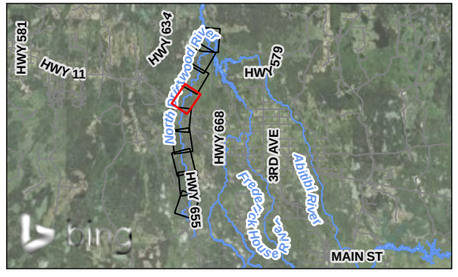

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 2.6

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and barriers to Upstream Passage in the North Driftwood River

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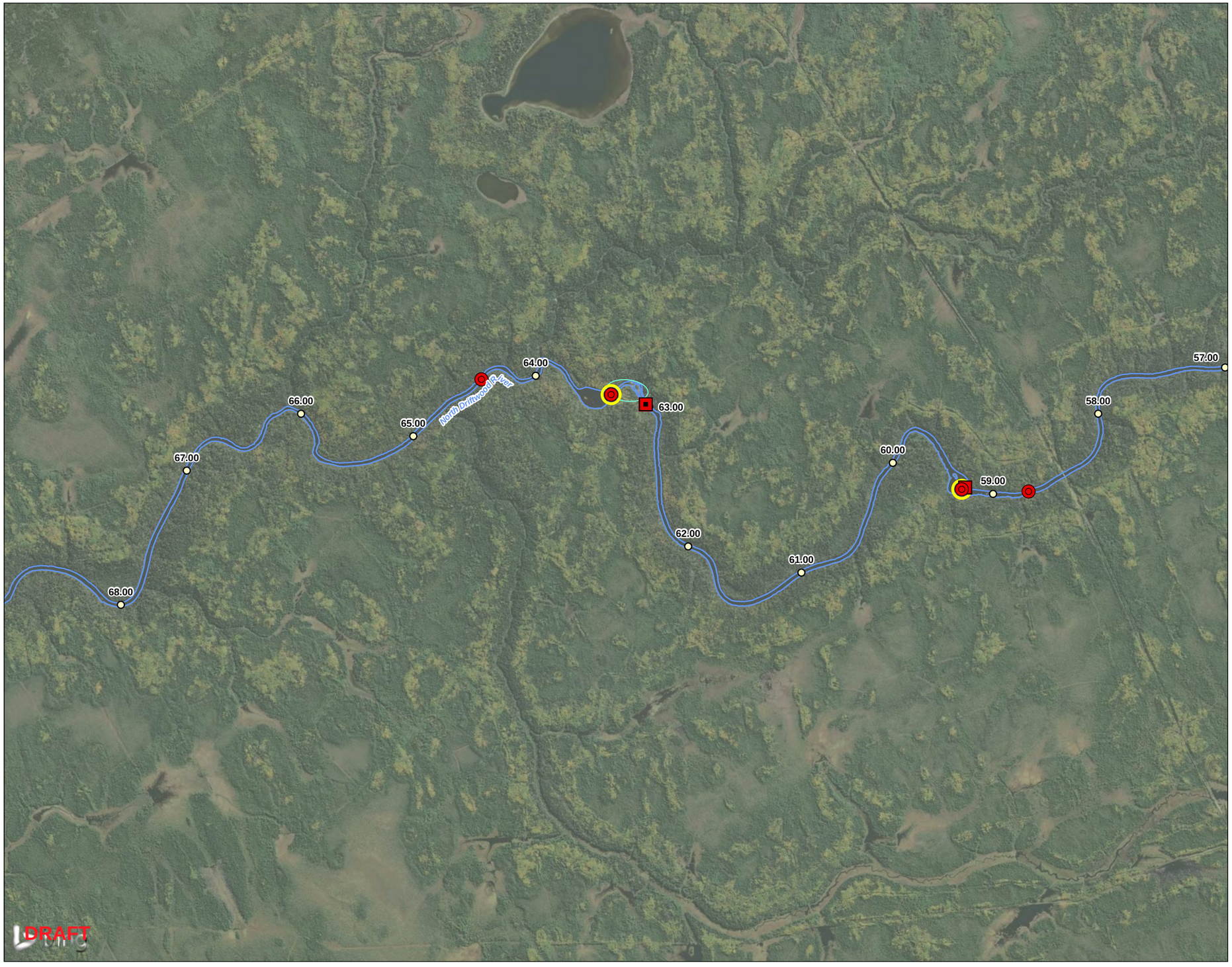

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody

N

0 0.5 1 km

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Notes

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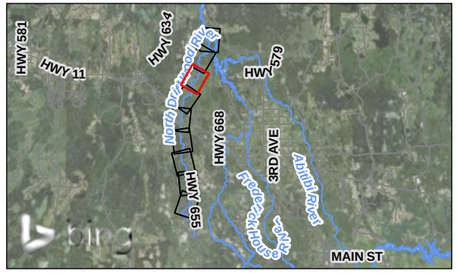

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 2.7

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and barriers to Upstream Passage in the North Driftwood River

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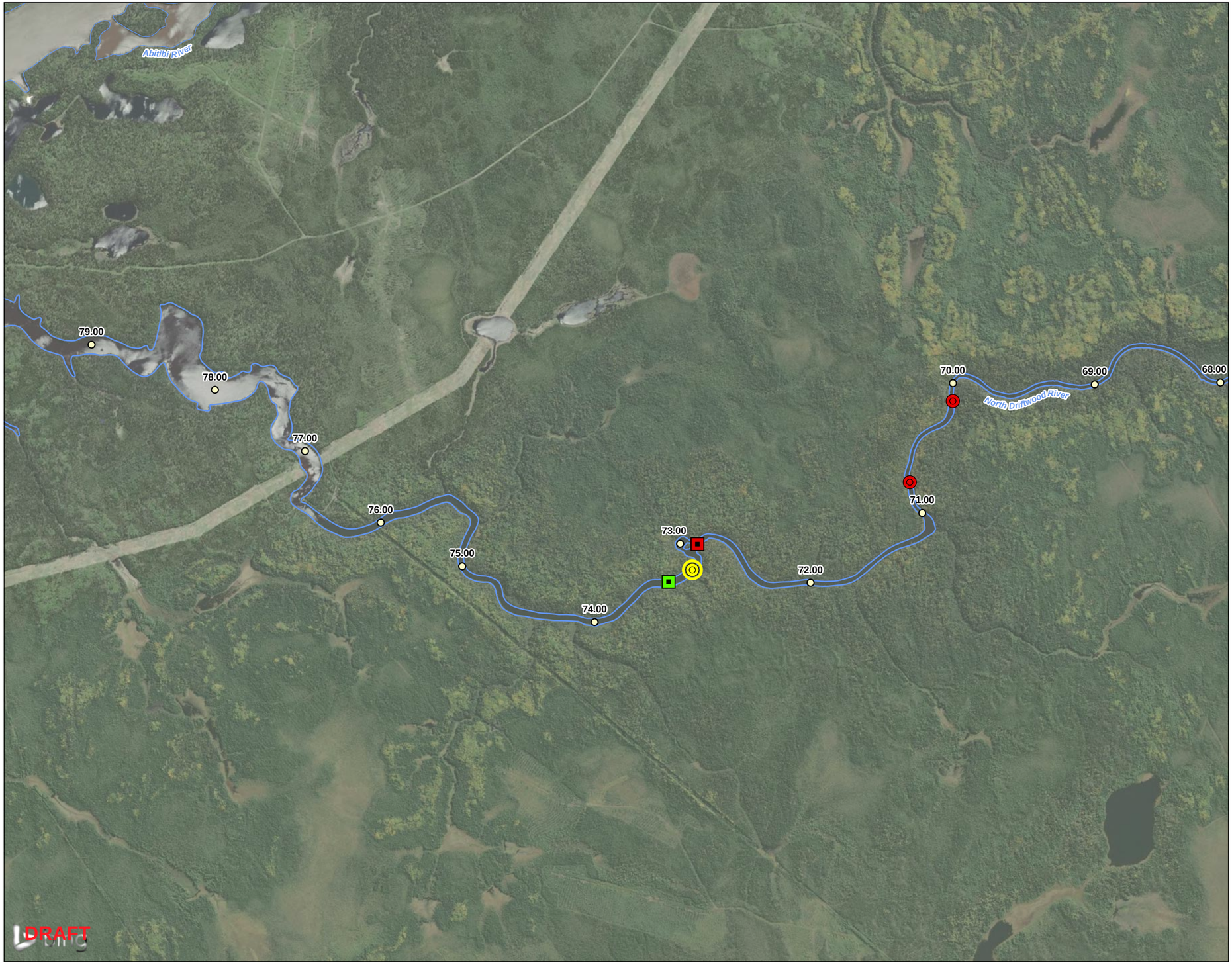

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody

N

0 0.5 1 km

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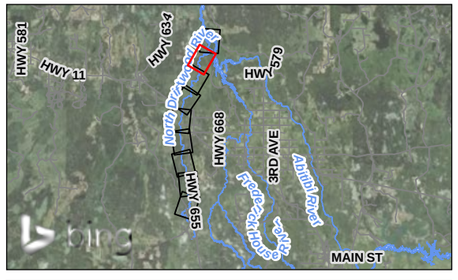

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 2.8

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and barriers to Upstream Passage in the North Driftwood River

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Stantec

CANADA NICKEL COMPANY

Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody

N

0 0.5 1 km

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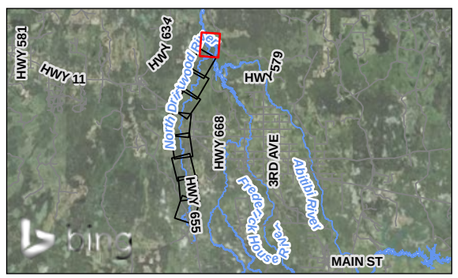

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 2.9

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and barriers to Upstream Passage in the North Driftwood River

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August 12, 2024
Mathieu Boucher, Environmental Manager

Reference: **Lake Sturgeon Aerial Habitat Survey and eDNA Sampling, Spring 2024**

Attachment 3 North Driftwood River Aerial Survey Results, May 2024

KP (upstream from mouth)	KP (downstream from Project Area)	Spring 2024 eDNa Sampling Location	CoordiNates	Lake Sturgeon potential spawning	Facies	Flow	DomiNant substrate	Subdominant substrate	Potential Barrier for Lake Sturgeon	Spawning Potential for Other Species
11.75	73.27	Yes	49°20'09.6"N 81°21'40.0"W	Low	Riffle	Slow	Bedrock	Boulder	Passable with reserve (passible in high flow)	Savi, Catostomidea
12.2	72.88	No	49°20'06.1"N 81°21'33.8"W	Weak	Cascadees, falls and riffles	Variable, slow to fast	Bedrock	Boulder	Impassable with reserve (passible in high flow)	Savi, Catostomidea
14.2	70.78	No	49°19'22.0"N 81°21'49.9"W	None	Little slow riffle	Slow	Bedrock	Boulder	No	None
14.9	70.12	No	49°19'06.1"N 81°21'34.5"W	None	Little slow riffle	Slow	Bedrock	Boulder	No	None
20.6	64.42	No	49°16'49.8"N 81°22'05.4"W	Weak	Little slow riffle	Slow	Bedrock	Boulder	No	Savi, Catostomidea
21.6-21.8	63.3-63.35	Yes	49°16'27.8"N 81°22'29.4"W (ds) 49°16'22.6"N 81°22'37.4"W (us)	Weak	Cascadees, falls and riffles	Variable, slow to fast	Bedrock	Boulder	Impassable without reserve (not even by salmoid)	Savi, Catostomidea
25.75	59.21	Yes	49°15'34.8"N 81°23'49.4"W	None	Cascadees, falls and riffles	Variable, slow to fast	Bedrock	Boulder	Impassable with reserve (passible in high flow)	Savi, Catostomidea
26.25	58.76	No	49°15'23.1"N 81°24'00.3"W	None	Little slow riffle	Slow	Bedrock	Boulder	No	None
30 -30.4	54.14-54.85	No	49°13'48.5"N 81°24'08.7"W (ds) 49°13'47.6"N 81°24'38.4"W (us)	High	Serie of glide, slow and fast riffles	Slow to Fast	Boulder - bedrock	cobble	No	Savi, Catostomidea
32 -32.9	52.17-52.89	No	49°13'27.2"N 81°25'25.6"W (ds) 49°13'14.2"N 81°25'53.4"W (us)	High	Serie of glide, slow and fast riffles	Slow to Fast	Boulder - bedrock	cobble	No	Savi, Catostomidea
32.4	52.61	No	49°13'22.3"N 81°25'36.0"W	None	Fall 1 m	Fast	Bedrock	Boulder	Impassable with reserve (passible in high flow)	None
35.2	49.82	No	49°12'04.6"N 81°26'09.4"W	Fair	Glide, slow and fast riffles	Slow to Fast	Boulder	cobble	No	Savi, Catostomidea
35.4	49.58	No	49°11'57.3"N 81°26'12.8"W	None	Glides	Slow	Boulder	cobble	No	None
38 - 38.2	46.79-47.02	No	49°10'43.4"N 81°26'14.1"W (ds) 49°10'36.4"N 81°26'13.3"W (us)	High	Serie of glide, slow and fast riffles	Slow to Fast	Boulder - bedrock	cobble	No	Savi, Catostomidea
38.7	46.28	No	49°10'21.8"N 81°26'16.4"W	None	Cascadees, falls and riffles	Slow to Fast	Bedrock	Boulder	No	None
46.95	38.02	No	49°06'31.3"N 81°26'32.4"W	None	Fast to slow riffle and glides	Slow to Fast	Bedrock	Boulder	No	None
48.25	36.72	No	49°05'54.1"N 81°26'34.9"W	None	Fast to slow riffle and glides	Slow to Fast	Bedrock	Boulder	No	None

KP (upstream from mouth)	KP (downstream from Project Area)	Spring 2024 eDNa Sampling Location	CoordiNates	Lake Sturgeon potential spawning	Facies	Flow	DomiNant substrate	Subdominant substrate	Potential Barrier for Lake Sturgeon	Spawning Potential for Other Species
49.5	35.44	No	49°05'17.0"N 81°26'26.5"W	High	Long rapids section with glide, slow and fast riffles	Slow to Fast	Boulder - bedrock	cobble	No	Savi, Catostomidea
51.6	33.33	No	49°04'35.0"N 81°25'59.5"W	None	Glides	Slow	na	na	No	None
51.8	33.14	No	49°04'30.7"N 81°26'05.4"W	None	Fast to slow riffle and glides		Bedrock	Boulder	No	None
51.95	33.04	No	49°04'28.0"N 81°26'07.7"W	None	Little slow riffle	Slow	Bedrock	Boulder	No	Savi, Catostomidea
52.05	32.94	No	49°04'25.5"N 81°26'05.8"W	High	Short rapids section with glide, slow and fast riffles	Slow to Fast	Boulder - bedrock	cobble	No	Savi, Catostomidea
52.20 - 52.4	32.47-32.64	No	49°04'20.0"N 81°26'05.7"W (ds) 49°04'16.3"N 81°26'08.4"W (us)	None	Serie of glide and slow riffles	Slow	Bedrock	Boulder	No	Savi, Catostomidea
53.2 - 53.6	31.45-31.77	No	49°03'59.6"N 81°26'05.2"W (ds) 49°03'51.5"N 81°26'07.6"W (us)	Fair	Serie of glide and slow riffles	Slow to moderate	Boulder - bedrock	cobble	No	Savi, Catostomidea
58.95	26.21	Yes	49°01'34.6"N 81°25'33.0"W	None	No riffle	na	na	na	No	None
59.5	25.46	No	49°01'18.3"N 81°25'11.8"W	Fair	Glide and slow riffles	Slow	Boulder - bedrock	cobble	No	Savi, Catostomidea
60.5	24.5	No	49°00'55.1"N 81°25'06.4"W	weak to fair	Glide and slow riffles	Slow	Boulder	cobble	No	Savi, Catostomidea
61	23.97	No	49°00'41.5"N 81°25'06.2"W	weak to fair	Glide and slow riffles	Slow	Boulder	cobble	No	Savi, Catostomidea
61.1	23.86	No	49°00'39.2"N 81°25'09.1"W	weak to fair	Glide and slow riffles	Slow	Boulder	cobble	No	Savi, Catostomidea
61.6	23.57	No	49°00'31.2"N 81°25'03.0"W	None	Little slow riffle	Slow	Bedrock	Boulder	No	Savi, Catostomidea
61.7	23.37	No	49°00'26.9"N 81°24'58.3"W	None	Little slow riffle	Slow	Bedrock	Boulder	No	Savi, Catostomidea
62.1	22.86	No	49°00'19.2"N 81°25'08.7"W	High	Short rapids section with glide and slow riffles	Slow to moderate	Boulder	cobble	No	Savi, Catostomidea
62.2	22.7	Yes	49°00'16.6"N 81°25'06.6"W	High	Short rapids section with glide and slow riffles	Slow to moderate	Boulder	cobble	No	Savi, Catostomidea
62.3	22.63	No	49°00'15.0"N 81°25'11.5"W	Weak	Short rapids section with glide and slow riffles	Slow to moderate	Boulder	cobble	No	Savi, Catostomidea
63.2	21.69	No	49°00'01.0"N 81°24'47.1"W	None	Short rapids section with glide and slow riffles	Slow	Boulder	Na	No	Savi, Catostomidea
81.8	3.22	No	48°53'27.2"N 81°25'47.5"W	None	Low riffle	Low	Sand	Sand	No	None

August 12, 2024
Mathieu Boucher, Environmental Manager

Reference: **Lake Sturgeon Aerial Habitat Survey and eDNA Sampling, Spring 2024**

Attachment 4 North Driftwood River Aerial Survey Photolog, May 2024

Photo 1: Feature observed at KP 73.27 downstream of the Project Area. Potential spawning location and barrier for Lake Sturgeon. Photo facing south.

