5.8 Fish and Fish Habitat

5.8.1 Rationale for Valued Component Selection

Fish and fish habitat and aquatic SAR are protected under federal legislation by the *Fisheries Act* and *SARA*. Habitat that supports fish may be altered, disturbed, or destroyed as a result of direct or indirect disturbances from the Project. Works determined to result in Harmful Alteration, Disruption or Destruction (HADD) of fish habitat or death of fish by means other than fishing require authorization under Section 35 of the *Fisheries Act*. Furthermore, deposition of mine waste into waters frequented by fish requires authorization under Section 36 of the *Fisheries Act*, and registration under Schedule 2 of the MDMER.

SAR are listed under the *SARA* and *Nova Scotia Endangered Species Act*. Those which are listed by the Committee on the Status of Endangered Wildlife In Canada (COSEWIC), or listed as S1-S3 by the ACCDC are considered SOCI. SOCI have no legal protection under endangered species legislation; however all fish species are protected under the *Fisheries Act.*

The Fish and Fish Habitat VC is linked to:

- Groundwater and Surface Water Resources (Sections 5.5 and 5.6: the predicted effect of the Project on Fish and Fish Habitat ties directly to predicted project interactions on groundwater and surface water quality and quantity modelling, and specifically on the linkages between the groundwater and surface water VCs. Predicted indirect effects to fish and fish habitat are based on model results provided in Sections 5.5 and 5.6).
- Wetlands: baseline methods and results related to identification of wetlands are described in Section 5.7. Wetlands that support fish habitat are further evaluated in Chapter 5.8.
- Socioeconomic Conditions and Indigenous Peoples: impacts to fish and fish habitat could affect usage of the PA by Mi'kmaq of Nova Scotia and local community members, for both traditional and recreational fishing.

5.8.2 Baseline Program Methodology

A Fish and Fish Habitat Baseline Report was prepared (Appendix H.1) to support the description of the existing conditions related to fish and fish habitat within the Fish Habitat Study Area (FHSA). The FHSA is defined as the entirety of the PA, with a southern extension to incorporate a downstream portion of Gold Brook. Key components of the baseline report include:

- Identification and initial characterization of aquatic habitats throughout the PA (wetland and watercourse delineation)
- In situ water quality measurements
- Benthic invertebrate community evaluation
- Fish collection
- Environmental DNA (eDNA)
- Detailed fish habitat surveys

The baseline program methodologies were selected with the key objectives of facilitating identification and avoidance of fish habitat where possible, understanding the potential project interactions with fish and their habitat, and to support an eventual regulatory application for HADD under the *Fisheries Act*. A summary of baseline survey methods and results are provided herein; full details related to fish and fish habitat baseline survey methodologies are outlined in Section 2.0 of the Fish and Fish Habitat Baseline Report (Appendix H.1).

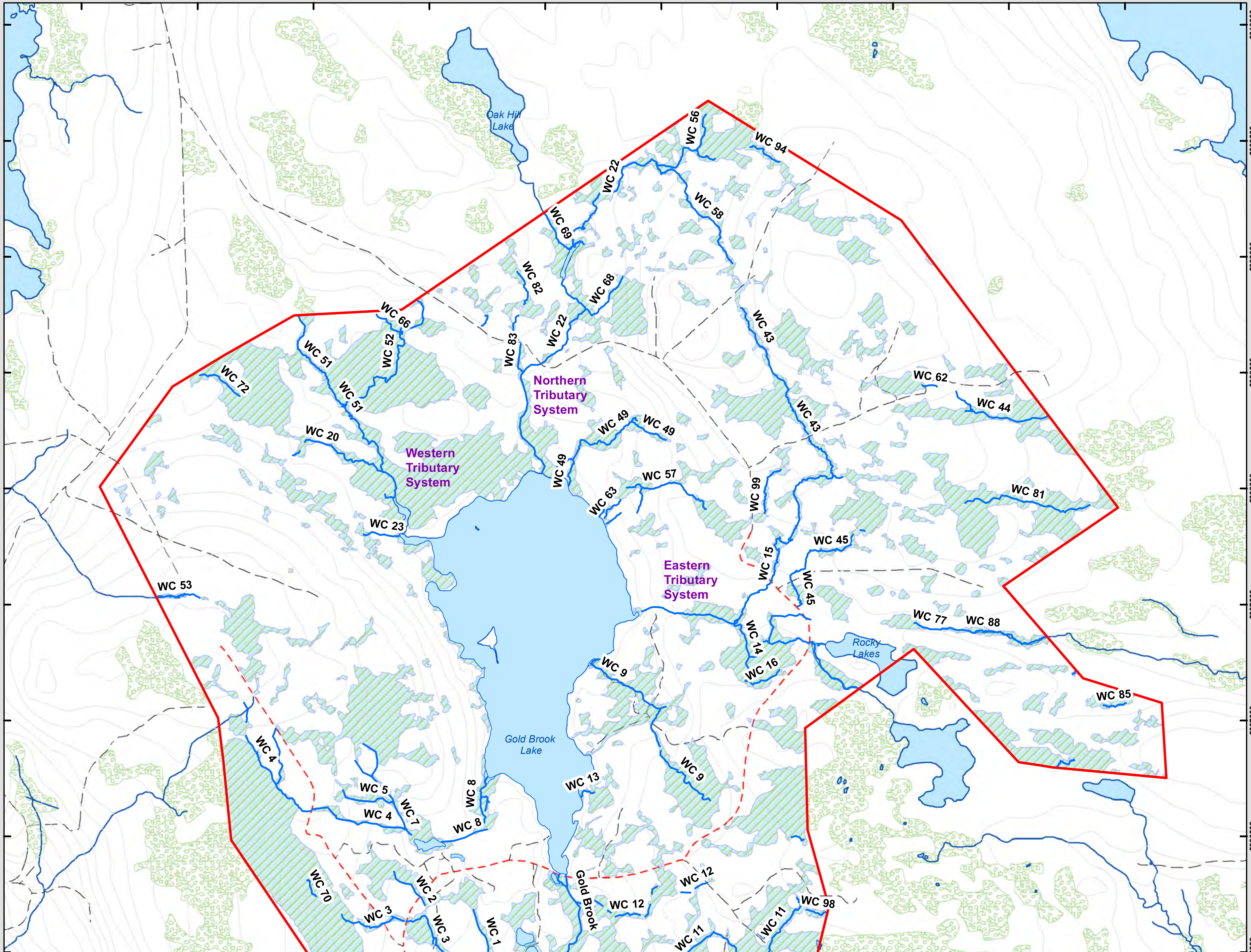
5.8.2.1 Wetland and Watercourse Delineation

Watercourse identification and description, as well as wetland delineation and evaluation were completed across the FHSA from 2017 to 2021 in accordance with Nova Scotia standards for identification of watercourses and wetlands. A detailed account of wetland delineation methods and results is provided in the Wetlands Baseline Report (Appendix G.1), and further detail related to initial baseline fish habitat characterization is outlined in the Fish and Fish Habitat Baseline Report (Appendix H.1). Each of these aquatic habitats were evaluated for the presence of fish habitat and potential ability to support fish species during initial assessment and identification.

Fish habitat is described as any aquatic feature that is contiguous with a fish bearing stream, whether it is located within a watercourse, wetland, waterbody, or wetland mosaic. Fish habitat will primarily be described in the context of watercourses and lakes, however the terms ‘open water’ and ‘wetland mosaic’ will be occasionally used, as defined below (and fully described in Appendix H.1). Where fish habitat is present in a watercourse that flows through a wetland in an entrenched channel, that habitat is described in the context of the watercourse. Where fish habitat is present in a wetland, but outside of an entrenched channel, it is described as a wetland mosaic (accessible to fish). In addition, watercourses were assumed to provide fish habitat, regardless of whether they are directly connected to fish bearing streams or proven to be occupied by fish. In an effort to make conservatively inclusive decisions in this effects assessment, even those watercourses lacking connectivity to known fish bearing streams (i.e., WC99, WC57, WC69, etc.,) are included as fish habitat, and proposed for offsetting if a project interaction is proposed.

Open water features were identified as either off-line ponds or components of linear watercourses. From a regulatory perspective, open water features are defined as watercourses by the Environment Act. Habitats were considered open water habitats if less than 2 m depth, <8 ha in size, and had less than 50% vegetative cover, following guidance from the Army Corps of Engineers wetland delineation manual (United States Army Corps of Engineers, 2009). Wetland mosaics are unlike open water as they have greater than 50% vegetation and less than 2 m of standing water. These habitats provide ephemeral or perennial fish access, depending on the contribution of flow from the associated watercourse.

The results of baseline wetland and watercourse delineation were used to inform all additional field programs; particularly detailed fish habitat evaluations and fish collection. Delineated wetlands, watercourses and waterbodies are shown on Figure 5.8-1.



Prepared For:

SIGNAL GOLD

FIGURE 5.8-1a

Goldboro Gold Project

Delineated Wetlands and Watercourses

Goldboro, NS

- Field Delineated Watercourses
- NSTDB Watercourses Outside PA
- NSECC Wetland Inventory
- Open Water
- EARD Project Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 125 250 500 m

1:15,490 Scale when printed @ 11" x 17"

Drawn By: MMD
Reviewed By: MM
Date: 2022-05-20

McCallum Environmental Ltd.

Document Name: 220519_Fig5.8-2_FishHab

Prepared For:

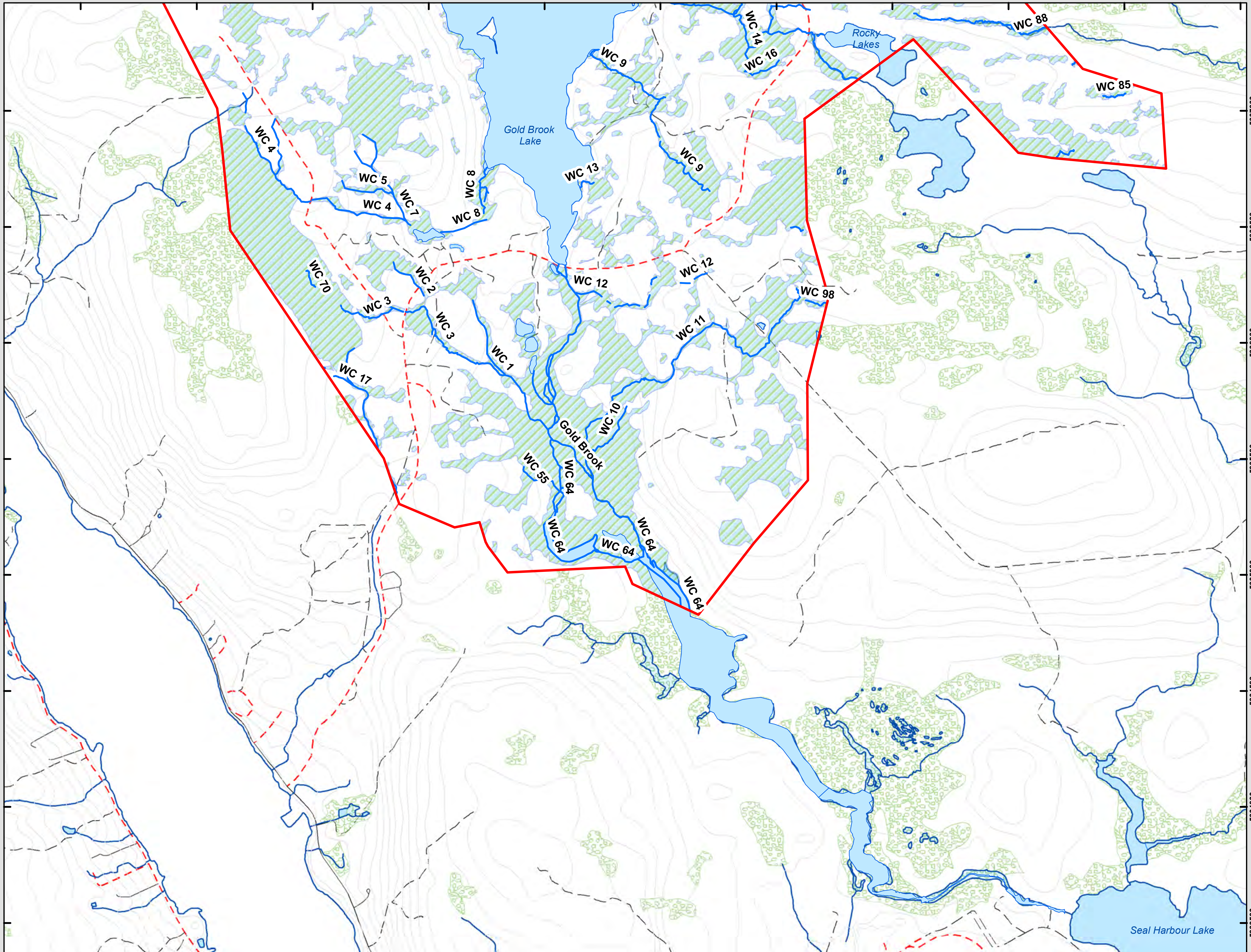
SIGNAL GOLD

FIGURE 5.8-1b

Goldboro Gold Project

Delineated Wetlands and Watercourses

Goldboro, NS



Field Delineated Watercourses
NSTDB Watercourses Outside PA
NSECC Wetland Inventory
Open Water
EARD Project Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
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Drawn By: MMD
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McCallum Environmental Ltd.

Document Name: 220519_Fig5.8-2_FishHab

5.8.2.2 In-situ Water Quality

In-situ water quality measurements were recorded at all electrofishing and trapping sites prior to each sampling event. In addition, water quality measurements were recorded for each watercourse delineated through detailed habitat assessments. These water quality measurements were collected using a calibrated YSI Multi-Probe water quality instrument (or equivalent) or a combination of a Myron Ultrapen DO Pen Probe and Hannah Combo pH/Conductivity/TDS Probe at the time of the sampling event/survey. The pen probes used collectively measure dissolved oxygen, temperature, pH, conductivity and total dissolved solids. Locations of water quality measurements coincide with fish collection locations, shown on Figure 3 in Appendix H.1.

5.8.2.3 Benthic Invertebrate Sampling

Benthic invertebrate sampling within lotic (riverine) systems were collected using a 12" x 12" Surber Sampler equipped with a 500 µm Nitex Net. Sampling was conducted in shallow riffle locations when available, and habitat type (riffle, run, pool) was noted at each sampling location. Benthic invertebrates were collected in the net by disturbing the area within the 12" x 12" frame, which was placed firmly in contact with the stream bottom. Field staff stood upstream of the Surber Sampler and scrubbed rock, vegetation, and woody debris within the frame area, allowing for the current to push dislodged invertebrates into the net. Once scrubbed, larger objects were removed from the frame area and the top 2-5 cm of fine substrate remaining was disturbed to complete sample collection. Additionally, in lotic systems three benthic samples (littoral, mid-depth, maximum depth) were taken using an Eckman Dredge. Once collected, samples were transferred to sample bags and preserved in the field using a 99% isopropyl alcohol solution. Samples were delivered to Envirosphere Consultants Ltd. in Windsor, Nova Scotia for biological analysis. Benthic invertebrate sample locations are shown on Figure 3 in Appendix H.1.

5.8.2.4 Fish Collection

Quantitative fish collection involves a closed site setup (reach is isolated with barrier nets) and triple passes of electrofishing. This site setup allows for population estimates, and is the preferred methos for fish sampling, unless the physical characteristics of the stream do not allow for reach isolation, or if fish abundance is expected the be low. Qualitative electrofishing involves an open site setup with a single pass of electrofishing. This method is suitable to determine species richness and relative (not absolute) abundance by calculation of Catch Per Unit Effort (CPUE).

Quantitative electrofishing was undertaken using barrier nets (1 8" mesh) that were secured to the stream bed at either end of the reach to isolate an area of habitat within each watercourse. Within each isolated reach, a minimum of three passes with the electrofisher were completed. Additional passes were completed if depletion in catch was not obtained after the first three passes. If no fish were captured after two passes, the third pass was deemed unnecessary. The number and characteristics of fish collected during each pass were recorded so that quantitative fish population estimates could be calculated. The total seconds of electrofishing effort were also recorded.

Qualitative electrofishing surveys were performed using an "open" site methodology with no barrier nets. One pass with a backpack electrofisher was performed unless crew members noted a high number of fish that evaded capture. In that case, a second or third pass was performed to obtain greater species representation. In the Salmonid Field Protocols Handbook: Techniques for Assessing Status and Trends in Salmon and Trout Populations (Temple and Pearsons, 2007) the authors describe the use of single-pass electrofishing without barrier nets and provide a summary of academic reports supporting this method (Johnson et al., 2007). Though the technique does not support estimates of absolute abundance or population estimates, research has found that single-pass electrofishing works well to determine species richness (Simonson and Lyons, 1995), and relative abundance (Kruse et al., 1998). Qualitative species abundance estimates were calculated using electrofishing CPUE indices, standardized to 300 seconds of effort (Scruton and Gibson, 1995).

Supplementary trapping was used at locations where electrofishing was not deemed to be efficient, effective or safe (e.g., deeper water, high conductivity). At these sampling locations, biologists deployed either baited minnow traps or eel pots. Fyke nets were used at various locations and seine netting was performed at one location (near the outlet of Gold Brook Lake). CPUE was determined for each trap type and fish species based on trapping effort, which was calculated as total catch or total catch per species per wetted hour. Fish collection locations are shown on Figure 3 in Appendix H.1.

5.8.2.5 eDNA Sampling

eDNA samples were collected to identify whether fish are present within the historic settling ponds and to provide a second method to determine the presence or absence of Atlantic salmon within the Gold Brook shore direct watershed (1EQ-SD31). Samples were collected at four locations within the FHSA, and at a fifth location outside of the FHSA. Samples from the historic settling ponds were collected using the eFish primer developed by BV laboratory.

Atlantic salmon are expected to occur in the eastern adjacent New Harbour secondary watershed (1EQ-4), but not within the watershed containing Gold Brook Lake and Gold Brook, based on consultation with DFO, and based on a review of Gibson et al. (2010). Samples were collected within three locations in the 1EQ-SD31 secondary watershed, with a fourth sample location within the 1EQ-4 watershed, and submitted to Dr. Paul entzen's laboratory at Dalhousie University for processing.

Standard protocols outlined by the British Columbia Ministry of Environment (MOE) were strictly adhered to for sample collection, labelling, filtration and sanitization between samples at every stage of the process (BC Ministry of Environment, 2017). Each sample was collected in triplicate. Sample filtration occurred in the evening of 13 October 2021. As described in the BC MOE protocol, one field blank sample per day is recommended. Since sample analysis was complete at two separate laboratories, however, two field blank samples were completed, allowing one field blank to accompany samples submitted to each laboratory. eDNA sample locations and sample collection and filtration data are provided on Figure 3 and Appendix E of Appendix H.1.

5.8.2.6 Detailed Fish Habitat Assessments

Detailed fish habitat surveys within selected watercourses were conducted using standard methodologies to gather key measurements such as reach length (m), reach wetted and bankfull width (m), reach slope (%), stream substrate composition (% composition), water depths (m), water velocities (m/s), cover (%), and riparian habitat per habitat unit. The data was used to determine the overall habitat area within each reach as well as the habitat suitability based on measured stream substrate, water depths, and water velocities (habitat parameters) for each fish species identified within the Project Area. Lacustrine surveys were completed within Rocky Lake and Gold Brook Lake, where measurements of depth (m), substrate composition, cover and water quality were recorded.

Detailed habitat assessments were not completed for three watercourses expected to be directly impacted by the Project (WC99 and upstream sections of WC3 and WC4), due primarily to infrastructure or PA boundary shifts after detailed habitat surveys were completed.

5.8.3 Baseline Conditions

A summary of baseline conditions is presented in the following sections. Full details related to baseline conditions are outlined in Appendix H.1.

5.8.3.1 Watershed

The PA is predominantly found within the New Harbour/Salmon Primary watershed (1EQ), and the secondary shore direct watershed (1EQ-SD31, herein referred to as the "Gold rook secondary watershed") (Figure 1, Appendix H.1). The topography of the Gold Brook secondary watershed gently slopes towards Gold Brook Lake, and, as the lake empties into the Gold Brook system, the landscape flattens further into a low-relief valley. Elevation within the PA ranges from approximately 40 to 110 masl. This watershed has a total surface area of 4,003 ha, extending from Oak Hill Lake in the north to Drum Head in the south.

The PA lies within two primary watersheds and five secondary watersheds:

- 1EP – Country Harbour Watershed
    - 1EP-1 – Isaacs Harbour

- 1EP-SD1 – Isaacs Harbour Shore Direct

- 1EQ – New Harbour/Salmon River Watershed
  - 1EQ-SD31 – Gold Brook Shore Direct
  - 1EQ-SD29 – Coddles Harbour Shore Direct
  - 1EQ-4 – New Harbour

The Goldboro area was an active and productive mining area from 1893 to 1910. There are historic workings as well as known environmental hazards throughout the area due to this history of mining. Locations that are known to have been used for tailings disposal during past milling operations, none of which were neither contained nor remediated. Tailings migrated from the streams and wetlands where they were deposited into the downstream receiving environment (Gold Brook) and may present a continuing threat to fisheries resources. Sampling has occurred to identify the extent of historic tailings between 2003 and 2021. Tailings have been identified, primarily within close proximity to the proposed pits within and surrounding Gold Brook (Appendices E.1 and E.2). The Country Harbour Primary Watershed (1EP) hugs the western edge of the PA, which is further subdivided by two secondary watersheds: a shore direct watershed (1EP-SD1, herein referred to as the “Isaacs Harbour secondary watershed”) and the Isaacs Harbour River secondary watershed (1EP-1). Approximately 17 ha of the northwestern edge of the PA falls within the Isaacs Harbour River secondary watershed (1EP-1). This watershed has a total surface area of 7,824 ha, which extends south through Isaacs Harbour River and Meadow Lake to Isaacs Harbour at Route 332. The southwestern corner of the PA (85 ha) falls within the Isaacs Harbour secondary watershed (1EP-SD1). This shore direct watershed encompasses 697 ha along the eastern shoreline of Isaacs Harbour.

The most northern section of the PA lies within the largest of the five secondary watersheds found within the PA, the New Harbour R. secondary watershed. A total of 83 ha of the PA falls within the New Harbour R. secondary watershed, this watershed has a total surface area of 14 963 ha. Various large lakes (Loon Lake, Eight Mile Lake, etc.) exist within this watershed, all generally flowing into the New Harbour River which drains into New Harbour Cove.

Coddle’s Harbour secondary watershed lies within the southeastern portion of the PA. Only 49 ha of the PA falls within the Coddle’s Harbour secondary watershed that has a total surface area of 2,179 ha. This watershed contains one main watercourse that starts within the PA and flows southeast through Fowlers Lake and Basin Lake before draining into Coddle’s Harbour. Other first and second order streams and lakes lie within this watershed.

5.8.3.2 Wetlands and Watercourses

Throughout the PA, 66 watercourses and 223 wetlands have been identified and delineated, these are described in the Goldboro Fish Baseline report (MEL, 2022) and Goldboro Wetland Baseline report (MEL, 2022), respectively. In addition to wetlands and watercourses, waterbodies within the PA include Gold Brook Lake and Rocky Lake. Additional open water features identified include two historic settling ponds, the Beaver Pond (which is located within WL18), and portions of Gold Brook where it opens into wide open flat habitat. Furthermore, two wetland mosaics were identified; Wetland Mosaic A is located south of the Settling Ponds, and Wetland Mosaic B is located at the convergence of channels A and H of Gold Brook. These features are shown on Figure 6g and 6h, respectively, in Appendix H.1.

5.8.3.2.1 Gold Brook Lake

Gold Brook Lake is the predominant feature within the Gold Brook secondary watershed. It collects flow from four main tributary systems:

- Northern tributary (including WC22, WC58 and WC69 bringing flow from Oak Hill Lake in the headwaters of the secondary watershed)
- Western tributary (including WC43, WC15, WC47, WC45, WC50, WC16, and WC39/WC14 bringing flow from the Rocky Lakes)
- Southwestern tributary (WC4, WC5, WC6, WC7 and WC8)
- Eastern tributary (including WC19, WC20, WC23, WC24 and WC99)

Gold Brook Lake is relatively large is size at 79 hectares, when compared to the area of the secondary, shore direct watershed (~4000 ha) (Figure 6a to d, Appendix H.1). Depth within Gold Brook Lake ranges between 0.61 m to 3.05 m, with the deepest basin running north to south through the central-eastern extent of the lake based on bathymetry data collected by Signal Gold (Figure 6, Appendix H.1). This littoral zone, which typically extends up to 2 m in depth, accounts for approximately 40% (32 ha) of the lake's overall area. Field measurements of depth matched the bathymetry data closely, with 3.35 m representing the maximum recorded depth throughout Gold Brook Lake.

Evidence of tannins (clear, yet tea-colored water) was observed throughout the Lake. Secchi depths recorded within the lake ranged between 0.75-1.06 m. Based on trophic status indices presented in Carlson and Simpson (1996), lakes with secchi disk measurements below 2 m typically fall into the eutrophic category. Eutrophic lakes tend to be shallow and warm, with relatively high nutrient inputs; they are known to support warm water fish species. However, it is important to note that secchi depth is to be considered indicative, rather than conclusive, of trophic status as there are multiple factors affecting water clarity and therefore secchi depth measurements (Carlson and Simpson, 1996).

A total of 473 individual fish were collected throughout all seasonal fish collection programs in Gold Brook Lake. Seventy-three percent of the individuals observed were yellow perch (n=346). The remaining fish collected in Gold Brook Lake comprised of 14% banded killifish (n=66), 5% blacknose shiner (n=25), 4% American eel (n=19), 3% golden shiner (n=15), and less than 1% brook trout (n=2). Within Gold Brook Lake, the benthic community had a low to low/moderate diversity of organisms (3 – 11 taxa per sample); and low to high abundances (301 – 7,568 individuals per metre squared).

5.8.3.2.2 Rocky Lake

Rocky Lake is a small lake, approximately 3.9 ha in size, located at the eastern extent of the PA, straddling the PA boundary. This is a headwater system; the outlet (WC39) converges with the outlet of another Rocky Lake (both together are called Rocky Lakes) located east of the PA boundary. These form the headwaters to the eastern tributary, WC14, which drains west to Gold Brook Lake (Figure 6c, Appendix H.1). The average depth throughout Rocky Lake was 1.07 m, with a maximum depth observed at 1.95 m. One secchi depth was recorded at 1.48 m, indicating Rocky Lake likely falls into the eutrophic category based on the trophic status indices presented by Carlson and Simpson (1996).

Water quality measurements recorded within Rocky Lake show consistent acidic conditions, with pH measurements ranging between 4.62 and 4.79. All measurements fall outside of the CCME FWALs and indicate suboptimal pH range for some fish species. Similar to Gold Brook Lake, it is likely that species such as brook trout and yellow perch tolerate these low pH conditions. Dissolved oxygen levels were favourable to fish habitat, with measurements ranging between 9.96-11.67 mg/L. A total of 186 individuals were collected and released throughout all seasonal fish collection programs. Ninety-one percent of the individuals observed were golden shiner (n=170), while the remaining 9% (16 individuals) were American eel.

5.8.3.2.3 Gold Brook

Gold Brook is a perennial, third order watercourse. This watercourse is a braided system that has one main channel (WC64A) and approximately 10 branches (WC64, branches B through K). This watercourse was delineated into twelve homogenous fish habitat reaches during detailed habitat mapping. Gold Brook originates at the southern outlet of Gold Brook Lake and flows south through the PA. The entirety of Gold Brook remains within WL1 as it braids numerous times for approximately 1 km before flowing into the final reach (Reach 12) where it becomes a large open flat with no observed branches. Watercourses 3, 10, 11, 12 and 55 all flow into Gold Brook, along with a wetland mosaic at the Settling Pond Outlet.

The open water section of Gold Brook (Reach 12) reaches up to approximately 240 m in width. While a full bathymetric survey was not completed, depths throughout this reach are estimated to exceed 1 m, and this flat habitat type is dominated by a muck and detritus substrate. These reaches provide suitable habitat for all life stages of golden shiner, yellow perch, banded killifish, adult American eel, and brook trout.