Photo 2: Potential barrier for Lake Sturgeon observed at KP 72.88 downstream from the Project Area. No spawning potential for Lake Surgeon. Photo facing north.

Photo 3: Riffle observed at KP 70.78 downstream from the Project Area. No spawning potential for Lake Sturgeon. Photo facing west.

Photo 4: Riffle observed at KP 70.12 downstream from the Project Area. No spawning potential for Lake Sturgeon. Photo facing east.

Photo 5: Riffle observed at KP 64.42 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo facing southwest.

Photo 6: Potential barrier for Lake Sturgeon observed at KP 63.3-63.35 downstream from the Project Area. No spawning potential for Lake Sturgeon. Photo facing northwest.

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Stantec

Title
Features observed in the North Driftwood River -Spring 2024 Aerial Surveys

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Photo 3: Potential barrier for Lake Sturgeon observed at KP 59.21, downstream from the Project Area. No spawning potential for Lake Sturgeon. Photo facing north.

Photo 8: Riffle observed at KP 58.76 downstream from the Project Area. No spawning potential for Lake Sturgeon. Photo facing south.

Photo 9: Series of Riffles observed from KP 51.14 – 54.85 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo taken at KP 52.2, facing southwest.

Photo 10: Potential barrier for Lake Sturgeon and series of Riffles observed from KP 52.17-52.89 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo facing southwest.

Photo 11: Potential barrier for Lake Sturgeon observed at KP 52.61 downstream from the Project Area. Photo facing southeast.

Photo 12: Riffle observed at KP 49.82 downstream of the Project Area. Spawning potential for Lake Sturgeon. Photo facing northwest.

Photo 13: Riffle observed at KP 49.58 downstream of the Project Area. No spawning potential for Lake Sturgeon. Photo facing northwest.

Photo 14: Series of Riffles observed from KP 46.79 – 47.02 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo taken at KP 52.2, facing south.

Photo 15: Riffle observed at KP 46.28 downstream of the Project Area. No spawning potential for Lake Sturgeon. Photo facing south.

Photo 16: Riffle observed at KP 38.02 downstream of the Project Area. No spawning potential for Lake Sturgeon. Photo facing northwest.

Photo 17: Riffle observed at KP 36.72 downstream of the Project Area. No spawning potential for Lake Sturgeon. Photo facing west.

Photo 18: Riffle observed at KP 35.44 downstream of the Project Area. Spawning potential for Lake Sturgeon. Photo facing east.

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Photo 19: Riffle observed at KP 33.33 downstream of the Project Area. No spawning potential for Lake Sturgeon. Photo facing southeast.

Photo 20: Riffle observed at KP 33.14 downstream of the Project Area. No spawning potential for Lake Sturgeon. Photo facing southeast.

Photo 21: Riffle observed at KP 33.04 downstream of the Project Area. No spawning potential for Lake Sturgeon. Photo facing southeast.

Photo 22: Riffle observed at KP 32.94 downstream of the Project Area. Spawning potential for Lake Sturgeon. Photo facing southeast.

Photo 23: Series of riffle observed from KP 32.47 – 32.64 downstream of the Project Area. No spawning potential for Lake Sturgeon. Photo facing northeast.

Photo 44: Series of riffles observed from KP 31.45 – 31.77 downstream of the Project Area. Spawning potential for Lake Sturgeon. Photo facing southeast.

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Photo 25: Riffle observed at KP 25.46 downstream of the Project Area. Spawning potential for Lake Sturgeon. Photo facing southwest.

Photo 26: Riffle observed at KP 24.5 downstream of the Project Area. Spawning potential for Lake Sturgeon. Photo facing southeast.

Photo 27: Riffle observed at KP 23.97 downstream of the Project Area. Spawning potential for Lake Sturgeon. Photo facing southeast.

Photo 28: Riffle observed at KP 23.86 downstream of the Project Area. Spawning potential for Lake Sturgeon. Photo facing northeast.

Photo 29: Riffle observed at KP 23.57 downstream of the Project Area. No spawning potential for Lake Sturgeon. Photo facing southeast.

Photon 30: Riffle observed at KP 23.37 downstream of the Project Area. No spawning potential for Lake Sturgeon. Photo facing east.

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Photo 30: Riffles observed at KP 22.83 and 22.7 downstream of the Project Area. Spawning potential for Lake Sturgeon. Photo facing southwest.

Photo 31: Riffle observed at KP 22.63 downstream of the Project Area. Spawning potential for Lake Sturgeon. Photo facing southeast.

Photo 52: Riffle observed at KP 21.69 downstream of the Project Area. No spawning potential for Lake Sturgeon. Photo facing south.

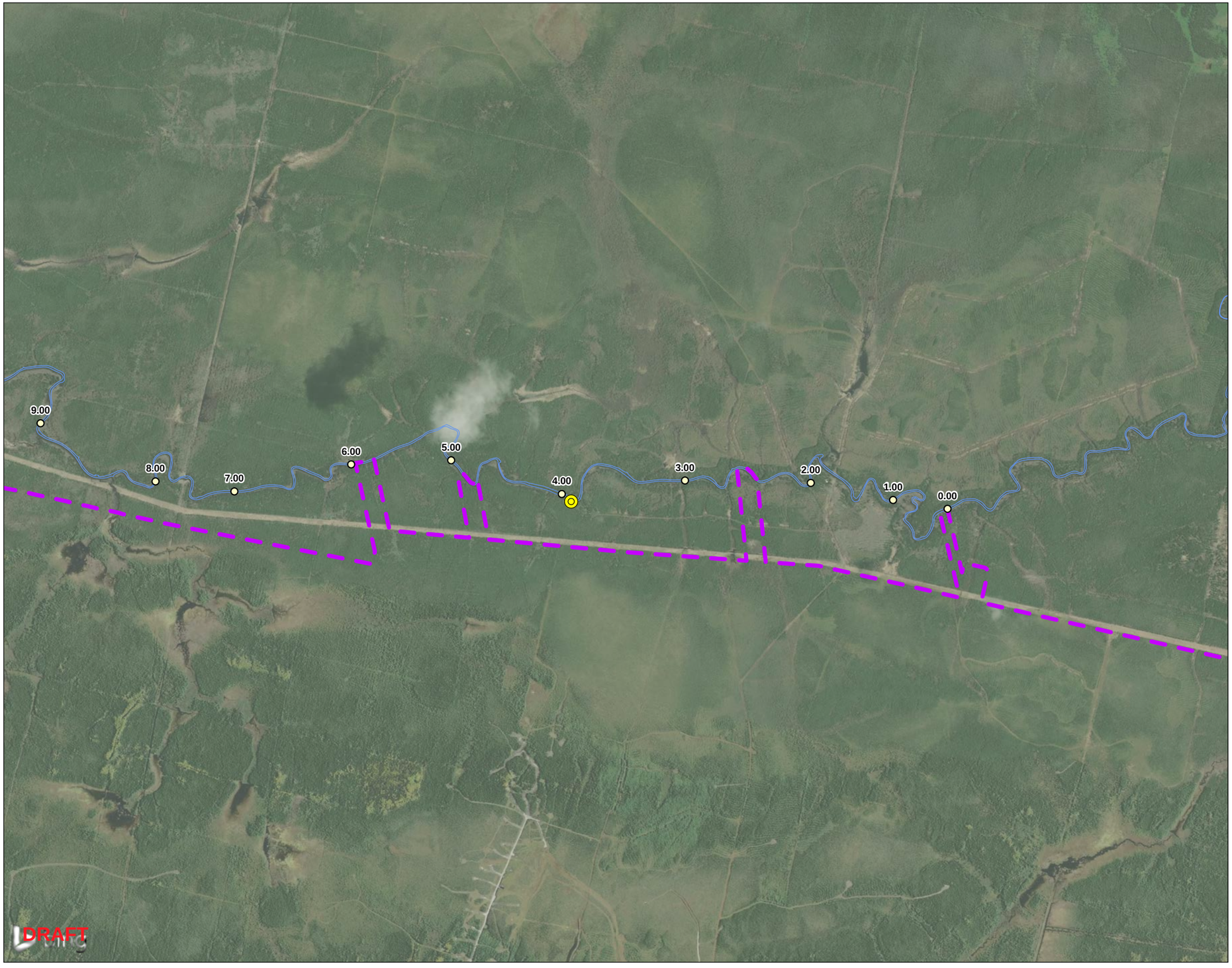
Photo 63: Riffle observed at KP 3.22 downstream of the Project Area. No spawning potential for Lake Sturgeon. Photo facing southeast.

Filepath:\\ca0224-ppfss01\work_group\01609\active\160930456\03_data\field\aquatics\2024 spring aquatic program\edna and aerial surveys\final\attachments\att_4_ndr_photolog_mlh.docx

August 12, 2024
Mathieu Boucher, Environmental Manager

Reference: **Lake Sturgeon Aerial Habitat Survey and eDNA Sampling, Spring 2024**

Attachment 5 eDNA Sampling Sites, Potential Lake Sturgeon Spawning Habitat, and Barriers to Upstream Fish Passage in the Buskegau and West Buskegau Rivers



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Watercourse
- Waterbody

N

0 0.5 1 km

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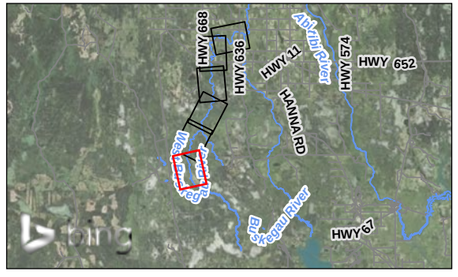

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 5.1

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and Barriers to Upstream Passage in the West Buskegau River

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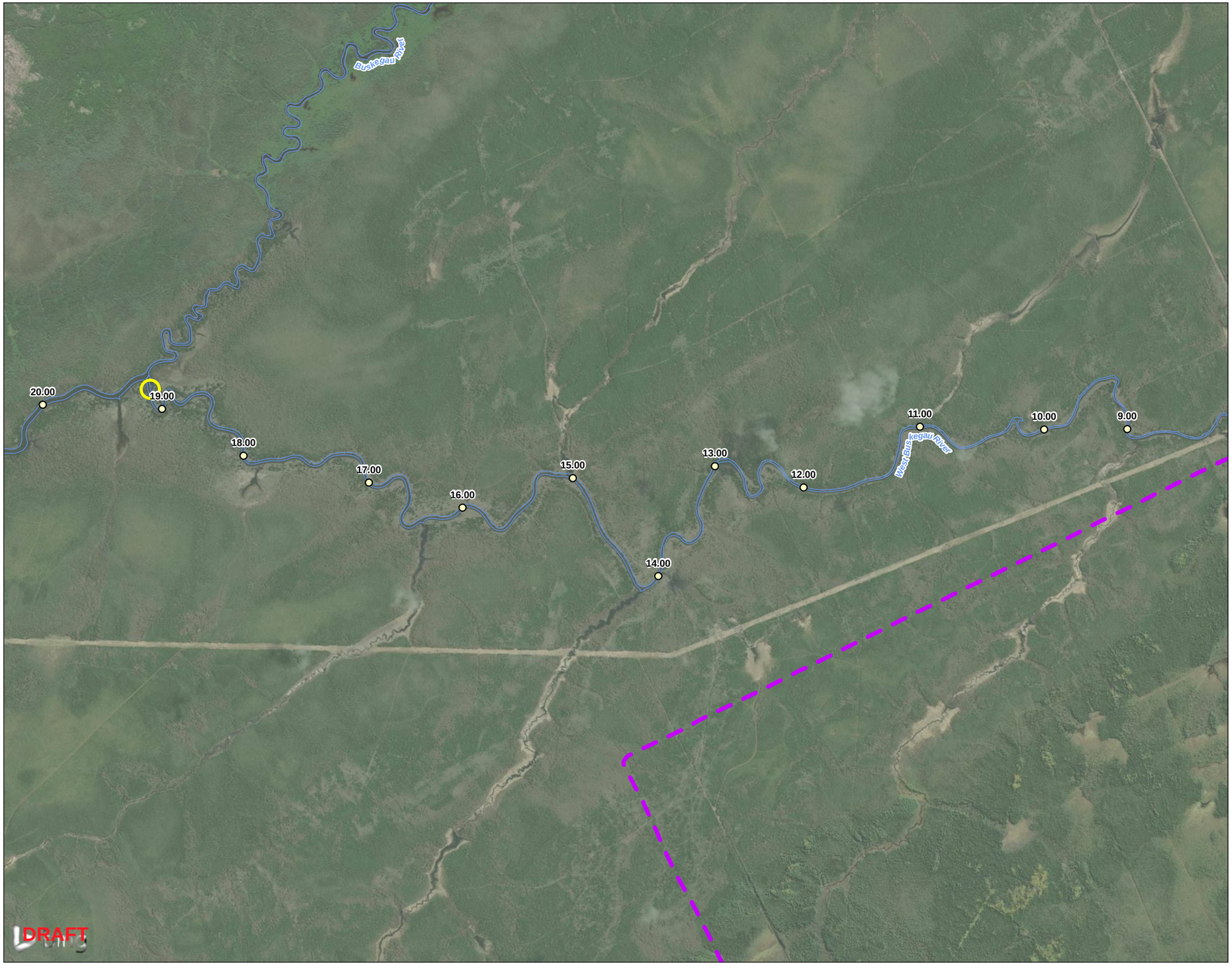

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody
- eDNA Sampling Site - Spring 2024

N

0 0.5 1 km

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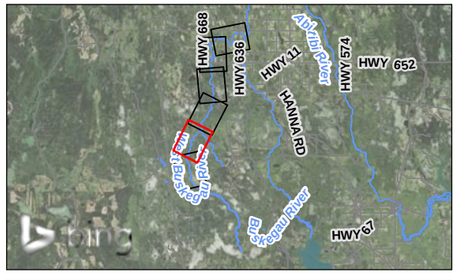

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 5.2

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and Barriers to Upstream Passage in the West Buskegau River

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Stantec

CANADA NICKEL COMPANY

Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody

N

0 0.5 1 km

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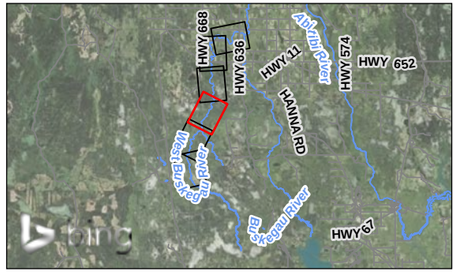

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 5.3

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and Barriers to Upstream Passage in the West Buskegau River