Two wetland mosaics were described in association with Gold Brook. Wetland Mosaic A is located south of the settling pond outlet, between the historic settling ponds and Gold Brook, and Wetland Mosaic B is located upstream of the open water portion of Gold Brook (Reach 12). Wetland mosaics had some direct connectivity to Gold Brook and are described as partially accessible to fish based on presence of shallow standing water in hummocks (approximately 50% standing water cover). Wetland mosaics are predicted to support all life stages of banded killifish, golden shiner and yellow perch, along with juvenile and adult brook trout and American eel.

During the 2020-2021 field program, three rounds of electrofishing and additional trapping were completed to confirm fish presence in two sections of Gold Brook. These efforts resulted in the capture of five species of fish throughout the system, including banded killifish, brook trout, American eel, golden shiner, and yellow perch.

5.8.3.3 Water Quality

Water quality measurements recorded throughout the 2020 field program show a general increase in water temperatures throughout the summer with a peak of 23.7ºC in August. However, water temperatures over the summer of the 2021 field program showed a slight increase between early summer and mid-summer but dropped in late summer, peaking at 20.4ºC in July. The watercourse is considered acidic and somewhat limiting to fish as pH levels were periodically recorded below five, but non-limiting to cold-water species based on temperature. Benthic invertebrate community assessment analyses completed within Gold Brook show that the aquatic ecosystem supports secondary productivity at a capacity that supports the fish community.

Throughout the FHSA, water quality measurements were recorded in-situ during fish and fish habitat surveys. Recorded summer temperatures ranged from 11.7℃ to 28.3℃ in 2020 and in 2021 temperatures ranged from 10.3℃ to 25.8℃. Temperatures within smaller, first and second order streams remained within the suitable temperature range for salmonids throughout the summer, whereas temperatures measured within larger watercourses and waterbodies regularly measured above suitable range for cold-water fish species.

Throughout the FHSA, in situ measurements of pH within aquatic features ranged between 3.89 to 7.71, with an average pH of 4.97. Only two sampling sites (WC1 and WC3) exhibited pH levels within CCME recommended range for freshwater aquatic life (6.5-9). About two thirds of the measurements recorded in-situ during fishing efforts and habitat assessment exhibited pH levels so low (<5.0) as to expect to cause harm to the eggs and fry of salmonid species (Canadian Council of Resource and Environment Ministers (CCREM), 1987).

More than 75% of dissolved oxygen (DO) levels recorded across aquatic features within the FHSA were below the minimum CCME recommended concentration of DO for early life stages of cold-water fishes, while 27% were below levels suitable for any life stage of cold or warm-water fishes (CCME, 1999). Low DO levels were measured throughout watercourses during detailed habitat assessments conducted in mid-August. Overall, low pH levels, elevated summer temperatures, and low DO concentrations limit fish habitat quality within select systems.

5.8.3.4 eDNA Sampling

eDNA sampling was conducted at four locations within the FHSA, and at a fifth location outside of the FHSA. Analysis of samples collected within the southern settling pond confirm detection of fish DNA. Atlantic salmon were expected to occur in the eastern adjacent New Harbour watershed (1EQ-4), but were not believed to occur within the secondary watershed containing Gold Brook Lake and Gold Brook, based on consultation with DFO and a review of Gibson et al. (2014). Atlantic salmon DNA was not detected in either of the three samples collected within the PA (1EQ-SD31 watershed). However, it was detected in the sample collected in the adjacent New Harbour watershed.

5.8.3.5 Fish Habitat

During the 2020-2021 field program, fish collection efforts involved approximately 4,424 hours of trapping (various types), 546 minutes of qualitative electrofishing and 1,098 minutes of quantitative electrofishing. This resulted in capture of a total of six species and 1817 individual fish within the FHSA, including yellow perch, American eel, brook trout, golden shiner, banded killifish, and blacknose shiner. While not identified through dedicated fishing surveys, ninespine stickleback may be present within the FHSA based on fish studies conducted for the Goldboro LNG project (AMEC, 2006). A summary of fish collection throughout 2020-2021 is provided in Table 5.8-1. Full details on sample methods, locations and results are provided in Appendix H.1.

Table 5.8-1 Fish Species Collected within the PA (2020-2021)

Species	Species Code	SRank	SARA/ NSESA/ COSEWIC Listing	Total Catch	
				#	%
Yellow Perch *(Perca flavescens)*	YLP	S5	N/A	547	30.1 %
American Eel (*Anguilla rostrata*)	EEL	S2	COSEWIC: Threatened	537	29.6 %
Brook Trout (*Salvelinus fontinalis*)	BKT	S3	N/A	394	21.7 %
Golden Shiner (*Notemigonous crysoleucas*)	GSH	S4	N/A	186	10.2 %
Banded Killifish (*Fundulus diaphanous*)	BKF	S5	COSEWIC: Not at Risk	128	7.0 %
Blacknose Shiner (*Notropis heterolepis*)	BNS	S4	N/A	25	1.4 %
			Total	1817	

5.8.3.6 Summary of Baseline

Predicted residual impacts from the Project primarily affect first and second order intermittent and perennial streams. Fish habitat viability and accessibility within these systems are partially restricted by seasonally low water levels and resultant obstacles to fish passage. Suitable overwintering habitat within stream systems are limited, particularly for juvenile and adult life stages of trout, which require stable flows, deeper pools, and rocky instream cover. Aquatic features primarily provide suitable young of year and juvenile rearing habitat for brook trout and juvenile American eel, as well as foraging opportunities for adult life stages. Other species confirmed or potentially residing in the PA are generally restricted to low velocity areas with a direct connection to Gold Brook or Gold Brook Lake. The lack of identified suitable spawning habitat for brook trout within the PA is likely a limiting feature to overall brook trout productivity. Overall, low pH levels and low DO concentrations limit fish habitat quality within the small, intermittent streams throughout the PA. Smaller first and second order streams with more permanent flow regimes may provide areas of summer thermal refuge for brook trout, a cold-water species.

5.8.4 Consideration of Consultation and Engagement Results

Key issues raised during Mi’kmaq engagement and public consultation related to fish and fish habitat include potential effects to brook trout and American eel. American eel is a culturally significant species to the Mi’kmaq of Nova Scotia for traditional use. Brook trout is fished recreationally in this area by local residents as well. Concerns were related to direct impacts and indirect impacts to these species and the habitats upon which they rely, and concerns were raised about relocating fish (during rescue efforts) from areas with historic tailings.

5.8.5 Effects Assessment Methodology

5.8.5.1 Boundaries

Spatial Boundaries

PA - The PA encompasses the immediate area in which Project activities may occur and are likely to cause direct and indirect effects to fish and fish habitat. The PA includes the infrastructure associated with the mine site plus a buffer of 100 – 200 m. The PA is shown on Figure 5.8-1. In addition to the PA, a FHSA was defined, which incorporates the entirety of the PA, and an extension downstream along Gold Brook. The extent of the FHSA was determined based on model extents used in the ground water and surface water chapters. Baseline field work was completed throughout the FHSA (Figure 5.8-1).

LAA – The LAA encompasses adjacent areas outside of the PA where Project related effects to fish and fish habitat are reasonable expected to occur. For fish and fish habitat, the LAA consists of secondary watersheds, or portions of, that intersect with the PA. LAA boundaries were defined considering the maximum expected extent of direct and indirect impacts to the aquatic environment, as well as the type and location of Project activities in each watershed. The LAA is defined as the collection of the below secondary watersheds and shown in Figure 5.8-1:

- Gold Brook Shore-Direct (1EQ-SD31)
- Portion of Isaacs Harbour River (1EP-1)
- Portion of Isaacs Harbour Shore-Direct (1EP-SD1)
- Portion of New Harbour River (1EQ-4)
- Portion of Coddles Harbour Shore-Direct (1EQ-SD29)

The Project infrastructure lies predominantly within the Gold Brook shore direct watershed (1EQ-SD31). Where portions of watersheds have been included, it is not expected that impacts to the aquatic environment, including fish habitat, will extend beyond the PA. Within these four secondary watersheds, Project infrastructure is limited to roads, surface water management structures, organic stockpiles, TMF, and a portion of the mill area. Based on the type and location of this infrastructure and considering the planned water management systems, these activities are not expected to impact downgradient portions of these watersheds beyond natural variability. As the Project has potential to cause direct and indirect effects to fish and fish habitat outside of the PA, the LAA is the appropriate boundary for evaluation of this VC.

No RAA is defined for this VC, as the effects are expected to occur entirely within the LAA.

Temporal Boundaries

The temporal boundaries are related to the duration of each phase of the Project. The duration of each phase is provided in Table 5.8-2.

Table 5.8-2 Project Timeline

Project Phase	Duration
Construction	2 years
Operations	11 years
Closure	24 years

Within the assessment of effects to fish and fish habitat, the operations phase is further described based on two different modelling timelines. The East Pit extraction will occur between Year 1 and 8 of the Operations Phase, while the West Pit extraction will occur through Years 1 and 11 of operations. The indirect effects to fish and fish habitat are evaluated through these individual scenarios within the overall Operations Phase.

Technical Boundaries

No specific technical boundaries are identified for assessment of effects to fish and fish habitat.

Administrative Boundaries

Effects of the Project on fish and fish habitat were evaluated within the framework offered by the *Fisheries Act (*1985) and supporting policy statements and management objectives from DFO, including those referenced herein. DFO interpretation of HADD of fish habitat supports the evaluation of this VC. Furthermore, the Project will require addition to Schedule 2 of the MDMER under the *Fisheries Act*. Administrative boundaries include the *SARA* and *Nova Scotia Endangered Species Act*.

5.8.5.2 Hydrologic and Hydraulic Modelling

Collection and treatment of contact water and clean water surrounding project infrastructure is expected to result in indirect impacts to fish and fish habitat through reduction in flow. The determination of indirect effect to fish habitat through flow reduction is based on modelled results provided in the Section 5.6 and in the Water Balance Analysis

Summary Report provided in Appendix F.5; a full description of water balance methods, results and sensitivity analysis is provided therein.

The effects of flow reduction were evaluated through delineation of local catchment areas using a NSDNRR Digital Elevation Model (DEM), supported by GoldSim modelled flow reductions at a series of assessment points. Assessment points were selected based on delineated watercourses, catchment areas, and the relative location of proposed infrastructure and water management features. A table listing the assessment points used to identify the occurrence and extent of indirect impacts to fish, and justification for selection is provided in the Water Balance Analysis Summary Report (Table 2.1, Appendix F.5). The Water Balance Analysis Summary Report also provides tables listing the treatment facilities and open pits, sources of inflows and discharge locations during each Project phase (Tables 4.2 - 4.4, Appendix F.5).

The water balance analysis uses a combination of daily and average monthly climate date inputs, including daily precipitation (rainfall, snowfall), daily average temperature, average monthly evapotranspiration, and average monthly lake evaporation. A 50-year record of daily precipitation and average temperature values were obtained from the Deming ECCC climate station (ID 8201410) for the years 1956 to 2005, as recommended by DFO (2013). The Deming climate station is located approximately 37 km from the PA, within the Atlantic Coast Ecoregion.

Average monthly lake evaporation values were obtained from the Truro ECCC climate station (ID 8205990), which is the nearest ECCC climate station to the site that records lake evaporation data. It is located approximately 129 km from the PA. The values of the baseflow and surface runoff recession constants were manually adjusted to match the simulated flows to the observed daily flow rates at the Lake Outlet assessment point, which coincides with the SW-12-21 surface water monitoring station. The simulated and observed daily flow rates were compared from April 1 to November 22, 2021. Daily precipitation data were obtained from the Collegeville Auto (ID 8201001) ECCC climate station to drive the soil-water balance working model. Collegeville Auto is the closest climate station to the site with precipitation records that overlap with the monitoring period. The Collegeville Auto climate station is located approximately 43 km from the PA; however, the Deming climate station is more likely to experience representative precipitation patterns as it is closer to the Atlantic coast.

Daily baseflow and surface runoff volumes were calculated at each assessment point by multiplying the respective runoff coefficients by the yield and catchment area. This methodology assumes that the groundwater flow divides follow the catchment boundaries, which is considered an appropriate assumption for the PA under baseline conditions, due to the higher hydraulic conductivity of the overburden material compared to the bedrock as presented in the Groundwater Modelling Report (Appendix F.2).

Baseflow volume variations to the natural lakes and watercourses were determined using the groundwater model for the Project, described in Section 5.5. The baseflow impacts were incorporated into the water balance analysis as percent changes from baseline conditions at each assessment point.

5.8.5.2.1 Gold Brook Hydrologic and Hydraulic Analysis

The evaluation of potential flow reductions on the Gold Brook system was completed using two key methods: a hydrologic model, followed by a hydraulic model. According to the Ecological Flow Requirements guidance (DFO, 2013), "for cumulative water use >10% of the instantaneous discharge or that results in flows < 30% of the mean annual discharge (MAD), a more rigorous level of assessment is recommended to evaluate potential impacts on ecosystem functions which support fisheries". The results of the hydrologic modelling show an expected change in flow greater than 10%; as a result, an additional method of evaluation was incorporated to address potential indirect impacts through a more rigorous level of assessment. This hydraulic modelling exercise supplements the hydrologic model; both modelling methods are outlined below.

A combined hydrology and water balance model was developed using GoldSIM to predict impacts of development of the Project on nearby watercourses as it relates to streamflow. The output of this model provides an evaluation of daily flows, which can be used to identify indirect impacts to fish habitat. One hydrologic assessment point was established at the outlet of Gold Brook Lake, accompanied by an additional seven downstream assessment points, which have been established upstream and downstream of proposed infrastructure, with the furthest downstream assessment point located at the inlet of Gold Brook into Seal Harbour Lake.

One limitation of the hydrologic model is that it does not account for attenuation of water within Gold Brook Lake; as a result, flow data at both baseline and at each project phase is shown as relatively low based on precipitation data. In reality, precipitation is naturally attenuated in the lake and flow spikes in Gold Brook have not been observed, and are not expected. To account for the lack of lake attenuation in the model, streamflow at the Gold Brook assessment points are presented as moving 7-day averages; presented on a daily time step. Even with the 7-day averaging to simulate lake attenuation, artificial spikes in baseline and Project phase stream flows still occur, especially when baseline flow is very low. This limitation is not carried forward in the HEC-RAS hydraulic model, which further justifies inclusion of that method to evaluate effects of the Project on fish habitat.

The assessment of impacts to the hydraulic regime of Gold Brook was done using the 2-dimensional capabilities of the computer model HEC-RAS (USACE, 2021). HEC-RAS is a computer program that models the hydraulics of water flow through natural rivers and is widely used to predict hydraulic parameters of interested such as water surface profiles and flow velocities. HEC-RAS software is the industry standard software for evaluation of water levels within river systems. HEC-RAS is commonly used in many applications involving the assessment of free-surface flows including environmental flow assessment, assessment of river and river systems for environmental analysis, floodplain modelling, flow routing simulations through reservoirs and design of cross-drainage and open channel hydraulic structures. A 2-dimensional model approach was required to properly simulate the braided channel configuration of Gold Brook immediately downstream of the Gold Brook Lake outlet.

The hydraulic model was developed to simulate the 10^{th} percentile and average flow conditions along Gold Brook for the baseline and West Pit EOM scenarios. The West Pit EOM scenario was selected for evaluation as it represents the worst-case predicted flow reductions observed in the hydrologic modelling. Detailed results of this modelling exercise are presented in Section 5.6.6.1.4. The 10^{th} percentile flow conditions were chosen to be representative of dry-year conditions in the catchment.

By resolving the Shallow Water equations (SWE) or Diffusion Wave equations (DWE), the program determines the characteristics of the resulting flow as it propagates downstream. Manning's roughness coefficients are required by the HEC-RAS model to calculate energy losses due to friction between cross-sections. Manning coefficients were estimated based on analysis of aerial imagery and consultation of available literature. Manning's coefficients of 0.04 was chosen for the main river channel.

The geometric representation of the Gold Brook main channel and of the adjacent flood prone areas is required for the hydrodynamic model that is used to estimate flow depths, extents, and velocities. Geometric details are represented with digital terrain models, which assemble available topographic and bathymetric data for the studied site.

The DEM of the study area has 1-meter by 1-meter planar resolution that provides a generalized representation of both surface and ground features. The obtained DEM was hydrologically corrected. The depressions in the DEM were filled. The stream network was burned into the DEM using the available bathymetric transects so that there would be a continuous flow path.

The hydrodynamic model also requires upstream and downstream boundary conditions to calculate the hydraulic conditions in the reach. Upstream boundary conditions used in the hydrodynamic model were flows derived from the water balance model for Baseline and West Pit EOM conditions. Downstream boundary condition is an assumed normal water level of 29.82 m at Seal Harbour Lake.

5.8.5.2.2 Gold Brook Lake Hydraulic Model

The impact of the proposed mine development on the water levels in Gold Brook Lake were assessed by routing the baseline and West Pit EOM daily flow records through the lake storage using the HEC-HMS software and comparing the corresponding lake level results. Lake inflow is equal to the sum of the total runoff from the natural drainage areas of the lake and discharge from a combination of the north settling pond, central settling pond, East Pit, West Pit, and TMF water treatment facility, depending on the mine development phase. Lake outflow is equal to lake inflow minus lake evaporation, water demand withdraws during operations and lake flow routing effects. The lake outflow is calculated at the Lake Outlet assessment point.

The assessment was performed using 50 realizations of the daily flow time series for each of the baseline and West Pit EOM conditions based on 50 years of the historical climate record. The West Pit EOM development phase was selected for this analysis, because the largest reductions in flow volume on Gold Brook are predicted to occur during this year on an average annual basis. The active storage volume of the lake was equated to a water surface elevation using a stage-storage relationship, calculated from the lidar for the site. It is assumed that the water surface elevation in the lidar represents permanent lake level, which would correspond to the invert elevation of the two 1,800 mm diameter corrugated steel pipe (CSP) culverts that control the outflow from the lake to Gold Brook.

5.8.5.2.3 Interpretation of Regulatory Guidelines

Effects to fish and fish habitat through flow reductions have been assessed using guidance outlined in the Framework for Assessing the Ecological Flow Requirements to support Fisheries in Canada (DFO, 2013). According to DFO (2013), “The scientific literature supports natural flow regimes as essential to sustaining the health of riverine ecosystems and the fisheries dependant on them. Riverine ecosystems and the fisheries they sustain are placed at increasing risk with increasing alteration of natural flow regimes”.

Riverine systems are naturally dynamic, with seasonal and annual variability; as a result, determination of the occurrence and extent of an effect to fish and fish habitat can be difficult to determine. To support this determination, DFO (2013) provides the following guidance:

- “Cumulative flow alterations <10% in amplitude of the actual (instantaneous) flow in the river relative to a “natural flow regime” have a low probability of detectable effects to ecosystems that support commercial, recreational or Aboriginal fisheries. Such projects can be assessed with “desktop” methodologies.
- Cumulative flow alterations that result in instantaneous flows < 30% of the MAD have a heightened risk of impacts to fisheries.

For cumulative water use >10% of the instantaneous discharge or that results in flows < 30% of the MAD, a more rigorous level of assessment is recommended to evaluate potential impacts on ecosystem functions which support fisheries”. It is worth noting that further guidance on more rigorous assessment methods and interpretation of results is not provided by DFO (2013).

A key limitation of the Ecological Flow Requirement guidance identified by DFO (2013) is that the determination of effects to fish and fish habitat are not well understood in intermittent, seasonal, or ephemeral watercourses. The in-stream flow needs for watercourses that naturally lack flow at certain times of the year are not well understood, and guidance is lacking to determine effects to fish habitat in these systems. As a result, if these systems are encountered in the effects assessment, a determination will be made based on known physical parameters of the watercourse, known or expected fish usage, and predicted alterations in the natural flow regime. Of the watercourses with expected indirect impact, the majority are small perennial streams, though WC9 is classified as having intermittent portions, WC11 is described as ephemeral, and WC19-20 are discontinuous and partially subterranean in the upper reach.

The Projects predicted effects to watercourses were modelled at a suite of 29 assessment points (Figure 5.6-5), under three scenarios:

- East Pit EOM: This represents the end of extraction of the East Pit, which is expected in Year 8 of operations. It will have been mined to its full potential and will begin to fill with water in accordance with the proposed mine reclamation plan. Till and organic stockpiles will have been removed and/or used as cover material for the WRSAs. The will and organics stockpile areas will drain to their baseline receivers.
- West Pit EOM: This represents the end of extraction of the East Pit and the West Pit; also known as the end of the operations phase (Year 11). At this point, extraction will be complete, and the pit will begin to fill with water. The employee accommodations area will be removed and restored to baseline conditions. During this phase, neither pit is filled with water.

- Closure: This represents the timeframe when extraction has completed within both pits, and both pits have refilled to form end pit lakes (Year 35). Overflow from the pits will be directed to Gold Brook Lake.

The three phases have all been compared to baseline (natural flow regime). The hydrologic model was run through 50 iterations (climate years) on a daily timestep to capture the natural seasonal and annual variability in discharge. The determination of effects was completed in two steps:

- comparison of baseline and individual phase hydrographs with a ‘normal year’ hydrograph (median, or 50th percentile of the 50 year climate record; selected as the year 1986 based on 50th percentile mean annual precipitation).
- comparison of baseline and individual phase hydrographs based on a ‘dry year’ (10th percentile of the 50 year climate record) assessment for selected assessment points. The year 2001 was selected based on the 10th percentile mean annual precipitation.

For the first component of this evaluation, the median output of the hydrometric model was selected to prepare the “normal” year hydrograph. Modelled flow data was then compared to baseline flow data to identify the following parameters:

- A hydrograph showing daily flow for each individual Project phase compared with baseline daily flow.
- The change in flow from baseline to each individual Project phase was calculated and presented on a bar chart as a percent change from baseline.
- Summary of the number of days per year with a predicted change of greater than 10% from baseline.
- Summary of the number of days per year each system naturally falls below the 30% MAD. This is compared with the predicted number of days that the system would fall below 30% MAD within each Project phase. This identifies whether, in a ‘normal year’, the low flow period would be exacerbated or reduced.

The complete series of median (Q50) hydrographs and associated statistics are provided in Appendix H.2. Based on this initial assessment, a clear determination of effects could be made at particular assessment points; meaning that the impacts were substantial enough to form a conclusion related to HADD of fish habitat. Other assessment points were identified to require additional (more rigorous) assessment using a modelled low-flow year (i.e., effects were not substantial enough to make a determination of HADD of fish habitat based only on the 50th percentile output of the model). Additional assessment was determined to be required for two specific reasons:

- An effect is expected (i.e., greater than 10% change in flow is predicted), but additional assessment was determined to identify whether fish passage could be limited during a low-flow year to upstream fisheries resources, or,
- No effect is expected in a ‘normal year’ (i.e., no predicted reduction in flow greater than 10%); however Project interactions <10% change could result in exacerbation of the low flow period (<30% MAD). This is a conservative interpretation of the DFO ecological framework to carry these systems forward for additional assessment, where the framework states that the “Cumulative flow alterations <10% in amplitude of the actual (instantaneous) flow in the river relative to a “natural flow regime” have a low probability of detectable effects to ecosystems that support commercial, recreational or Aboriginal fisheries.”

This second phase of the evaluation was completed in a similar manner to the first phase, however hydrographs and associated descriptive statistics were prepared using the ‘dry year’ scenario, rather than the ‘normal year’ scenario. It is important to note that hydrologic systems are incredibly complex; in any given year, a watercourse can experience a high peak flow and a dry low flow period. As a result, it is difficult to synthesize 50 years worth of climate data into a simple determination of effects.

The area of indirect impact to fish and fish habitat is quantified conservatively based on the total area of each watercourse, water body or wetland mosaic. Habitat measurements were recorded using methods outlined in detail in the Fish and Fish Habitat Baseline Report (Appendix H.1). In some cases, based on the extent and timing of a predicted effect, Signal Gold has suggested a revised offsetting ratio to account for variability in flow reduction effects (for example, an 11% reduction in flow year-round will be proposed for offsetting at a lower ration than a system with a predicted 98% reduction in flow). The HADD has been calculated based on the total area of each watercourse, waterbody or wetland mosaic. This approach is highly conservative, as these streams are expected to still provide fish habitat, albeit changed fish habitat.

5.8.5.3 Thresholds for Determination of Significance

A significant effect to fish and fish habitat is defined as:

- A Project-related HADD of fish habitat or the death of fish, as defined by the Fisheries Act, that cannot be mitigated, or offset; and an unauthorized Project-related alteration of fish habitat.

The characterization criteria for environmental effects are outlined in Table 5.8-3.

Table 5.8-3 Characterization Criteria for Environmental Effects

Characterization	Quantitative Measure or Definition of Qualitative Categories
Magnitude	<u>N</u> – no detectable change in fish habitat quantity or quality: – Less than 1% change in surface flow – No direct loss of fish habitat <u>L</u> – a measurable change in fish habitat quantity or quality, but within natural variation with consideration of the following variables: – Less than 10% change in surface flow not affecting the ability of fish to use the habitat to carry out one or more life processes – No direct loss of fish habitat <u>M</u> – a measurable change in fish habitat quantity or quality which partially limits the ability of fish to use the habitat to carry out one or more life processes (i.e., an effect which occurs only seasonally) with consideration of the following variables – Less than 25% change in surface flow not affecting the ability of fish to use the habitat to carry out one or more life processes – Partial direct loss of fish habitat <u>H</u> – a measurable change in fish habitat quantity or quality to an extent which limits the ability of fish to use the habitat to carry out one or more life processes with consideration of the following variables – More than 25% change in surface flow not affecting the ability of fish to use the habitat to carry out one or more life processes – Complete direct loss of fish habitat
Geographic Extent	<u>PA</u> – direct and indirect effects from Project activities are restricted to the PA <u>LAA</u> – Residual effects extend into the LAA <u>RAA</u> – not defined for this assessment.
Timing	<u>N/A</u> — seasonal aspects are unlikely to affect VCs <u>A</u> — seasonal aspects may affect VCs
Duration	<u>ST</u> – effects are limited to occur from as little as 1 day to 12 months <u>MT</u> – effects can occur beyond 12 months and up to 3 years <u>LT</u> – effects extend beyond 3 years <u>P</u> – valued component unlikely to recover to baseline conditions
Frequency	<u>O</u> – effects occur once <u>S</u> – effects occur at irregular intervals throughout the Project <u>R</u> – effects occur at regular intervals throughout the Project <u>C</u> – effects occur continuously throughout the Project

Table 5.8-3 Characterization Criteria for Environmental Effects

Characterization	Quantitative Measure or Definition of Qualitative Categories
Reversibility	**RE** – VCs will recover to baseline conditions before or after Project activities have been completed. **PR -** mitigation cannot guarantee a return to baseline conditions **IR** – effects to VCs are permanent and will not recover to baseline conditions

5.8.6 Project Interactions and Potential Effects

The intention of this section is to describe the expected project interactions and potential effects to fish and fish habitat, that could result from development of the Project, based on a review of DFO's Pathways of Effects guidance. Table 5.8-4 provides a summary of potential effects, effects pathways and measurable parameters used throughout the effects assessment.

Table 5.8-4 Potential Effects to Fish and Fish habitat, Effects Pathway, and Measurable Parameters for Fish Habitat

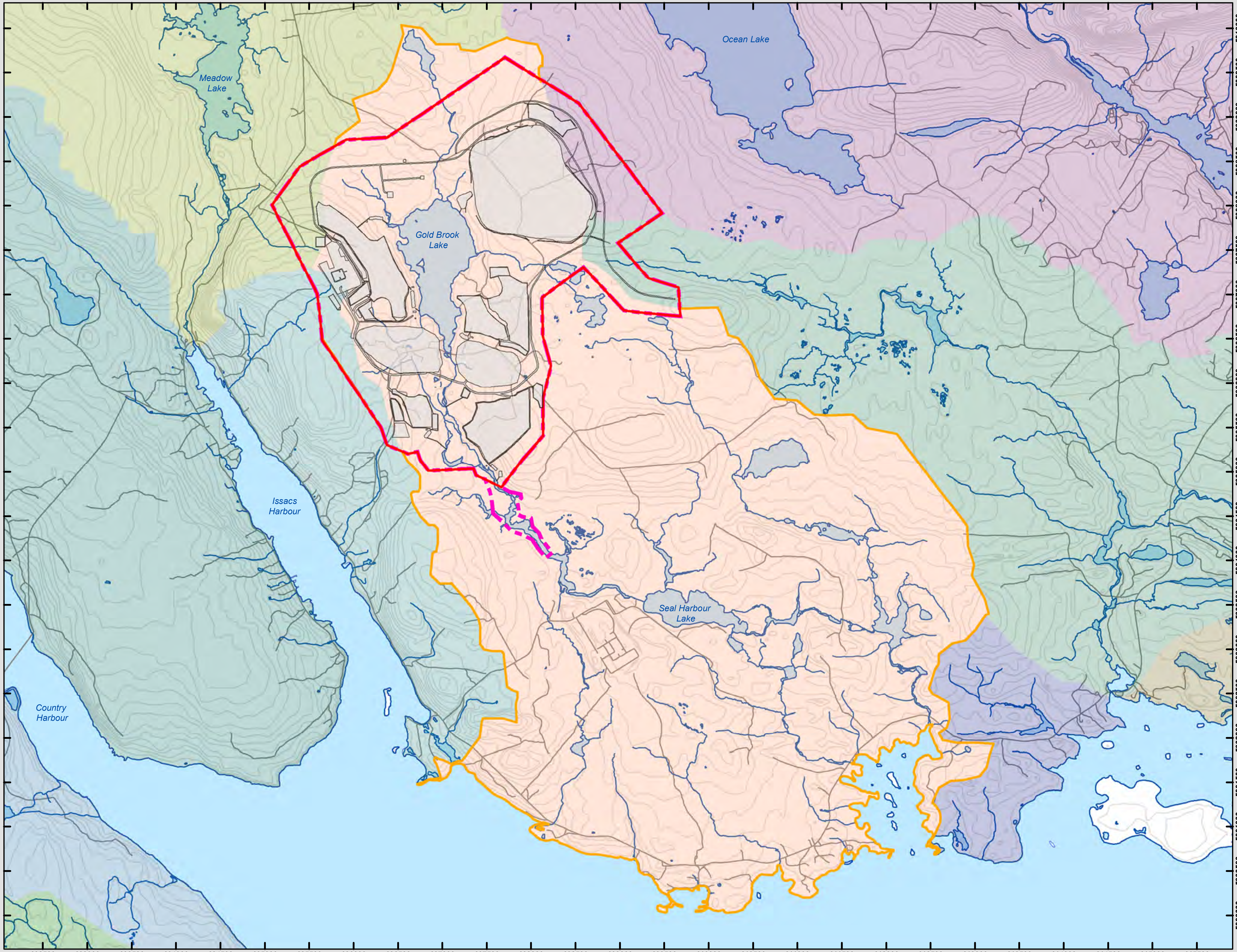
Impact Type	Potential Effect	Effect Pathway	Measurable Parameter(s)
Direct Impacts	Change in fish habitat quantity	- Direct removal of fish habitat through dewatering, re-routing, infill, excavation, or road crossing	- Area of direct impact to fish habitat
Indirect Impacts	Change in fish habitat quality	- Change in catchment area and resultant changes in flow - Changes in water quality through mine water management practices - Release of deleterious substances	- Water level and monthly flow - Water quality compared with relevant guidelines - Fish habitat suitability
	Change in fish health and survival	- Use of industrial equipment in or near water - Release of deleterious substances - Changes in water quality through mine water management practices - Blasting in or near fish habitat - Impingement or entrainment of fish through water management activities	- Abundance - Mortality - Sublethal effects to fish

The effects assessment to fish habitat is completed with the understanding that an authorization under the *Fisheries Act* will be required due to unavoidable direct and indirect impacts to fish habitat. Modelling exercises were completed to support predictions of Project interactions on groundwater, and surface water quality and quantity; and considered in terms of the effects on the fish which reside in surface water features within the FHSA. Table 5.8-5 identifies reasonably foreseeable Project activities and their potential effects on Fish and Fish Habitat. Where an interaction between the Project and Fish Habitat is not expected, that relevant Project Activity is not included in the table below (i.e., waste management, site maintenance and repairs). Effects to fish and fish habitat that may occur through accidents and malfunctions are described in Section 5.14.

Table 5.8-5 Project Activities and Fish Habitat Interactions

Project Phase	Duration	Relevant Project Activity
Construction	2 years	Clearing, grubbing, and grading
		Drilling and rock blasting
		Topsoil, till, and waste rock management
		Surface infrastructure installation and construction
		Haul road construction
		TMF construction
		Collection ditch and settling pond construction
		Watercourse and wetland alteration
Operations	11 years	Drilling and blasting
		Open pit dewatering
		Ore management
		Waste rock management
		Surface water management
		Cyanide and reagent management
		Tailings management
		Water treatment
Closure	24 years	Demolition
		Earthworks
		Water treatment

Table 5.8-6 provides a summary of all fish habitat which was identified within the PA (Figure 5.8-2). It outlines the determination of which habitats were carried through the effects assessment, based on expected direct or indirect effects. Fish habitat with predicted effects are carried through the effects assessment and carried forward into Table 5.8-7. Table 5.8-7 provides details related to the type of potential project interaction, effect pathway, commencement of proposed impact and duration of proposed impact.



Prepared For:

SIGNAL GOLD

FIGURE 5.8-2

Goldboro Gold Project

Fish and Fish Habitat Spatial Boundaries and Secondary Watersheds

Goldboro, NS

Legend	
Proposed Infrastructure	
EARD Project Area	
Fish Habitat Local Assessment Area	
Fish Habitat Study Area	

Secondary Watersheds

- 1EP-1
- 1EP-SD1
- 1EP-SD11
- 1EP-SD12
- 1EP-SD2
- 1EQ-4
- 1EQ-SD28
- 1EQ-SD29
- 1EQ-SD30
- 1EQ-SD31

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 500 1,000 2,000 m

1:40,000 Scale when printed @ 11" x 17"

Drawn By: MMD
Reviewed By:MM

Date: 2022-05-20

McCallum Environmental Ltd.

Document Name: 220519_FigXX-1_LAA

Table 5.8-6 Summary of Fish Habitat Evaluated in the Effects Assessment

Secondary Watershed	Fish Habitat	Impact Proposed	Carried through Effects Assessment
Gold Brook (1EQ-SD31)	WC1	Direct	Yes
	WC2	Direct	Yes
	WC3	Direct and indirect	Yes
	WC4*	Direct	Yes
	WC5	Direct	Yes
	WC6	Direct	Yes
	WC7	Direct	Yes
	WC8	Direct	Yes
	WC9	Direct and indirect	Yes
	WC10	Indirect	Yes
	WC11	Direct and indirect	Yes
	WC12	Direct	Yes
	WC13	Direct	Yes
	WC14	Indirect	Yes
	WC15	Direct	Yes
	WC16	Indirect	Yes
	WC19	Indirect	Yes
	WC20	Indirect	Yes
	WC22	Direct and Indirect	Yes
	WC23	Direct	Yes
	WC24	Indirect	Yes
	WC39	Direct	Yes
	WC43	Direct	Yes
	WC45	Direct	Yes
	WC47	Direct	Yes
	WC49	Direct	Yes
	WC50	Indirect	Yes
	WC51	Direct	Yes
	WC52	Direct	Yes
	WC55	Indirect	Yes
	WC56	None	No
	WC57	Direct	Yes

Table 5.8-6 Summary of Fish Habitat Evaluated in the Effects Assessment

Secondary Watershed	Fish Habitat	Impact Proposed	Carried through Effects Assessment
	WC58	Direct	Yes
	WC59	Direct	Yes
	WC60	None	No
	WC61	Direct	Yes
	WC62	None	No
	WC63	Direct	Yes
	WC64 (Gold Brook)	Direct and Indirect	Yes
	WC65	Direct	Yes
	WC66	None	No
	WC67	None	No
	WC68	None**	No
	WC69	None	Yes***
	WC71	None	No
	WC72	Direct	Yes
	WC73	None	No
	WC81	Direct	Yes
	WC82	None	No
	WC83	None	No
	WC86	None	No
	WC94	None	No
	WC96	None	No
	WC98	None	No
	WC99	Direct	Yes
	Wetland Mosaic A	Indirect	Yes
	Wetland Mosaic B	Indirect	Yes
	Settling Ponds	Indirect	Yes
	Beaver Pond	Direct	Yes
	Gold Brook Lake	Indirect	Yes
	Rocky Lake	Indirect	Yes
Isaacs Harbour Shore Direct (1EP-SD1)	WC17	None	No
	WC21	None	No
	WC54	None	No

Table 5.8-6 Summary of Fish Habitat Evaluated in the Effects Assessment

Secondary Watershed	Fish Habitat	Impact Proposed	Carried through Effects Assessment
	WC70	None	No
Isaacs Harbour River (1EP-1)	WC53	None	No
Coddles Harbour Shore Direct (1EQ-SD29)	WC77	None	No
	WC85	None	No
	WC87	None	No
	WC88	Direct	Yes
New Harbour River (1EQ-4)	WC44	None	No
	WC81	Direct	Yes

* WC4 is shown as being located within the 1EP-SD1 watershed based on provincially mapped watersheds. Based on field verification; however, we have confirmed that it flows into Gold Brook Lake, and is therefore within the 1EQ-SD31 watershed.

**Current infrastructure layout shows a haul road impact to WC68; this will be refined to avoid WC68 during detailed design and micro-siting of the haul road.

***Carried through effects assessment as an upstream control point for flow reduction.

The following watercourse numbers lie outside of the PA: WC18, 25-38, 40-42, 46, 48, 74-76, 78-80, 84, 89-93, 95, and 97

Table 5.8-7 Overview of Potential Project Interaction Types, Commencement, and Duration

Fish Habitat	Potential Interaction Description	Potential Interaction Type	Duration of Interaction
WC1	Interruption of flow and Haul Road	Direct	Permanent
WC2	West Pit	Direct	Permanent
WC3	Interruption of flow and Haul Road	Direct	Permanent
WC3	Flow reduction from upstream impacts	Indirect	Permanent
WC4	Ditch, Haul Road and interruption of flow	Direct	Permanent
WC5	Haul Road	Direct	Permanent
WC6	Interruption of flow and Haul Road	Direct	Permanent
WC7	Interruption of flow and Haul Road	Direct	Permanent
WC8	Interruption of flow and Haul Road	Direct	Permanent
WC9	Water management crossing	Direct	Permanent
WC9	Flow reduction	Indirect	Permanent
WC10	Flow reduction	Indirect	Permanent
WC11	West Pit and flow reduction	Indirect	Permanent
WC12	East Pit	Direct	Permanent
WC13	Flow reduction	Direct	Permanent

Table 5.8-7 Overview of Potential Project Interaction Types, Commencement, and Duration

Fish Habitat	Potential Interaction Description	Potential Interaction Type	Duration of Interaction
WC14	Flow reduction	Indirect	Permanent
WC15	TMF and flow reduction	Direct	Permanent
WC16	Flow reduction	Indirect	Permanent
WC19	Flow reduction	Indirect	Permanent
WC20	Flow reduction	Indirect	Permanent
WC22	Haul Road	Direct	Permanent
WC23	Flow reduction	Direct	Permanent
WC24	Flow reduction	Indirect	Permanent
WC39	Haul Road	Direct	Permanent
WC43	TMF	Direct	Permanent
WC45	TMF	Direct	Permanent
WC47	TMF	Direct	Permanent
WC49	TMF	Direct	Permanent
WC50	Flow reduction	Indirect	Permanent
WC51	Haul Road	Direct	Permanent
WC52	Haul Road	Direct	Permanent
WC55	Flow reduction	Indirect	Permanent
WC57	TMF	Direct	Permanent
WC58	Haul Road	Direct	Permanent
WC59	Complete loss of catchment area from TMF	Direct	Permanent
WC61	Flow reduction	Direct	Permanent
WC63	Flow reduction	Direct	Permanent
WC64 (Gold Brook)	Haul Road	Direct	Permanent
WC64 (Gold Brook)	Flow reduction	Indirect	Permanent
WC65	Flow reduction	Direct	Permanent
WC72	Haul Road	Direct	Permanent
WC81	Haul Road	Direct	Permanent
WC88	Haul Road	Direct	Permanent
WC99	TMF	Direct	Permanent
Wetland Mosaic A	Flow reduction	Indirect	Permanent
Wetland Mosaic B	Flow reduction	Indirect	Permanent
Settling Ponds	Flow reduction	Indirect	Permanent
Beaver Pond	West Pit	Direct	Permanent

Table 5.8-7 Overview of Potential Project Interaction Types, Commencement, and Duration

Fish Habitat	Potential Interaction Description	Potential Interaction Type	Duration of Interaction
Gold Brook Lake	Flow reduction	Indirect	Permanent
Rocky Lake	Flow reduction	Indirect	Permanent

5.8.6.1 Direct Impacts

The Project will require direct impacts to fish habitat to support infrastructure development. Direct impacts are defined as:

- Any impact which directly overprints fish habitat.
- In some cases, direct impacts include sections of downstream habitats, if significant direct impacts to headwater habitats are proposed which will result in a complete loss of habitat in a downstream section of stream.
- Similarly, if direct impact prevents fish passage to an upstream portion of a watercourse and fish passage structures are not practical or viable, the upstream portion may be considered as a direct impact.

Considering the effects pathways identified in Table 5.8-4, direct impacts are those project interactions which are expected to result in a change in fish habitat quantity, measured in square meters of lost habitat. The pathways of effects to fish habitat quality and fish health and survival are described in detail under indirect impacts, mostly based on predicted flow reductions in stream systems and reduction in water levels in lotic environments associated with mine water management requirements during operations and closure phases of the Project.

As described in the baseline program methodology section and in Appendix H.1, detailed habitat assessments were completed on all fish habitat with predicted direct or indirect impacts. Detailed transect measurements were recorded at a 50-m frequency within each individual watercourse reach. The bankfull width of each transect survey point was used along with reach length to calculate the impact area. Where impact is proposed to an open water feature or wetland mosaic, the delineated polygon is used to calculate impact area.

For the effects assessment, the qualitative watercourse description for WC99 has been considered, and the detailed habitat descriptions available for WC3 and WC4 have been extrapolated to include the upstream reaches. Detailed habitat descriptions for these three watercourses will be completed during the summer of 2022 and conclusions relating to direct impact to these systems will be updated, if and as required, at the permitting stage.

Shifts in road alignment are expected during the detailed design phase in areas where haul roads cross several watercourses (i.e., WC39 and 14) to reduce impacts and ensure NSECC guidance relating to watercourse crossings are fully considered (i.e. crossings should be perpendicular to the watercourse) (NSE, 2015). These watercourse crossings were included as direct impacts. The proposed haul road alignment shifted following completion of detailed habitat assessment (i.e., WC58, WC51) and thus, quantitative habitat assessments are not yet completed for the specific crossing location. For these proposed impacts, qualitative descriptions were used to estimate direct impact area, and further detail will be collected in the field once detailed design and engineering of the road has been completed, prior to permitting.

In addition, the current haul road design overprints a section of WC68; the Proponent commits to avoiding this section of the watercourse in subsequent detailed design to minimize direct impacts, and thus, direct impact to this section of watercourse has not been included in fish and fish habitat impact estimates in this EARD.

A haul road is proposed to cross Gold Brook (WC64); this is described as a direct impact of 127 m^2 of fish habitat. At this time, the Proponent has not committed to any specific crossing type as detailed engineering is not yet complete but has calculated a conservative direct impact assuming a pipe culvert installation. Given the width of Gold Brook and the braided nature of the channel, the Proponent will continue to engage with NSECC and complete necessary detailed design to identify the most appropriate stream crossing type at this (or a nearby) location.

Throughout the construction phase, direct impacts to fish and fish habitat are expected to occur through construction of site roads, water management structures such as ditching systems, pit development, and commencement of the TMF. Wetland and watercourse alteration will commence to prepare the site for infrastructure development.

Construction of the till and organic stockpiles, mill area, and employee accommodations will all occur during the construction phase; though none will result in direct impact to fish habitat, due to micro-siting efforts to avoid impacts. During this stage, site preparation including clearing, grubbing and de-watering of the East and West Pit areas will result in direct impacts to fish habitat.

During the operations phase, WRSAs will be constructed; however no additional direct impacts to fish habitat are proposed during this phase. Indirect impacts are expected through the operations phase primarily through pit dewatering, ore, waste rock and tailings management, and water management. Similarly, no additional direct impacts are expected through the closure phase but indirect impacts will continue through this phase due to on-going water management, and overall permanent changes in surface water movement within the PA.

Summary of Direct Impacts

Throughout the construction, operations and closure phases of the Project, direct impact to fish and fish habitat is required to facilitate Project development. Impact areas have been quantified in m^2 in Table 5.8-8 and shown on Figure 5.8-3.

Table 5.8-8 Summary of Direct Impact to Fish Habitat

Water-shed	Fish Habitat	Stream Order	Fish species known or expected	Infrastructure	Habitat Type(s)	**Length (m)**	**Wetted Width (m)**	**Bankfull Width (m)**	**Number of Transects**	**Area (m^2)**
1EQ-SD31	WC1	1	BKT, EEL	West Pit, Haul Road	Riffle, Run	363	0.5-2.1	1.4-2.1	6	660
	WC2	1	BKT, EEL	West Pit	Flat	212	0.4-0.8	0.8-1.4	4	259
	WC3	1	BKT, BKF, EEL, GSH, YLP	West Pit	Run	957	0-0.8	0.5-1.8	10	850
	WC4	1-2	BKT, EEL	Haul Road, Ditch, West Pit	Flat, Riffle-run	1191	0.65-2.0	0.9-2.6	2	1554
	WC5	1	BKT, EEL	West Pit	Run	260	0.0	0.4-0.5	2	119
	WC6	1	BKT, EEL	Ditch	Riffle-run	104	0.0-0.5	0.5-0.9	3	69
	WC7	1-2	BKT, EEL	West Pit, Haul Road	Riffle-run	485	0.0-1.5	0.5-1.5	8	422
	WC8	3	BKF, BKT, BNS, EEL, GSH, YLP	West Pit	Run, Riffle, Pool	534	0.0-1.55	0.65-2.4	3	594
	WC9	1	BKF, BKT, BNS, EEL, GSH, YLP	Northeast Till Stockpile, Ditch	Run	110	0.0	0.8	1	9
	WC11	1	BKF, BKT, EEL, GSH, YLP	Haul Road, East Pit	Flat	1073	0.3-1.45	0.3-1.7	15	963

Table 5.8-8 Summary of Direct Impact to Fish Habitat

Water-shed	Fish Habitat	Stream Order	Fish species known or expected	Infrastructure	Habitat Type(s)	**Length (m)**	**Wetted Width (m)**	**Bankfull Width (m)**	**Number of Transects**	**Area (m²)**
	WC12	1	BKF, BKT, EEL, GSH, YLP	East Pit	Flat	389	0.0-2.3	0.3-2.7	6	609
	WC13	1	BKF, BKT, BNS, EEL, GSH, YLP	Flow Reduction	Flat	87	0.55-1.0	0.65-1.25	2	83
	WC15	2	BKT, EEL	TMF	Flat, Riffle, Riffle-run	1358	0.25-2.5	0.25-2.9	11	1894
	WC22	2	BKF, BKT, BNS, EEL, GSH, YLP	Haul Road	Riffle-run	15	4.7	4.98	1	74
	WC23	1	BKF, BKT, BNS, EEL, GSH, YLP	Flow reduction	Flat	169	0.95-1.1	1.2-1.5	2	225
	WC43	1	BKT, EEL	TMF	Flat	684	0.3-1.5	0.5-1.6	11	725
	WC45	1	BKT, EEL	TMF	Riffle, Flat	640	0.5-1.85	0.6-1.85	7	708
	WC47	1	BKT, EEL	TMF	Flat	47	0.65	0.8	1	38
	WC49	1	BKF, BKT, BNS, EEL, GSH, YLP	TMF and flow reduction	Flat	858	0.25-1.3	0.55-1.55	12	943
	WC51	1	BKF, BKT, EEL, YLP	Haul Road	Flat	14	0.8	1.35	1	149
	WC52	2	BKF, BKT, EEL, YLP	Haul Road	Flat	117	1.0	1.0	1	117
	WC57	1	None	TMF	Riffle-run, Riffle	441	0.6-1.1	0.95-1.35	7	460
	WC58	1	BKT, EEL	Haul Road	Flat	12	0.4	0.6	1	7
	WC59	1	N/A	TMF	Flat	120	0.0-0.5	0.8-0.95	2	107
	WC61	1	BKF, BKT, BNS, EEL, GSH, YLP	Flow Reduction	Riffle-run	81	0.4-0.85	0.6-1.0	2	67
	WC63	1	BKF, BKT, BNS, EEL, GSH, YLP	Flow Reduction	Riffle	57	0.45	0.6	2	63
	WC64 (Gold Brook)	3	BKF, BKT, BNS, EEL, GSH, YLP	Haul Road	Riffle	25	4.2-5.05	4.7-5.2	1	127

Table 5.8-8 Summary of Direct Impact to Fish Habitat

Water-shed	Fish Habitat	Stream Order	Fish species known or expected	Infrastructure	Habitat Type(s)	**Length (m)**	**Wetted Width (m)**	**Bankfull Width (m)**	**Number of Transects**	**Area (m^2)**
	WC65	1	BKF, BKT, BNS, EEL, GSH, YLP	Flow Reduction	Riffle	57	0.45	0.6	1	34
	WC72	1	N/A	Haul Road	Flat	13	2.0	2.0	1	26
	WC99	1	N/A	TMF	Run	242	0.75	1.0	0	242
	Beaver Pond	3	BKF, BKT, BNS, EEL, GSH, YLP	West Pit	Open water	N/A	N/A	N/A	0	4060
1EQ-4	WC81	1	N/A	Haul Road	Flat	13	2.2	2.2	1	29
1EQ-SD29	WC88	1	N/A	Haul Road	Flat	14	0.75	0.75	1	10
Total (m^2)										16,296
Total (Habitat Units)										162.96

Items in bold will be listed under Schedule 2 of the MDMER.

As outlined in Table 5.8-8, direct impacts to fish habitat are required for 32 watercourses and one open water feature (the Beaver Pond, located within WL18). With the exception of Gold Brook (where a haul road crossing is proposed), WC8, and the associated beaver pond within WL18, all fish habitat proposed for direct impact are first and second order watercourses. WC8 is a third order watercourse, however it is relatively small and disturbed with discontinuous flow, particularly in the downstream reach as it approaches Gold Brook Lake. In total, 16,296 m^2, or 162.96 habitat units will require authorization under the *Fisheries Act.*

The *Fisheries Act* prohibits the deposition of mine waste into a natural waterbody considered “waters frequented by fish”. However, if this is required, a Proponent can request an amendment to Schedule 2 of the MDMER, administered by ECCC. Schedule 2 lists waterbodies frequented by fish that have been approved to be used as Tailings Impoundment Areas (TIAs). To be added to Schedule 2, a regulatory amendment is required. TIAs are broadly defined by ECCC as tailings, waste rock, till and organics stockpiles, low grade ore, settling ponds, ditch lines etc. To receive an addition to Schedule 2, the Proponent must complete a comprehensive assessment of the alternatives to disposal of mine waste in a waterbody frequented by fish.

Considerable micro-siting of project infrastructure has occurred to reduce overall impacts to fish habitat, which is described in detail in Section 2.8 (Alternative Means of Carrying out the Project). Watercourses underlain by the TMF (WC15, 43, 45, 47, 49, 57, 59, and 99) will require addition to Schedule 2 of the MDMER to allow for deposition of mine waste into waters frequented by fish (Figure 5.8-3). All other mine waste deposition will avoid waters frequented by fish (Waste Rock Piles, ditches and settling ponds, and other stockpiles for organics, till, overburden, and low-grade ore).

The Project layout has been developed to avoid direct impacts to any lacustrine environments; no direct impact is required for any lakes within the LAA, including Oak Hill Lake, Rocky Lakes and Gold Brook Lake.

Impacts related to the development of the open pits, pit perimeter berm, TMF and internal haul roads are expected to be permanent. In addition, direct impact is expected to occur in small first-order streams where the headwater or a large component of the catchment area will be removed (i.e., WC13, WC23, WC49, WC61, WC63 and WC65). While these situations do not involve direct infrastructure placement on fish habitat, they were conservatively counted as a direct loss based on professional judgement and familiarity with the baseline conditions, and proposed Project

Interactions in the headwaters. Those systems expected to experience more moderate or small flow reductions will be evaluated in further detail in the indirect effects section, supported by hydrological modelling data.

As part of the open pit development, the fish access between Gold Brook Lake, through WC8 and upstream to WC4, 5, 6, and 7 will be removed (Figure 5.8-3). Based on the results of fishing surveys and fish habitat assessments, fish passage is currently limited upstream into the upper reaches of this system, based on subterranean flows in WC8 and potentially limited passage through the Beaver Pond. Throughout all fish collection completed between 2018 and 2021, fish have not been captured or observed in WC4-7. In 2018, five American eel and two brook trout were captured over three consecutive days of trapping within Beaver Pond in WL18; though it is possible that the same individual(s) were captured on subsequent days. Regardless of low density and poor connectivity to fish habitat, these systems (WC4-8) were determined to be fish habitat, and subject to HADD authorization under the *Fisheries Act.*

Fish habitat proposed for direct impact to support the Project is primarily used by American Eel and Brook Trout; and to a lesser extent, Yellow Perch and forage fish (Blacknose and Golden Shiner, along with Banded Killifish). In the table above, Yellow Perch is indicated as 'known or expected to be present' in various watercourses, primarily due to direct connectivity with water features known to support Yellow Perch. All Yellow Perch captured within the PA were found in Gold Brook Lake, or in very close proximity to the lake (Gold Brook at the outlet of the Lake, and in WC20/23, which constitutes an open water extension of the lake at the confluence with these watercourses). Direct impacts are therefore expected to primarily effect Brook Trout and American Eel, based on abundance and distribution, and the locations of direct impacts (only within linear stream systems). Full descriptions of fish habitats proposed for direct impact are outlined in Fish and Fish Habitat Baseline Report (Appendix H.1). A summary of fish habitat of systems proposed for direct impact (Table 5.8-7) and shown on Figure 5.8-3.

Fish rescues will occur in all watercourses to be directly impacted. Direct mortality of fish is expected to be low and limited to incidental loss of fish through fish rescue activities. MEL's recent experience with fish rescues indicates that incidental mortality typically falls in the range of less than 3% of captures, depending on site characteristics and catchability of fishes. Additional detail relating to proposed fish rescue methodology can be found in Section 5.8.7.2.