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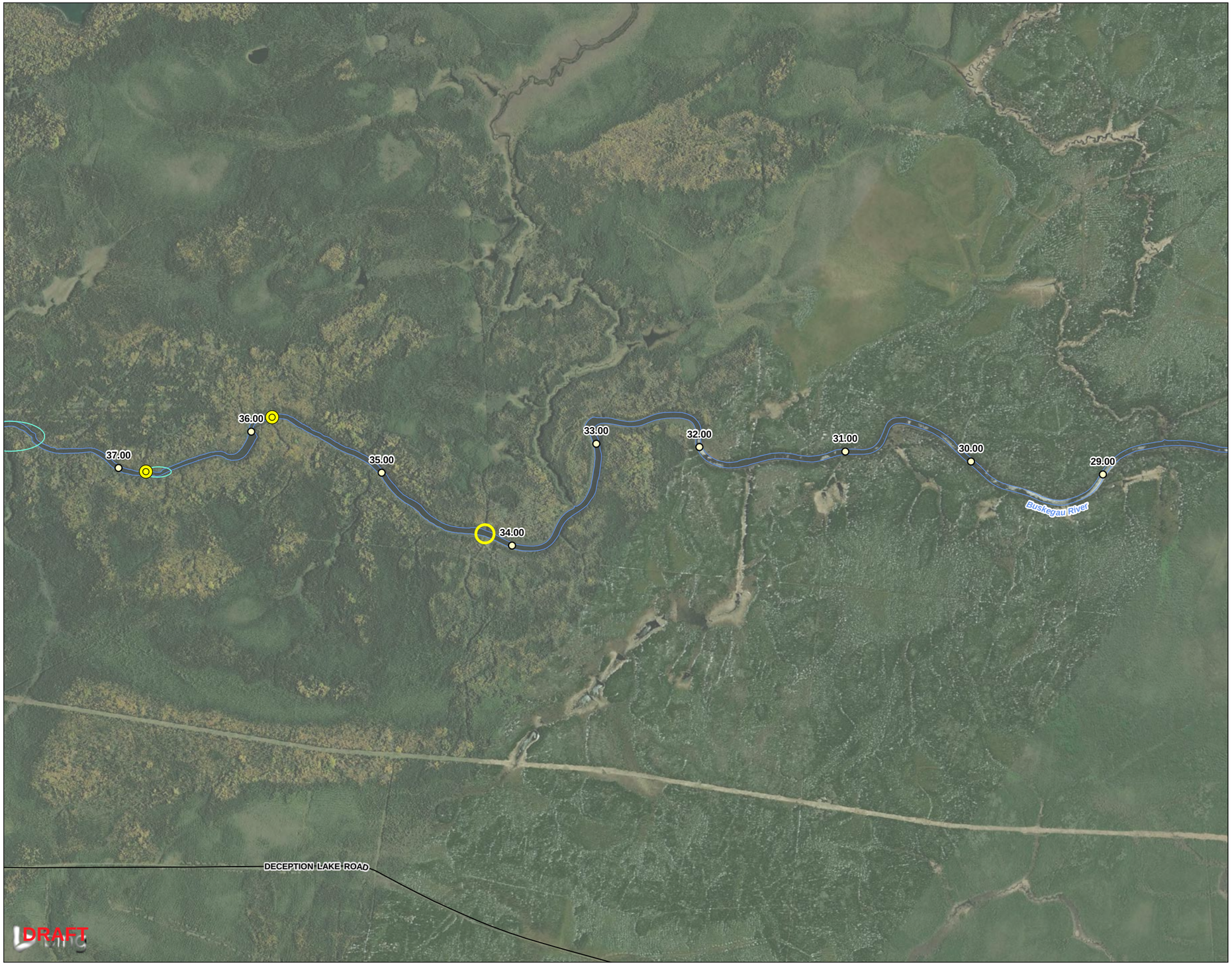

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody

N

0 0.5 1 km

1:25,000 (At original document size of 11x17)

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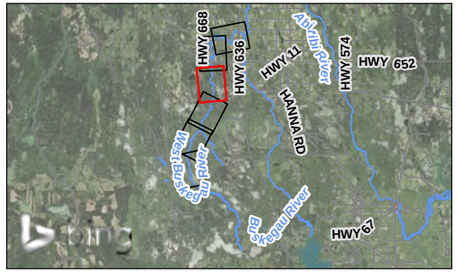

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 5.4

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and Barriers to Upstream Passage in the West Buskegau River

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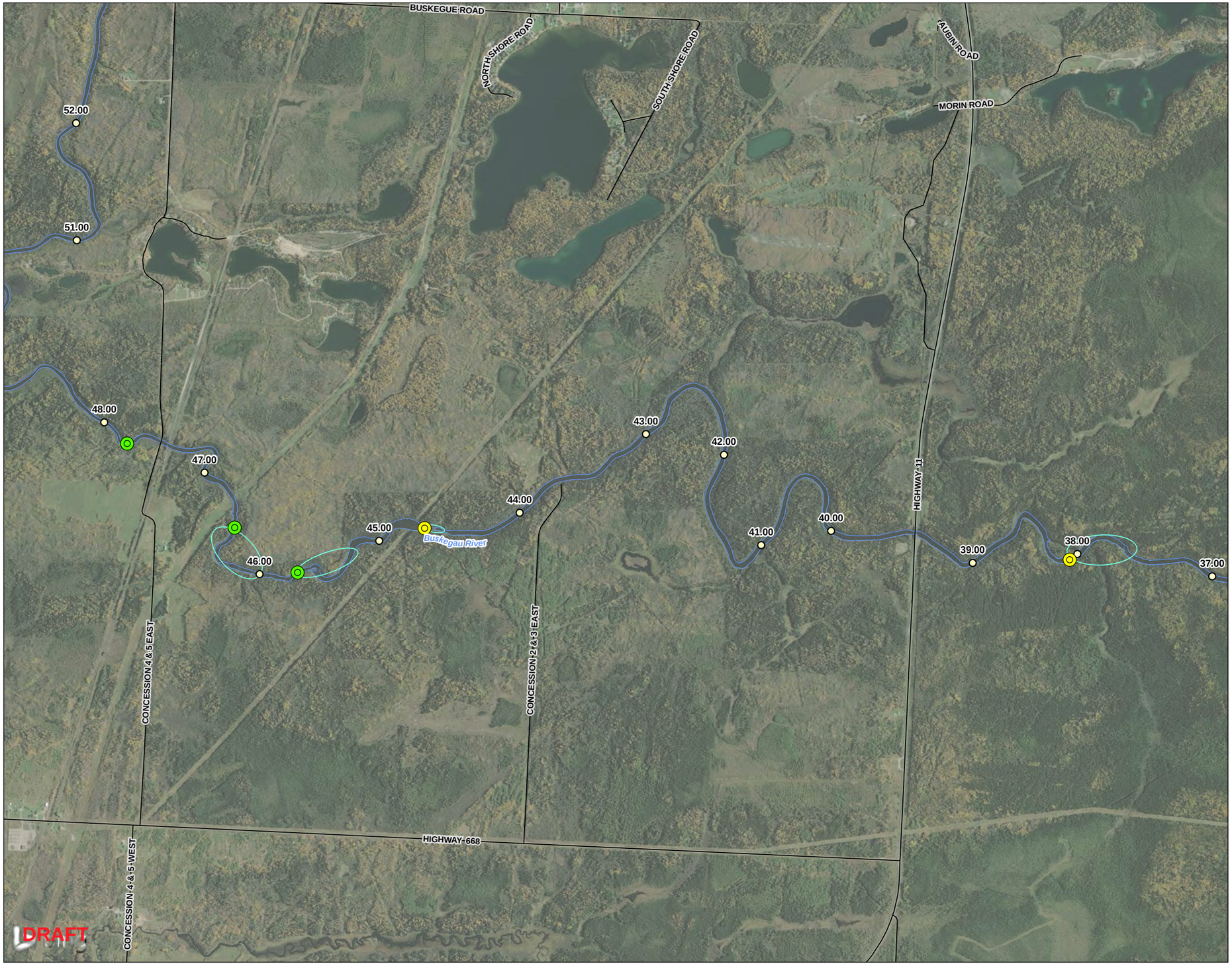
C:\1604\01\Work_in_Progress\160903456\GIS\160903456.aprx\Attachment 5.4 - eDNA Sites, Habitat Potential, and Barriers to Upstream Passage in the West Buskegau River_160903456_Rev.mxd 2024-08-12 By: malcazaren



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody

N

0 0.5 1 km

1:25,000 (At original document size of 11x17)

Notes

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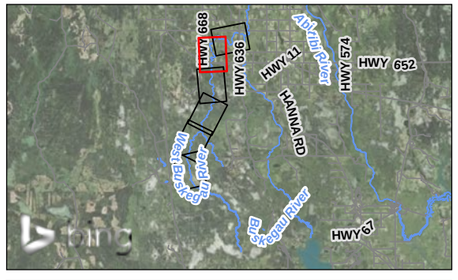

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 5.5

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and Barriers to Upstream Passage in the West Buskegau River

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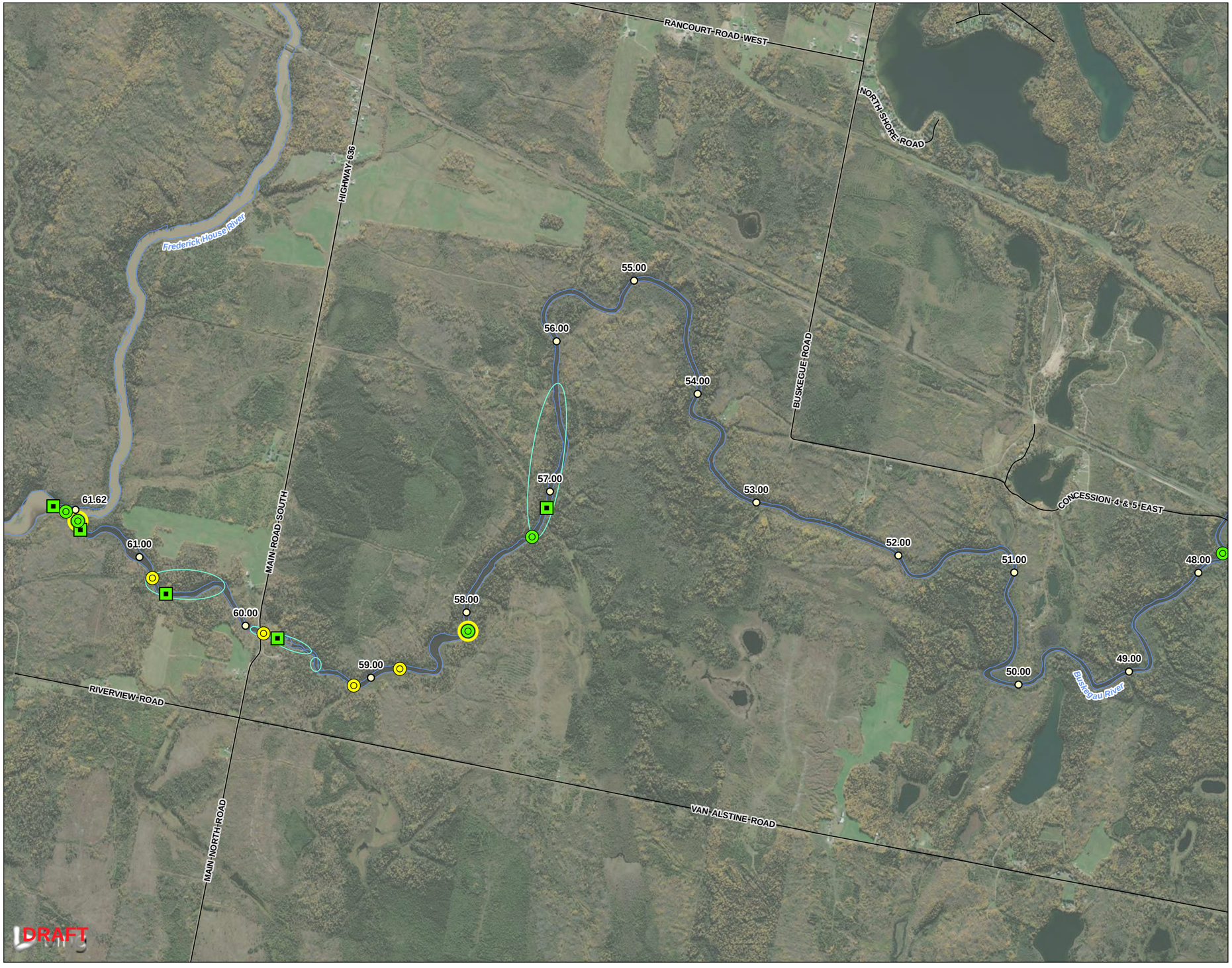

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area (PA)
- Planned eDNA Sampling Location
- Kilometer Point Downstream of the Project Area
- Riffle or Rapid Extent

Aerial Survey Investigation Points

- Passable Impediment Without Reservation
- Impassable With Reservation
- Impassable Without Reservation
- Riffle with High Lake Sturgeon Spawning Potential
- Riffle with Low to Fair Lake Sturgeon Spawning Potential
- Riffle with No Lake Sturgeon Spawning Potential

Base Features

- Road
- Waterbody

N

0 0.5 1 km

1:25,000 (At original document size of 11x17)

Notes

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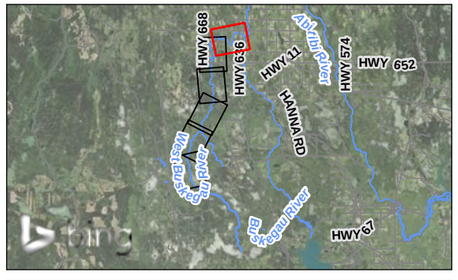

Project Location
Timmins, Ontario

160903456 REVA
Prepared by malcazaren on 2024-08-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
Attachment 5.6

DRAFT

Title
eDNA Sampling Sites, Lake Sturgeon Spawning Habitat Potential, and Barriers to Upstream Passage in the West Buskegau River

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August 12, 2024
Mathieu Boucher, Environmental Manager

Reference: **Lake Sturgeon Aerial Habitat Survey and eDNA Sampling, Spring 2024**

Attachment 6 West Buskegau River Aerial Survey Results, May 2024

KP (upstream from mouth)	KP (downstream from Project Area)	Spring 2024 eDNa Sampling Location	CoordiNates	Lake Sturgeon potential spawning	Facies	Flow	DomiNant substrate	Subdominant substrate	Potential Barrier for Lake Sturgeon	Spawning Potential for Other Species
0	61.65	No	49.114050, -81.140188	High	Glides+ slow + fas riffle + pools	Fast + moderate + slow + lamiNar	Boulder + bedrock	Cobble + gravel	2 passable with no reserve	Savi, Catostomidea
0.0 -0.1	61.54	Yes	49°06'52.0"N 81°08'28.9"W	High	Riffle	Fast + lamiNar + pool	Boulder + bedrock	Cobble + gravel	Passable with reserve (passable in high flow)	Savi, Catostomidea
0.8 to 1.6	59.96-60.83	no	49°07'00.5"N 81°08'55.2"W (ds) 49°07'06.8"N 81°09'28.3"W (us)	Fair	Serie of little slow + fast riffles	Little Fast	Bedrock + boulder	Cobble	No	Savi, Catostomidea
1.8 -2.1	59.51-59.87	no	49°07'07.2"N 81°09'32.6"W (ds) 49°07'09.2"N 81°09'49.2"W (us)	Weak to fair	Serie of little slow + fast riffles + cascades + little falls	Variable	Bedrock + boulder	Cobble	Passable with reserve (passable in high flow)	Savi, Catostomidea
2.5	59.13	no	49°07'14.1"N 81°10'03.4"W	Weak	Little slow riffle	Small Fast	Bedrock	Boulder	No	None
2.75	58.8	no	49°07'08.9"N 81°10'16.5"W	Weak	Little slow riffle	LamiNar	Bedrock	Boulder	No	None
3.5	58.12	Yes	49°06'58.6"N 81°10'35.1"W	High	Little slow + fast riffle	Fast + lamiNar + pool	Boulder +cobble	Bedrock + gravel	No	Savi, Catostomidea
4.5	57.11	no	49°06'30.7"N 81°10'51.7"W	None	Little slow riffle	slow + lamiNar	Boulder +cobble	Na	Passable with reserve	None
4.25 - 5.7	56.33-57.33	no	49°06'37.1"N 81°10'49.0"W (ds) 49°06'07.0"N 81°10'47.6"W (us)	High to fair	Serie of little slow + fast riffles	Little Fast	Bedrock + boulder	Cobble	No	Savi, Catostomidea
13.8	47.78	no	49°06'12.8"N 81°14'21.5"W	High	Little slow riffle	Fast + lamiNar	Boulder +cobble	Gravel	No	Savi, Catostomidea
15.1 - 15.5	46.04-46.55	no	49°05'50.0"N 81°14'46.2"W (ds) 49°05'45.8"N 81°14'59.9"W (us)	High	Serie of little slow riffles	Little Fast	Boulder + cobble	Gravel + sand	No	Savi, Catostomidea
15.9 - 16.4	45.21-45.74	no	49°05'36.7"N 81°14'59.3"W (ds) 49°05'25.9"N 81°14'51.7"W (us)	High	Serie of little slow riffles	Little Fast	Boulder + cobble	Gravel + sand	No	Savi, Catostomidea
17.0 -17.1	44.54-44.66	no	49°05'11.1"N 81°14'43.7"W (ds) 49°05'07.5"N 81°14'44.4"W (us)	Fair	Little slow riffles	Little Fast	Boulder + cobble	Gravel + sand	No	Savi, Catostomidea
23.5 - 24.2	37.53-38.06	no	49°02'58.7"N 81°14'44.4"W (ds) 49°02'45.2"N 81°14'42.9"W (us)	Fair	Fast riffles	Fast - hight	Boulder + cobble	Gravel + sand	No	Savi, Catostomidea
24.8 - 24.9	36.6-36.7	no	49°02'23.7"N 81°14'47.9"W (ds) 49°02'20.2"N 81°14'47.3"W (us)	Low	Cascade	Fast	Bedrock	Boulder	No	None