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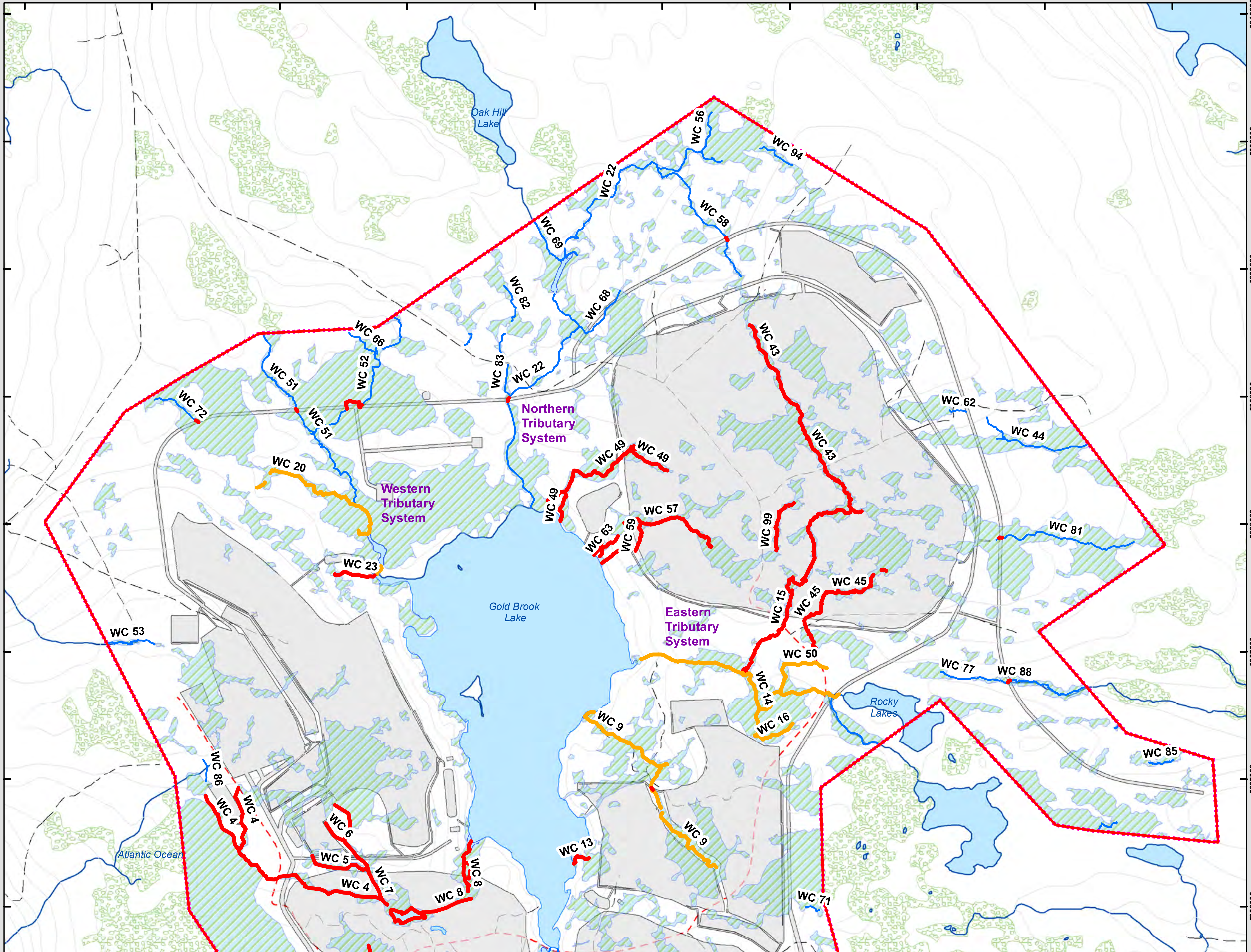
FIGURE 5.8-3a

Goldboro Gold Project

Direct and Indirect Impacts to Fish Habitat

Goldboro, NS



Impact to Fish Habitat

- Direct
- Indirect
- Field Delineated Watercourses
- NSTDB Watercourses Outside PA
- NSECC Wetland Inventory
- Proposed Infrastructure
- Wetland Mosaic
- Waterbodies
- Fish Habitat Study Area
- EARD Project Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

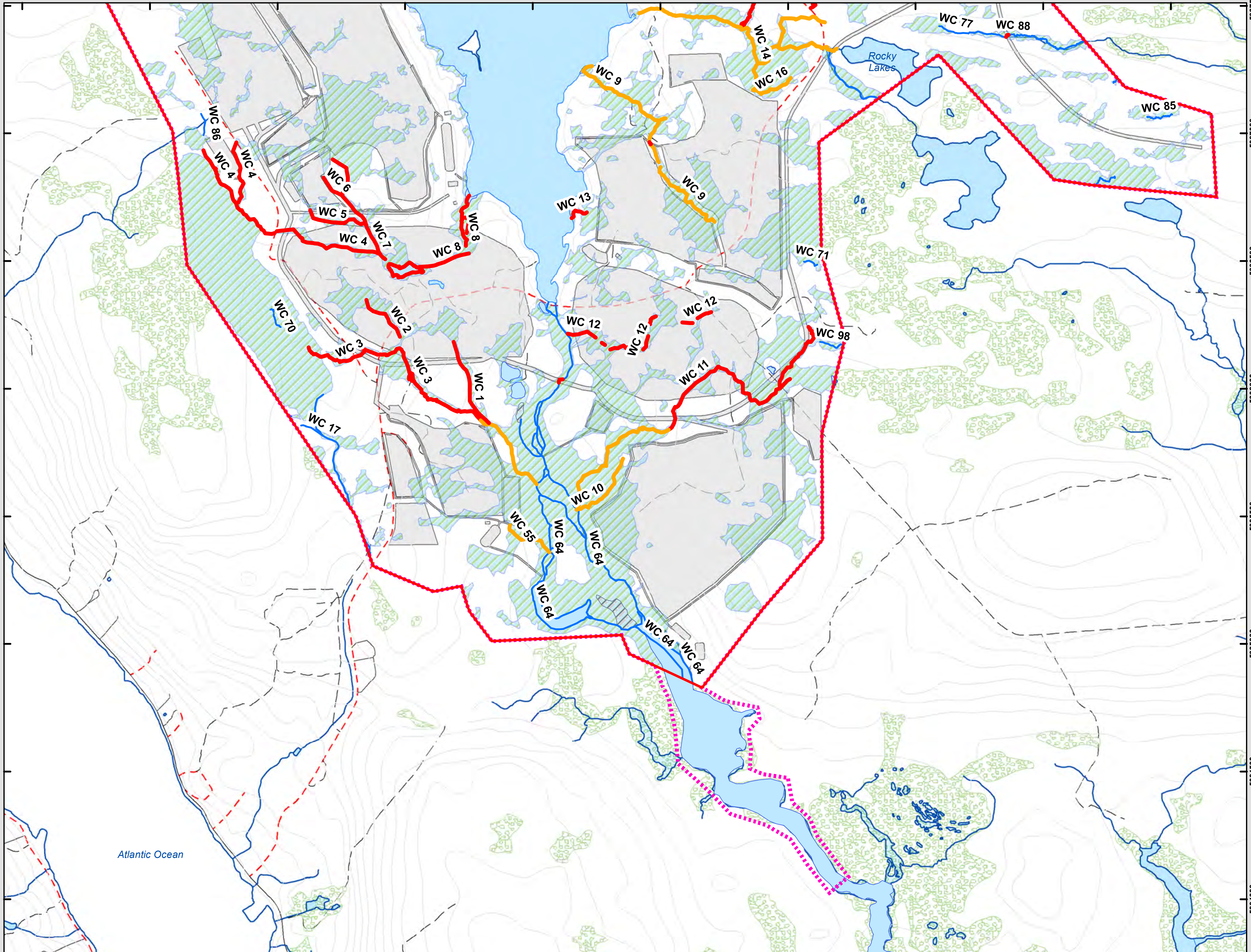
0 125 250 500 m

1:14,080 Scale when printed @ 11" x 17"

Drawn By: MMD
Reviewed By: MM
Date: 2022-05-20

McCallum Environmental Ltd.

Document Name: 220519_Fig5.8-3_Impacts



Prepared For:

SIGNAL GOLD

FIGURE 5.8-3b

Goldboro Gold Project

Direct and Indirect Impacts to Fish Habitat

Goldboro, NS

Impact to Fish Habitat

- Direct
- Indirect
- Field Delineated Watercourses
- NSTDB Watercourses Outside PA
- NSECC Wetland Inventory
- Proposed Infrastructure
- Wetland Mosaic
- Waterbodies
- Fish Habitat Study Area
- EARD Project Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 125 250 500 m

1:14,070 Scale when printed @ 11" x 17"

Drawn By: MMD
Reviewed By: MM
Date: 2022-05-20

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Document Name: 220519_Fig5.8-3_Impacts

5.8.6.2 Indirect Impacts

Indirect effects to fish and fish habitat can occur through any mechanism that affects the quality of fish habitat or changes in fish health and survival. Throughout this section, indirect effects to fish and fish habitat will be explored through the following pathways of effects:

- Changes in catchment area and resultant changes in flow driven by collection and treatment of mine water
- Changes in water quality through mine water management
- Release of deleterious substances
- Use of industrial equipment in or near water, including the risk of impingement or entrainment of fish through water management activities
- Blasting near fish habitat

5.8.6.2.1 Flow Reductions

Results of the hydrologic modelling using a daily time-step and the 50th and 10th percentile model output are provided in the following section. Throughout this section, the term 'normal year' is used to describe results based on the 50th percentile model output. The term 'dry year' is used to describe results based on the 10th percentile model output, and 'low flow' is used to describe the seasonal low flow which occurs annually when flow falls below the 30% MAD for that year.

The summary of hydrologic modelling results provided in Tables 5.8-9 and 5.8-10 includes an identification of the predicted exacerbation of the natural low flow, where project interactions could lengthen or shorten the time in which flow would normally fall below 30% MAD for that year. If the low flow period is shortened, it is described as a negative number in the last column, compared with a lengthening of the low flow period, represented by a positive number in the last column. Table 5.8-9 provides a summary of hydrologic modelling results from a normal year model output. Selected sites were evaluated under a dry year scenario; a summary of these results is provided in Table 5.8-9. Hydrographs and summary tables are provided in Appendix H.2.

Table 5.8-9 Summary of Hydrologic Modelling Results; normal year

System	Assessment Point	Phase	Range of predicted flow change	# of days per year with predicted flow reduction > 10%	Exacerbation of Low Flow (< 30% MAD) Predicted?	# of days per year change in Low Flow (< 30% MAD)
Western Tributary to GBL	WC51-US	East Pit EOM	0	0	No	0
		West Pit EOM	0	0	No	0
		Closure	0	0	Yes	1
	WC20-DS	East Pit EOM	-30 to -7	362	Yes	30
		West Pit EOM	-30 to -7	362	Yes	30
		Closure	-30 to -1	344	Yes	23
	WC20-DS1	East Pit EOM	-6 to -2	0	Yes	4
		West Pit EOM	-6 to -2	0	Yes	4

Table 5.8-9 Summary of Hydrologic Modelling Results; normal year

System	Assessment Point	Phase	Range of predicted flow change	# of days per year with predicted flow reduction > 10%	Exacerbation of Low Flow (< 30% MAD) Predicted?	# of days per year change in Low Flow (< 30% MAD)
		Closure	-6 to 0	0	Yes	7
	WC20-DS2	East Pit EOM	-11 to -3	119	Yes	9
		West Pit EOM	-11 to -3	121	Yes	9
		Closure	-11 to 0	106	Yes	14
Northern Tributary to GBL (from Oak Hill Lake)	WC69-US	East Pit EOM	0	0	No	0
		West Pit EOM	0	0	No	0
		Closure	0	0	Yes	1
	WC22-US	East Pit EOM	-3 to -1	0	Yes	1
		West Pit EOM	-3 to -1	0	Yes	1
		Closure	-4 to -1	0	Yes	2
	WC22-DS1	East Pit EOM	-8 to -4	0	Yes	4
		West Pit EOM	-8 to -4	0	Yes	4
		Closure	-10 to -4	0	Yes	7
	WC22-DS2	East Pit EOM	-8 to -4	0	Yes	4
		West Pit EOM	-8 to -4	0	Yes	4
		Closure	-9 to -4	0	Yes	7
Eastern Tributary to GBL (from Rocky Lake)	WC50-DS	East Pit EOM	-60 to -51	365	Yes	85
		West Pit EOM	-60 to -51	365	Yes	85
		Closure	-62 to -51	365	Yes	67
	WC14-US	East Pit EOM	-3 to -1	0	Yes	5
		West Pit EOM	-2 to 0	0	Yes	4
		Closure	-1 to 0	0	Yes	7

Table 5.8-9 Summary of Hydrologic Modelling Results; normal year

System	Assessment Point	Phase	Range of predicted flow change	# of days per year with predicted flow reduction > 10%	Exacerbation of Low Flow (< 30% MAD) Predicted?	# of days per year change in Low Flow (< 30% MAD)
	WC14-DS1	East Pit EOM	-29 to -15	365	Yes	15
		West Pit EOM	-28 to-15	365	Yes	15
		Closure	-31 to -15	365	Yes	16
	WC14-DS2	East Pit EOM	-61 to -25	365	Yes	36
		West Pit EOM	-61 -25	365	Yes	36
		Closure	-44 to -19	365	Yes	19
	WC14-DS3	East Pit EOM	-73 to -45	365	Yes	76
		West Pit EOM	-73 to -45	365	Yes	77
		Closure	-64 to -42	365	Yes	57
	WC14-DS4	East Pit EOM	-71 to -43	365	Yes	71
		West Pit EOM	-72 to -43	365	Yes	71
		Closure	-63 to -40	365	Yes	55
	WC16-DS	East Pit EOM	-100 to -46	365	Yes	114
		West Pit EOM	-100 to -46	365	Yes	116
		Closure	-100 to -46	365	Yes	66
WC9	WC9-DS	East Pit EOM	-60 to -49	365	Yes	82
		West Pit EOM	-44 to -40	365	Yes	67
		Closure	-21 to -21	365	Yes	46
Gold Brook Tributaries	WC3-DS1	East Pit EOM	-100 to -68	365	Yes	157
		West Pit EOM	-77 to -64	365	Yes	130
		Closure	-81 to -64	365	Yes	103
	WC3-DS2	East Pit EOM	-100 to -54	365	Yes	121

Table 5.8-9 Summary of Hydrologic Modelling Results; normal year

System	Assessment Point	Phase	Range of predicted flow change	# of days per year with predicted flow reduction > 10%	Exacerbation of Low Flow (< 30% MAD) Predicted?	# of days per year change in Low Flow (< 30% MAD)
		West Pit EOM	-70 to -49	365	Yes	82
		Closure	-68 to -47	365	Yes	64
	WC55-DS	East Pit EOM	-17 to -15	365	Yes	17
		West Pit EOM	-17 to -14	365	Yes	17
		Closure	-15 to -2	334	Yes	15
	WC10-DS	East Pit EOM	-66 to +377	362	Yes	120
		West Pit EOM	-66 to -28	365	Yes	121
		Closure	-63 to -3	352	Yes	83
	WC11-DS	East Pit EOM	-62 to +9	307	Yes	11
		West Pit EOM	-19 to +1	347	Yes	17
		Closure	-20 to +2	338	Yes	16
Gold Brook	Lake Outlet	East Pit EOM	-24 to +9474	116	Yes	78
		West Pit EOM	-26 to +3426	217	Yes	78
		Closure	-41 to +2968668	59	Yes	135
	GB-DS1	East Pit EOM	-28 to +10510	163	No	-265
		West Pit EOM	-29 to +4743	255	No	-266
		Closure	-15 to +2564378	11	No	-181
	GB-DS2	East Pit EOM	-38 to +20398	202	No	-273
		West Pit EOM	-40 to +15205	277	No	-282
		Closure	-28 to +2220841	47	No	-208
	GB-DS3	East Pit EOM	-41 to +19605	235	No	-286

Table 5.8-9 Summary of Hydrologic Modelling Results; normal year

System	Assessment Point	Phase	Range of predicted flow change	# of days per year with predicted flow reduction > 10%	Exacerbation of Low Flow (< 30% MAD) Predicted?	# of days per year change in Low Flow (< 30% MAD)
		West Pit EOM	-42 to +15897	288	No	-289
		Closure	-31 to +2138874	55	No	-219
	GB-DS4	East Pit EOM	-40 to +22584	209	No	-287
		West Pit EOM	-42 to +17912	277	Np	-287
		Closure	-30 to +2167843	49	No	-215
	GB-DS5	East Pit EOM	-44 to +27951	200	No	-287
		West Pit EOM	-45 to +25070	256	No	-287
		Closure	-34 to +2067773	58	No	-216
	GB-DS6	East Pit EOM	-46 to +32137	194	No	-287
		West Pit EOM	-47 to +29335	250	No	-287
		Closure	-37 to +2000630	68	No	-216
	GB-DS7	East Pit EOM	-24 to +2109	179	No	-288
		West Pit EOM	-26 to +1095	242	No	-288
		Closure	-11 to +1838805	3	No	-237

Table 5.8-10 Summary of Hydrologic Modelling Results; dry year

System	Assessment Point	Phase	Range of predicted flow change	# of days per year with predicted flow reduction >10%	Exacerbation of Low Flow (<30% MAD) Predicted?	# of days per year in change in Low Flow
Northern Tributary	WC22-US	East Pit EOM	-3 to -1	0	No	0

System	Assessment Point	Phase	Range of predicted flow change	# of days per year with predicted flow reduction >10%	Exacerbation of Low Flow (<30% MAD) Predicted?	# of days per year in change in Low Flow
to GBL (from Oak Hill Lake)		West Pit EOM	-3 to -1	0	No	0
		Closure	-3 to -1	0	No	0
	WC22-DS1	East Pit EOM	-8 to -4	0	Yes	5
		West Pit EOM	-8 to -4	0	Yes	5
		Closure	-8 to -4	0	Yes	5
	WC22-DS2	East Pit EOM	-7 to -4	0	Yes	4
		West Pit EOM	-7 to -4	0	Yes	4
		Closure	-7 to -4	0	Yes	4
Eastern Tributary to GBL (from Rocky Lake)	WC14-US	East Pit EOM	-3 to -1	0	Yes	5
		West Pit EOM	-1 to 0	0	Yes	6
		Closure	-1 to 0	0	Yes	5
	WC14-DS1	East Pit EOM	-28 to -15	365	Yes	16
		West Pit EOM	-27 to -15	365	Yes	18
		Closure	-27 to -15	365	Yes	18
	WC14-DS2	East Pit EOM	-58 to -28	365	Yes	34
		West Pit EOM	-58 to -25	365	Yes	36
		Closure	-37 to -20	365	Yes	23
	WC14-DS3	East Pit EOM	-70 to -45	365	Yes	60
		West Pit EOM	-71 to -45	365	Yes	63
		Closure	-37 to -20	365	Yes	22
	WC14-DS4	East Pit EOM	-69 to -43	365	Yes	59
		West Pit EOM	-69 to -43	365	Yes	62
		Closure	-57 to -40	365	Yes	49

Western Tributary to Gold Brook Lake

The western tributary incorporates WC51, WC20, WC19 and WC24. This system is determined to provide suitable habitat for all life history stages of banded killifish, yellow perch and golden shiner (golden shiner and yellow perch mostly in close proximity to Gold Brook Lake), and adult American eel and brook trout. Due to collection of water from the northwest WRSA, flow reduction is expected in this tributary system.

The WC51-US assessment point is an upstream control point for this western tributary system; the Project will not affect streamflow at WC51-US.

- WC19 is hydrologically isolated and upstream of WC20 but presumed to be accessible to fish at some times of the year. For the effects assessment, WC19 is conservatively grouped with WC20, despite the subterranean reach between them. WC24 is a small reach, parallel to WC20 near the confluence with Gold Brook Lake (Figure 5.8-3). Fish habitat quality in WC20 is somewhat limited under baseline conditions based on low DO and pH; which are likely to be exacerbated with flow reductions. During fish collection, water temperatures ranged between 14.5-18.0 degrees. This habitat consists of perennial flow in flat and riffle habitat types and is confirmed to be used by adult American eel and brook trout. Banded killifish and yellow perch are found in the open water sections closer to Gold Brook Lake.
- Reductions in daily flow throughout WC20 are predicted between 0 and 30% through all Project phases. The low flow period is predicted to be exacerbated by between 0-30 days through all Project phases. Daily flow reduction and exacerbation of low flow is the highest at the furthest upstream point (WC20-DS). While this exceeds the 10% flow reduction, it is important to note that the reach upstream of this point are low flow with discontinuous sections (including a completely subterranean section 50-m in length between WC19 and 20). DFO (2013) acknowledges that the in-stream flow needs for watercourses which naturally lack flow at certain times of the year are not well understood, and it is therefore difficult to determine effects to fish habitat in these systems. In the lower portion of the watercourse at assessment point WC20-DS1, the flow reduction decreases, with zero days greater than 10% flow reduction. Flow reduction and exacerbation of low flow increases closer to the inlet to the lake, with a 9 - 14 day extension of low flow.
- Further evaluation using a dry year scenario was not determined necessary.
- The open water section adjacent to Gold Brook Lake is not expected to experience flow reduction, as it is essentially an extension of the lake; therefore, driven hydrologically by lake levels rather than upland flow.

Based on DFO guidance, the reduction in flow predicted in the Western Tributary is expected to affect a maximum of 3,800 m^2 of fish habitat. The predicted flow reductions through this system are expected to trigger a HADD and require a Fisheries Act Authorization (FAA). The predicted flow reductions are conservative estimates of potential change in stream flow. In practice, this system, as shown in Appendix H.2, is expected to maintain some functions to support fish most of the year throughout the life of mine. There is no increase in flow at closure based on the current mine water management plan, and as a result, this change in habitat quality will be permanent.

Northern Tributary to Gold Brook Lake

In the northern tributary (WC69 and 22), flow is directed from Oak Hill Lake to Gold Brook Lake (Figure 5.8-3). Assessment point WC69-US is the true upstream point, with no flow alteration expected in this catchment area from the proposed Project. This system is assessed for flow reduction based on collection and treatment of contact water around the TMF, located in the eastern extent of this catchment area.

WC69 and 22 consist of flat, riffle and pool habitats, with widths and depths ranging between 1.3-12 m and 0.1 to over 1.0 m, respectively. Within the open water portion of WC22, surface temperatures reached up to 24 °C. Elsewhere within WC22, temperatures ranged between 5.8 and 20.5 °C, as measured in situ during fish collection surveys. Various reaches of this system provide suitable habitat for young of year (YOY), juvenile and adult brook trout, juvenile and adult American eel, and all life history stages of golden shiner. Adult American eel and brook trout are confirmed within these watercourses.

- In a normal year, none of the predicted daily flows are expected to change by more than 10%, during any phase of the Project, and

- The low flow period is predicted to be lengthened by up to 4-7 days.
- Based on a more rigorous assessment using the dry year scenario, the conclusions are consistent. No change in flow greater than 10% is predicted to occur on any day of the year, and the low flow period is expected to lengthen by only five days per year during all Project phases.
- Usage of the habitat for passage between Gold Brook Lake and Oak Hill Lake is expected to remain. A slight exacerbation of low flow may result in avoidance of the habitat by brook trout, as a coldwater species. Eel are more tolerant to disturbance and warm temperatures (Kanno and Beazley, 2004); so it is not expected that their usage of the habitat will be affected by the predicted exacerbation in the low flow period.

In an average year, the low flow period is predicted to lengthen by up to 7 days (2% of the year); in a dry year this low flow period is predicted to lengthen by only 5 days (1% of the year) and use of the habitat is expected to remain. Furthermore, during both normal and dry years, it is predicted that there will be zero days with a 10% or greater reduction in flow. As a result, the Project is not expected to cause HADD of fish habitat in this northern tributary system.

Eastern Tributary to Gold Brook Lake

The eastern tributary consists of the system that connects Rocky Lake to Gold Brook Lake, including WC14 as the main branch, and tributaries to WC14 including WC50 and WC16 (Figure 5.8-3). Project interactions within the eastern tributary catchment area include collection and treatment of contact water from the TMF, northeast WRSA and adjacent organics stockpile. Fish collection within WC14 revealed usage of this system by brook trout and American eel. Golden shiner were identified in both Gold Brook Lake and Rocky Lake, so it is possible that this species uses WC14 as a corridor between the two lakes. Habitats present within this system are generally suitable for YOY, juvenile and adult brook trout, and adult American eel. WC14 is characterized as having perennial flow, ranging between 1-9 m wide, and up to 0.33 m in depth. Habitat types include riffles, runs and flats, and throughout seasonal fish collection, in situ temperature measurements ranged between 14.6-23 °C. At the upstream extent of WC14 (WC14-US) no reduction in flow exceeding 10% is predicted, during any day of the year, throughout all Project phases. The low flow period may be exacerbated for up to five days during operation, and seven days at closure; though this is still not accompanied by a 10% reduction in flow. This upstream section is approximately 98 m in length; to be conservative, it is not separated from downstream portions for the calculation of indirect impact area and determination of HADD.

At all four downstream assessment points on WC14, hydrographs showing daily flow indicate that flow reduction greater than 10% is predicted to occur throughout the year, through all Project phases (ranging from 29-73% reduction).

A more rigorous assessment was completed to identify impacts to fish habitat in a dry year; primarily to determine whether passage would be available between Rocky Lake and Gold Brook Lake. When considering Project related reductions in a dry year, flow is predicted to remain above 30% MAD for between 145 -223 days per year but exacerbations of the low flow period are predicted for between 5 and 60 days (depending on the Project phase and assessment point). Fish sensitive to warmer temperatures and lower flow (i.e., brook trout) may selectively avoid passage through WC14, particularly during low flow; however, passage is expected to be provided, especially during higher flow seasons (April-June and September-February).

WC50 is a perennial, first order stream which ranges between 0.55-1.9 m wide, and between 8-19 cm deep. WC16 is similar in nature, with an average width of 0.5 m and an average depth of 10 cm. Fish collection was not completed in WC50 or WC16; though it is expected that they are inhabited by brook trout and American eel, due to contiguity with WC14. Within WC50, daily flow reductions of 51-62% are expected to occur throughout the year, during all Project phases. This flow reduction is expected to result in HADD of fish habitat; a more rigorous level of assessment is not required. Within WC16, daily flow reductions of 46-100% are predicted to occur throughout the year, during all Project phases. This flow reduction is expected to result in HADD of fish habitat; a more rigorous level of assessment is not required.

Based on the prediction in daily flow reductions throughout WC15, WC50, and WC16 for all Project phases and the irreversible nature of these reductions, these systems are expected to experience a HADD of fish habitat, accounting for 3,588 m^2 of fish habitat.

WC9

WC9, a first order tributary to Gold Brook Lake, was assessed to identify indirect impacts due to proposed collection of contact water surrounding the northeast till stockpile and northeast wasterock area (Figure 5.8-3). WC9 ranges between 0.2-2.4 m wide and up to 23 cm deep, and it is comprised of flat and run habitat types. Brook trout and American eel have been documented within WC9, in low abundance relative to the amount of effort. Water temperatures measured in situ during fish collection range between 1.7-18.7°C (high flow fish collection occurred throughout the year), and during some fish collection events, pH and DO measurements fell below CCME FWAL guidelines. Suitable habitat is provided for YOY, juvenile and adult brook trout, and juvenile and adult American eel.

WC9 is predicted to experience a reduction in daily flow greater than 10% every day of the year, through all Project phases. This corresponds with an exacerbation of the low flow period by 82 days at East Pit EOM to a 46 day exacerbation of low flow at closure.

Flow reduction is predicted to result in a HADD of fish habitat, affecting 1,082 m^2 of fish habitat. Given that this effect is expected during a normal flow year and a full HADD is expected for the stream length, no further evaluation of the dry year scenario was deemed necessary.

Gold Brook Tributaries

Tributaries to Gold Brook that have been assessed for indirect impacts based on flow reduction include WC3, WC55, WC10 and WC11 (Figure 5.8-3). These systems have been evaluated for indirect effects based on collection of contact water surrounding the southwest till stockpile and associated organics stockpile, southeast WRSA and both pits.

WC3 is a perennial second order watercourse that flows southwest into Gold Brook; it ranges in width between 0.5-2.4 m and 7-14 cm depth. The habitat is comprised of run, riffle and flat habitat types. Temperatures recorded during fish collection ranged between 11.7-18.1°C. No fish were captured or observed in WC3. Habitat present is suitable for YOY, juvenile and adult brook trout, juvenile and adult American eel, and all life stages of banded killifish.

In a normal year, WC3 is predicted to experience a reduction in daily flow greater than 10%, every day of the year during all Project phases. This corresponds with an exacerbation of the low flow period between 64-157 days per year.

WC55 is a perennial first order stream, 215 m in length, flowing southwest into Gold Brook. It ranges between 0.7-1.0 m wide and is on average 7 cm deep; comprised of a flat habitat type, suitable for adult American eel and brook trout. Fish collection has not been completed in WC55; though it is expected to be accessible and available to any fish species present within Gold Brook. In a normal year, daily flows are predicted to decrease by more than 10% every day of the year during East and West Pit EOM, and 334 days per year at closure. This corresponds with an exacerbation of the low flow period by 15-17 days per year.

WC10 is a perennial watercourse, 307 m in length. It ranges between 0.3-0.9 m wide, and up to 10 cm deep, and it is comprised of flat and riffle habitat types, suitable for juvenile and adult brook trout and adult American eel. In situ pH measurements indicate slightly acidic conditions (pH – 4.36-4.76). Fish collection has not been completed in WC10, however it is expected to be accessible and available to any fish species present within Gold Brook. During a normal year, daily flows in WC10 are predicted to decrease by more than 10% nearly every day of the year, with a corresponding exacerbation of the low flow period between 83-120 days per year during all Project phases.

WC11 is a perennial first order watercourse, between 0.35-1.7 m wide and up to 0.14 m deep. It consists of flat and riffle habitat, suitable for juvenile and adult brook trout and adult American eel. Similarly to WC10, in situ water quality measurements indicate slightly acidic conditions. Fish collection was not completed in WC11. Direct impact is required in the upper half of WC11 to support pit development and associated haul roads. During a normal year, daily flows in WC11 greater than 10% are predicted to occur between 307-347 days per year, with a corresponding exacerbation of the low flow period by 11-17 days.

Throughout the Gold Brook tributaries (WCs 3, 55, 10 and 11), flow reduction is predicted to result in a HADD of fish habitat, affecting 1,586 m^2 of habitat suitable for American eel and brook trout. Given that these effects are expected during a normal flow year and a HADD is expected for each stream, no further evaluation of the low-flow year was deemed necessary.

Gold Brook

The Project has potential to result in indirect effects to Gold Brook through several pathways, as the most proximate downstream receiving environment. These pathways include potential flow reduction from groundwater and surface water interactions in the East and West Pits, and collection of runoff from the southwest till stockpile and the southeast WRSA. Gold Brook is shown on Figure 5.8-3.

The evaluation of potential flow reductions on the Gold Brook system was completed using two key methods; a hydrologic model, followed by a hydraulic model. As described in the Ecological Flow requirements guidance (DFO, 2013); “For cumulative water use >10% of the instantaneous discharge or that results in flows < 30% of the MAD, a more rigorous level of assessment is recommended to evaluate potential impacts on ecosystem functions which support fisheries”. Throughout Gold rook, flow reductions are predicted to exceed 10% (to varying degrees based on location and Project phase).

Signal Gold has presented hydrographs showing the seasonal occurrence of flow reductions predicted by the hydrologic model to support the determination of indirect effects to fish habitat as one part of this ‘more rigorous assessment’. Furthermore, an additional modelling approach was completed to support determination of effects to fish habitat. The HEC-RAS hydraulic model was used to supplement predicted flow reductions through an evaluation of predicted changes in vertical water levels to support the analysis of Project impacts to fish habitat. HEC-RAS software is the industry standard software for evaluation of water levels within river systems and is commonly used in many applications involving the assessment of free-surface flows including environmental flow assessment.

Gold Brook is a perennial, third order watercourse. This watercourse is a braided system that has one main channel (WC64A) and approximately 10 branches (WC64, branches B through K). The braided channels are described in the Fish and Fish Habitat Baseline Report (Appendix H.1). These portions of Gold Brook provide suitable habitat for YOY, juvenile and adult brook trout, adult American eel, all life history stages of golden shiner, and all life history stages of yellow perch and banded killifish, primarily in slower and deeper reaches.

During all Project phases, it is important to note that an increase in flow is predicted at the various assessment points along Gold Brook during low flow periods (mainly the summer months). This is due to continual release of treated effluent into Gold Brook Lake, which essentially supplements flow during low flow periods. This is a passive, natural release of water from the lake, with no modification to the lake outlet: high percentage increases in flow are reflective of very low flow at baseline, supplemented by more continuous flow from the lake, and are not expected to affect the geomorphology of the lake outlet or watercourse.

During East Pit EOM, daily flow reductions are predicted to occur between 24-46% along the length of Gold Brook. The reductions in flow are predicted to occur during seasonal high flow periods. Due to a continual release of water from Gold Brook Lake, it is predicted that daily flows will generally increase during the low flow period, and the time of the low flow period will be lengthened by 78 days at the Lake Outlet but shortened by between 265-288 days per year at all subsequent points.

During West Pit EOM when neither pit is full nor releasing to the environment, daily flow reductions of 26 to 47% are predicted to occur. The low flow period is predicted to be lengthened at the Lake Outlet by 78 days but shortened at all subsequent downstream points by between 266-288 days. Overall, Gold Brook is expected to experience an increase in flow relative to baseline in the low flow scenario.

At closure, when both pits are full and passively releasing to the natural environment, daily flow reductions are predicted to occur between 41% at the Lake Outlet to 11% at GB-DS7. It is important to note, however, as shown on the hydrographs (Appendix H.2) that these predicted reductions in flow are occurring during high flow periods. The low flow period is predicted to be lengthened by 135 days at the Lake Outlet and shortened by between 181 and 237 days at all subsequent downstream points.

Based on guidance provided by DFO (DFO, 2013), the predicted flow reduction that corresponds with high flow periods are not expected to result in effects to fish and fish habitat. However, given the fact that flow reductions predicted through the hydrologic model are greater than 10%, a supplemental analysis (HEC-RAS model) was completed as a more rigorous assessment to further support the initial conclusion that the predicted flow reductions do not result in effects to fish and fish habitat. The HEC-RAS model was completed for West Pit EOM conditions which are considered the worst-case scenario.

The HEC-RAS model outputs predict that for low flow conditions, there is an expected increase of flows from baseline to West Pit EOM conditions. This increase of 15 cm is expected to occur only in the ponded area in the middle of the brook reach where the channel is wide or not well defined (approximately between channel stationing 1,600 m and 4,000 m). Elsewhere in the modelling domain, water level elevations are expected to increase by varying amounts (not exceeding 15 cm) and are not predicted to decrease at any point.

For average flow conditions, the difference in water levels can be considered negligible (i.e., approximately 4 cm decrease in water levels).

Following results from the HEC-RAS model, given that water levels are not expected to decrease through the Gold Brook system, there are no predicted effects on fish habitat present in Gold Brook, and wetland mosaics associated with Gold Brook.

As directed by the Ecological Flow requirements (DFO, 2013), Signal Gold evaluated effects to fish habitat in Gold Brook based on predictions of daily flow reductions. Based on the predicted timing of flow reductions relative to baseline conditions (during high flow periods), and to support a further rigorous level of assessment, an additional evaluation following a HEC-RAS model was completed to identify whether changes in the water level were predicted in Gold Brook. Following this evaluation, it was identified that changes in daily flow are not predicted to have a substantial or harmful negative effect on water levels during average flow (up to a 4 cm decrease in water level) or in low flow (15 cm increase in water level) and thus impacts to fish and fish habitat are not predicted in Gold Brook.

Gold Brook Lake

The results presented on Figure 5.6-11 show that there is a maximum reduction in lake level of approximately 15 cm, which corresponds to the maximum values in the baseline and West Pit EOM daily flow timeseries. The WBA indicates that during the wet periods (seasonal high flow conditions over the full 50-year historical climate period) the lake water level for West Pit EOM conditions will be lower than in baseline conditions, but more importantly, during low flow conditions the impacts are negligible.

Fish collection was completed in four main areas within Gold Brook Lake (north, east, south and west) three times throughout the summer of 2021 and a total of 473 individuals were collected and released. Yellow perch represented 62% of all fish captured from Gold Brook Lake (n = 294). Smaller components of banded killifish, American eel, golden shiner, brook trout, and blacknose shiner were observed throughout the fish collection program.

According to Kanno and Beazley (2004), yellow perch are considered a coolwater species, with intermediate tolerance to disturbance. Their habitat preference is for shallows within large lakes, ponds and quiet rivers, with sand and gravel substrates and aquatic vegetation cover (Grant and Lee, 2004; McCarthy, Grant and Scruton, 2006). American eel can be found in a range of depths and temperatures, and prefer soft substrates, boulder, and rubble with occasional aquatic vegetation, as both juveniles and adults (Grant and Lee, 2004; McCarthy, Grant and Scruton, 2006). According to Grant and Lee (2004), and McCarthy, Grant and Scruton (2006), brook trout prefer riverine habitats over lacustrine, with preferred depth ranges of 0.01 m to 1.5 m with juveniles tending to use pools up to 1.5 m in depth, more so than other life history stages).

Depths in Gold Brook Lake range between 0.61 m to 3.05 m, with the deepest basin running north to south along the central-eastern extent of the lake (Figure 6, Appendix H.1). The littoral zone, which typically extends up to 2 m in depth, accounts for approximately 40% (32 ha) of the lake's overall area. Field measurements of depth collected during fish collections was consistent with bathymetry data, with 3.35 m representing the maximum recorded depth throughout Gold Brook Lake. Even with a potential high-flow reduction in lake level of up to 15 cm at West Pit EOM (and an associated negligible change in water level during low flow), the usage of Gold Brook Lake by this species, and others encountered in lower abundance, is not expected to be impacted by predicted water level decreases.

Impacts in Adjacent Watersheds

While substantial effort was made to have Project infrastructure within a single secondary watershed (Gold Brook,1EQ-SD31), some infrastructure is proposed to extend into adjacent watersheds. Where collection and treatment of contact water is proposed, fish and fish habitat may be indirectly impacted through flow reduction. As the extensions of infrastructure outside of the Gold Brook secondary watershed are small in relation to the overall watershed sizes, detailed analysis of flow reduction has not been completed. Instead, the proportion of flow reduction is expected to be consistent with the area lost to the watershed where precipitation is collected and released elsewhere. Watercourses described herein are shown on Figure 5.8-3.

Indirect effects to fish habitat through flow reduction may occur from collection of contact water from the TMF and associated organics stockpile, and from the northwest WRSA and associated organics stockpile. The mill area and employee accommodations areas extend into adjacent watersheds as well; though no indirect impacts are predicted here, as drainage is not collected from either of these areas (i.e., rainfall will continue to flow naturally into baseline catchments). Cross drainage will be maintained along haul roads; as a result, they are not considered in the indirect effects to fish habitat based on flow reduction.

Table 5.8-11 provides a summary of potential flow reduction impacts to adjacent watersheds, based on a catchment area (baseline) and catchment area reduction ratio. It is important to note that this summary is conservatively inclusive, as the organic stockpiles will be temporary in nature – they will be removed during the closure phase to be used in site reclamation.

Table 5.8-11 Summary of Potential Flow Reduction Impacts to Adjacent Watersheds

Watershed	Watershed Area (ha)	Infrastructure	Infrastructure Area (ha)	Total Area (ha)	Watershed Area Impact (as %)	Effect to Fish Habitat Predicted?
Isaac's Harbour River (1EP-1)	7,876.8	Northwest WRSA	0.6	0.8	0.01%	No
		Organic Stockpile	0.2			
New Harbour River (1EQ-4)	14,933.6	TMF	5.9	10.6	0.07%	No
		Organic Stockpile	4.7			
Coddles Harbour Shore Direct (1EQ-SD29)	2,179	TMF	0.8	0.8	0.04%	No

Catchment area boundaries and impacts were assessed based on the Project defined local catchment areas, verified by field delineation of watercourses and flow path, which may differ slightly from the secondary watershed GIS boundaries. As a result, the only infrastructure located in the Isaacs Harbour Shore-Direct (1EP-SD1) watershed is the employee accommodations which is not expected to result in changes to catchment area or flow redistribution.

Based on catchment area ratios, collection of contact water in adjacent watersheds accounts for less than 0.1% in each respective watershed during operations; at closure, this is expected to decrease even further with removal and recontouring of the organic stockpiles. According to Harmal and others (2006) and Di Baldassarre and Montanari (2009), a 10% error in streamflow measurements and discharge calculations is considered reasonable. A change in streamflow of <10% is considered low magnitude as it is within natural variability. As a result, no indirect impact from flow reduction is predicted to occur within adjacent watersheds.

Summary of Indirect Effects base on Flow Reduction

The Project is predicted to result in indirect impacts to fish habitat through flow reduction required to collect and treat contact water prior to discharging to the environment. Through the evaluation of predicted daily flow reductions, Signal

Gold has identified four systems that are expected to be affected by flow reduction to varying degrees. Based on the varying degrees of flow reduction, Signal Gold is proposing various offsetting ratios to reflect the predicted impacts to fish habitat. Signal Gold acknowledges that DFO will be responsible for determining final ratios for offsetting.

The eastern tributary to Gold Brook Lake, WC9 and the four tributaries to Gold Brook (WC3, 10, 11 and 55) are all predicted to experience flow reductions which will fundamentally change fish access and fish habitat provision. As a result, Signal Gold is proposing a 2:1 offset ratio, similar to that proposed for direct impact to fish habitat.

Flow reductions predicted in the western tributary system are, however, relatively minor and for the most part, fish habitat is expected to remain. Reductions in daily flow throughout this system are predicted between 0 and 30% and the low flow period is predicted to be exacerbated by between 0-30 days through all Project phases. Daily flow reduction and exacerbation of low flow is the highest at the furthest upstream point (WC20-DS); where flow is naturally low and discontinuous particularly between WC19 and WC20. The in-stream flow needs for watercourses that naturally lack flow at certain times of the year are not well understood, and guidance is lacking to determine effects to fish habitat in these systems. At assessment point WC20-DS1, the flow reduction decreases, with zero days greater than 10% flow reduction. Flow reduction and exacerbation of low flow increases closer to the inlet to the lake, with a 9 - 14 day extension of low flow. As this system is predicted to experience greater than 10% flow reduction, it is acknowledged as a HADD of fish habitat; however, given the flow reductions are relatively low particularly in the lower portion with continuous perennial flow, a lower offset ratio is proposed as shown in Table 5.8-12.

Based on a combination of hydrologic and hydraulic modelling, no harmful alteration of fish habitat is expected within the northern tributary, Gold Brook Lake, Gold Brook, or fish habitat within adjacent watersheds. Fish habitat to be indirectly impacted by Project related flow reductions are summarized in Table 5.8-12, and shown on Figure 5.8-3.

Table 5.8-12 Summary of predicted indirect impacts to fish habitat due to flow reduction

Watercourse system	Indirect Impact Area	Proposed Offset Ratio*	Proposed Offset Area*
Western Tributary to Gold Brook Lake	3,800 m^2	1:1	3,800 m^2
Eastern Tributary to Gold Brook Lake	3,588 m^2	2:1	7,176 m^2
WC9	1,082 m^2	2:1	2,164 m^2
Gold Brook Tributaries	1,586 m^2	2:1	3,172 m^2
Total	**10,056 m^2 (100 Habitat Units)**		**16,312 m^2 (163 Habitat Units)**

* Signal Gold acknowledges that DFO will be responsible for determining final ratios for offsetting.

5.8.6.2.2 Water Quality Effects

Guidance outlined in this section is derived from the predictive water quality assessment completed for the Project, which is described in further detail in Section 5.6 and in Appendix F.7. The results of water quality predictions will be presented in the following sections, specifically related to thermal impacts, water quality predictions at discharge locations, including Gold Brook Lake.

Surface Water Quality

There are several federal and provincial guidelines that outline the quality of water criteria for discharge from the Project into a natural water body. Specifically, this COC assessment focuses on potential COCs identified in the:

- MDMER Objectives (MDMER, 2022)
- CCME WQG for the Protection of FWAL, Freshwater (CCME, 2022)
- Tier 1 NSE EQS for surface water (NSE, 2021)

The MDMER objectives regulate the concentration of certain constituents within effluent discharge (last point of control), while the CCME and Tier 1 EQS guidelines are applicable to the concentration of constituents within the receiving water bodies. The more conservative guideline between CCME and Tier 1 EQS was taken as the applicable regulatory limit.

In addition to the MDMER, CCME and Tier 1 EQS regulatory guidelines, SSWQG have been established for certain constituents. SSWQG have been developed for constituents where the background concentrations exceed CCME and Tier 1 EQS Guidelines or a risk hazard assessment has been performed on the receiving water body. When background concentrations were shown to exceed the CCME or Tier 1 EQS regulatory limit, the 95th Percentile background concentration was taken to be the SSWQG. In addition, SSWQG were developed for Cadmium, Cobalt, Lead, Zinc and Nitrite as shown in the Site-Specific Water Quality Compliance memo included in Appendix F.7. If a SSWQG was established for a given constituent, this was assumed to take precedence over the CCME and Tier 1 EQS regulatory limits.

A full list of background (baseline) COCs, and predicted water quality parameters by Project phase are presented in Appendix F.7. A summary of water collection, treatment and release locations through each Project phase is provided in Section 5.6.5.3.2. Predictions of water quality parameters are based on full integration of the water balance model and predictive source term model as described in Section 5.6.5.3. Over the life of the Project, water will be directed to five settling ponds, and the East and West Pits. The proposed discharge points for the Project are described in Section 5.6.5.3.2. A near-field mixing zone model was created to determine the extent of the three-dimensional dilution zone around the points of effluent discharge where mixing of the effluent (treated mine contact water) and the receiving waters (Gold Brook Lake and River system) occurs. This is commonly referred to as Near Field Region (NFR) or Initial Dilution Zone (IDZ). The mixing zone model was created for the NFR using the modelling software CORMIX, which solves various equations of turbulence structure and is commonly used for the analysis, prediction, and design of an effluent discharge into a receiving water body. Constituent concentrations in Gold Brook Lake and Gold Brook were calculated once full-mixing has been reached.

Gold Brook Lake is the receiving water body for three discharge points during operations: the TMF, north settling pond, and central settling pond. The East and West Pits will discharge water to Gold Brook Lake once they have finished filling with water. The East Pit is expected to be filled by Year 19, and the West Pit is expected to be filled by Year 35. The effluent from each of the Gold Brook Lake assessment points were found to fully mix within 100 m of the discharge points. However, for all discharge locations into Gold Brook Lake, one assessment point was used for the entire lake in order to capture all constituent loading entering the Lake. This assessment point presents the water quality within Gold Brook Lake once all discharge locations have been considered. As such, the Gold Brook Lake assessment point presents the worst-case scenario for concentrations within Gold Brook Lake. Within Gold Brook, full mixing was found to occur in less than 100 m at both discharge locations. As such, water quality assessment points were established 100 m downstream of each discharge point into Gold Brook.

Certain constituents are predicted to exceed regulatory limits either in effluent discharge or within the receiving watercourse due to impacts to the Project on the water quality of the runoff. During times where there are predicted exceedances of regulatory limits occurring, treatment of the effluent will be required to ensure water quality parameters are below regulatory limits. Treatment is predicted to be required for metals, nitrogen species, and cyanide. No further treatment of mine water discharge is predicted to be required following year 38. The predicted treatment requirements for each Project phase are summarized in Section 5.6.6.2.2. A Water Monitoring Plan has been developed (Appendix F.11), which outlines surface water monitoring locations, frequency, and parameters for both surface water and groundwater to demonstrate compliance with:

- MDMER Objectives
- CCME WQGs for the Protection of FWAL
- NS Tier 1 EQS for Surface Water
- Site-specific criteria (based on background data and site-specific risk assessment)

An IA has yet to be obtained; additional sampling requirements may apply under the future IA or Environmental Effects Monitoring (EEM) program and are not fully detailed in this monitoring plan. These requirements will be fully determined once the Project becomes subject to MDMER.

The Project will not be permitted to release water which exceeds regulatory guidelines; the release of water will be monitored and treated prior to release. No indirect impacts to fish and fish habitat from the Project are expected through the release of effluent into Gold Brook Lake and Gold Brook as a result of effluent quality meeting regulatory guidelines.

Release of Deleterious Substances

Another pathway for indirect effects to fish and fish habitat related to water quality is through release of deleterious substances. All deleterious substances will be stored in appropriate secondary containment, particularly within the Mill. Fuel storage, refueling, and equipment servicing will not occur within 30 m of a watercourse or waterbody, to prevent accidental release of fuel into surface water. Standard spill prevention and response procedures will be in place and communicated to all relevant personnel.

The Project is proposed in an historic mining district, with historic contaminated tailings remaining in Gold Brook Lake and Gold Brook. Sampling has occurred to identify the extent of historic tailings between 2003 and 2021. Tailings have been identified, primarily within close proximity to the proposed pits, including within an adjacent to Gold Brook. Historic tailings directly disrupted by Project activity will be excavated and transported to the TMF for long-term disposal. With proper tailings management, no indirect effects to fish habitat are expected.

Tailings management within the TMF will be conducted with the primary goal to prevent release of deleterious substances to the receiving environment. The estimated runoff volumes from the EDF and IDF were used to determine the storage volume and corresponding wet freeboard depth required within the TMF to manage each storm event. The estimated peak flows for the IDF were used to design the TMF emergency overflow spillways. Maintaining PAG waste materials within the long-term saturated zone in the TMF will prevent the onset of ARD conditions and help reduce metal leaching from the PAG material. Furthermore, a lined polishing pond will be designed to store four days of TMF water treatment plant discharge capacity. This pond has been designed to meet the CDA Technical Guidelines for Mining Dams (CDA, 2013; CDA, 2019) and includes freeboard and design earthquake ground motion considerations to minimize operational risks. The TMF will be fully lined and capped to further reduce water quality effects. Full details are provided in Section 2.

Erosion and release of sediment could occur as a result of the Project. Proactive and diligent adherence to erosion and sediment control is the best defense against sediment release. Regular mining activities such as milling, crushing, and surface mining can create siltation and sedimentation in neighbouring water bodies. Milling and crushing will be contained in buildings as much as possible. Roadbeds will be constructed from on-site NAG material. Erosion and sediment control measures will be monitored, and dust control measures will be implemented when necessary.

In-stream works have the potential to result in direct mortality to fish, and destruction or disruption of fish habitat based on physical alteration, sediment release and water management. In-stream work will only occur where permitted, following all approval conditions, relevant guidelines and codes of practice for protection of fish and fish habitat. Intake screen guidelines will be adhered to, to prevent impingement and entrainment of fish, and in-stream works will only occur following completion of a fish rescue, to prevent mortality of fish. Buffers will be maintained on watercourses wherever possible, and removal of vegetation will be minimized. Cleared areas will be regraded and revegetated as soon as possible to reduce the likelihood of sediment releases.

Settling pond releases could result in release of sediment laden water to the receiving waterbodies. To prevent this, the total treatment capacity of all settling ponds have been designed to accommodate up to a 1:100 year, 24 hours storm, with a 5% climate change contingency, and at least 0.3 m of freeboard. Structurally, ponds are designed based on Hurricane Beth rainfalls without overtopping. During high flow, a 24-hour residence time will still be maintained, and coagulants/flocculants will be available as treatment for fine sediments in the north, central and southeast ponds. At the central and east ponds, the spillways are directed to the nearest pit. At all other site ponds, spillways flow directly into the receiving environment (Gold Brook Lake and Gold Brook). All pond outlet structures will be equipped with emergency shut-off valves that can be closed if any water quality parameter exceedances are triggered. The ponds will be designed with enough freeboard to accommodate the inflow while shut-off valves are closed. In the event pond capacity is reached during an emergency shut-off, the impacted water will be pumped, or collected in a vacuum truck, and transported to the nearest settling pond with available capacity, or to the nearest pit where it will be held until settling pond capacity becomes available. Prior to any 5-year storm, ponds will be drained into the central or east ponds, maximizing capacity of all other ponds, thereby minimizing the likelihood of reaching capacity and engaging the emergency shut-off valves. Further details are provided in the Stormwater Management Design – Hydrologic Modeling Report (Appendix F.4). Further details on accidents and malfunctions, including pond failures, are presented in Section 5.14.

Temperature Impacts

The impacts of the Project on baseflow contributions to the watercourses in the Gold Brook catchment were estimated by comparing the percentage of total flow that is contributed by baseflow between baseline and East Pit EOM, West Pit EOM, and closure conditions. Baseflow temperatures are typically lower than water temperatures in a waterbody or watercourse, particularly in the warmer months. As a result, baseflow has a cooling effect on the temperature of the total flow in the watercourse.

In baseline conditions, baseflow represents approximately 26% of the total flow in the tributaries to Gold Brook Lake and Gold Brook, including WC-14, based on the BFI of 0.26, which is compatible with the groundwater modelling completed for the Project. On Gold Brook, baseflow represents 1-10% of the total flow from GB-DS1 to GB-DS7. This is because the Gold Brook Lake outflow, which includes runoff from the entire Gold Brook Lake drainage area, is incorporated into the surface flow component of the total flow.

The groundwater and water balance models predict that WC-14 and Gold Brook will experience a reduction in baseflow as a percentage of the total flow in the East Pit EOM, West Pit EOM, and closure scenarios. Baseflow will be reduced to 10% of the total flow during the East Pit EOM and West Pit EOM scenarios and 18% of total flow during closure at the WC-14-DS4 assessment point. The WC-14-DS4 assessment point is located on WC-14, at the inlet to Gold Brook Lake. The results at this assessment point represent the cumulative baseflow impacts along the watercourse. The baseflow reductions in this system can be attributed to the lining of the TMF that is located within the baseline catchment of WC-14, and the drawdown effect of the East and West Pits on the groundwater table. WC14 is proposed as an indirect impact due to surface flow reduction (expected HADD), regardless of thermal impacts from baseflow reduction; as a result, this is not considered an additional impact that requires quantification.

There will be no baseflow contributions to Gold Brook at the GB-DS1 assessment point during the East Pit EOM and West Pit EOM due to the proximity of the East and West Pits. At closure, baseflow contributions to Gold Brook at GB-DS1 will be reduced to less than 1% of total flow. However, baseflow only represents 1% of the total flow at this location in baseline conditions. Baseflow will be reduced to 7% of the total flow during the East Pit EOM development phase, and 9% of total flow during the West Pit EOM and closure scenarios at the GB-DS7 assessment point. The GB-DS7 assessment point is located on Gold Brook at the inlet to Seal Harbour Lake. Baseflow represents less than <10% of total flow under baseline conditions and predicted reductions through Gold Brook are approximately 3%. Generally, the fish species present in the brook are currently handling a wide range of temperatures and thus are presenting as temperature tolerant, and it is understood that temperature is non-limiting for eel. As a result, potential changes in temperature through this system during the life of mine are not expected to be harmful to fish; however, monitoring through the Aquatic Effects Management Plan (AEMP) will be completed to verify baseline temperatures through Gold Brook and temperatures across all phases of the Project.

Water temperature affects the metabolic rates and biological activity of aquatic organisms, thus influencing the use of habitat by aquatic biota. There are no CCME guidelines related to temperature and aquatic biota. Temperature preferences of fish vary between species, as well as with size, age and season. Salmonids are cold-water fish species, meaning they require cold water to life and reproduce (Bowlby et al., 2014; Kanno and Beazley, 2004). The optimal temperature range for growth of juvenile brook trout is 10-20°C (The Stream Steward, nd). American eel, however, have a broader temperature range preference, and can tolerate temperatures up to 25°C (Fuller et al., 2019; Kanno and Beazley, 2004).

Baseline temperatures measured in situ during fish collection and late summer habitat assessments range between 17.5-25.9°C. It is important to note, however, that in situ temperature measurements were typically recorded close to surface, rather than in the deepest parts of a watercourse, where thermal refuge may be provided. Gold Brook is a relatively wide, shallow channel (or series of channels) typically lacking cover. The baseline temperatures are at times sub-optimal for the growth of juvenile brook trout; although trout were consistently captured throughout the Gold Brook system. Baseline temperatures within Gold Brook are considered to be non-limiting to American eel. Continuous flow from Gold Brook Lake into Gold Brook is expected to maintain the current thermal regime, given that baseflow (cooler water) only contributes 1% of flow at this location during baseline. Furthermore, due to inputs of treated effluent from the TMF into Gold Brook Lake, Gold Brook is predicted to experience a surplus of flow during low flow, effectively shortening the length of the low flow period. Baseline riparian lakeshore conditions are expected to remain throughout the life of the mine. The Proponent will monitor temperatures at various locations along Gold Brook as part of the Aquatic Effects Monitoring Plan (AEMP) and implement additional mitigative measures if necessary, as described in Section 5.8.7.