KP (upstream from mouth)	KP (downstream from Project Area)	Spring 2024 eDNa Sampling Location	CoordiNates	Lake Sturgeon potential spawning	Facies	Flow	DomiNant substrate	Subdominant substrate	Potential Barrier for Lake Sturgeon	Spawning Potential for Other Species
25.75	35.81	no	49°01'59.0"N 81°14'27.3"W	Low	Fast riffles	Fast	Bedrock	Boulder	No	None
27.5	34.17	Yes	49°01'12.7"N 81°14'57.6"W	None	Na	Na	Na	Na	No	Na
42.8	19.17	Yes	48°55'16.4"N 81°16'32.2"W	None	Na	Na	Na	Na	No	Na
57.6	3.93	no	48°50'30.7"N 81°18'45.2"W	Low	Fast riffles	Fast	Bedrock	Boulder	No	None

August 12, 2024
Mathieu Boucher, Environmental Manager

Reference: **Lake Sturgeon Aerial Habitat Survey and eDNA Sampling, Spring 2024**

Attachment 7 Buskegau River/West Buskegau River Aerial Survey Photolog, May 2024

Photo 1: Potential barrier and spawning location for Lake Sturgeon observed at the junction between Frederick House River and WBR. Photo facing northwest.

Photo 2: Potential barrier and spawning location for Lake Sturgeon observed at KP 61.54 downstream from the Project Area. Photo facing west.

Photo 5: Set of riffles observed from KP 59.96 – 60.83 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo taken at KP 59.96 and does not display the full riffle extent.

Photo 4: Set of Riffles observed from KP 59.51 – 59.87 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo facing West.

Photo 5: Potential Lake Strugeon barrier observed at KP 59.65 downstream from the Project Area. Photo facing south.

Photo 6: Riffle observed at KP 59.13 downstream from the Project Area. Spawning for Lake Sturgeon. Photo facing West.

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Photo 7: Riffle observed at KP 58.8 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo facing West.

Photo 8: Riffles observed at KP 58.12 downstream from the Project Area. Spawning for Lake Sturgeon. Photo facing West.

Photo 9: Potential Lake Strugeon barrier at KP 57.11 downstream from the Project Area. Photo facing northwest.

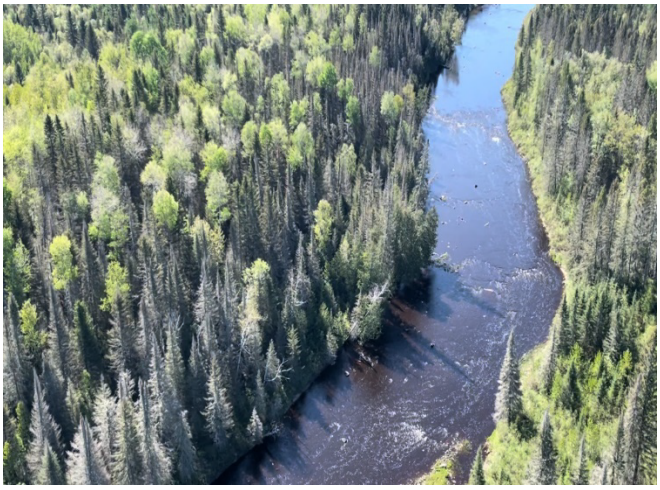

Photo 10: Set of riffles observed from KP 56.33 – 57.33 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo taken at KP 56.6 and does not display the full riffle extent.

Photo 11: Riffles observed at KP 47.78 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo facing southeast.

Photo 12: Set of riffles observed from KP 46.04 – 46.55 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo taken at KP 46.3 and does not display the full riffle extent.

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Photo 13: Set of riffles observed from KP 45.21 - 45.74 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo taken at KP 45.5 and does not display the full riffle extent.

Photo 14: Set of Riffles observed at KP 44.54 - 44.66 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo facing south.

Photo 15: Set of Riffles observed at KP 37.53 – 38.06 downstream from the Project Area. Spawning potential for Lake Sturgeon. Photo taken at KP 37.8 and does not display the full riffle extent.

Photo 16: Set of Riffles observed at KP 36.6 -36.7 downstream from the Project Area. No spawning potential for Lake Sturgeon. Photo facing southeast.

Photo 17: Riffle observed at KP 35.81 downstream from the Project Area. No spawning potential for Lake Sturgeon. Photo facing south.

Photo 18: Riffles observed at KP 3.98 downstream from the Project Area. No spawning potential for Lake Sturgeon. Photo facing southeast.

Filepath:\\ca0224-ppfss01\work_group\01609\active\160930456\03_data\field\aquatics\2024 spring aquatic program\edna and aerial surveys\final\attachments\att_7_wbr_photolog_mlh.docx

Appendix D Fish Tissue Data

Table D.1 Contaminants in Northern Pike Tissue Samples from North Driftwood River Watershed, 2021-2022

Parameter	Lowest Detection Limit	Units	Gerry Lake								Martin Lake					Sutherland Lake		Jack Lake	Summary Statistics				
			NDR-GERLK-GN1-F1-NPK	NDR-GERLK-GN1-F2-NPK	NDR-GERLK-GN1-F3-NPK	NDR-GERLK-GN1-F4-NPK	NDR-GERLK-GN1-F5-NPK	NDR-GERLK-GN1-F6-NPK	NDR-GERLK-GN1-F7-NPK	NDR-GERLK-GN1-F8-NPK	NDR-MARLK-GN1-F1-NPK	NDR-MARLK-GN1-F2-NPK	NDR-MARLK-GN1-F3-NPK	NDR-MARLK-GN1-F4-NPK	NDR-MarLk-GN1-NRPK-F1	NDR-SutLk-GN1-NRPK-F1	NDR-SutLk-GN1-NRPK-F2	NDR-JacLk-GN1-NRPK-F1	n	Minimum	Maximum	Mean	Standard Deviation
			27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	20-Oct-2022	21-Oct-2022	21-Oct-2022	22-Oct-2022					
Moisture	0.50	%	81.7	81.6	79.4	79.5	79.8	80.6	79.7	81.9	79.8	78.4	80.9	78.8	79.5	79.2	78.8	79.1	16	78.4	81.9	79.9	1.1
Aluminum	2.0	mg/kg	10.1	4.6	4.9	<2.0	3.8	3.6	4.0	6.2	6.1	4.8	4.2	<2.0	<2.0	<2.0	<2.0	3.9	16	<2.0	10.1	4.1	2.1
Aluminum	0.40	mg/kg wwt	1.86	0.84	1.01	<0.40	0.78	0.70	0.82	1.12	1.24	1.05	0.80	<0.40	<0.40	<0.40	<0.40	0.81	16	<0.40	1.86	0.81	0.39
Antimony	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	16	<0.010	0.010	0.010	0
Antimony	0.0020	mg/kg wwt	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0022	16	<0.0020	0.0022	0.0020	0.0001
Arsenic	0.020	mg/kg	0.114	0.237	0.124	0.308	0.206	0.249	0.369	0.630	0.357	0.261	0.383	0.784	0.116	0.045	0.051	0.034	16	0.034	0.784	0.267	0.209
Arsenic	0.0040	mg/kg wwt	0.0209	0.0436	0.0256	0.0631	0.0416	0.0484	0.0747	0.114	0.0723	0.0564	0.0731	0.167	0.0238	0.0093	0.0108	0.0071	16	0.0071	0.1670	0.0532	0.0422
Barium	0.050	mg/kg	0.288	0.399	0.252	0.115	0.142	0.265	0.072	0.217	0.172	0.274	0.158	0.083	0.118	0.295	0.056	0.223	16	0.056	0.399	0.196	0.097
Barium	0.010	mg/kg wwt	0.053	0.073	0.052	0.024	0.029	0.051	0.015	0.039	0.035	0.059	0.030	0.018	0.024	0.061	0.012	0.046	16	0.012	0.073	0.039	0.018
Beryllium	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	16	<0.010	<0.010	<0.010	-
Beryllium	0.0020	mg/kg wwt	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	16	<0.0020	<0.0020	<0.0020	-
Bismuth	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	0.011	<0.010	0.014	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.016	16	<0.010	<0.016	<0.011	<0.002
Bismuth	0.0020	mg/kg wwt	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0021	<0.0020	0.0026	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0034	16	<0.0020	<0.0034	<0.0021	<0.0004
Boron	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	16	<1.0	<1.0	<1.0	-
Boron	0.20	mg/kg wwt	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	16	<0.20	<0.20	<0.20	-
Cadmium	0.0050	mg/kg	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0053	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	16	<0.0050	<0.0053	<0.0050	<0.0001
Cadmium	0.0010	mg/kg wwt	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	16	<0.0010	<0.0011	<0.0010	<0.0000
Calcium	20	mg/kg	2210	1870	3980	2070	3340	5450	673	4510	2910	2930	3380	1760	3180	5940	2170	6080	16	673	6080	3278	1567
Calcium	4.0	mg/kg wwt	406	345	821	424	675	1060	136	815	589	633	645	373	652	1230	461	1270	16	136	1270	658	319
Cesium	0.0050	mg/kg	0.0369	0.0610	0.0380	0.0848	0.0867	0.0997	0.104	0.175	0.0676	0.0933	0.0959	0.120	0.0662	0.125	0.138	0.0788	16	0.0369	0.1750	0.0919	0.0361
Cesium	0.0010	mg/kg wwt	0.0068	0.0112	0.0078	0.0174	0.0175	0.0194	0.0211	0.0317	0.0137	0.0201	0.0183	0.0254	0.0136	0.026	0.0293	0.0164	16	0.0068	0.0317	0.0185	0.0071
Chromium	0.050	mg/kg	0.157	0.102	0.102	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.168	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	16	<0.050	<0.168	<0.071	<0.040
Chromium	0.010	mg/kg wwt	0.029	0.019	0.021	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.036	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	16	<0.010	<0.036	<0.014	<0.008
Cobalt	0.020	mg/kg	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	16	<0.020	<0.020	<0.020	-
Cobalt	0.0040	mg/kg wwt	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	16	<0.0040	<0.0040	<0.0040	-
Copper	0.10	mg/kg	0.96	0.81	1.00	0.71	0.71	0.65	0.51	0.65	0.83	0.66	0.65	0.63	0.69	0.88	0.79	0.59	16	0.51	1.00	0.73	0.13
Copper	0.020	mg/kg wwt	0.176	0.149	0.207	0.146	0.144	0.126	0.103	0.117	0.169	0.143	0.125	0.134	0.141	0.182	0.167	0.124	16	0.103	0.207	0.147	0.027
Iron	3.0	mg/kg	24.8	23.8	17.9	7.4	11.2	13.3	8.9	16.9	12.4	11.2	13.6	5.5	9.3	10.3	7.4	10.4	16	5.5	24.8	12.8	5.6
Iron	0.60	mg/kg wwt	4.55	4.38	3.70	1.51	2.26	2.59	1.80	3.06	2.52	2.42	2.60	1.16	1.91	2.13	1.58	2.17	16	1.16	4.55	2.52	0.98
Lead	0.020	mg/kg	0.043	0.022	0.044	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	16	<0.020	<0.044	<0.023	<0.008
Lead	0.0040	mg/kg wwt	0.0079	<0.0040	0.0091	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	16	<0.0040	<0.0091	<0.0046	<0.0016
Lithium	0.50	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	16	<0.50	<0.50	<0.50	-
Lithium	0.10	mg/kg wwt	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	16	<0.10	<0.10	<0.10	-
Magnesium	2.0	mg/kg	1690	1660	1660	1600	1580	1610	1580	1570	1650	1510	1590	1650	1570	1560	1480	1540	16	1480	1690	1594	58
Magnesium	0.40	mg/kg wwt	310	305	343	327	320	314	320	283	335	326	303	350	322	325	314	322	16	283	350	320	16
Manganese	0.050	mg/kg	2.64	3.08	4.19	1.61	3.22	3.23	0.452	3.48	2.35	2.93	3.23	1.07	3.3	2.41	0.763	2.74	16	0.452	4.190	2.543	1.055
Manganese	0.010	mg/kg wwt	0.485	0.567	0.866	0.330	0.651	0.628	0.092	0.630	0.476	0.634	0.617	0.227	0.676	0.501	0.162	0.572	16	0.092	0.866	0.507	0.208
Mercury	0.0050	mg/kg	2.31	1.63	2.67	1.87	3.69	9.81	10.2	33.3	2.98	2.29	3.26	6.12	1.22	0.984	1.42	1.56	16	0.984	33.3	5.3	8.0
Mercury	0.0010	mg/kg wwt	0.425	0.299	0.550	0.383	0.746	1.91	2.06	6.03	0.603	0.494	0.621	1.33	0.25	0.204	0.301	0.325	16	0.204	6.03	1.0	1.4
Methylmercury	5.0	mg/kg	3.01	1.69	3.34	2.00	3.33	14.2	11.2	34.5	3.59	2.44	2.76	7.63	0.851	0.652	0.834	0.113	16	0.113	34.5	6	9
Methylmercury	1.0	mg/kg wwt	0.553	0.311	0.690	0.409	0.672	2.76	2.27	6.23	0.726	0.526	0.526	1.62	0.174	0.135	0.177	0.235	16	0.135	6.23	1.13	1.56
Molybdenum	0.020	mg/kg	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	16	<0.020	<0.020	<0.020	-
Molybdenum	0.0040	mg/kg wwt	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	16	<0.0040	<0.0040	<0.0040	-
Nickel	0.20	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	16	<0.20	<0.20	<0.20	-
Nickel	0.040	mg/kg wwt	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	16	<0.040	<0.040	<0.040	-
Phosphorus	10	mg/kg	12200	12200	13000	11700	12100	13700	11200	13400	12100	11500	12500	11700	11200	13900	12000	13900	16	11200	13900	12394	918
Phosphorus	2.0	mg/kg wwt	2240	2250	2680	2400	2440	2660	2260	2410	2450	2490	2380	2490	2290	2880	2540	2900	16	2240	2900	2485	205
Potassium	20	mg/kg	19400	20700	19500	19400	18900	20100	17800	18200	19000	17500	18600	19100	19500	20200	21800	21000	16	17500	21800	19419	1152
Potassium	4.0	mg/kg wwt	3560	3810	4020	3980	3820	3910	3610	3290	3850	3770	3540	4050	3990	4190	4620	4390	16	3290	4620	3900	330
Rubidium	0.050	mg/kg	26.1	40.0	26.5	40.8	38.7	32.5	29.3	32.4	40.1	30.2	39.8	35.5	39.5	42.7	41.3	23.7	16	23.7	42.7	34.9	6.3
Rubidium	0.010	mg/kg wwt	4.78	7.35	5.46	8.34	7.81	6.32	5.94	5.85	8.12	6.51	7.59	7.54	8.09	8.86	8.76	4.94	16	4.78	8.86	7.02	1.34
Selenium	0.050	mg/kg	0.561	0.569	0.565	0.634	0.626	0.505	0.451	0.560	0.584	0.514	0.648	0.697	0.502	0.400	0.462	0.433	16	0.400	0.697	0.544	0.084
Selenium	0.010	mg/kg wwt	0.103	0.105	0.117	0.130	0.126	0.098	0.091	0.101	0.118	0.111	0.124	0.148	0.103	0.083	0.098	0.090	16	0.083	0.148	0.109	0.017
Sodium	20	mg/kg	1570	1020	1760	1420	1730	1670	1460	2470	1440	1680	1760	1950	2250	1640	1410	1690	16	1020	2470	1683	340
Sodium	4.0	mg/kg wwt	288	188	363	292	349	325	296	446	291	362	336	414	461	341	300	352	16	188	461	338	67
Strontium	0.050	mg/kg	0.627	0.525	1.03	0.363	0.824	1.45	0.118	1.26	0.719	0.906	1.04	0.499	0.928	1.46	0.406	1.56	16	0.118	1.56	0.857	0.428
Strontium	0.010	mg/kg wwt	0.115	0.097	0.212	0.074	0.166	0.282	0.024	0.229	0.146	0.196	0.198	0.106	0.19	0.302	0.086	0.326	16	0.024	0.326	0.172	0.086
Tellurium	0.020	mg/kg	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	16	<0.020	<0.020	<0.020	-
Tellurium	0.0040	mg/kg wwt	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	16	<0.0040	<0.0040	<0.0040	-
Thallium	0.0020	mg/kg	0.0100	0.0199	0.0098	0.0241	0.0210	0.0147	0.0121	0.0150	0.0223	0.0272	0.0179	0.0245	0.0181	0.0114	0.0087	0.0040	16	0.0040	0.0272	0.0163	0.0066
Thallium	0.00040	mg/kg wwt	0.00183	0.00367	0.00203	0.00493	0.00423	0.00286	0.00245	0.00272	0.00452	0.00586	0.00341	0.00520	0.0037	0.00237	0.00185	0.00084	16	0.00084	0.00586	0.00328	0.00140
Tin	0.10	mg/kg	0.14	0.23	0.12	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	1.14	0.40	0.22	0.19	16	<0.10	1.14	0.21	0.26
Tin	0.020	mg/kg wwt	0.026	0.041	0.026	0.021	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.234	0.084	0.046	0.040	16	<0.020	0.234	0.042	0.054
Uranium	0.0020	mg/kg	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	16	<0.0020	<0.0020	<0.0020	-
Uranium	0.00040	mg/kg wwt	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	16	<0.00040	<0.00040	<0.00040	-
Vanadium	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	16	<0.10	<0.10	<0.10	-
Vanadium	0.020	mg/kg wwt	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	16	<0.020	<0.020	<0.020	-

Table D.1 Contaminants in Northern Pike Tissue Samples from North Driftwood River Watershed, 2021-2022

Parameter	Lowest Detection Limit	Units	Gerry Lake								Martin Lake					Sutherland Lake		Jack Lake	Summary Statistics				
			NDR-GERLK-GN1-F1-NPK	NDR-GERLK-GN1-F2-NPK	NDR-GERLK-GN1-F3-NPK	NDR-GERLK-GN1-F4-NPK	NDR-GERLK-GN1-F5-NPK	NDR-GERLK-GN1-F6-NPK	NDR-GERLK-GN1-F7-NPK	NDR-GERLK-GN1-F8-NPK	NDR-MARLK-GN1-F1-NPK	NDR-MARLK-GN1-F2-NPK	NDR-MARLK-GN1-F3-NPK	NDR-MARLK-GN1-F4-NPK	NDR-MarLk-GN1-NRPK-F1	NDR-SutLk-GN1-NRPK-F1	NDR-SutLk-GN1-NRPK-F2	NDR-JacLk-GN1-NRPK-F1	n	Minimum	Maximum	Mean	Standard Deviation
			27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	27-Oct-2021	20-Oct-2022	21-Oct-2022	21-Oct-2022	22-Oct-2022					
Zinc	0.50	mg/kg	24.2	19.5	24.3	15.8	17.7	20.7	25.3	23.4	21.2	17.1	22.0	17.9	20.9	31.4	26.2	28.9	16	15.8	31.4	22.28	4.34
Zinc	0.10	mg/kg wwt	4.44	3.59	5.02	3.22	3.58	4.03	5.12	4.23	4.29	3.68	4.19	3.81	4.27	6.51	5.57	6.02	16	3.22	6.51	4.47	0.934
Zirconium	0.20	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	16	<0.20	<0.20	<0.20	-
Zirconium	0.040	mg/kg wwt	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.042	<0.040	<0.040	<0.040	<0.040	16	<0.040	0.042	0.040	0.001

Notes: "-" not applicable; mg/kg wwt = milligram per kilogram wet weight; mg/kg dwt = milligram per kilogram dry weight.
Light green highlighted text indicates an exceedance of the Ontario sensitive population (0.5 mg/kg) and Health Canada (0.5 mg/kg) guidelines for total mercury for human consumption.
Dark green highlighted text indicates an exceedance of the Ontario consumption guideline developed for the general human population (1.8 mg/kg) for total mercury.
Grey highlighted text indicates an exceedance of the CCME guideline for methylmercury (33 µg/kg).
Bolded text indicates an exceedance of the Federal Environmental Quality Guideline (FEQG) for selenium in whole body fish tissues (6.7 mg/kg dwt)

Table D.2 Contaminants in Forage Fish Composite Tissue Samples from North Driftwood River, West Buskegau River, and Jocko Creek Watersheds, 2021-2022

Analyte	Lowest Detection Limit	Units	North Driftwood River Watershed																				
			NDR-S-01-PD-COMP-01	NDR-S-01-PD-COMP-02	NDR-S-01-PD-COMP-03	NDR-P-03-NRDB-COMP-01	NDR-P-03-NRDB-COMP-02	NDR-P-03-NRDB-COMP-03	NDR-P-03-MT1-NRDC-COMP1	NDR-P-03-MT1-NRDC-COMP2	NDR-P-03-MT1-NRDC-COMP3	NDR-P-03-MT1-NRDC-COMP4	NDR-P-03-MT1-NRDC-COMP5	NDR-P-03-MT1-FTMN-COMP1	NDR-P-03-MT1-FTMN-COMP2	NDR-P-01-MT1-FSDC-COMP1	NDR-P-01-MT1-FSDC-COMP2	NDR-P-01-MT1-FSDC-COMP3	NDR-P-01-MT1-FSDC-COMP4	NDR-P-01-MT1-FSDC-COMP5	NDR-P-06-MT1-FSDC-COMP1	NDR-P-06-MT1-FSDC-COMP2	NDR-P-06-MT1-FSDC-COMP3	NDR-P-06-MT1-FSDC-COMP4	NDR-P-06-MT1-FSDC-COMP5
			23-Oct-2021	23-Oct-2021	23-Oct-2021	23-Oct-2021	23-Oct-2021	23-Oct-2021	14-Oct-2022	14-Oct-2022	14-Oct-2022	14-Oct-2022	14-Oct-2022	14-Oct-2022	14-Oct-2022	14-Oct-2022	14-Oct-2022	14-Oct-2022	14-Oct-2022	14-Oct-2022	15-Oct-2022	15-Oct-2022	15-Oct-2022	15-Oct-2022	15-Oct-2022
Moisture	0.50	%	76.2	75.7	75.3	76.1	75.0	74.5	81.6	80.8	80.5	78.8	79.6	78.2	80.1	78.3	77.5	78.7	79.5	78.1	79.6	79.6	75.8	78.7	76.6
Aluminum	2.0	mg/kg	4.2	11.2	4.3	8.6	20.8	9.9	19.1	19.6	12.4	18.4	21.7	43.4	64.3	8.1	3.1	4.7	6.4	3.8	5.5	9	5.1	9.1	9.3
Aluminum	0.40	mg/kg wwt	1.00	2.73	1.06	2.05	5.19	2.51	3.52	3.76	2.41	3.9	4.41	9.45	12.8	1.76	0.7	0.99	1.3	0.83	1.13	1.84	1.24	1.94	2.18
Antimony	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Antimony	0.0020	mg/kg wwt	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic	0.020	mg/kg	0.125	0.092	0.093	0.059	0.063	0.082	0.102	0.096	0.100	0.088	0.133	0.136	0.178	0.066	0.105	0.112	0.079	0.087	0.07	0.051	0.068	0.044	0.071
Arsenic	0.0040	mg/kg wwt	0.0297	0.0225	0.0229	0.0140	0.0157	0.0209	0.0189	0.0184	0.0195	0.0186	0.0271	0.0297	0.0353	0.0143	0.0237	0.0238	0.0163	0.0191	0.0142	0.0104	0.0164	0.0095	0.0166
Barium	0.050	mg/kg	2.77	2.05	3.50	12.0	11.4	11.2	10.2	8.22	9.13	13.5	13.8	14.0	20.3	22.7	6.09	36	35	8.52	62.5	15.6	15.2	17.6	17.5
Barium	0.010	mg/kg wwt	0.659	0.500	0.864	2.86	2.84	2.86	1.88	1.58	1.78	2.87	2.8	3.04	4.04	4.92	1.37	7.65	7.18	1.86	12.8	3.18	3.67	3.75	4.11
Beryllium	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Beryllium	0.0020	mg/kg wwt	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Bismuth	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth	0.0020	mg/kg wwt	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Boron	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Boron	0.20	mg/kg wwt	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium	0.0050	mg/kg	0.0739	0.0457	0.113	0.0540	0.0426	0.116	0.0744	0.056	0.0884	0.0613	0.184	0.0552	0.209	0.0333	0.0564	0.043	0.0333	0.0407	0.0484	0.0412	0.0449	0.0358	0.0562
Cadmium	0.0010	mg/kg wwt	0.0176	0.0111	0.0279	0.0129	0.0106	0.0295	0.0137	0.0107	0.0172	0.013	0.0374	0.012	0.0415	0.0072	0.0127	0.0092	0.0068	0.0089	0.0099	0.0084	0.0109	0.0076	0.0132
Calcium	20	mg/kg	23800	16000	33900	41400	43200	32600	38900	42900	39200	61700	42700	42800	46800	40200	28800	32000	48100	37200	35400	39000	40000	28200	48300
Calcium	4.0	mg/kg wwt	5660	3900	8380	9880	10800	8300	7170	8230	7630	13000	8690	9330	9310	8710	6490	6800	9850	8150	7230	7960	9680	6000	11300
Cesium	0.0050	mg/kg	0.0322	0.0280	0.0170	0.0268	0.0336	0.0298	0.0315	0.0317	0.0327	0.0331	0.0418	0.0214	0.0299	0.0752	0.0967	0.0705	0.0726	0.127	0.116	0.137	0.138	0.2	0.0965
Cesium	0.0010	mg/kg wwt	0.0077	0.0068	0.0042	0.0064	0.0084	0.0076	0.0058	0.0061	0.0064	0.007	0.0085	0.0046	0.006	0.0163	0.0218	0.015	0.0149	0.0278	0.0236	0.028	0.0335	0.0425	0.0226
Chromium	0.050	mg/kg	0.063	<0.050	0.063	0.067	0.068	0.054	0.209	0.160	0.133	0.180	0.098	0.189	0.374	0.183	0.140	0.183	0.781	<0.050	0.074	<0.050	<0.050	0.109	0.068
Chromium	0.010	mg/kg wwt	0.015	0.012	0.015	0.016	0.017	0.014	0.038	0.030	0.026	0.038	0.020	0.041	0.074	0.040	0.031	0.039	0.160	<0.010	0.015	<0.010	<0.010	0.023	0.016
Cobalt	0.020	mg/kg	0.067	0.045	0.060	0.027	0.037	0.031	0.043	0.046	0.04	0.039	0.045	0.065	0.084	0.047	0.048	0.093	0.081	0.062	0.108	0.061	0.052	0.07	0.051
Cobalt	0.0040	mg/kg wwt	0.0160	0.0109	0.0149	0.0065	0.0093	0.0079	0.008	0.0087	0.0078	0.0084	0.0092	0.0142	0.0167	0.0102	0.0107	0.0198	0.0165	0.0135	0.022	0.0124	0.0127	0.015	0.012
Copper	0.10	mg/kg	7.82	4.24	8.52	15.6	14.1	22.8	7.61	6.31	9.55	9.21	17.5	3.32	3.43	2.81	3.35	4.35	3.13	3.58	4.87	5.54	4.81	4.43	4.07
Copper	0.020	mg/kg wwt	1.86	1.03	2.10	3.72	3.52	5.81	1.4	1.21	1.86	1.95	3.56	0.723	0.682	0.61	0.754	0.926	0.641	0.784	0.996	1.13	1.16	0.944	0.954
Iron	3.0	mg/kg	85.7	85.9	79.3	144	166	138	159	154	154	181	181	192	236	159	181	184	180	177	201	191	210	215	209
Iron	0.60	mg/kg wwt	20.4	20.9	19.6	34.3	41.4	35.2	29.3	29.5	30	38.3	36.8	41.9	47	34.5	40.7	39.1	36.9	38.6	41.1	39	51	45.8	49
Lead	0.020	mg/kg	0.100	0.050	0.147	0.070	0.056	0.063	0.139	0.096	0.09	0.151	0.142	0.136	0.192	0.099	0.109	0.136	0.112	0.098	0.148	0.116	0.125	0.074	0.122
Lead	0.0040	mg/kg wwt	0.0239	0.0122	0.0363	0.0167	0.0140	0.0161	0.0257	0.0184	0.0175	0.0319	0.029	0.0297	0.0383	0.0215	0.0246	0.0289	0.0229	0.0214	0.0303	0.0236	0.0302	0.0159	0.0287
Lithium	0.50	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Lithium	0.10	mg/kg wwt	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium	2.0	mg/kg	1260	1180	1410	1520	1560	1400	1850	1880	1750	2100	1790	1930	1800	1680	1430	1610	1710	1420	1510	1520	1470	1350	1650
Magnesium	0.40	mg/kg wwt	300	286	348	363	389	358	341	360	342	444	365	420	358	364	322	342	350	312	309	310	356	288	386
Manganese	0.050	mg/kg	26.7	13.1	38.3	10.7	12.4	9.74	12	13.4	11.6	17.4	16.9	16.4	20.4	37.3	33.8	38.6	44.5	30.6	28	32.1	28.7	27.8	33.6
Manganese	0.010	mg/kg wwt	6.36	3.19	9.45	2.54	3.10	2.48	2.21	2.56	2.27	3.69	3.43	3.58	4.07	8.09	7.62	8.2	9.12	6.7	5.72	6.55	6.94	5.93	7.87
Mercury	0.0050	mg/kg	0.402	0.282	0.520	0.143	0.153	0.180	0.124	0.0992	0.14	0.152	0.249	0.0714	0.106	0.0866	0.268	0.142	0.103	0.167	0.114	0.153	0.225	0.146	0.213
Mercury	0.0010	mg/kg wwt	0.0958	0.0686	0.128	0.0342	0.0383	0.0458	0.0229	0.019	0.0274	0.0322	0.0506	0.0156	0.021	0.0188	0.0603	0.0303	0.0211	0.0365	0.0234	0.0313	0.0545	0.0311	0.05
Methylmercury	5.0	µg/kg	474	300	533	150	151	186	108	92.7	107	111	207	55.6	85.7	72.7	291	141	90.9	157	105	142	252	158	209
Methylmercury	1.0	µg/kg wwt	113	73.0	132	35.8	37.7	47.4	19.8	17.8	20.9	23.5	42.0	12.1	17.0	15.8	65.5	29.9	18.6	34.4	21.5	29	61.1	33.7	48.9
Molybdenum	0.020	mg/kg	0.153	0.128	0.136	0.131	0.125	0.143	0.115	0.093	0.12	0.134	0.153	0.15	0.106	0.13	0.144	0.208	0.178	0.136	0.213	0.149	0.14	0.139	0.132
Molybdenum	0.0040	mg/kg wwt	0.0364	0.0311	0.0336	0.0312	0.0313	0.0364	0.0212	0.0179	0.0234	0.0283	0.0311	0.0326	0.021	0.0282	0.0325	0.0443	0.0364	0.0298	0.0435	0.0304	0.0338	0.0296	0.0308
Nickel	0.20	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Nickel	0.040	mg/kg wwt	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Phosphorus	10	mg/kg	20000	16100	25200	28200	29500	24500	28100	32700	28600	40700	30100	31600	32500	30600	23500	26400	34400	27000	26400	27400	29700	23000	33600
Phosphorus	2.0	mg/kg wwt	4760	3930	6220	6730	7360	6240	5190	6280	5570	8620	6130	6880	6460	6630	5300	5620	7050	5910	5410	5600	7190	4910	7880
Potassium	20	mg/kg	11300	11600	10900	11200	11200	11200	12500	12900	12400	11800	11900	12800	13900	12900	12300	13800	13900	12500	13600	13500	12200	13200	12600
Potassium	4.0	mg/kg wwt	2680	2830	2700	2680	2790	2850	2310	2470	2410	2500	2420	2790	2760	2800	2780	2940	2850	2730	2790	2760	2960	2810	2940
Rubidium	0.050	mg/kg	35.2	38.3	27.4	17.7	16.5	16.9	17.9	18.3	17	15.8	17.4	13.9	16.7	34.2	34.4	30.3	34.1	39	30.9	31.9	36.7	38.1	26.5
Rubidium	0.010	mg/kg wwt	8.38	9.34	6.75	4.22	4.13	4.30	3.3	3.52	3.31	3.34	3.54	3.03	3.33	7.42	7.76	6.46	6.98	8.53	6.31	6.51	8.89	8.13	6.21
Selenium	0.050	mg/kg	1.17	1.05	1.24	1.08	1.10	1.52	1.48	1.34	1.78	1.19	2.01	1.45	1.98	0.663	0.886	0.702	0.634	0.875	0.781	0.802	0.865	0.747	0.914
Selenium	0.010	mg/kg wwt	0.279	0.257	0.307	0.257	0.274	0.389	0.273	0.256	0.347	0.252	0.408	0.315	0.394	0.144	0.200	0.149	0.13	0.191	0.16	0.164	0.209	0.159	0.214
Sodium	20	mg/kg	3320	3140	3360	3080	3060	2930	1820	1930	2010	2270	2260	3630	3480	4090	3720	4000	4250	3580	3680	4120	3690	3830	4130
Sodium	4.0	mg/kg wwt	791	764	830	736	765	746	335	370	392	480	461	792	692	887	837	852	871	782	751	842	894	817	968
Strontium	0.050	mg/kg	16.8	12.7	18.1	35.8	37.4	27.5	34.7	33.7	34	52.8	35.4	33.9	43.7	49.1	25.1	35.2	52	39.6	67.4	42.5	47.7	43.3	59.1
Strontium	0.010	mg/kg wwt	4.01	3.09	4.47	8.54	9.35	7.01	6.39	6.46	6.63	11.2	7.2	7.37	8.69	10.6	5.66	7.5	10.6	8.66	13.8	8.68	11.6	9.23	13.8
Tellurium	0.020	mg/kg	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Tellurium	0.0040	mg/kg wwt	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Thallium	0.0020	mg/kg	0.0263	0.0182	0.0257	0.0059	0.0065	0.0058	0.0079	0.0065	0.008	0.0072	0.0064	0.0182	0.0196	0.0099	0.0124	0.0124	0.0101	0.0242	0.0165	0.0185	0.0183	0.0192	0.0168
Thallium	0.00040	mg/kg wwt	0.00627	0.00443	0.00635	0.00142	0.00163	0.00148	0.00146	0.00125	0.00155	0.00153	0.0013	0.00396	0.0039	0.00215	0.0028	0.00263	0.00207	0.0053	0.00337	0.00378	0.00444	0.0041	0.00394
Tin	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.86	0.89	0.91	0.59	0.67	0.57	0.69	0.66	0.37	0.54	0.54	0.50	0.55	0.66	0.25	0.37	0.59
Tin	0.020	mg/kg wwt	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.159	0.171	0.177	0.124	0.137	0.125	0.136	0.144	0.083	0.115	0.111	0.109	0.113	0.135	0.061	0.079	0.138
Uranium	0.0020	mg/kg	0.0051	0.0043	0.0046	0.0209	0.0158	0.0198	0.0081	0.0062	0.008	0.012	0.0135	0.0272	0.0306	<0.0020	0.0048	0.004	0.0029	<0.0020	0.0047	0.0048	0.0023	0.0029	0.0103
Uranium	0.00040	mg/kg wwt	0.00122	0.00105	0.00113	0.00500	0.00394	0.00504	0.00149	0.00119	0.00156	0.00255	0.00274	0.00591	0.00609	<0.00040	0.00107	0.00085	0.0006	<0.00040	0.00095	0.00099	0.00055	0.00062	0.00241
Vanadium	0.10	mg/kg	<0.10	<0.10	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.31	0.3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Vanadium	0.020	mg/kg wwt	<0.020	<0.020	0.028	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.067	0.059	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	0.50	mg/kg	123	104	128	303	307	243	278	272	294	360	312	134	135	224	134	165	243	146	228	182	133	166	174
Zinc	0.10	mg/kg wwt	29.4	25.4	31.5	72.3	76.8	61.9	51.3	52.2	57.4	76.1	63.5	29.1	26.8	48.7	30.1	35.2	49.7	32	46.6	37.1	32.2	35.3	40.7
Zirconium	0.20	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Zirconium	0.040	mg/kg wwt	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Notes: "-" not applicable; mg/kg wwt = milligram per kilogram wet weight; mg/kg dwt = milligram per kilogram dry weight.
Light green highlighted text indicates an exceedance of the Ontario sensitive population (0.5 mg/kg) and Health Canada (0.5 mg/kg) guidelines for total mercury for human consumption.
Dark green highlighted text indicates an exceedance of the Ontario consumption guideline developed for the general human population (1.8 mg/kg) for total mercury.
Grey highlighted text indicates an exceedance of the CCME guideline for methylmercury (33 µg/kg).
Bolded text indicates an exceedance of the Federal Environmental Quality Guideline (FEQG) for selenium in whole body fish tissues (6.7 mg/kg dwt)