5.8.6.2.3 Effects of Blasting on Fish

Indirect impacts to fish and indirect impacts to fish behavior, spawning grounds, and migration patterns are possible from blasting activities associated with mine development. The detonation of explosives near watercourses within the PA can produce post-detonation shock waves which involves a rise to a high peak pressure and then a subsequent fall to below ambient hydrostatic pressure. This pressure deficit can cause impacts in fish (Wright and Hopky, 1998). An overpressure in excess of 100 kPa can result in effects in fish including damage to the swim bladder in finfish, and potential rupture and hemorrhage to the kidney, liver, spleen and sinus venous. It is also possible that fish eggs and larvae can be damaged (Wright and Hopky, 1998). The degree of damage is related to the type of explosive, size and pattern of the charges and the distance to the watercourse, depth of water within the watercourse, and species, size and life stage of the fish. Sub lethal effects have also been observed including changes in fish behavior on several occasions as a result of noise produced during blasting (Wright and Hopky, 1998).

Signal Gold will adhere to setback recommendations and other mitigation strategies to minimize impact to fish and fish habitat from blasting activities outlined by DFO in the Measures to Avoid Causing Harm to Fish and Fish Habitat Including Aquatic Species at Risk Pertaining to Blasting (DFO, 2018). Blasting mitigation minimizes or eliminates the potential for negative effects on fish or fish habitat which might occur as a result of the use of explosives in open pit workings (Chad Robinson, personal communication, March 11, 2022). Key blast mitigation practices are:

- Blasts charge weights will be minimized, and blasts will be designed with sufficient delay between charges to reduce the overall detonation to a series of smaller explosions. This may be achieved with the use of electronic detonators which have an accuracy of < 1 millisecond.
- Blasts will be designed to limit charge size/charge weight and detonation velocity to keep instantaneous pressure (overpressure) and peak particle velocity (PPV) below levels that would impact fish or fish habitats (100kPa overpressure and 13 mm/s PPV).
- Engineering controls will put in place to eliminate fly-rock from the blast area entering water.
- All blast holes will be back-filled completely (stemmed) with angular gravel with a particle size of approximately 1/12th the diameter of the borehole, to the level of the substrate interface.

All shock tubes and lead wires will be recovered and removed after each blast. Furthermore, the potential for impacts to fish and fish habitat will be minimized by adhering to setback distances outlined in Wright and Hopky (1998) to achieve overpressure and vibration limits protective of fish and their eggs. A Blast Management Plan will be submitted to support the IA application process.

5.8.6.3 Summary of Direct and Indirect Impacts

A summary of Project related direct and indirect impacts is provided in Table 5.8-13.

Table 5.8-13 Summary of Predicted Direct and Indirect Impacts to Fish Habitat

Watercourse system	Area	Proposed Offset Ratio	Proposed Offset Area
Direct Impact	16,296 m^2	2:1	32,592 m^2

Watercourse system	Area	Proposed Offset Ratio	Proposed Offset Area
Indirect Impact: Flow Reductions	3,800 m^2 – Western Tributary 6,256 m^2 – All other indirect impacts	1:1 – Western Tributary to Gold Brook Lake, 2:1 – All other indirect impacts	16,312 m^2
Total			**48,904 m^2** **489 Habitat Units**

* Signal Gold acknowledges that DFO will be responsible for determining final ratios for offsetting.

Detailed habitat evaluation included ground-truthing areas proposed for direct impact, and multiple years of fish collection. This has provided a solid basis for Signal Gold to understand fish usage of habitats within the PA and has allowed for micro-siting of infrastructure away from fish habitat wherever practical. The impact area for direct loss of fish habitat is based on a surface area measurement, which has been facilitated through field-verified measurements supported by GIS analysis.

Similar to direct impacts, the habitats proposed for indirect impact have been evaluated through detailed habitat assessments and fish collection. As a result, Signal Gold has a high degree of certainty in the habitat area and habitat usage by fish species. Indirect effects related to surface and ground water quality and quantity are, however, based on predictive modelling. While predictive modelling has been completed with layers of explicitly stated contingencies and conservatism, models do inherently involve a level of uncertainty, given their predictive nature. The Proponent has identified methods to validate models based on measured site parameters, which will be used to continuously update and adjust model predictions and mitigative measure as necessary.

5.8.7 Mitigation

Section 5.8.6.1 and 5.8.6.2 outline the predicted maximum direct and indirect impacts to fish and fish habitat. Efforts to mitigate effects will be outlined throughout this section, following the mitigation sequence of avoidance/minimization of impact, mitigation, and offsetting.

5.8.7.1 Measures to Avoid and Minimize

Measures to avoid impacts to fish and fish habitat are the highest priority in the mitigation sequence. Throughout the iterative process of developing the current Project infrastructure layout, avoidance of effects to fish habitat was attained through several key design considerations. Initial delineation of wetlands and watercourses within the PA was completed through 2017-2021 to allow for fish and fish habitat to inform an optimized site layout and reduce potential impact to fish habitats. This delineation of wetlands and watercourses facilitated infrastructure planning; and as a result, the following Project components have been planned to avoid direct impact to fish and fish habitat:

- Mill area
- Northwest WRSA
- Southwest till stockpile
- Employee accommodation
- Southwest WRSA
- Northeast till stockpile
- Northeast WRSA
- Organic stockpiles

Construction of haul roads, water management infrastructure, the East and West Pits and the TMF will result in unavoidable impacts to fish and fish habitat. The TMF will directly overprint fish habitat, which requires a regulatory amendment to Schedule 2 of the MDMER. Signal Gold completed a Multiple Accounts Assessment to optimize placement of the TMF and reduce impacts to fish and fish habitat. Thirteen sites were initially considered, which were then narrowed down to four TMF locations for the full MAA. Avoidance of impacts to fish habitat in a known Atlantic salmon secondary watershed was considered an important factor in the MAA. One specific TMF placement option was within the New Harbour River secondary watershed (1EQ-4), northeast of the proposed TMF. Another option was considered within the Isaacs Harbour River secondary watershed (1EP-1) to the north of the Plant Site. Both of these options are in secondary watersheds known to support Atlantic salmon; as a result, they were ruled out of the MAA. See Section 2.8 for further detail on additional options considered for placement of the TMF.

Early in the design process, Gold Brook and Gold Brook Lake were identified as key aquatic habitats for avoidance, and these habitats were therefore considered as constraints for infrastructure placement. Exploratory drilling has confirmed that the resource is continuous between the East and West Pits however, Signal Gold has planned for two individual pits to avoid impacts to historic tailings and fish habitat. Furthermore, based on initial and ongoing fish collection within the PA, it was confirmed that the first and second order streams within the PA exhibited relatively low abundance and diversity in the fish community. While it is difficult to determine the exact cause of low abundance and diversity in the fish community, it may reflect historic land use and earlier disturbance of the PA by historic gold mining activity; presence of historical contamination associated with these mining activities; relatively low pH, high summer temperatures, or some combination thereof.

According to consultation with DFO, it is recognized that protection of Southern Uplands Atlantic Salmon is a DFO priority. According to Bowlby et al. (2013), juvenile Atlantic Salmon have been identified in 21 of the 72 river systems which fall under the SU designatable unit. owlby et al. (2013) state that “these 21 rivers should be considered the highest priority for habitat allocation, given that they are likely to contain small wild populations”. As a result, the SU Atlantic Salmon has been identified as a sensitive species and a key environmental constraint.

According to Bowlby et al. (2013), Atlantic Salmon are known to inhabit the New Harbour watershed, eastern and adjacent to the PA. eDNA sampling confirmed detection of this species in the New Harbour River watershed, and failed to detect salmon DNA within the PA. As a result, substantial measures were employed to place site infrastructure nearly entirely within the Gold Brook (1EQ-SD31) watershed, to prevent impacts to a sensitive population of SU Salmon in the adjacent watershed.

5.8.7.2 Measures to Mitigate

Where avoidance and minimization of impacts to fish and fish habitat are not practical, mitigation measures must be employed to further reduce impacts to fish and fish habitat. Standards for working in or near water are well understood and will be followed. All road crossings will be designed to meet NSECC fish passage guidelines, and Signal Gold will consider bridges as road crossings wherever practical. Standard mitigation measures will include, but are not limited to erosion and sediment controls, site water management, watercourse and wetland alteration permitting, permitting under the *Fisheries Act*, adherence to timing windows to protect sensitive life cycle periods, and end-of-pipe protection for intakes.

5.8.7.2.1 Fish Rescue

During the permitting phase of the Project, a detailed Fish Rescue Plan will be prepared and submitted to DFO. Fish rescues are the key method to avoid death of fish where direct impact to fish habitat is unavoidable. The specific plan for each individual fish rescue must be developed on a site-specific basis; however, the general approach to completion of fish rescues is provided herein.

The primary goal of fish rescue work is to capture and relocate as many fish as is reasonably practical, with habitat area and complexity, water temperature and turbidity, access, and safety considerations as the key constraints. As the extent of those constraints is somewhat unknown, a quantitative estimate of fish mortality is not provided herein.

Fish rescue work will not occur without permission granted under the *Fisheries Act* (2019) for a HADD, and death of fish by means other than fishing. It is expected that a small proportion of fish present may not be successfully rescued; however, it is the goal of a fish rescue operation to minimize the death of all fish in habitat to be lost. It is our professional opinion, based on experience with EAs throughout Canada, that a specific depletion target or mortality estimate is not typically required, or accurate, at the EA stage. The Proponent commits to a reasonable level of effort to rescue as many fish as practical, and that the details surrounding reasonable depletion targets will be completed at the permitting phase in consultation with DFO.

Guidance for the approach to a fish rescue was obtained from Fisheries and Oceans Canada (2015; Appendix F, Fish Rescue Guidelines). While the specific capture methods will be finalized during permitting, the general approach will involve a combination of passive trapping, seine netting, dip netting, and electrofishing in habitats where each is effective. Timing of fish rescue activities will be closely coordinated with habitat dewatering or other water diversion/infilling activities during construction.

The fish rescue will be completed by a team of aquatic ecologists, experienced in the collection, handling and transfer of fish. The team will obtain a scientific research license which allows for collection of fish, including collection for fish rescue purposes. A fish transfer license would only be required if fish are to be transferred from one watershed to another, which is not being considered. Release locations within the same watercourse, or those watercourses where natural connectivity exists will be used. This will reduce the likelihood of fish being transferred from a habitat with historic tailings into an area free of tailings. The team will adhere to all specific terms and conditions of the Scientific Licence. For linear and open water features which are safely wadeable and easily isolated, the following approach to fish rescue will be taken:

- The license holder will identify the area to be isolated and barrier nets (or similar, such as berms) will be installed on the upstream and downstream ends of the habitat.
- The specific fish rescue methodology will vary based on factors such as depth, substrate, wadeability, water temperature and turbidity of the water. The following techniques will be used either alone or in combination, until an appropriate depletion target is reached:
    - passive trapping (minnow traps, eel pots, fyke nets)
    - seining
    - electrofishing
    - dip-netting
- The effectiveness of this approach is expected to be high, with little to no mortalities expected. Recent and past experience suggests that mortality of fish that have been captured and handled during relocation activities is typically in the range of 1 to 3%.
- Standard Operating Procedures (SOP) for each method as well as an overall plan that will describe methods of holding, transporting, and monitoring fish during rescue will be provided as part of the permitting process.
- All fish collection methods selected are based on inherent low mortality (i.e., gill nets and other lethal fish collection methods will not be used).
- The rescue will be completed to minimize handling and stress to fish, particularly if completed during warmer months. Measures such as oxygen supplementation and water cooling will be used as needed. To reduce handling and stress to fishes, measurements of length, weight and age class, will not be recorded, unless requested by DFO. Fish will be released into the natural environment as soon as possible, and the rescue team will closely monitor fish for signs of stress throughout all stages of the fish rescue. The rescue team may be supported by 'porters' as necessary, to facilitate efficient movement and release of fish back into the natural environment.

Fish rescue release points will be identified within the Fish Rescue Plan. Typically, the fish rescue release point is located downstream of the isolated reach; however, in some cases an alternative location may be required, based on species composition and downstream habitat type.

For open water features where safe wading is not possible due to water depth and soft substrate (i.e., the Beaver Pond in WL18), the Proponent will consider the use of a barge or boat-based electrofisher or rely on passive trapping. In this habitat, the fish rescue will likely occur through successive isolation of sections where possible, using repeated days of extensive trapping efforts and seine netting. This work will be conducted immediately prior to, and during dewatering efforts, to facilitate isolation of fish in smaller, shallower portions, where fishing efforts can be concentrated.

During the completion of each rescue reach, personnel will remain on site during all de-watering to dip-net any fish remaining in the reach, wherever safely practical. This will allow an estimate of mortalities to be provided to DFO in a summary report outlining results of the fish rescue.

5.8.7.2.2 Water Quantity and Quality

Signal Gold will develop and implement a detailed Erosion and Sediment Control (ESC) Plan which is proactive and protective of fish and fish habitat. Contact water will be collected and treated prior to release. Release of contact water from Project ponds will only be permitted if monitoring indicates compliance with all regulatory guidelines specified in Section 5.8.6.2.

In-stream works will only be completed where approved, adhering to all Approval conditions. In-stream works will be completed with minimal disturbance to riparian habitat, which provide shade and erosion protection that is protective of fish habitat.

Temperatures and water levels will be monitored throughout Gold Brook Lake and Gold Brook to ensure that collection of contact water does note result in a harmful alteration, disruption or destruction of fish habitat. Signal Gold will consider mitigation measures in consultation with DFO on an as needed basis to remediate any thermal impacts, including but not limited to additional vegetation and shading on site ponds and riparian zones, cooling trenches or groundwater wells.

Wherever possible, Signal Gold will avoid refueling, fuel storage, and servicing of equipment within 30-m of a watercourse or water body, to prevent accidental release of deleterious substances to fish habitat. If this is not possible (e.g., non-mobile equipment like cranes), additional mitigation measures will be implemented. Diligent spill prevention, preparedness and response measures will be key components of construction, operations and reclamation works completed within the PA.

A Water Monitoring Plan has been developed, which includes monitoring at well locations between the proposed pits and Gold Brook Lake, to measure changes in groundwater elevations and groundwater quality. This monitoring plan also serves to confirm model predictions (Appendix F.11).

5.8.7.2.3 Blasting

To minimize effects of blasting on fish, a Blast Management Plan will be developed and strictly adhered to. Appropriate blast designs for open pit mining will be developed to limit blasting impacts (vibration, fly-rock and overpressure). All appropriate information for each blast will be documented including hole-depth and the quantity of explosive used, blast timing, and monitoring data. All blasting will adhere to guidelines outlined by Wright and Hopky (1998) and will adhere to *Nova Scotia Blasting Regulations*. Specific mitigation measures for blasting are outlined in Section 5.8.6.2.

5.8.7.2.4 Mitigation Measures Summary

The Proponent has outlined measures to avoid and minimize impacts to fish and fish habitat. Table 5.8-14 outlines mitigative measures to further protect fish and fish habitat. These mitigative measures will be confirmed through site monitoring activities and adaptively managed based on the results of ongoing monitoring activities.

Table 5.8-14 Proposed Mitigation Measures for Fish and Fish Habitat

Project Phase	Mitigation
Construction	Complete permitting processes under the *Fisheries Act* and wetland/watercourse alterations.
	Adhere to all Approval conditions outlined in regulatory approvals, specifically related to timing of works outside of sensitive time windows for fish
	Complete culvert installations and upgrades (where applicable) in accordance with the NSE Watercourse Standard (2015) or as relevant at the time of construction
	Complete site kick-off meetings with relevant staff/contractors to educate and confirm policies related to working around fish habitats. Ensure fish habitat is adequately signed or flagged in the field, and clearly communicated to staff/contractors.
	Complete further micro-siting of infrastructure to reduce impacts to fish habitat; particularly for haul road crossings
	Limit vegetation clearing, revegetate slopes as soon as possible, and maintain a 30-m buffer on fish habitat wherever practical. Use vegetated buffers to provide shade to onsite ponds wherever practical. Minimize removal of upgradient vegetation and stabilize shorelines disturbed by Project activities
	Minimize temporal extent of in-stream works as much as practical. Ensure machinery on site is clean and maintained and free of fluid leaks, and that all Approval conditions for in-stream works are communicated and adhered to.
	Complete fish rescue within all fish bearing streams to be impacted by the Project, as described in the Fish Rescue Plan
	Develop and implement the Final Offsetting Plan, including monitoring for effectiveness of the Offsetting Plan
	Develop and implement Historic Tailings Management Plan
Construction, Operations and Closure	Implement and adhere to the site-specific Erosion and Sediment Control Plan. Use clean, non-ore bearing, non-watercourse derived, non-toxic materials for erosion and control measures. Incorporate drainage structures, where necessary, to dissipate hydraulic energy and maintain flow velocities sufficiently low to prevent erosion of native soil material.
	Follow spill preparedness protocols and ensure fueling areas are a minimum of 30 m from wetlands and watercourses.
	Use and maintain properly sized screens on any water intakes or outlet pipes to prevent entrainment or impingement of fish (DFO, 2020).
	Follow DFO-advised Measures to avoid causing harm to fish and fish habitat pertaining to blasting (DFO, 2019). Develop and implement a detailed Blast Management Plan.
	Develop and implement a Mine Water Management Plan. This will include collection and treatment of water, as necessary, and contingency measures.
	Develop and implement an Aquatic Effects Monitoring Program

5.8.7.3 Measures to Offset

Offsetting investigations for the Project are ongoing. A multi-step review process has been undertaken to identify potential offsetting concepts, including:

- Desktop review of local watersheds
- Desktop review of watersheds containing aquatic Species-at-Risk, with an emphasis on those containing Atlantic salmon
- Desktop review of watersheds that are known to have been anthropogenically degraded and where fish habitat restoration projects could potentially exist

- Engagement with the Mi’kmaq of Nova Scotia to discuss fish habitat restoration priorities
- Engagement with community-based watershed groups to discuss fish habitat restoration priorities
- Engagement with landowners
- Field assessment of locations identified in the desktop review process to determine their feasibility

Conceptual offsetting projects presented within the Conceptual Fish Habitat Offsetting Plan (Appendix H.3) have been developed using DFO guidance and include locations where offsets may be both technically and logistically feasible while being primarily beneficial for fish species impacted by the Project – American eel and brook trout. Preliminary offsetting identification and selection have been guided by the principles from DFO’s Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat (2019b).

DFO’s guiding principles clarify a preference for offsetting measures located within the vicinity of a Project, as measures to benefit local fish populations and fish habitat are most likely to balance the residual effects of a project (DFO, 2019b). The PA is predominantly found within the New Harbour/Salmon Primary watershed, and the Gold rook secondary watershed. In keeping with DFO’s guiding principles, preliminary offset identification was first initiated within the Gold Brook secondary watershed, in the immediate vicinity of the PA. Potential offset identification was then expanded to primary watersheds that contain the PA – the New Harbour/Salmon and Country Harbour primary watersheds.

The desktop review for potential offset concepts was then performed within primary watersheds with anticipated ecological similarities to that of the PA (i.e., Southern Upland watersheds along the Eastern Shore). This included the St. Mary’s, Liscomb, the East West Sheet Harbour. Proven techniques in these geographic settings that could support similar fish species through in-kind habitat restoration were prioritized to offset lost habitat, as they were considered lower-risk and biologically relevant. Three additional drivers guided selection of priority watersheds for offset identification: watersheds that support Atlantic salmon, watersheds with proportionally higher rates of anthropogenic disturbance, and watersheds where landowner relationships have been established.

The Conceptual Offset Plan presents options where working relationships with landowners have been established, as well as high priority sites identified through desktop review for further evaluation. Conceptual offsetting options have been ranked and include the rehabilitation of degraded aquatic habitats caused by channelization of streams and draining of former wetland areas by agricultural activities. Restoration methods are well-known and can be successful if used in the proper location. Proven techniques in geographic settings that could support similar fish species through “in-kind” habitat creation were prioritized to offset lost habitat, as they are considered lower-risk and biologically relevant. Offsetting opportunities closer to the PA will be investigated as offset planning continues and will serve as a focus for engagement.

Signal Gold has commenced and will continue engagement with DFO and will follow their guidance documents to identify requirements for Authorization under the Fisheries Act, and to identify the scope of the offsetting requirements. Engagement with the Mi’kmaq of Nova Scotia have commenced and will continue through the selection and implementation processes for offsetting projects. The proposed offsetting concepts require further engagement with the Mi’kmaq, DFO, and relevant stakeholders on acceptability and ranking of the preliminary options. Preferred offsetting options will be further refined based on these discussions as Signal Gold begins the detailed offset planning process. It is also possible that alternative approaches not listed in the Conceptual Fish Habitat Offset Plan could be integrated into any Final Authorization Application if required.

5.8.8 Monitoring and Follow-up

Signal Gold will be implementing a series of mine and environmental management and monitoring plans to guide the development and operation of the Project, including an AEMP to be implemented during construction, operation, and closure phases of the proposed Project. The AEMP will be established as a requirement of the permits and licenses under which the proposed Project will operate (e.g., Metal MDMER under the Fisheries Act, Fisheries Act Authorization, Provincial IA, and NSECC wetland and watercourse approvals). The focus of the AEMP will be to ensure regulatory compliance, monitor the effectiveness of mitigation measures, and to verify the predictions of the effects assessment. An EEM will be fully implemented to support compliance monitoring requirements at each proposed final discharge point under MDMER and will form one component of the broader AEMP.

The goal of the AEMP will be to eliminate or minimize potential adverse effects on the aquatic receiving environment, while systematically seeking to enhance positive effects. Spatially, the AEMP will focus on the mine site area and the identified receiving environment for the Project including Gold Brook, Gold Brook Lake and Seal Harbour Lake, as well as reference sites. The AEMP is anticipated to include monitoring programs for:

- Surface Water Quality: the physical, chemical, biological, and aesthetic characteristics of water
- Surface Water Hydrology: water quantity and water flow
- Sediment Quality: the physical, chemical and biological characteristics of sedimentary materials
- Periphyton: the assemblage of algae, bacteria, and other organisms that attach to submerged substrates (e.g., suspended sediments). As primary producers, periphyton are important food sources for grazers, such as zooplankton and benthic invertebrates
- Benthic Invertebrates: benthos representing an important link between primary producer communities and higher trophic levels in aquatic ecosystems
- Fish Habitat and Community Surveys
- Fish Health and Fish Tissue Studies, as needed

Data collected during monitoring programs will document trends in monitoring results and enable a comparison to the predicted project effects. Data and analysis will be provided in annual reports, as well as in any mandated regulatory reporting. A Response Framework will provide a systematic approach for responding to the findings of the AEMP. Indications of possible unacceptable changes trigger Action Levels, with increasing responses required if unacceptable changes become more likely.

5.8.9 Company Commitments

During the permitting and detailed design stage, additional micro-siting of infrastructure will be considered to further avoid impacts to watercourses.

5.8.10 Residual Effects and Significance

A significant effect on the Fish and Fish Habitat VC was defined in Section 5.8.6 as:

- A Project-related HADD of fish habitat or the death of fish, as defined by the Fisheries Act, that cannot be mitigated, or offset; and an unauthorized Project-related alteration of fish habitat.

This effects assessment was developed to be consistent with Fish and Fish Habitat Protection Policy (DFO, 2019), which states “the Department interprets “harmful alteration, disruption or destruction” as any temporary or permanent change to fish habitat that directly or indirectly impairs the habitat’s capacity to support one or more life processes of fish.” However, it is recognized that the total impacts determined within this assessment will be further reviewed and determination of the amount of HADD will be made by DFO during the authorization application process. The determination of significance of effects has been made in consideration of multiple linkages between other VCs, specifically surface water and ground water interactions.

The effects assessment includes:

- Direct and indirect effects have been quantified through detailed habitat evaluations and modelling exercises to identify indirect effects to water quality and quantity. Of particular importance is the interpretation of effects related to flow reductions, which is based on a predictive modelling exercise, with explicit conservatism, assumptions, and limitations. This model was executed on a daily timestep to provide an interpretation of effects in the context of instantaneous flow reductions.
- All fish habitat with proposed direct or indirect impacts have been accounted for in the Conceptual Offset Plan, which will be further refined prior to the Fisheries Act permitting process for harmful alterations to fish habitat.

- Site specific mitigation measures have been proposed to minimize, avoid and minimize the extent and duration of effects to fish and fish habitat, including both direct and indirect effects.

Residual HADD of fish habitat is outlined in Tables 5.8-8 and 5.8-12. Conceptual offsetting plans have been estimated and described in Section 5.4 of the Conceptual Offset Plan (Appendix H.3).

A significant adverse effect to fish and fish habitat as not been predicted for the project for the following reasons, with consideration of the ecological and social context of the LAA surrounding the PA:

- During Construction:
  - Direct impact to fish and fish habitat will occur, primarily to support development of the open pits, stockpiles, haul roads, water management features, and the TMF. The impacts associated with the pits is considered unavoidable to support Project development. Impacts associated with haul roads and water management features have been and will continue to be optimized to further reduce impacts to fish habitat prior to permitting. A MAA has been completed to support the placement of the TMF on waters frequented by fish.
  - The water collection and treatment system will be constructed, and collection of contact water will commence near the end of the construction phase of the project.
  - Strict adherence to the Erosion and Sediment Control plan will limit the potential indirect effects to fish and fish habitat commencing in the construction phase and continuing throughout the operational life of the Project.
  - The death of fish by means other than fishing will be limited by the completion of fish rescue wherever direct impact is required.
  - All habitats proposed for direct and indirect effects through construction, operation, and closure will be accounted for and included in the Conceptual Offset Plan to support the Fisheries Act Authorization for harmful alteration to fish habitat. The Conceptual Offset Plan will be executed as close as possible to the timing of the impacts to reduce time lag.
- During Operation:
  - No new direct impacts to fish habitat will be required
  - Water collection, treatment and release will occur, resulting in indirect impacts to fish and fish habitat, primarily due to flow reduction. Water quality will be maintained through collection and treatment of effluent discharge, to ensure compliance with NSE Tier 1 EQS guidelines or MDMER guidelines as appropriate
  - Prediction of potential HADD associated with flow reductions has been presented in this EARD conservatively, and potential offsetting projects have been identified such that it has been demonstrated that losses can be mitigated through appropriate offsetting project implementation.
- During Closure:
  - With appropriate treatment of effluent, the magnitude of effects to Gold Brook and Gold Brook Lake is considered negligible (within established criteria at the 100 m compliance point).
  - Predicted flows in Gold Brook at closure are consistent with pre-development conditions.

Table 5.8-15 Residual Effects on Fish and Fish Habitat

Project Phase	Mitigation and Compensation Measures	Nature of Effect	Residual Effects Characteristics						Residual Effect	Significance
			Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility		
Construction (Habitat loss from watercourse alterations)	Erosion and sediment control Code of practice and best management practices for working in water Spill preparedness Wetland and watercourse permitting Fish rescue Final Offset Plan	A	H	PA Adverse effect to fish habitat is limited to the PA	A Watercourse alterations to occur between June 1 and September 30 to avoid sensitive fish window	P Direct effects are expected to be permanent	O Effects to occur once during construction	IR VC will not recover to baseline	Harmful Alteration, Disruption and Destruction of Fish Habitat	Not Significant
Construction, Operations and Closure (Altered hydrology due to surface and groundwater interactions)	Watercourse and *Fisheries Act* permitting Final Offset plan	A	M-H	LAA Effect to fish habitat extend beyond the PA	A Seasonal habitat provisions may affect the VC	P Indirect effects are expected to be long term to permanent	R Effect will occur regularly during seasonal low flow	PR VC will partially recover to baseline	Harmful Alteration, Disruption and Destruction of Fish Habitat	Not Significant
Operations (Water quality effects)	Water collection and treatment as required to adhere to all applicable guidelines Erosion and sediment control Spill preparedness	A	L	PA Adverse effect to fish habitat is limited to the PA	A Seasonal habitat provisions may affect the VC	P Water quality effects are expected to be permanent	R Effect will occur at regular intervals as construction progresses	PR VC will partially recover to baseline	Alteration of Fish Habitat	Not Significant
Construction, Operations (Blasting)	Follow blast management plan	A	L	PA Adverse effect to fish habitat is limited to the PA	A Blasting to occur to occur between June 1 and September 30 to avoid sensitive fish window	ST Effects are expected to be short term	S Effects are expected to be sporadic	RE VC is expected to recover to baseline.	Disruption of Fish Habitat	Not Significant
Legend (refer to Table 5.8-3 for definitions)										
Nature of Effect A – Adverse P – Positive	Magnitude N – Negligible L – Low M – Moderate H – High	Geographic Extent PA – Project Area LAA – Local Assessment Area RAA – Regional Assessment Area		Timing N/A – Not Applicable A – Applicable	Duration ST – Short-Term MT – Medium-Term LT – Long-Term P – Permanent	Frequency O – Once S – Sporadic R – Regular C – Continuous	Reversibility RE – Reversible IR – Irreversible PR – Partially Reversible			

5.9 Terrestrial Environment

5.9.1 Rationale for Valued Component Selection

Terrestrial environment encompasses upland and wetland habitats, associated vegetation communities and wildlife species that depend on these habitats, including terrestrial SAR and SOCI. The terrestrial environment was chosen as a VC because ecosystems, habitat, vegetation communities, and fauna species reliant on these habitats may be altered directly or indirectly by proposed Project activities.