Analyte	Lowest Detection Limit	Units	NDR-S-05-MT1-BRST-COMP1	NDR-S-05-MT1-BRST-COMP2	NDR-S-05-MT1-FSDC-COMP1	NDR-S-05-MT1-FSDC-COMP2	NDR-S-05-MT1-NRDC-COMP1	NDR-S-05-MT1-NRDC-COMP2	NDR-Trib-02-MT1-BRST-COMP1	NDR-Trib-02-MT1-NPDC-COMP1	NDR-S-01-MT1-BRST-COMP1	NDR-JacLk-MT1-BRST-COMP1	Summary Statistics					West Buskegau River Wate
			15-Oct-2022	15-Oct-2022	15-Oct-2022	15-Oct-2022	15-Oct-2022	15-Oct-2022	17-Oct-2022	17-Oct-2022	23-Oct-2022	22-Oct-2022	n	Minimum	Maximum	Mean	Standard Deviation	24-Oct-2022
Moisture	0.50	%	78.8	77.2	74.2	76	74.9	76.2	76.8	73.3	78.4	79.3	33	73.3	81.6	77.6	2.11	80.5
Aluminum	2.0	mg/kg	27.4	24.9	4.9	29.4	3.7	4.9	31.1	11.5	23.8	27.3	33	3.1	64.3	15.5	13.4	8.6
Aluminum	0.40	mg/kg wwt	5.81	5.69	1.26	7.06	0.94	1.18	7.23	3.08	5.14	5.67	33	0.70	12.8	3.39	2.80	1.67
Antimony	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	33	<0.010	<0.010	<0.010	-	<0.010
Antimony	0.0020	mg/kg wwt	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	33	<0.0020	<0.0020	<0.0020	-	<0.0020
Arsenic	0.020	mg/kg	0.137	0.153	0.112	0.083	0.089	0.08	0.134	0.100	0.112	0.168	33	0.044	0.178	0.099	0.033	0.134
Arsenic	0.0040	mg/kg wwt	0.0291	0.0348	0.0287	0.0199	0.0224	0.019	0.0311	0.0268	0.0242	0.0349	33	0.0095	0.0353	0.0221	0.0069	0.026
Barium	0.050	mg/kg	6.79	7.15	5.36	11.4	14.6	17.4	11.1	3.32	9.61	11.4	33	2.05	62.5	14.1	11.6	18.8
Barium	0.010	mg/kg wwt	1.44	1.63	1.38	2.72	3.66	4.14	2.58	0.888	2.08	2.37	33	0.500	12.8	3.09	2.38	3.66
Beryllium	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	33	<0.010	<0.010	<0.010	-	<0.010
Beryllium	0.0020	mg/kg wwt	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	33	<0.0020	<0.0020	<0.0020	-	<0.0020
Bismuth	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	33	<0.010	<0.010	<0.010	-	<0.010
Bismuth	0.0020	mg/kg wwt	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	33	<0.0020	<0.0020	<0.0020	-	<0.0020
Boron	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	33	<1.0	<1.0	<1.0	-	<1.0
Boron	0.20	mg/kg wwt	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	33	<0.20	<0.20	<0.20	-	<0.20
Cadmium	0.0050	mg/kg	0.0349	0.0416	0.0274	0.0396	0.0463	0.034	0.122	0.0898	0.0797	0.125	33	0.0274	0.2090	0.0681	0.0430	0.0706
Cadmium	0.0010	mg/kg wwt	0.0074	0.0095	0.007	0.0095	0.0116	0.0081	0.0285	0.024	0.0172	0.026	33	0.0068	0.0415	0.0151	0.0091	0.0137
Calcium	20	mg/kg	31600	31400	24900	32800	40900	40000	32800	26500	37200	50500	33	16000	61700	37324	8873	37500
Calcium	4.0	mg/kg wwt	6710	7160	6420	7850	10300	9540	7630	7090	8030	10500	33	3900	13000	8293	1825	7290
Cesium	0.0050	mg/kg	0.0314	0.0292	0.0374	0.097	0.0938	0.126	0.0809	0.0947	0.0461	0.0205	33	0.017	0.200	0.066	0.045	0.018
Cesium	0.0010	mg/kg wwt	0.0067	0.0067	0.0096	0.0232	0.0235	0.03	0.0188	0.0253	0.01	0.0042	33	0.0042	0.0425	0.0148	0.0102	0.0035
Chromium	0.050	mg/kg	0.090	0.145	<0.050	0.069	<0.050	<0.050	0.096	<0.050	0.077	0.077	33	<0.050	0.781	0.126	0.136	0.088
Chromium	0.010	mg/kg wwt	0.019	0.033	<0.010	0.017	<0.010	<0.010	0.022	0.013	0.017	0.016	33	<0.010	0.160	0.027	0.028	0.017
Cobalt	0.020	mg/kg	0.127	0.155	0.046	0.056	0.042	0.067	0.187	0.059	0.155	0.054	33	0.027	0.187	0.068	0.038	0.091
Cobalt	0.0040	mg/kg wwt	0.027	0.0354	0.0119	0.0135	0.0107	0.0159	0.0435	0.0158	0.0336	0.0113	33	0.0065	0.0435	0.0152	0.0085	0.0177
Copper	0.10	mg/kg	4.52	5.5	5.25	4.76	4.6	4.42	4.85	13.5	5.02	6.99	33	2.81	22.8	6.98	4.69	3.42
Copper	0.020	mg/kg wwt	0.961	1.25	1.35	1.14	1.15	1.06	1.13	3.61	1.08	1.45	33	0.61	5.81	1.59	1.17	0.665
Iron	3.0	mg/kg	188	181	180	189	178	161	165	82.8	166	135	33	79.3	236	166	38.1	184
Iron	0.60	mg/kg wwt	39.8	41.2	46.2	45.2	44.7	38.4	38.3	22.1	35.8	27.9	33	19.6	51.0	37.0	8.23	35.9
Lead	0.020	mg/kg	0.095	0.086	0.049	0.064	0.081	0.067	0.336	0.174	0.214	0.303	33	0.049	0.336	0.122	0.065	0.177
Lead	0.0040	mg/kg wwt	0.0202	0.0197	0.0126	0.0152	0.0203	0.016	0.0782	0.0466	0.0461	0.0628	33	0.0122	0.0782	0.0271	0.0143	0.0345
Lithium	0.50	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	33	<0.50	<0.50	<0.50	-	<0.50
Lithium	0.10	mg/kg wwt	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	33	<0.10	<0.10	<0.10	-	<0.10
Magnesium	2.0	mg/kg	1620	1590	1240	1230	1500	1460	1620	1240	1620	1980	33	1180	2100	1572	230	1210
Magnesium	0.40	mg/kg wwt	345	362	319	296	376	348	377	331	350	410	33	286	444	349	37	236
Manganese	0.050	mg/kg	34.8	45.3	20.5	23.9	25.4	26.6	101	36.7	67.9	68.7	33	9.74	101	30	19	31
Manganese	0.010	mg/kg wwt	7.4	10.3	5.29	5.72	6.37	6.35	23.6	9.82	14.7	14.2	33	2.21	23.6	6.83	4.36	6.04
Mercury	0.0050	mg/kg	0.0404	0.0545	0.171	0.103	0.184	0.112	0.153	0.23	0.174	0.355	33	0.0404	0.520	0.176	0.101	0.0944
Mercury	0.0010	mg/kg wwt	0.0086	0.0124	0.044	0.0247	0.0462	0.0266	0.0356	0.0615	0.0375	0.0736	33	0.0086	0.128	0.040	0.025	0.0184
Methylmercury	5.0	µg/kg	29.2	36.3	148	96.6	167	111	126	184	150	265	33	29.2	533	166	109.5	86.7
Methylmercury	1.0	µg/kg wwt	6.2	8.3	38.0	23.1	41.9	26.5	29.3	49.0	32.4	54.9	33	6.20	132	38.2	27.2	16.9
Molybdenum	0.020	mg/kg	0.17	0.149	0.144	0.147	0.149	0.143	0.118	0.102	0.14	0.136	33	0.093	0.213	0.141	0.025	0.157
Molybdenum	0.0040	mg/kg wwt	0.0361	0.0339	0.0371	0.0352	0.0374	0.0341	0.0275	0.0271	0.0302	0.0282	33	0.0179	0.0443	0.0316	0.0057	0.0305
Nickel	0.20	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	33	<0.20	<0.20	<0.20	-	<0.20
Nickel	0.040	mg/kg wwt	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	33	<0.040	<0.040	<0.040	-	<0.040
Phosphorus	10	mg/kg	27200	27100	22700	25500	28800	30300	28300	21900	29300	35700	33	16100	40700	28079	4753	24500
Phosphorus	2.0	mg/kg wwt	5780	6180	5860	6100	7220	7240	6580	5860	6330	7410	33	3930	8620	6255	957	4760
Potassium	20	mg/kg	13900	14000	11400	11900	12000	13000	12900	11600	14600	14600	33	10900	14600	12606	1050	3830
Potassium	4.0	mg/kg wwt	2960	3200	2930	2850	3020	3100	3000	3100	3150	3040	33	2310	3200	2815	216	745
Rubidium	0.050	mg/kg	33.7	33.2	27.2	26.8	30.9	33.9	42.8	30.2	52.4	18.4	33	13.9	52.4	28.3	9.5	10.1
Rubidium	0.010	mg/kg wwt	7.16	7.56	6.99	6.42	7.75	8.08	9.96	8.08	11.3	3.81	33	3.03	11.3	6.39	2.26	1.96
Selenium	0.050	mg/kg	0.716	0.69	0.847	0.726	0.764	0.689	0.919	0.9	1.04	1.05	33	0.634	2.01	1.05	0.37	0.802
Selenium	0.010	mg/kg wwt	0.152	0.157	0.218	0.174	0.192	0.164	0.214	0.241	0.225	0.219	33	0.130	0.408	0.233	0.075	0.156
Sodium	20	mg/kg	4650	4440	3340	3520	3500	3520	4550	2940	5120	5450	33	1820	5450	3528	860	1380
Sodium	4.0	mg/kg wwt	988	1010	861	844	878	840	1060	785	1110	1130	33	335	1130	793	196	268
Strontium	0.050	mg/kg	25.7	27.7	26	36.5	48.8	53.8	32	19.8	34.6	28.7	33	12.7	67.4	36.7	12.6	50.8
Strontium	0.010	mg/kg wwt	5.46	6.32	6.69	8.75	12.2	12.8	7.45	5.29	7.48	5.95	33	3.09	13.8	8.15	2.74	9.88
Tellurium	0.020	mg/kg	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	33	<0.020	<0.020	<0.020	-	<0.020
Tellurium	0.0040	mg/kg wwt	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	33	<0.0040	<0.0040	<0.0040	-	<0.0040
Thallium	0.0020	mg/kg	0.0315	0.0284	0.0198	0.0182	0.0195	0.0183	0.0404	0.0199	0.0486	0.0068	33	0.0058	0.0486	0.0173	0.0100	0.0245
Thallium	0.00040	mg/kg wwt	0.0067	0.00647	0.0051	0.00436	0.0049	0.00437	0.00939	0.00531	0.0105	0.0014	33	0.00125	0.0105	0.0039	0.0023	0.00476
Tin	0.10	mg/kg	0.91	0.64	0.28	0.49	0.40	0.59	0.66	0.53	0.87	1.91	33	<0.10	1.91	0.55	0.35	0.7
Tin	0.020	mg/kg wwt	0.194	0.145	0.072	0.118	0.100	0.142	0.155	0.143	0.188	0.397	33	<0.020	0.397	0.118	0.072	0.135
Uranium	0.0020	mg/kg	0.0044	0.0046	<0.0020	0.0026	0.0022	0.0027	0.0042	0.0022	0.0045	0.0028	30	0.0022	0.0306	0.0081	0.0076	<0.0020
Uranium	0.00040	mg/kg wwt	0.00094	0.00106	<0.00040	0.00063	0.00057	0.00064	0.00098	0.00058	0.00098	0.00058	30	0.00055	0.00609	0.00180	0.00167	<0.00040
Vanadium	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.11	<0.10	0.11	<0.10	33	<0.10	0.31	0.11	0.050	<0.10
Vanadium	0.020	mg/kg wwt	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.026	<0.020	0.023	<0.020	33	<0.020	0.067	0.023	0.010	<0.020
Zinc	0.50	mg/kg	134	153	117	158	170	182	166	126	149	173	33	104	360	191	69	246
Zinc	0.10	mg/kg wwt	28.4	34.8	30.1	37.8	42.6	43.5	38.7	33.6	32.1	35.8	33	25.4	76.8	42.4	14.5	47.9
Zirconium	0.20	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	33	<0.20	<0.20	<0.20	-	<0.20
Zirconium	0.040	mg/kg wwt	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	33	<0.040	<0.040	<0.040	-	<0.040