Provincial and federal legislation that protect wildlife and their habitat include the Canada *SARA*, and *Migratory Birds Convention Act,* along with NS *Endangered Species Act, Wildlife Act*, and *Environment Act.* Associated policies include but not limited to, the NS Wetland Conservation Policy (NSE, 2019). This broad VC includes the following major groups based on taxonomical and ecological similarities:

- Terrestrial Habitat and Vegetation
- Terrestrial Fauna
- Avifauna

5.9.2 Baseline Program Methodology

The terrestrial environment is a broad VC and includes a diverse group of species, habitat, and taxa. Field methods varied depending on the targeted species, group of species, or habitat being surveyed. These methods are summarized throughout this effects assessment chapter. Further details on survey methods, timing, and results are found in Appendix I.1 – 1.3.

5.9.2.1 Priority Species List

A priority species list was created to guide all surveys described in this VC. Species rankings used in the biophysical reports and terrestrial effects assessment are based on rankings retrieved from the Atlantic Canada Conservation Data Centre (ACCDC) on January 26, 2021. A priority species list functions as an over-arching tool to guide survey design and effort. Priority species include SOCI and SAR. The definition of a priority species and detailed methods in developing this list is described in (Appendix I.1 and I.2).

5.9.2.2 Terrestrial Habitat and Vegetation

Terrestrial habitat and vegetation surveys including vegetation community assessments, vascular and non-vascular plant and lichen surveys were completed from 2017 to 2021. Overviews of each survey method, including details on survey dates are described in the following sections.

5.9.2.2.1 Vegetation Communities and Habitats

Several key public GIS datasets were reviewed to better understand known existing conditions and to aid in field survey design and effects assessment method, including PA spatial boundaries, provincial data sources (including the NSDNRR forestry layer), and aerial imagery (Appendix I.2). The NS vegetation community classification guides were used when available. However, when vegetation communities were not defined in NS classification systems, classification systems from Maine were used. Classification guides included:

- Forest Ecosystem Classification System (Neily et al., 2010)
- Natural Landscapes of Maine (Gawler & Cutko, 2018)
- "Classification of Heathlands and Related Plant Communities on arrens Ecosystem in Nova Scotia" (Porter et al., 2020)

Terrestrial ecologists completed vegetation community assessments from November 9 to 12, 2018 and through May to September 2021. These surveys were completely concurrently with wetland delineation and rare flora inventory programs. The field data were used to delineate approximate boundaries of documented vegetation communities. Vegetation types were then delineated using orthophotos at a 1:10,000 scale on QGIS software and the area (ha) of each vegetation type was calculated. Further details on survey methodology are found in Appendix I.3.

5.9.2.2.2 Vascular and Non-Vascular Plants

Prior to undertaking the vascular and non-vascular plant field assessment, a detailed desktop review of known flora observations and potential habitat for vegetation within the PA was completed to support survey design. Several databases were reviewed, including the ACCDC Database, provincial and federal databases, the Atlantic Coastal Plain Flora (ACPF) database and the Mersey Tobeatic Research Institute (MTRI) database.

A priority species list (Section 5.9.2.1) was used to identify rare species with elevated potential to be within the PA and guide the preliminary desktop survey route. Field surveys took place in growing seasons in 2017 to 2021 and all major habitats were surveyed, targeting habitats with elevated potential to support priority species (Appendix I.2). Details on the vascular and non-vascular plant surveys are described in Appendix I.2.

5.9.2.2.3 Lichens

Lichen surveys were completed throughout the PA in November 2018, August 2019, and November 2020, and opportunistically during vascular and non-vascular plant surveys. Boreal felt lichen predictive habitat polygons, mature forested swamps, mature stands adjacent to watercourses or lakes, and areas subject to high humidity were targeted (Appendix I.2).

The following information was collected for any priority lichen species identified during field surveys: site location, date, scientific name, count, size, habitat (substrate, general habitat), location (UTM NAD83), along with a photograph and any relevant comments. Chemical spot tests were used when necessary for identification and were completed following methodologies described in Lichen of North America (Brodo et al., 2001). Details on the lichen surveys are described in Appendix I.2.

5.9.2.3 Terrestrial Fauna

Terrestrial fauna surveys and assessment for mainland moose, bat hibernacula, snapping turtles, and general wildlife were completed in 2017 to 2021. An overview of each survey is described in the sections below.

5.9.2.3.1 Mainland Moose

Mainland moose surveys were completed in 2017 to 2021 by Pellet Group Inventory (PGI) surveys and winter track surveys. Surveys covered high moose probability habitats, such as fens, marshes, cleared corridors, and mature forested areas. Given that mainland moose have large home ranges, moose surveys were completed within and outside of the PA to provide additional regional context (Appendix I.2).

Track surveys were completed on foot by two observers experienced in recognition of moose, deer, and other wildlife tracks, scat, and browse. During the winter track surveys, all signs, including scat, tracks, and visual/auditory observations were recorded. All deer and moose signs, as well as any priority species observations, were photographed and georeferenced. During the PGI surveys, field staff focused on any scat present within the PA. Details on mainland moose survey methods are described in (Appendix I.2).

Following completion of mainland moose surveys and during preparation of the environmental effects assessment, an updated mainland moose recovery plan: "Recovery Plan for the Moose (Alces Americana) in Mainland Nova Scotia" (NSDNRR, 2021) was released. This Recovery Plan (as described in Section 5.9.2.3.1), identifies core habitat throughout the province including the PA Due to potential implications for the Project, and Project risk, additional surveys (e.g., winter tracks and PGI) were undertaken to increase survey effort and coverage across the LAA. The data have not been analysed at this time and results are not carried forward in the result sections. A technical report will be provided to Signal Gold in July 2022 and the report will then be provided to NSDNRR.

5.9.2.3.2 Bats

Bat hibernacula and roosting assessments were conducted in June 2017, 2019, and 2021. Abandoned mine openings (AMOs), as well as an abandoned warehouse building in the PA, were visited to search for potential roosting and hibernacula (Appendix I.2). All additional AMOs within a 5 km radius were visited as a 5 km radius encompasses the maximum distance where negative impacts to wildlife from noise and vibrations are predicted (Section 5.9.6.2).

During all biophysical surveys within the PA, biologists recorded any evidence of caves, open wells, cavities in mature trees, rock outcrops, or other potential hibernacula or maternity roosting habitats, or any incidental observations of bats (Appendix I.2).

5.9.2.3.3 Snapping Turtles

Targeted, species-specific surveys were completed to assess usage of the PA by snapping turtles through roadside snapping turtle surveys. Two rounds of surveys were conducted on June 2 and June 16, 2021 along gravel roadsides in proximity to waterbodies (Appendix I.2). These gravel paths were slowly driven or walked while looking for disturbed gravel, soil, or sand mounds with evidence of digging, or turtle shells. Any gravel or sandy beaches adjacent to Gold Brook Lake were also surveyed for snapping turtle activity (Appendix I.2).

5.9.2.3.4 General Wildlife

General wildlife surveys occurred concurrently within the suite of biophysical surveys from 2017 to 2021 and wildlife observations were recorded, including species name, and observed habitat. Incidental priority species observations required further detail and involved georeferencing, individual numbers and photographs if possible.

5.9.2.4 Avifauna

Several resources were reviewed to understand the available avifauna habitat and conditions within the PA, including the Canada Important Bird Areas (IBA) database, the ACCDC observation database, the Maritime Breeding Bird Atlas (MBBA), and the Canada Wildlife Service Migratory Bird Sanctuary (CWS-MBS).

These data sets were used, in conjunction with the priority species list (Appendix I.1), to aid in survey selection and design. Survey design involved point counts (PC), watch counts (WC), and transect searches. Identified bird species were categorized into seven functional groups including: waterfowl, shorebirds, other waterbirds, diurnal raptors, nocturnal raptors, passerines, and other landbirds. Further details on avifauna survey methodology are described in Appendix I.1. Table 5.9-1 summarizes avifauna baseline surveys completed from 2017 to 2021.

Table 5.9-1 Avifauna Field Surveys Conducted during the Baseline Surveys

Survey	Dates	Summary	Survey Design
Spring migration surveys	May 2019, May 2021	Spring surveys were used to document the presence of spring migrating birds and early nesters	66 point counts (PC) and two watch counts (WC)
Breeding bird surveys	June 2017, June to July 2019, June 2021	Surveys throughout June and early July were used to detect breeding species, and if SAR avifauna use habitats within the PA	66 breeding bird PCs and 23 transects
Fall migration surveys	September 2019, August to September 2021	Surveys from late August to September were used to detect bird species as they begin to migrate south for winter.	49 PCs and three WCs

Table 5.9-1 Avifauna Field Surveys Conducted during the Baseline Surveys

Survey	Dates	Summary	Survey Design
Common nighthawk surveys	June 2017, June 2021	Surveys were used to document presence of common nighthawks in the PA.	10 PCs
Nocturnal owl surveys	April 2017, April 2021	Surveys were used to document presence of nocturnal owls in the PA	Eight PCs
Waterfowl surveys	August to September 2021	Surveys were used to document use of Gold Brook Lake by waterfowl species. Also completed to understand effects of traditionally hunted species for First Nations	One waterfowl PC
Detailed methodology described in Appendix I.1.			

5.9.3 Baseline Conditions

The baseline conditions of the terrestrial environment, including terrestrial habitat and vegetation, terrestrial fauna and avifauna are described below. These descriptions also include results from a desktop review and in-field assessments.

5.9.3.1 Terrestrial Habitat and Vegetation

The terrestrial habitat and vegetation surveys included vegetation community assessments, vascular and non-vascular plant and lichen surveys. An overview of the baseline conditions is described below.

5.9.3.1.1 Vegetation Community Assessments

The PA is within the Eastern Interior and the Eastern Shore Ecodistricts, which are within the Eastern and Atlantic Coastal Ecoregion, respectively (NSDNRR, 2005) (Appendix I.3).

The Eastern Interior Ecodistrict is one of the largest in the province and extends from Pockwock Lake to the town of Guysborough (NSDNRR, 2005). Soil depths vary, and often along the coast, bedrock is highly visible. Depending on soil depths, a variety of climax forest communities can be found. Within shallow, acidic soils, often closer to the coast, the forest community is dominated by softwood tree species such as balsam fir (*Abies balsamea*), black spruce (*Picea mariana*), red spruce (*P. rubens*), and white spruce (*P. glauca*). In contrast, landscapes with deeper soils, often on hills and drumlins support tolerant hardwood species, such as yellow birch (*Betula alleghaniensis*), sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), and shade intolerant species such as red maple (*Acer rubrum*).

Topography, geology, and soils vary within the Eastern Shore Ecodistrict, which extends from the east side of Halifax peninsula to Chedabucto peninsula. The Ecodistrict is heavily influenced by the Atlantic Coast, which creates conditions that support boreal-like forest communities (NSDNRR 2005). This area consists of granite outcrops, greywackes and slates of the Goldenville Group. Soils are generally nutrient poor, acidic and tree cover is primarily dominated by balsam fir, black spruce, red spruce, and white spruce (NSDNRR-like forest communities (NSDNRR, 2005). This area consists of granite outcrops, greywackes and slates of the Goldenville and Halifax formations. Soils are generally nutrient poor, acidic and tree cover is primarily dominated by balsam fir, black spruce, red spruce, and white spruce (NSDNRR, 2005).

The landscape of the PA is a mosaic of cutovers, regenerative stands, roads, trails, historical mine workings and intact mature conifer and mixedwood stands, and open and forested wetlands. Nine natural vegetation community groups and 21 vegetation types were observed within the PA. The Mixedwood Forest Group (MW) was the most abundant upland forest group, accounting for approximately 16% (192.4 ha) of the PA. The most abundant wetland group was the Wet Coniferous Forest group (WC) at 20% (239.2 ha) of the PA. Cutovers accounted for 14% (167.7 ha) of the PA.

During the surveys, the upland vegetation groups – Coastal Forests (CO), Shrubland and Barren Group (S), Spruce-Hemlock Forest Group (SH), Spruce-Pine Forest Group (SP) and Mixedwood Forest Group (MW) were observed. The wetland vegetation groups include Wet Coniferous Forest Group (WC), Wet Deciduous Forest Group (WD), Peatland Group (PG) and the Marsh Group (MG). All other human-disturbed landscapes were grouped in the cutover group. Table 5.9-2 lists natural vegetation community groups and types observed. Vegetation community results are provided in Appendix I.3. Further descriptions of the vegetation types observed within the PA are described in Appendix I.3

Table 5.9-2 Vegetation Types Observed within the PA

Community Type	Vegetation Group	Vegetation Type (VTs)	Successional Stage	Area within the PA		Classification System
				%1	ha	
Upland Communities	Coastal Forest Group	CO1 – Black spruce – Balsam fir/Foxberry/Plume moss	Edaphic Climax	2	25.6	FEC
		CO4 – Balsam fir/Foxberry – Twinflower	Mid to Late-successional	10	119.6	
	Coastal Forest Group Total			12	145.2	
	Spruce-Hemlock Forest Group	SH5 – Red spruce – Balsam fir Schreber's moss	Mid-successional	5	56.15	FEC
		SH6 – Red spruce – Balsam fir/Stair-step moss – Sphagnum	Mid-successional	4	45.7	
		SH8 – Balsam fir/Wood fern Schreber's moss	Early to mid-successional	4	46.5	
	Spruce-Hemlock Forest Group Total			13	148.35	
	Spruce – Pine Forest Group	SP5 – Black spruce/Lambkill/Bracken	Early to late-successional	6	78.40	FEC
		SP6 – Black spruce – Red maple/Bracken – Sarsaparilla	Early to mid-successional	<1	2.70	
		SP7 – Black spruce/False holly Ladies' tresses Sphagnum	Early to mid-successional	7.5	88.0	
	Spruce-Pine Forest Group Total			14	169.1	
	Mixedwood Forest Group	MW2 – Red spruce – Red maple – White birch/Goldthread	Mid-successional	<1	8.9	FEC
		MW4 – Balsam fir – Red maple/Wood sorrel – Goldthread	Early to Mid-successional	15	183.5	
	Mixedwood Forest Group Total			16	192.4	
	Shrubland and Barren Group	S3 – Mixed Tall Shrubland	Early to Mid-successional	2	25	C. Porter et al., 2021

Table 5.9-2 Vegetation Types Observed within the PA

Community Type	Vegetation Group	Vegetation Type (VTs)	Successional Stage	Area within the PA		Classification System
				%1	ha	
		S5 – Sheep Laurel Inland Heath	Early to Mid-successional	<1	7	
	Shrubland and Barren Group Total			2	32	
Wetland Communities	Wet Coniferous Forest Group	WC1 – Black spruce/Cinnamon fern/Sphagnum	Edaphic climax	5	58	FEC
		WC2 – Black Spruce/Lambkill – Labrador tea/Sphagnum	Edaphic climax	15	177.5	
		WC6 – Balsam fir/Cinnamon fern – Three seeded Sedge/Sphagnum	Edaphic climax	<1	3.7	
	Wet Coniferous Forest Group Total			20	239.2	
	Wet Deciduous Forest Group	WD2 – Red maple/Cinnamon Fern/Sphagnum	Edaphic climax	<1	9.7	FEC
	Wet Deciduous Forest Group Total			<1	9.7	
	Peatland Group	PG1 -Huckleberry – Crowberry Bog	Mid to Late-successional	5	55.5	NLM adapted
		PG2 – Sweetgale Mixed Shrub Fen	Mid to Late-successional	<1	3.8	
		PG3 – Coastal Sedge Fen	Mid to Late-successional	<1	0.92	
		PG4 – Sheep Laurel Dwarf Shrub Bog	Mid to Late-successional	<1	2.5	
	Peatland Group Total			5	62.7	
	Marsh Group	MG1 – Horsetail – Tall Meadow Rue / Ribbed Bog Moss Marsh	Early to Mid-successional	<1	9	MEL2
	Marsh Group Total			<1	9	

[1] This calculation was determined by dividing the area (ha) of the vegetation type by the total area of all observed vegetation types (including cutovers).

[2] Neither the FEC or NLM systems accurately describe these vegetation community types, therefore, MEL biologists characterized the vegetation community by dominant species observed.

5.9.3.1.2 Vascular and Non-Vascular Plants

The ACCDC report identified four priority vascular plants and eight lichen species within 5 km of the PA (Appendix I.2):

- Two SAR lichen species were observed and include: boreal felt lichen (*Erioderma pedicellatum;* NSESA and SARA Endangered), blue felt lichen (*Pectenia plumbea,* NSESA: Vulnerable; SARA: Special Concern).
- Four locations of blue felt lichen were observed within the PA.
- Four SOCI vascular plant species and six SOCI lichens were also observed.

Additionally, two Old Forest polygons (ID# 3486 and 3246) are located 3.06 and 3.03 km north of the PA, respectively (NSDNR, 2006). Loon Lake Nature Reserve is located 4.04 km northeast of the PA, and Isaacs Harbour River Wilderness Area (pending) is located 4.8 km north of the PA.

A total of 133 vascular plant species, 40 bryophyte species, including five priority species (northern comandra (*Geocaulon lividum*, S3), Wiegand's sedge (*Carex wiegandii,* S3), variegated scouring rush (*Equisetum variegatum*, S3), NS agalinis (*Agalinis neoscotia*, S3S4), and southern twayblade (*Neottia bifolia*, S3)) were identified within the PA. Within the PA, 2% (n=3) of the vascular plants are exotic, 98% (n=130) are native and of all species observed, 6% (n=8) are belonging to the Atlantic Coastal Plain Flora Group (ACPFG).

Eight species belonging to the ACPFG were observed within the PA. The ACPFG is a unique group of vascular plants found in a narrow range from Florida to NS, with a few disjunct populations along the Georgian Bay region in Ontario. Many of the SAR within NS belong to this group. Although most ACPFG are common in NS and have no regulatory protection, they are a unique group with narrow range in North America. The ACPFG species observed within the PA are: dwarf huckleberry (*Gaylussacia bigeloviana*), northern bayberry (*Morella pensylvanica*), lance-leaved violet (*Viola lanceolata*), prickly bog sedge (*Carex atlantica*), bog fern (*Coryphopteris simulatat*), blue-eyed grasses (*Sisyrinchium angustifolium*), NS agalinis (*Agalinis neoscotia*), and southern twayblade (*Neottia bifolia*).

Of the eight ACPFG species observed, only two priority species were identified – NS agalinis (S3S4) and southern twayblade (S3). Further descriptions of the vascular plants observed are described in Appendix I.2.

Thirty lichens including seven priority lichens were observed within the PA. These include two SAR: blue felt lichen (*Pectenia plumbea,* SARA Special Concern, NSE Vulnerable, S3) and frosted glass whiskers (*Sclerophora peronella,* SARA Special Concern, S1?); and include five SOCI species: shingle lichen (*Fuscopannaria cf. sorediata,* S3), appressed jellyskin lichen (*Leptogium subtile,* S3), peppered moon lichen (*Sticta fuliginosa,* S3), corrugated shingles lichen (*Fuscopannaria cf. ahlerni,* S3), and slender monk's hood lichen (*Hypogymnia vittata,* S3S4) (Appendix I.2).

Portions of large wetland complexes provided mature conifer and hardwood species, which support habitat for many SAR/SOCI lichen. Blue felt lichen polygons were targeted and often consisted of black and red spruce, which are not suitable host trees for blue felt lichen in NS. Blue felt lichen polygons that appeared to be recently harvested or were regenerative forests, were not visited as these habitats are not suitable for blue felt lichen. Blue felt lichen habitat indicator species such as *Frullania sp.,* salted shell lichen (*Coccocarpia palmicola*) and *Lobaria spp.* Growing on balsam fir were not observed.

Additionally, some of the blue felt lichen polygons were within fragmented habitats and bordered by scattered historical clear cuts and existing roads, which leads to drying effects and sub-optimal conditions for lichens. Therefore, habitat suitability was often low throughout the PA due to the presence of historically forested areas, historical mining and road networks present across the PA.

5.9.3.1.3 Species at Risk (SAR) and Species of Conservation Interest (SOCI)

Two SAR lichen species (blue felt lichen and frosted glass whiskers) were observed during the dedicated survey period as well as incidentally and five SOCI species: shingle lichen (*Fuscopannaria cf. sorediata,* S3), appressed jellyskin lichen (*Leptogium subtile,* S3), peppered moon lichen (*Sticta fuliginosa,* S3), corrugated shingles lichen (*Fuscopannaria cf. ahlerni,* S3), and slender monk's hood lichen (*Hypogymnia vittata,* S3S4) were observed (Appendix I.2). Five SOCI vascular plants (NS agalinis, northern comandra, Wiegand's sedge, variegated scouring rush, southern tway-blade).

Blue felt lichen and frosted glass whiskers are both listed as of Special Concern under the *SARA.* Although considered to be SAR, they do not have the same level of protection of species listed as Threatened, Endangered or Extirpated under the Act. Descriptions of blue felt lichen and frosted glass whiskers observations and habitat descriptions are summarized below.

A 100 m setback from the SAR blue felt lichen and frosted glass whiskers is required as per *At-Risk Lichens – Special Management Practices* (NSDNRR, 2018). This special management practice (SMP) although originally intended to apply to Crown land, has been used as a guidance document for provincial and federal Environmental Assessments by NSDNRR. These setbacks were considered in the design of the Project and discussed in Section 0.

Blue Felt Lichen

Blue felt lichen are large, blue-grey lichens, with a prominent black-blue fungal mat and red-brown fruiting bodies. Blue felt lichen is commonly found on the trunks of old hardwood trees in moist habitats or near streams or lakes. It prefers cool, humid woodlands with mixed coniferous/hardwood or deciduous dominant swamps (COSEWIC, 2010). Blue felt lichen was observed at 50 locations within the PA with a total of 225 thalli, during dedicated lichen surveys and incidentally during other surveys. Generally, blue felt lichen was observed within forested wetland habitats or in upland habitats close to wetlands, watercourses, or lakes. Forested softwood and mixedwood swamps were the most dominant habitats where this species was observed and was exclusively found on mature red maples. Blue felt lichen habitat was observed throughout the PA. See (Appendix I.2 and) section 5.9.6.1.1 and section 0 for observation locations.

Frosted Glass Whiskers

Frosted glass whiskers belong to a group known as calicioids or “stubble” lichen, due to their tiny, stalked structures, which are imbedded into substrates. It generally occurs on hardwoods, usually on the exposed heartwood of living trunks, particularly red maple. It is most often found in mature and old-growth coniferous and deciduous forests (COSEWIC, 2005). One occurrence of frosted glass whiskers was observed within the heartwood of a mature red maple within a swamp and contained over 100 podetia (stalks). This wetland, which was dominated by mature balsam fir with scattered mature red maples and high cinnamon fern cover, was the only location frosted glass whiskers was observed. Habitat for this species, which overlaps with that of blue felt lichen, was observed throughout the PA. See Appendix I.2 and Section 5.9.6.1.1 and 5.9.7 for observation locations.

5.9.3.2 Terrestrial Fauna

Based on the ACCDC, a total of 52 priority terrestrial fauna (including invertebrate) species were observed within 100 km of the PA and within significant overwintering habitat for deer. Furthermore, the little brown myotis (*Myotis lucifugus;* Endangered) has been observed within 28 km from the PA and bat hibernaculum have been observed within 5 km (Appendix I.2).

Five NSDNRR significant habitat polygons occur within the PA and several others are outside and in the general area, including deer wintering, SAR and SOC polygons (Appendix I.2).

5.9.3.2.1 Mainland Moose

The PA is located within a mainland moose concentration area and contains several Special Management Practices (SMP) moose patches (Appendix I.2). The PA overlaps mainland moose core habitat, which has been identified throughout the province as essential for the long-term survival and recovery of mainland moose (NSDNRR, 2021). Core habitat is determined using several attributes, such as suitability of forest cover, winter and summer foraging habitat, and suitability for calving (NSDNRR, 2021). Currently core habitat is defined but not protected through legislation. High moose suitability scores are created by determining the abundance of the key habitats described above and road density within a 10 km hexagon. Based on a comparison of a map showing the core habitat layer (Figure 10 of the “Recovery Plan for the Moose (*Alces Alces Americana*) in Mainland Nova Scotia” (NSDNRR, 2021), the PA does not intersect high Habitat Suitability Index (HSI) values and is not considered a priority area for conservation.

The mainland moose (*Alces alces americana*) is listed as endangered under NSESA and considered S1, or critically imperilled, by the ACCDC. Moose, the largest member of the deer family (*Cervidae*), prefers boreal forest and mixed wood habitats with an abundant food source of young twigs and stems from deciduous trees and shrubs. As large mammals, moose are prone to thermal stress in summer, and often seek refuge in coniferous forests with full canopy cover. Moose are adept swimmers and often forage for submerged aquatic vegetation, which provide minerals critical for antler growth. During winter, their long legs and large bodies allow them to move through deep snow, relatively unhindered by cold weather, which may be restrictive to smaller Cervids such as white-tailed deer.

While moose preferences can change as the abundance of available habitat changes (Osko et al., 2004), and habitat selection shows a high degree of variability among individuals (McLaren et al., 2009), moose generally require large areas with diverse habitat types (Snaith & Beazley, 2004). Moose habitat preferences are correlated with forage and cover requirements, as well as breeding behaviours (Peek et al., 1976). Early successional deciduous vegetation is the main source of moose forage, food types often associated with open or disturbed areas (Snaith et al., 2002; Snaith & Beazley, 2004; Parker, 2003). The presence of early successional trees and shrubs is particularly important during winter months (Parker, 2003). Regenerating vegetation provides good moose browse for 5-40 years following disturbance, such as fire, disease, timber harvest, and wind-throw (Snaith et al., 2002; Snaith & Beazley, 2004). Fire appears to be the most important disturbance in terms of providing quality moose habitat (Parker, 2003 and references therein).

In NS, the most important food species for moose are maples (red, sugar, mountain), as well as yellow and white birch (Snaith & Beazley, 2004). In late spring/summer, particularly June, aquatic vegetation can be an important component of the diet of moose (Peek et al., 1976; Fraser et al., 1980), but the fact that moose have persisted in areas containing infrequent or unsuitable wetlands suggests that these areas are not essential foraging grounds for moose in NS (Snaith & Beazley, 2004). This is supported by the findings of Telfer (1967a) who observed no moose feeding on aquatic vegetation in the Cobequid region. Water bodies such as streams, ponds, and lake shorelines can be important for relief from heat stress in summer (Parker, 2003) because moose are not well adapted for temperatures above 14-20°C (Snaith & Beazley, 2004). Moose have also been shown to preferentially select dense, mature forests with a closed canopy in summer (Schwab and Pitt, 1991) as canopy provides shade and heat relief. Dussault et al. (2004) determined that moose showed behavioural adaptations to avoid heat stress in the summer, including using thermal shelters during the day and increasing nocturnal activity.