WBR-P-04-MT1-FSDC-COMP2	WBR-P-04-MT1-FSDC-COMP3	WBR-P-04-MT1-FSDC-COMP4	WBR-P-04-MT1-FSDC-COMP5	WBR-P-03-MT1-FSDC-COMP1	WBR-P-03-MT1-FSDC-COMP2	WBR-P-03-MT1-FSDC-COMP3	WBR-P-03-MT1-FSDC-COMP4
24-Oct-2022	24-Oct-2022	24-Oct-2022	24-Oct-2022	24-Oct-2022	24-Oct-2022	24-Oct-2022	24-Oct-2022
78.3	82.5	79.8	81.6	79.6	80.1	81.8	79.5
11	7.3	15.6	8.9	14	33.6	8.8	36.8
2.4	1.27	3.14	1.63	2.85	6.67	1.59	7.55
<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
0.17	0.194	0.239	0.154	0.113	0.235	0.117	0.166
0.037	0.0339	0.0484	0.0283	0.023	0.0467	0.0213	0.0341
8.98	7.64	37.3	13.7	33.5	12.7	38.8	23.9
1.95	1.34	7.54	2.52	6.82	2.53	7.04	4.9
<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
0.113	0.0926	0.0367	0.0745	0.0528	0.0325	0.0745	0.0343
0.0246	0.0162	0.0074	0.0137	0.0107	0.0064	0.0135	0.007
33200	33400	57800	39500	38700	34300	32800	41100
7200	5850	11700	7250	7880	6810	5960	8420
0.0286	0.0191	0.0189	0.0162	0.0161	0.0172	0.0217	0.0158
0.0062	0.0033	0.0038	0.003	0.0033	0.0034	0.0039	0.0032
0.088	0.052	0.072	0.104	0.079	0.113	0.066	0.196
0.019	<0.010	0.014	0.019	0.016	0.022	0.012	0.040
0.079	0.079	0.148	0.075	0.111	0.22	0.095	0.12
0.0172	0.0138	0.0298	0.0137	0.0227	0.0436	0.0173	0.0245
5.86	4.5	3.19	3.52	4.78	3.58	5.6	3.2
1.27	0.786	0.644	0.646	0.972	0.71	1.02	0.656
261	194	174	192	205	213	194	182
56.8	33.9	35.1	35.3	41.7	42.3	35.2	37.4
0.286	0.17	0.19	0.173	0.264	0.398	0.183	0.233
0.062	0.0297	0.0384	0.0317	0.0536	0.0791	0.0333	0.0478
<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1310	1220	1360	1260	1380	1340	1210	1220
285	214	276	232	280	265	219	250
22500	22800	33900	25700	24200	21900	22000	25200
4890	3990	6850	4710	4920	4350	3990	5160
4790	4400	4110	3780	3440	2640	4280	3460
1040	770	830	694	701	524	778	710
15.1	12.3	11.2	10.1	10.1	8.33	11	9.72
3.28	2.15	2.25	1.85	2.06	1.65	2	1.99
1.04	0.94	0.704	0.829	0.709	0.644	0.747	0.685
0.225	0.164	0.142	0.152	0.144	0.128	0.136	0.14
1610	1380	1480	1290	1360	982	1540	1290
350	242	300	237	276	195	279	265
35.9	39.2	75.2	44.6	47.2	33.2	44.7	53.8
7.8	6.85	15.2	8.19	9.61	6.59	8.11	11
<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
0.0226	0.0215	0.0404	0.0234	0.0148	0.0142	0.0135	0.0153
0.0049	0.00376	0.00816	0.0043	0.003	0.00282	0.00245	0.00314
0.56	0.6	0.49	0.77	0.56	0.66	0.73	0.66
0.122	0.104	0.099	0.142	0.113	0.132	0.132	0.136
0.0024	0.002	0.005	<0.0020	0.0028	0.0064	<0.0020	0.0057
0.00052	<0.00040	0.001	<0.00040	0.00057	0.00127	<0.00040	0.00117
<0.10	<0.10	0.10	<0.10	<0.10	0.13	<0.10	0.13
<0.020	<0.020	0.021	<0.020	<0.020	0.026	<0.020	0.026
212	223	286	231	245	274	212	247
46	39	57.9	42.4	49.9	54.3	38.5	50.6
<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Notes: "-" not applicable; mg/kg wwt = milli
Light green highlighted text indicates an ex
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Bolded text indicates an exceedance of the

Analyte	Lowest Detection Limit	Units	rshed									Jocko Creek Watershed											
			WBR-P-03-MT1-BSB-COMP1	WBR-P-03-MT1-BSB-COMP2	WBR-P-04-MT1-BSB-COMP1	WBR-P-04-MT1-BSB-COMP2	Summary Statistics					JC-S-01-MT1-LKCH-COMP1	JC-S-01-MT1-LKCH-COMP2	JC-S-01-MT1-LKCH-COMP3	JC-S-01-MT1-LKCH-COMP4	JC-S-01-MT1-LKCH-COMP5	JC-S-01-MT1-BRST-COMP1	JC-S-01-MT1-BRST-COMP2	Summary Statistics				
			24-Oct-2022	24-Oct-2022	24-Oct-2022	24-Oct-2022	n	Minimum	Maximum	Mean	Standard Deviation	19-Oct-2022	19-Oct-2022	19-Oct-2022	19-Oct-2022	19-Oct-2022	19-Oct-2022	19-Oct-2022	n	Minimum	Maximum	Mean	Standard Deviation
Moisture	0.50	%	79.8	80.9	79.7	78.1	13	78.1	82.5	80.2	1.29	78.9	77.4	77.4	75.4	76.9	80.2	79.9	7	75.4	80.2	78.0	1.73
Aluminum	2.0	mg/kg	70.3	111	48.7	28.6	13	7.3	111	31	31	16.4	8.8	8.3	9.8	8.2	7.7	8.6	7	7.7	16.4	9.7	3.0
Aluminum	0.40	mg/kg wwt	14.2	21.2	9.88	6.27	13	1.27	21.2	6.18	5.96	3.47	1.99	1.87	2.41	1.89	1.52	1.74	7	1.52	3.47	2.13	0.65
Antimony	0.010	mg/kg	<0.010	<0.010	<0.010	0.012	13	<0.010	0.012	0.010	0.001	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	7	<0.010	<0.010	<0.010	-
Antimony	0.0020	mg/kg wwt	<0.0020	<0.0020	<0.0020	0.0027	13	<0.0020	0.0027	0.0021	0.0002	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	7	<0.0020	<0.0020	<0.0020	-
Arsenic	0.020	mg/kg	0.156	0.193	0.208	0.154	13	0.113	0.239	0.172	0.040	0.053	0.058	0.076	0.09	0.055	0.092	0.093	7	0.053	0.093	0.074	0.018
Arsenic	0.0040	mg/kg wwt	0.0315	0.0369	0.0422	0.0338	13	0.0213	0.0484	0.0341	0.0084	0.0112	0.0132	0.0172	0.0222	0.0127	0.0182	0.0188	7	0.0112	0.0222	0.0162	0.0040
Barium	0.050	mg/kg	17.5	19.4	10.5	15.1	13	7.64	38.8	19.8	10.6	4.13	4.1	4.94	4.33	4.08	11.1	9.54	7	4.08	11.1	6.03	2.98
Barium	0.010	mg/kg wwt	3.54	3.71	2.14	3.31	13	1.34	7.54	3.92	2.05	0.872	0.928	1.12	1.06	0.942	2.19	1.92	7	0.872	2.19	1.29	0.53
Beryllium	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	13	<0.010	<0.010	<0.010	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	7	<0.010	<0.010	<0.010	-
Beryllium	0.0020	mg/kg wwt	<0.0020	<0.0020	<0.0020	<0.0020	13	<0.0020	<0.0020	<0.0020	-	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	7	<0.0020	<0.0020	<0.0020	-
Bismuth	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	13	<0.010	<0.010	<0.010	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	7	<0.010	<0.010	<0.010	-
Bismuth	0.0020	mg/kg wwt	<0.0020	<0.0020	<0.0020	<0.0020	13	<0.0020	<0.0020	<0.0020	-	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	7	<0.0020	<0.0020	<0.0020	-
Boron	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	13	<1.0	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7	<1.0	<1.0	<1.0	-
Boron	0.20	mg/kg wwt	<0.20	<0.20	<0.20	<0.20	13	<0.20	<0.20	<0.20	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	7	<0.20	<0.20	<0.20	-
Cadmium	0.0050	mg/kg	0.106	0.105	0.0666	0.0549	13	0.0325	0.113	0.070	0.028	0.118	0.112	0.168	0.216	0.118	0.124	0.112	7	0.112	0.216	0.138	0.039
Cadmium	0.0010	mg/kg wwt	0.0215	0.0202	0.0135	0.012	13	0.0064	0.0246	0.0139	0.0056	0.025	0.0252	0.0379	0.0531	0.0273	0.0247	0.0226	7	0.0226	0.0531	0.0308	0.0110
Calcium	20	mg/kg	58600	52600	41400	41100	13	32800	58600	41692	8996	33000	31300	46600	42600	31600	33100	33500	7	31300	46600	35957	6069
Calcium	4.0	mg/kg wwt	11900	10100	8410	9010	13	5850	11900	8291	1947	6950	7090	10600	10400	7290	6560	6740	7	6560	10600	7947	1761
Cesium	0.0050	mg/kg	0.0144	0.0221	0.0171	0.0122	13	0.0122	0.0286	0.0183	0.0041	0.209	0.198	0.215	0.145	0.119	0.12	0.156	7	0.119	0.215	0.166	0.0411
Cesium	0.0010	mg/kg wwt	0.0029	0.0042	0.0035	0.0027	13	0.0027	0.0062	0.0036	0.0009	0.0442	0.0448	0.0486	0.0355	0.0275	0.0237	0.0313	7	0.0237	0.0486	0.0365	0.0096
Chromium	0.050	mg/kg	0.186	0.335	0.273	0.217	13	0.052	0.335	0.144	0.089	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	7	<0.050	<0.050	<0.050	-
Chromium	0.010	mg/kg wwt	0.038	0.064	0.055	0.048	13	<0.010	0.064	0.029	0.018	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	7	<0.010	<0.010	<0.010	-
Cobalt	0.020	mg/kg	0.159	0.197	0.119	0.102	13	0.075	0.220	0.123	0.046	0.036	0.032	0.042	0.036	0.04	0.064	0.067	7	0.032	0.067	0.045	0.014
Cobalt	0.0040	mg/kg wwt	0.0321	0.0377	0.0242	0.0224	13	0.0137	0.0436	0.0244	0.0092	0.0076	0.0072	0.0095	0.0087	0.0092	0.0126	0.0135	7	0.0072	0.0135	0.0098	0.0024
Copper	0.10	mg/kg	6.6	6.35	7.49	6.16	13	3.19	7.49	4.94	1.49	4.04	5.11	5.86	6.48	4.35	5.76	5.55	7	4.04	6.48	5.31	0.867
Copper	0.020	mg/kg wwt	1.34	1.22	1.52	1.35	13	0.644	1.52	0.985	0.322	0.853	1.16	1.32	1.59	1	1.14	1.12	7	0.853	1.59	1.17	0.235
Iron	3.0	mg/kg	268	345	229	226	13	174	345	221	47	88	88.8	97	106	86.5	116	120	7	86.5	120	100	13.9
Iron	0.60	mg/kg wwt	54.3	66	46.6	49.6	13	33.9	66.0	43.9	10.2	18.6	20.1	22	26	20	23	24.2	7	18.6	26.0	22.0	2.61
Lead	0.020	mg/kg	0.434	0.488	0.345	0.34	13	0.170	0.488	0.283	0.109	0.362	0.305	0.613	0.663	0.314	0.434	0.406	7	0.305	0.663	0.442	0.142
Lead	0.0040	mg/kg wwt	0.0877	0.0933	0.0701	0.0746	13	0.0297	0.0933	0.0566	0.0226	0.0765	0.069	0.139	0.163	0.0724	0.086	0.0816	7	0.069	0.163	0.098	0.037
Lithium	0.50	mg/kg	<0.50	<0.50	<0.50	<0.50	13	<0.50	<0.50	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	7	<0.50	<0.50	<0.50	-
Lithium	0.10	mg/kg wwt	<0.10	<0.10	<0.10	<0.10	13	<0.10	<0.10	<0.10	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	7	<0.10	<0.10	<0.10	-
Magnesium	2.0	mg/kg	1480	1490	1190	1320	13	1190	1490	1307	101	1440	1490	1720	1420	1480	1540	1560	7	1420	1720	1521	101
Magnesium	0.40	mg/kg wwt	299	285	241	290	13	214	299	259	29	304	338	390	349	342	305	314	7	304	390	335	30
Manganese	0.050	mg/kg	175	154	49.8	47.9	13	30.6	175	61.5	46.8	35.4	32	50.7	38.8	35.6	51.4	37.3	7	32.0	51.4	40.2	7.7
Manganese	0.010	mg/kg wwt	35.5	29.5	10.1	10.5	13	5.36	35.5	12.2	9.32	7.48	7.24	11.5	9.52	8.21	10.2	7.51	7	7.24	11.5	8.81	1.63
Mercury	0.0050	mg/kg	0.133	0.153	0.133	0.109	13	0.0814	0.296	0.136	0.0560	0.295	0.247	0.484	0.532	0.319	0.319	0.391	7	0.247	0.532	0.370	0.105
Mercury	0.0010	mg/kg wwt	0.027	0.0292	0.0271	0.0238	13	0.0164	0.0643	0.0270	0.0124	0.0623	0.0559	0.109	0.131	0.0738	0.0632	0.0788	7	0.0559	0.131	0.082	0.028
Methylmercury	5.0	µg/kg	108	160	148	104	13	61.9	233	119	50.3	278	219	522	618	335	306	273	7	219	618	364	147
Methylmercury	1.0	µg/kg wwt	22	30.7	30	22.9	13	12.5	50.6	23.6	10.7	58.6	49.5	118	152	77.3	60.8	55	7	49.5	152	81.6	38.7
Molybdenum	0.020	mg/kg	0.144	0.156	0.138	0.164	13	0.131	0.324	0.178	0.049	0.109	0.106	0.107	0.105	0.077	0.095	0.107	7	0.077	0.109	0.101	0.011
Molybdenum	0.0040	mg/kg wwt	0.0291	0.0299	0.0281	0.0359	13	0.0229	0.0655	0.0354	0.0105	0.023	0.0241	0.0243	0.0258	0.0178	0.0188	0.0215	7	0.0178	0.0258	0.0222	0.0030
Nickel	0.20	mg/kg	<0.20	0.22	0.37	0.27	13	<0.20	0.37	0.22	0.05	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	7	<0.20	<0.20	<0.20	-
Nickel	0.040	mg/kg wwt	<0.040	0.042	0.075	0.06	13	<0.040	0.075	0.044	0.011	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	7	<0.040	<0.040	<0.040	-
Phosphorus	10	mg/kg	34800	33400	26000	27100	13	21900	34800	26462	4606	27200	25100	35200	30200	29600	30400	26800	7	25100	35200	29214	3296
Phosphorus	2.0	mg/kg wwt	7040	6380	5290	5950	13	3990	7040	5252	1012	5750	5690	7960	7400	6830	6040	5400	7	5400	7960	6439	972
Potassium	20	mg/kg	2100	2060	2720	2080	13	2060	4790	3361	948	12500	11100	12100	10900	11600	13700	15400	7	10900	15400	12471	1599
Potassium	4.0	mg/kg wwt	425	394	552	457	13	394	1040	663	185	2640	2510	2740	2670	2680	2710	3100	7	2510	3100	2721	182
Rubidium	0.050	mg/kg	7.04	7.09	8.13	6.5	13	6.5	15.1	9.7	2.4	29.4	28.1	27.9	21.2	20.1	26.4	31.5	7	20.1	31.5	26.4	4.2
Rubidium	0.010	mg/kg wwt	1.42	1.36	1.65	1.42	13	1.36	3.28	1.93	0.50	6.2	6.37	6.32	5.21	4.65	5.23	6.33	7	4.65	6.37	5.76	0.71
Selenium	0.050	mg/kg	0.922	1.01	1.05	0.858	13	0.644	1.05	0.842	0.141	0.834	0.794	0.944	1.03	0.942	0.89	0.96	7	0.794	1.030	0.913	0.080
Selenium	0.010	mg/kg wwt	0.186	0.193	0.214	0.188	13	0.128	0.225	0.167	0.031	0.176	0.18	0.214	0.253	0.218	0.176	0.193	7	0.176	0.253	0.201	0.029
Sodium	20	mg/kg	961	1010	1070	1070	13	961	1610	1263	222	3820	3470	3630	3270	3440	3890	4110	7	3270	4110	3661	294
Sodium	4.0	mg/kg wwt	194	194	217	235	13	194	350	250	46	806	785	822	803	794	771	828	7	771	828	801	20
Strontium	0.050	mg/kg	52.9	52	36	41.1	13	33.2	75.2	46.7	11.0	22.1	20.3	30.4	25.4	21.2	34.1	33.5	7	20.3	34.1	26.7	5.90
Strontium	0.010	mg/kg wwt	10.7	9.95	7.31	9.01	13	6.59	15.2	9.25	2.29	4.66	4.59	6.88	6.24	4.89	6.76	6.74	7	4.59	6.88	5.82	1.06
Tellurium	0.020	mg/kg	<0.020	<0.020	<0.020	<0.020	13	<0.020	<0.020	<0.020	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	7	<0.020	<0.020	<0.020	-
Tellurium	0.0040	mg/kg wwt	<0.0040	<0.0040	<0.0040	<0.0040	13	<0.0040	<0.0040	<0.0040	-	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	7	<0.0040	<0.0040	<0.0040	-
Thallium	0.0020	mg/kg	0.0303	0.032	0.0296	0.0272	13	0.0135	0.0404	0.0238	0.0081	0.0225	0.0237	0.0214	0.0225	0.019	0.0412	0.0527	7	0.019	0.053	0.029	0.013
Thallium	0.00040	mg/kg wwt	0.00613	0.00612	0.006	0.00596	13	0.00245	0.00816	0.00473	0.00169	0.00475	0.00537	0.00485	0.00552	0.00438	0.00817	0.0106	7	0.00438	0.0106	0.00623	0.00230
Tin	0.10	mg/kg	0.25	0.34	0.61	0.46	13	0.25	0.77	0.57	0.15	0.7	0.57	0.43	0.26	0.33	0.79	0.92	7	0.26	0.92	0.57	0.25
Tin	0.020	mg/kg wwt	0.050	0.065	0.124	0.100	13	0.050	0.142	0.112	0.028	0.147	0.13	0.096	0.064	0.076	0.157	0.186	7	0.064	0.186	0.122	0.045
Uranium	0.0020	mg/kg	0.0112	0.0114	0.0043	0.0025	13	<0.0020	0.0114	0.0046	0.0033	<0.0020	<0.0020	0.0025	0.0027	<0.0020	<0.0020	0.0027	7	<0.0020	0.0027	0.0023	0.0003
Uranium	0.00040	mg/kg wwt	0.00227	0.00217	0.00088	0.00055	13	<0.00040	0.00227	0.00092	0.00065	<0.00040	0.00045	0.00058	0.00066	<0.00040	<0.00040	0.00054	7	<0.00040	0.00066	0.00049	0.00010
Vanadium	0.10	mg/kg	0.30	0.41	0.18	<0.10	13	<0.10	0.41	0.15	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	7	<0.10	<0.10	<0.10	-
Vanadium	0.020	mg/kg wwt	0.061	0.078	0.037	<0.020	13	<0.020	0.078	0.030	0.019	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	7	<0.020	<0.020	<0.020	-
Zinc	0.50	mg/kg	223	241	263	266	13	212	286	244	24	179	161	199	169	170	166	145	7	145	199	170	17
Zinc	0.10	mg/kg wwt	45.1	46.1	53.4	58.3	13	38.5	58.3	48.4	6.5	37.9	36.5	45.1	41.4	39.4	33	29.2	7	29.2	45.1	37.5	5.27
Zirconium	0.20	mg/kg	<0.20	<0.20	<0.20	<0.20	13	<0.20	<0.20	<0.20	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	7	<0.20	<0.20	<0.20	-
Zirconium	0.040	mg/kg wwt	<0.040	<0.040	<0.040	<0.040	13	<0.040	<0.040	<0.040	-	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	7	<0.040	<0.040	<0.040	-

Notes: "-" not applicable; mg/kg wwt = milli
Light green highlighted text indicates an ex
Dark green highlighted text indicates an ex
Grey highlighted text indicates an exceeda
Bolded text indicates an exceedance of the

Table D.3 Contaminants in Northern Pike and Forage Fish Composite Tissue Samples from North Driftwood River, West Buskegau River, and Jocko Creek Watersheds, 2021-2022

Parameter	DL	Units	North Driftwood River Watershed										West Buskegau River Watershed					Jocko River Watershed				
			Northern Pike[1]					Forage Fish[2]					Forage Fish[3]					Forage Fish[4]				
			n	Min	Max	Mean	SD	n	Min	Max	Mean	SD	n	Min	Max	Mean	SD	n	Min	Max	Mean	SD
Aluminum	0.40	mg/kg wwt	16	<0.40	1.86	0.81	0.39	33	0.70	12.8	3.39	2.80	13	1.27	21.2	6.18	5.96	7	1.52	3.47	2.13	0.65
Antimony	0.0020	mg/kg wwt	16	<0.0020	0.0022	0.0020	0.0001	33	<0.0020	<0.0020	<0.0020	-	13	<0.0020	0.0027	0.0021	0.0002	7	<0.0020	<0.0020	<0.0020	-
Arsenic	0.0040	mg/kg wwt	16	0.0071	0.1670	0.0532	0.0422	33	0.0095	0.0353	0.0221	0.0069	13	0.0213	0.0484	0.0341	0.0084	7	0.0112	0.0222	0.0162	0.0040
Barium	0.010	mg/kg wwt	16	0.012	0.073	0.039	0.018	33	0.500	12.8	3.09	2.38	13	1.34	7.54	3.92	2.05	7	0.872	2.19	1.29	0.53
Beryllium	0.0020	mg/kg wwt	16	<0.0020	<0.0020	<0.0020	-	33	<0.0020	<0.0020	<0.0020	-	13	<0.0020	<0.0020	<0.0020	-	7	<0.0020	<0.0020	<0.0020	-
Bismuth	0.0020	mg/kg wwt	16	<0.0020	<0.0034	<0.0021	<0.0004	33	<0.0020	<0.0020	<0.0020	-	13	<0.0020	<0.0020	<0.0020	-	7	<0.0020	<0.0020	<0.0020	-
Boron	0.20	mg/kg wwt	16	<0.20	<0.20	<0.20	-	33	<0.20	<0.20	<0.20	-	13	<0.20	<0.20	<0.20	-	7	<0.20	<0.20	<0.20	-
Cadmium	0.0010	mg/kg wwt	16	<0.0010	<0.0011	<0.0010	<0.0000	33	0.0068	0.0415	0.0151	0.0091	13	0.0064	0.0246	0.0139	0.0056	7	0.0226	0.0531	0.0308	0.0110
Calcium	4.0	mg/kg wwt	16	136	1270	658	319	33	3900	13000	8293	1825	13	5850	11900	8291	1947	7	6560	10600	7947	1761
Cesium	0.0010	mg/kg wwt	16	0.0068	0.0317	0.0185	0.0071	33	0.0042	0.0425	0.0148	0.0102	13	0.0027	0.0062	0.0036	0.0009	7	0.0237	0.0486	0.0365	0.0096
Chromium	0.010	mg/kg wwt	16	<0.010	<0.036	<0.014	<0.008	33	<0.010	0.160	0.027	0.028	13	<0.010	0.064	0.029	0.018	7	<0.010	<0.010	<0.010	-
Cobalt	0.0040	mg/kg wwt	16	<0.0040	<0.0040	<0.0040	-	33	0.0065	0.0435	0.0152	0.0085	13	0.0137	0.0436	0.0244	0.0092	7	0.0072	0.0135	0.0098	0.0024
Copper	0.020	mg/kg wwt	16	0.103	0.207	0.147	0.027	33	0.61	5.81	1.59	1.17	13	0.644	1.52	0.985	0.322	7	0.853	1.59	1.17	0.235
Iron	0.60	mg/kg wwt	16	1.16	4.55	2.52	0.98	33	19.6	51.0	37.0	8.23	13	33.9	66.0	43.9	10.2	7	18.6	26.0	22.0	2.61
Lead	0.0040	mg/kg wwt	16	<0.0040	<0.0091	<0.0046	<0.0016	33	0.0122	0.0782	0.0271	0.0143	13	0.0297	0.0933	0.0566	0.0226	7	0.069	0.163	0.098	0.037
Lithium	0.10	mg/kg wwt	16	<0.10	<0.10	<0.10	-	33	<0.10	<0.10	<0.10	-	13	<0.10	<0.10	<0.10	-	7	<0.10	<0.10	<0.10	-
Magnesium	0.40	mg/kg wwt	16	283	350	320	16	33	286	444	349	37	13	214	299	259	29	7	304	390	335	30
Manganese	0.010	mg/kg wwt	16	0.092	0.866	0.507	0.208	33	2.21	23.6	6.83	4.36	13	5.36	35.5	12.2	9.32	7	7.24	11.5	8.81	1.63
Mercury	0.0010	mg/kg wwt	16	0.204	6.03	1.03	1.4	33	0.0086	0.128	0.040	0.025	13	0.0164	0.0643	0.0270	0.0124	7	0.0559	0.131	0.082	0.028
Methylmercury	1.0	µg/kg wwt	16	135	6230	1100	1600	33	6.20	132	38.2	27.2	13	12.5	50.6	23.6	10.7	7	49.5	152	81.6	38.7
Molybdenum	0.0040	mg/kg wwt	16	<0.0040	<0.0040	<0.0040	-	33	0.0179	0.0443	0.0316	0.0057	13	0.0229	0.0655	0.0354	0.0105	7	0.0178	0.0258	0.0222	0.0030
Nickel	0.040	mg/kg wwt	16	<0.040	<0.040	<0.040	-	33	<0.040	<0.040	<0.040	-	13	<0.040	0.075	0.044	0.011	7	<0.040	<0.040	<0.040	-
Phosphorus	2.0	mg/kg wwt	16	2240	2900	2485	205	33	3930	8620	6255	957	13	3990	7040	5252	1012	7	5400	7960	6439	972
Potassium	4.0	mg/kg wwt	16	3290	4620	3900	330	33	2310	3200	2815	216	13	394	1040	663	185	7	2510	3100	2721	182
Rubidium	0.010	mg/kg wwt	16	4.78	8.86	7.02	1.34	33	3.03	11.3	6.39	2.26	13	1.36	3.28	1.93	0.50	7	4.65	6.37	5.76	0.71
Selenium	0.050	mg/kg dwt	16	0.400	0.697	0.544	0.084	33	0.634	2.01	1.05	0.37	13	0.644	1.05	0.842	0.141	7	0.794	1.03	0.913	0.080
Selenium	0.010	mg/kg wwt	16	0.083	0.148	0.109	0.017	33	0.130	0.408	0.233	0.075	13	0.128	0.225	0.167	0.031	7	0.176	0.253	0.201	0.029
Sodium	4.0	mg/kg wwt	16	188	461	338	67	33	335	1130	793	196	13	194	350	250	46	7	771	828	801	20
Strontium	0.010	mg/kg wwt	16	0.024	0.326	0.172	0.086	33	3.09	13.8	8.15	2.74	13	6.59	15.2	9.25	2.29	7	4.59	6.88	5.82	1.06
Tellurium	0.0040	mg/kg wwt	16	<0.0040	<0.0040	<0.0040	-	33	<0.0040	<0.0040	<0.0040	-	13	<0.0040	<0.0040	<0.0040	-	7	<0.0040	<0.0040	<0.0040	-
Thallium	0.00040	mg/kg wwt	16	0.00084	0.00586	0.00328	0.00140	33	0.00125	0.0105	0.0039	0.0023	13	0.00245	0.00816	0.00473	0.00169	7	0.00438	0.0106	0.00623	0.00230
Tin	0.020	mg/kg wwt	16	<0.020	0.234	0.042	0.054	33	<0.020	0.397	0.118	0.072	13	0.050	0.142	0.112	0.028	7	0.064	0.186	0.122	0.045
Uranium	0.00040	mg/kg wwt	16	<0.00040	<0.00040	<0.00040	-	30	0.00055	0.00609	0.00180	0.00167	13	0.00040	0.00227	0.00092	0.00065	7	<0.00040	0.00066	0.00049	0.00010
Vanadium	0.020	mg/kg wwt	16	<0.020	<0.020	<0.020	-	33	<0.020	0.067	0.023	0.010	13	<0.020	0.078	0.030	0.019	7	<0.020	<0.020	<0.020	-
Zinc	0.10	mg/kg wwt	16	3.22	6.51	4.47	0.934	33	25.4	76.8	42.4	14.5	13	38.5	58.3	48.4	6.5	7	29.2	45.1	37.5	5.27
Zirconium	0.040	mg/kg wwt	16	<0.040	0.042	0.040	0.001	33	<0.040	<0.040	<0.040	-	13	<0.040	<0.040	<0.040	-	7	<0.040	<0.040	<0.040	-

Notes: DL = detection limit; n = sample size; SD = standard deviation; SE = standard error; "-" not applicable; mg/kg wwt = milligram per kilogram wet weight; mg/kg dwt = milligram per kilogram dry weight.
Light green highlighted text indicates an exceedance of the Ontario sensitive population (0.5 mg/kg) and Health Canada (0.5 mg/kg) guidelines for total mercury for human consumption.
Dark green highlighted text indicates an exceedance of the Ontario consumption guideline developed for the general human population (1.8 mg/kg) for total mercury.
Grey highlighted text indicates an exceedance of the CCME guideline for methylmercury (33 µg/kg).
Bolded text indicates an exceedance of the Federal Environmental Quality Guideline (FEQG) for selenium in whole body fish tissues (6.7 mg/kg dwt)

[1] Northern pike captured in the North Driftwood River watershed were captured in Jack Lake (n=2), Gerry Lake (n=8); Martin Lake (n=5) and Sutherland Lake (n=2).

[2] Forage fish captured in North Driftwood River Watershed included composite samples of brook stickleback (n= 5), fathead minnow (n = 2), finescale dace (n= 12), northern pearl dace (n= 4), and northern redbelly dace (n= 10).

[3] Forage fish captured in West Buskegau River Watershed included composite samples of brook stickleback (n= 4) and finescale dace (n= 9).

[4] Forage fish captured in Jocko Creek Watershed included composite samples of brook stickleback (n= 2) and lake chub (n= 5)