When female moose give birth to calves in spring, they often select islands or peninsulas due to natural protection from predators, or areas of high elevation with visibility and availability of escape routes (Wilton & Garner, 1991). In a study in mountainous regions of British Columbia (BC), only 52% of 31 GPS-collared female moose climbed to higher elevations to calve, while the other 48% changed little in elevation (Poole et al., 2007). Researchers found that females that remained at lower elevations preferentially selected areas with increased forage, decreased slope, and in closer proximity to water. Langley & Pletscher (1994) characterized calving areas in Montana and BC as having dense hiding cover and open patches with bare ground. Nederland et al. (1987) found that cows returned to the same summer range each spring, and Bogomolova and Kurochkin (2002) determined that cows returned to the same area of the forest every year before giving birth.

Mature, conifer forests are important for moose in NS during late winter (Telfer, 1967a; Peek et al., 1976; Parker, 2003) due to protection from extreme weather and lack of accumulating of snow to depths that hinder moose movement (Snaith & Beazley, 2004). Travelling in areas of deep snow can cause moose to expend a significant amount of energy (Lundmark and Ball, 2008) at a time when adequate forage may be scarce. Ideal winter habitat also includes regenerating mixed woods that provide both hardwood and softwood browse (Parker, 2003). In winter, moose in northern NS concentrate in small areas known as yards and move little (winter range of 2.6 km^2), particularly when the yard contains good browse as in the Cobequid region (Telfer, 1967a, b). In Quebec, most winter yards were determined to less than 0.5km^2 in area (Guertin et al., 1984). Prescott (1968) determined that the use of winter yards by moose in northeastern NS was influenced most heavily by having a variety of vegetation types and food availability was more important than cover in determining the attractiveness of winter habitat to moose (summarized from Parker, 2003). Moose yards in Quebec were characterized by gentle slopes with southern exposure, with pure or mixed stands of black spruce and adjacent patches of white birch, young balsam fir, and alder (Guertin et al., 1984). Other important winter food items include willow, which accounted for 35% of the winter diet of moose in northern BC (Goulet, 1985).

A similarly restricted winter range of moose was determined from studies in Minnesota (Ballenberghe and Peek, 1971; Phillips et al, 1973). Phillips et al. (1973) found that late winter ranges of all tracked moose were distinct in habitat from the areas used at other times of year and that summer-fall and early winter ranges were much larger. Furthermore, researchers determined that most moose returned to the same wintering area each year and that they used similar travel routes year between seasonal habitats. Geist (1963) suggested that moose return every year to their accustomed summer range. Seasonal movements between winter and summer ranges were reported in moose in Alberta, with individual movement of up to 20 km observed (Hauge & Keith, 1981). Even greater migrations between winter and non-winter ranges of up to 75 km were observed in BC, with non-winter ranges being twice as large as winter ranges (Demarchi, 2003). If the habitat in an area is diverse and provides necessary interspersion of open areas for foraging and dense, mature forests for cover and relief from snow, seasonal ranges need not be widely separated (Snaith & Beazley, 2004). For example, only 22% and 38% of adult moose in Michigan migrated between distinct summer and winter ranges in 1999 and 2000, respectively. In Alaska, 43% of bulls and cows had distinct winter and summer ranges and distance between ranges were up to 17 km (Bangs et al., 1984). In southwestern NS, the mean home range of moose was found to be large (55.2 km^2) because rocky, barren conditions mean the moose must range farther to obtain resources (see Snaith & Beazley, 2004). When moving between seasonal ranges, moose use well-established routes and travel corridors (Neumann 2009). Within seasons, daily movement rates of moose are higher in the summer than winter (McLaren et al., 2009).

Two sub-species of moose are present within Nova Scotia. The Cape Breton population (*Alces andersoni)* is an introduced species from Alberta and is abundant and stable. According to NSL&F (2007), the mainland moose (*Alces americana*) population has been reduced to approximately 1200 individuals, restricted to small, isolated sub-populations. The “Recovery Plan for the Moose (Alces Alces Americana) in Mainland Nova Scotia” identifies several limiting factors to moose abundance and distribution (NSDNR 2007). These include disease and parasites, poaching, access to habitat, development, forest practices, acid rain, and climate change. Of highest concern are threats related to disease and parasites, poaching, access to suitable habitat, and development.

The primary parasite threatening survival of mainland moose is a parasitic worm (*Parelaphostrongylus tenuis*), known as brainworm. Approximately 65% of white-tailed deer in NS are carriers of this parasite but it is not lethal to deer. According to NSL&F (2007, p.14), “Where moose and deer range overlap, brainworm is a significant mortality factor”. Because the abundance of white-tailed deer can have influence the health of mainland moose, signs of white-tailed deer are documented during mainland moose surveys.

Threats of poaching and access to moose habitat are correlated, as increased access to moose habitat can ultimately increase the level of poaching. These threats can result in lower viability of individual populations of moose by direct mortality and reduction in range. Similarly, land development of various types can result in increased access to moose habitat, fragmentation of habitat, and direct loss of habitat, while (potentially) further isolating sub-populations.

In 2017 and 2021, two track and one browse occurrence were observed in upland softwood forests. No other signs of moose were observed during targeted surveys or incidentally during the other biophysical field programs. Within and surrounding the PA, several moose habitats were observed including regenerative and cutovers that provide suitable foraging habitat in winter and summer, mature forested stands that can provide winter and summer cover, and open water features, such as Gold Brook Lake, that have potential for calving and aquatic feeding areas in summer. For further details on the moose survey results are presented in Appendix I.2.

Ongoing moose survey results as described in Section 5.9.3.2.1, which were initiated following release of the Recovery Plan and preparation of this environmental effects assessment, have not been analysed at this time and are not presented in this report. However, no moose observations or any signs were documented that would change the conclusions of this effects assessment during ongoing moose surveys. Should additional surveys identify large concentrations of moose, or additional sightings that change the conclusion of mainland moose interactions prior to the construction of the Project, NSDNRR will be contacted immediately to determine next steps with Project planning, and additional mitigation measures may be proposed.

5.9.3.2.2 Bat Hibernaculum

No bats were observed during the 2017, 2019 and 2021 surveys or incidentally during other biophysical surveys. In 2017, a potential bat roosting area was found in a core shack with evidence of guano. In 2019, surveys of the potential bat roosting area in this location, as well as one AMO, was determined unsuitable for bat hibernacula. The AMO had collapsed preventing entry and exit points for bats, and the core shack lacked insulation and would provide little to no protection from the cold and dry air during winter.

During the 2021 survey, twenty-six AMOs were surveyed within 5 km of the PA, and all were either infilled with rocks or dirt, filled with debris and/or flooded. Given this, none of the AMOs were identified as suitable bat hibernacula habitat. Mature forested stands exist within the PA and could provide roosting habitat but, no evidence of roosting was observed during the 2017 – 2021 surveys.

5.9.3.2.3 Snapping Turtle

No snapping turtles, sign or nests were observed during the dedicated or incidental surveys in the 2017 to 2021 biophysical survey program. Gravel along the roads, particularly adjacent to Gold Brook Lake, could provide nesting habitat for snapping turtles but, there was no evidence of these areas being used as nesting sites.

Overwintering habitat was observed in the pond associated with WL18. This area had depths of approximately 1 m (deep enough to prevent water from freezing at the bottom) and mucky substrate suitable for overwintering of snapping turtles (ECCC, 2020). Suitable water depths were observed at Gold Brook Lake; however, the cobble and boulder substrate was not suitable for overwintering.

5.9.3.2.4 General Wildlife

Wildlife species, including mammals and herpetofauna, were observed incidentally within the PA during biophysical surveys. See Table 5.9-3 for all incidental wildlife observations confirmed either visually or by sign (scat, tracks, etc.).

Table 5.9-3 General Wildlife Species observed within the PA

Scientific Name	Common Name	S-Rank
Mammal		
Lepus americanus	Snowshoe hare	S5
Odocoileus virginianus	White tailed deer	S5
Tamiasciursus hudsonicus	*American red squirrel*	S5
Lynx rufus	*Bobcat*	S5
Ursus americanus	American black bear	S5
Erethizon dorsata	North American porcupine	S5
Castor canadensis	North American beaver	S5
Peromyscus sp.	Deer mouse	S5
Microtus pennsylvanicus	Meadow vole	S5
Lontra canadensis	North American river otter	S5
Vulpes	Red fox	S5
Canis latrans	Eastern coyote	S5
Herpetofauna		
Pseudacris crucifer	Spring peeper	S5
Lithobates clamintans	Green frog	S5

Table 5.9-3 General Wildlife Species observed within the PA

Scientific Name	Common Name	S-Rank
Mammal		
Thamnophis sirtalis	Common garter snake	S5
Plethodon cinereus	Eastern red-backed salamanders	S5

5.9.3.2.5 Terrestrial Fauna Summary

Mainland moose were the only priority terrestrial fauna species observed as having used areas in the surveys. Moose are associated with mature coniferous and deciduous forests and require large tracts of forest for shelter, thermoregulation, and foraging. Moose are herbivores who live in boreal and mixedwood forests and are often found where there is an abundance of food (NSDNRR, 2021).

All potential bat hibernacula were visited during the field surveys and no bats were observed. Although, a potential bat roosting area was observed in the core logging facility in 2017, no evidence of this was observed in the subsequent surveys. No snapping turtles were observed, but potential overwintering and nesting habitat was observed within the PA.

Observations of general wildlife species included: porcupine, North American beaver, eastern coyote, garter snake and green frogs. All these species observed are expected given the habitat and geographical location of the PA.

5.9.3.3 Avifauna

The ACCDC report documented 7 SAR and 20 SOCI avifauna species within a 5 km radius of the PA (Appendix I.2). The reported SAR are summarized below. For a complete list of SOCI species see the ACCDC report in Appendix I.2:

- Bank swallow (*Riparia,* SARA Threatened, NSESA Endangered)
- Bank swallow (*Hirundo rustica*, SARA Threatened, NSESA Endangered)
- Canada warbler (*Cardellina canadensis*, SARA Threatened, NSESA Endangered)
- Short-eared owl (*Asio falmmeus*, SARA Special Concern)
- Common nighthawk (*Chordeiles minor*, SARA Threatened, NSESA Threatened)
- Olive-sided flycatcher (*Contopus cooperi*, SARA Threatened, NSESA Threatened)
- Evening grosbeak (*Circus hudsonius*, SARA Special Concern, NSESA Vulnerable)

The closest IBA, Country Island Complex (NS028), is approximately 6.4 km southwest of the PA (Appendix I.1) (Bird Studies Canada, 2012). The Country Island Complex (NS028) is located off the southeast coast of NS, near Country Harbor and Tor Bay, and is composed of several islands and peninsulas. Country Island is dominantly treeless and is known to have supported many roseate terns. Roseate terns have also been recorded nesting in nearby Goose Island, an unnamed island off Charlos Cove, Inner West Bird Island, Cooks Island, Dorts Island and Hog Island.

The closest Canada Wildlife Service Migratory Bird sanctuary (MBS) is Sea Wolf Island National Wildlife Area approximately 130 km northeast of the PA. The MBS is underlain by bedrock dominated by sandstone in the Gulf of St. Lawrence, approximately 4 km off the coast of Cape Breton, which supports over 40 species of birds, including great cormorants, herring gulls and great blue herons (ECCC, 2020). The habitats of the MBS are not consistent with the PA.

The MBBA square 20PR00 encompasses the entirety of the PA (results are provided in Appendix I.1). In the first MBBA Atlas, 44 possible, 16 probable and 21 confirmed breeding bird species were recorded. Of these species, four are SAR: Canada warbler (*Cardellina canadensis*), common nighthawk (*Chordeiles minor*), barn swallow (*Hirundo rustica*), and evening grosbeak (*Coccothraustes vespertinus*).

Five NSDNRR significant habitat polygons are within the PA and several others are outside and in the general area (Appendix I.1). Four SAR and SOC polygons are within the PA with observations of 11 priority species including two SAR: Canada warbler and olive-sided flycatcher.

The landscape of the PA includes cutovers, regenerative stands, historical mine workings, roads, trails, along with intact, mature conifer and mixedwood stands and open and forested wetlands. Stand heterogeneity and diversity within the PA provide a range of habitats suitable for a variety of bird species with various requirements. Open habitat such as cutovers, provide suitable hunting habitat for predatory birds such as northern hairier and American kestrel and open water habitats provide foraging and hunting habitat for waterfowl, waterbirds, shorebirds, and predatory birds such as Ospreys. Forests with stand heterogeneity (i.e., stands with different height classes) provided suitable habitat for foraging and breeding for many passerine species.

5.9.3.3.1 Spring Migration Surveys

In the spring migration surveys conducted in 2019 and 2021, a total of 1,232 individuals representing 58 species were observed during dedicated surveys. One SAR species (i.e., evening grosbeak) and nine SOCI species (i.e., black-backed woodpecker, blackpoll warbler, boreal chickadee, gray jay, pine siskin, red-breasted nuthatch, ruby-crowned kinglet, Swainson's thrush, and yellow-bellied flycatcher) were observed during the spring migration surveys. Detailed survey results are found in Appendix I.1.

Passerines comprised of 88% of all individual birds observed, followed by other landbirds (8%), other waterbirds (3%), and waterfowl (1%). White-throated sparrow (n=169) was the most abundant species observed, followed by palm warbler (n=92), and yellow-rumped warbler (n=72). No large flocks or obvious migration patterns were observed. All species identified are native species in this region of NS and the province. Typical and common habitat to support these species are present within the PA and surrounding landscape.

5.9.3.3.2 Breeding Bird Surveys

During breeding bird surveys, a total of 1,662 individual birds representing 64 species were observed. Three SAR species (Canada warbler, wood thrush and olive-sided flycatcher) and 11 SOCI species (boreal chickadee, fox sparrow, gray jay, greater yellowlegs, northern harrier, red-breasted nuthatch, ruby-crowned kinglet, spotted sandpiper, Swainson's thrush, Wilson's warbler, and yellow-bellied flycatcher) were observed during the breeding bird surveys.

Passerines, which were the most common bird functional group observed in the breeding bird surveys, were 83% of all individuals, followed by diurnal raptors (8%), other waterbirds (5%), other landbirds (2%), waterfowl (1%), and shorebirds (<1%). White-throated sparrow (n=179) was the most abundant species observed, followed by common yellowthroat (n=149), black-and-white warbler (n=95), hermit thrush (n=93) and magnolia warbler (n=92). Detailed survey results are found in Appendix I.1.

5.9.3.3.3 Fall Migration Surveys

In the fall migration surveys, 683 individual birds representing 29 species were observed. Eight SOCI species (i.e., American kestrel, bay-breasted warbler, boreal chickadee, gray jay, gray catbird, red-breasted nuthatch, ruby-crowned kinglet, and turkey vulture) were observed during the fall migration surveys.

Passerines were the most abundant functional bird group in the fall migration surveys and accounted for 85% of all individuals observed, followed by diurnal raptors (8%), other waterbirds (5%), and other landbirds (2%). Black-capped chickadee (n=108) was the most abundant species observed, followed by blue jay (n=57) and golden-crowned kinglet (n=54). No large flocks or obvious migration patterns were observed. All the species identified are native species in this region of NS and the province. Typical and common habitat to support these species are present within the PA and surrounding landscape. Detailed survey results are found in Appendix I.1.

5.9.3.3.4 Common Nighthawk Surveys

During common nighthawk surveys in 2017 and 2021, suitable breeding and foraging habitat was widespread within and adjacent to the PA including a pipeline ROW, open bogs, and disturbed areas. However, despite this habitat being present, no common nighthawks were observed during the surveys. Detailed survey results are found in Appendix I.1.

5.9.3.3.5 Nocturnal Owl Surveys

During surveys in 2017 and 2021, three owl species were observed including one SOCI species: boreal owl (*Aegolius funereus*). Species observed during the surveys were northern saw-whet owl (*Aegolius acadicus*), boreal owl (*Aegolius funereus*), and great horned owl (*Bubo virginianus*). Boreal owls were observed once in 2017 and not observed in 2021. Detailed survey results are found in Appendix I.1.

5.9.3.3.6 Waterfowl Surveys

During waterfowl surveys, one priority species (i.e., spotted sandpiper) was observed. In total, 12 individuals representing five species were observed during dedicated surveys. Drilling activity was occurring near Gold Brook Lake throughout the surveys, which caused a high level of noisedisturbance, which may have resulted in lower bird observations during this survey. Detailed survey results are found in Appendix I.1.

5.9.3.3.7 Species at Risk and Species of Conservation Interest

Several SAR and SOCI avifauna species were observed during the avifauna field program from 2017 to 2021 (Figure 7A-F). A summary of SAR and SOCI observed are described below; further details are described in Appendix I.1.

Four SAR avifauna species were observed throughout the dedicated survey periods as well as incidentally during all other biophysical surveys completed from 2017 to 2021 (Appendix I.1). The habitat within the PA comprises of a mosaic of softwood, mixedwood forested stands, regenerative forests, open water, treed and shrubbed wetlands and clearings which provide a wide range of habitats for bird species. The SAR avifauna species observed and a description of each SAR species, habitat requirements and the habitat present within the PA, are described below.

- Canada warbler (*Cardellina canadensis*; ACCDC: S3B; SARA: Threatened; NSESA Endangered)
- Evening grosbeak (*Hesperiphona vespertina*, ACCDC: S3S4B, S3N; SARA: Special Concern, NSESA: Vulnerable)
- Olive-sided flycatcher (*Contopus cooperi*, ACCDC: S2B, SARA: Threatened, NSESA: Threatened)
- Wood thrush (*Hylocichla mustelina*, ACCDC: SUB, SARA: Threatened)

Canada Warbler

The Canada warbler is a small brightly coloured songbird; the males have blue-gray upperparts and tail with a contrasting yellow throat and breast. Breeding habitat for the Canada warbler consists of a variety of landscapes but is commonly moist to wet forests with a dense deciduous shrub layer. Nests may be built on or near the ground on raised hummocks, within root masses, rotting tree stumps, clumps of grass, rock cavities, dense shrubs, and in regenerating forests (COSEWIC, 2020). Forested swamps with a well-developed shrub layer suitable for breeding and nesting were observed scattered throughout the PA. Fifteen Canada warbler individuals were observed during the breeding season and often found within treed swamps with a well-developed shrub layer or in dense upland forest near treed swamps (Appendix I.1). The treed swamp habitats were dominated by softwoods (i.e., balsam fir and black spruce) often with a prominent shrub layer comprising of speckled alder (*Alnus incana*) or mountain holly (*Ilex 382ucronate*) and blanketed with *Sphagnum* mosses. The upland forest habitats where Canada warbler were observed were dominated by balsam fir and black spruce, with a well-developed shrub layer of mountain holly. Within the PA, Canada warblers were observed within WL20, 25 and 117 (Appendix I.1).

Evening Grosbeak

Evening grosbeaks are a member of the true finch family (Fringillidae), are a short stocky, vibrant coloured and equipped with a large yellowish-green bill (COSEWIC 2016). This species breeds in Mexico, Canada, and the United States. In the winter months, their range can vary widely depending on the food source available and is often found in backyards at feeders. Breeding habitat is typically in open, mature mixedwood upland forests often dominated by balsam fir and white spruce and where their main food source, the spruce budworm (*Choristoneura* spp.) is present (COSEWIC, 2016). Softwood and mixedwood stands are present within the PA and do provide suitable breeding habitat for evening grosbeak, however, this species was only observed in the migration seasons and as a flyover. There was no evidence of evening grosbeak using the PA for breeding but may be using the area as a stop over and for foraging. Four observations totalling twenty individuals were made of evening grosbeak during spring migration and incidentally during 2021 (Appendix I.1).

Olive-sided Flycatcher

The olive-sided flycatcher is a small insectivore belonging to the "tyrant flycatchers" (*Tyrannidae*) family, with plumage with deep brownish olive grey above and whitish breast and throat (COSEWIC, 2018). Although members of this family can be strikingly similar, the distinctive three-note song reminiscent of the phrase "quick, three-beers" is often diagnostic (COSEWIC, 2018). The olive-sided flycatcher is a widespread migratory species, with 53% of its breeding range being encompassed in forested areas in Canada. Olive-sided flycatchers are often found on edges of coniferous or mixed forests with tall trees and snags, along open areas, or in burned forests with standing trees and snags (COSEWIC, 2018). Within the PA, two observations of olive-sided flycatcher were observed in softwood swamps (WL 17 and WL 42) adjacent to cutovers (Appendix I.1). The abundance of conifer dominant swamps, forested uplands and edge habitats from forestry activities (cutovers) within the PA provides suitable breeding habitat for olive-sided flycatcher and is widespread throughout the PA and surrounding area.

Wood Thrush

The wood thrush is a medium sized bird, which is generally rusty-brown on the upperparts with white underparts and large blackish spots on the breast and flanks. The wood thrush nests mainly in second-growth and mature deciduous and mixedwood forests. Wood thrush generally prefer large forest mosaics but can also be found in small forest fragments (COSEWIC, 2012). Forested communities in the PA are predominately softwood and heavily fragmented due to historical and on-going forestry activities. Large contiguous forest mosaics are scarce within the PA and therefore, suitable habitat for wood thrush is limited. One wood thrush was observed outside the PA in the breeding season in 2021 in mixedwood upland forests (Appendix I.1).

Species of Conservation Interest

Across all survey seasons, a total of 24 SOCI species were observed (Appendix I.1). The species and the survey season and type when they were observed are as follows:

- American kestrel (*Falco sparverius,* fall 2021, incidental)
- Bay-breasted warbler (*Dendroica castanea*; fall 2021)
- Black-backed woodpecker (*Picoides arcticus*; spring 2019, incidental)
- Blackpoll warbler (*Dendroica striata*, spring 2021)
- Boreal chickadee (*Poecile hudsonica*; spring 2021, breeding 2017, breeding 2019, breeding 2021, fall 2018, fall 2021, incidental)
- Canada jay (*Perisoreus canadensis*; spring 2019, spring 2021, breeding 2021, fall 2021, incidental)
- Fox sparrow (*Passerella iliaca*, breeding 2017)
- Gray catbird (*Dumetella carolinensis,* fall 2021, incidental)
- Greater yellowlegs (*Tringa melanoleuca*, spring 2021, incidental)
- Northern harrier (*Circus cyaneus,* breeding 2021, incidental)
- Pine grosbeak (*Pinicola enucleator*, incidental)
- Pine siskin (*Carduelis pinus*, spring 2019)
- Red crossbill (*Loxia curvirostra,* incidental)
- Red-breasted nuthatch (*Sitta canadensis*; spring 2019, Breeding 2017, breeding 2019, breeding 2021, fall 2018, incidental)

- Rough-legged hawk (*Buteo lagopus,* incidental)
- Ruby-crowned kinglet (*Regulus calendula*; spring 2019, spring 2021, breeding 2017, breeding 2019, breeding 2021, fall 2021, common nighthawk survey, incidental)
- Solitary sandpiper (*Tringa solitaria*, incidental)
- Spotted sandpiper (*Actitis macularius,* breeding 2017, waterfowl 2021, incidental)
- Swainson's thrush (*Catharus ustulatus*; spring 2021, breeding 2017, breeding 2019)
- Turkey vulture (*Cathartes aura*, fall 2021)
- Willet (*Tringa semipalmata*, spring 2021)
- Wilson's warbler (*Cardellina pusilla*, breeding 2017, breeding 2021, incidental)
- Yellow-bellied flycatcher (*Empidonax flaviventris*; spring 2019, breeding 2017, breeding 2019, breeding 2021, incidental)
- Boreal owl *(Aegolius funereus,* S2?B, 2017 nocturnal owl surveys)

5.9.4 Consideration of Consultation and Engagement Results

Signal Gold has undertaken an engagement and consultation program with the Mi'kmaq of Nova Scotia, stakeholders, regulators, and the public. These activities are described in more detail in Section 3. Throughout this process, various issues, concerns, and opportunities have been identified in relation to the Project. These matters have been considered within the context of this VC to help understand potential effects of the Project on the biophysical and socioeconomic environment and inform consideration of possible mitigation measures. Key issues raised during public consultation and Mi'kmaq engagement relating to terrestrial environment include:

- Loss of habitat as well as flora and fauna due to Project development.

The results of public consultation and Mi'kmaq engagement have been considered in the environmental effects assessment, including the Proponent's commitments on mitigation and monitoring measures and proposed compliance and effects monitoring programs, as well as the Proponent's broader commitment to ongoing public consultation and Mi'kmaq engagement. Specific to evaluating the effect on terrestrial environment, these are found within the following environmental effects assessment.

5.9.5 Effects Assessment Methodology

This section describes the method used to assess potential Project-related environmental effects on the terrestrial environment. These methods include identifying spatial boundaries, thresholds of determination of significance, including magnitude of effects metrics and habitat modelling techniques. These methods and definitions are carried forward to Project Interactions and Potential Effects (Section 5.9.6).

5.9.5.1 Boundaries

The scope of the environmental effects assessment is defined by spatial (i.e., geographic extent of Project effects), temporal (i.e., the timing of potential effects), administrative, and technical boundaries. Spatial boundaries were defined based on the expected maximum extent of direct and indirect impacts to terrestrial environment. Temporal boundaries are based on the anticipated duration and timing of Project activities. The assessment boundaries are described below.

5.9.5.1.1 Spatial Boundaries

The following spatial boundaries were used to evaluate Project effects and interactions, including residual effects to the terrestrial environment. The spatial boundaries described below are shown in Figure 5.9-1.

- PA – The PA encompasses the immediate area in which Project activities may occur and are likely to cause direct and indirect effects to the terrestrial environment. The PA includes the infrastructure associated with the mine site with a buffer of 100 – 200 m.

- (LA) – The LAA encompasses a 5 km buffer surrounding the PA. The LAA boundaries were defined based on the expected maximum extent of direct and impacts to the terrestrial environment. A 5 km buffer was selected to encompass the extent in which light levels emitted from the Project reach approximate background levels (0.1 lux) (Section 5.2) and in consideration of the maximum extent of noise levels from the Project.
- RAA – An RAA has not been defined for this VC as the maximum extent of indirect impacts is expected to be within the LAA, as defined.

Prepared For:

SIGNAL GOLD

FIGURE 5.9-1

LAA, PA and Project Infrastructure

Goldboro, NS

Terrestrial Environment LAA

Project Infrastructure

Project Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 750 1,500 3,000 m

1:55,000 Scale when printed @ 11" x 17"

Drawn By: MQ
Reviewed By: JG

Date: 2022-04-08

McCallum Environmental Ltd.

Document Name: 220408_LAA_PA_Infra

5.9.5.1.2 Temporal Boundaries

The temporal boundaries for the terrestrial environment effects assessment are defined by the construction, operations, and closure phase of the Project, and are summarized in Table 5.9-4.

Table 5.9-4 Project Timeline

Duration	Phase
2 years	Construction
11 years	Operation
24 years	Closure

5.9.5.1.3 Technical Boundaries

Prediction of habitat availability and loss within the LAA was limited by the accuracy of the models developed (Section 5.9.5.3). Habitats identified in these models were at a coarse scale and did not include other factors that could influence a species inhabiting an area (e.g., habitat adjacent to active quarries, roads, cutovers, or areas subject to sensory disturbance). The model may overpredict habitat types within the LAA, notably forested swamps, which were modelled based on the cartographically derived Depth to Water index (Section 5.9.5.1.3).

5.9.5.1.4 Administrative Boundaries

Administrative boundaries for the evaluation and management of the terrestrial environment include the Canada *Migratory Bird Convention Act* (MBCA), *Migratory Bird Regulations,* and *SARA* along with the NS *Wildlife Act, Endangered Species Act,* "Wetland Conservation Policy (2011)", and "At-Risk Lichens – Special Management Practices" (NSDNRR, 2018).

5.9.5.2 Thresholds for Determination of Significance

Table 5.9-5 summarizes the characterization criteria for environmental effects to the terrestrial environment. The timing of residual effects for the terrestrial environment considers when the residual environmental effect is expected to occur, seasonal aspects, and sensitive time periods for flora and fauna. The duration of residual effects considers the time frame over which the effects are likely to last, ranging from short-term to permanent. For the effects assessment for Terrestrial Environment, long term reflects effects that extend beyond three years. The frequency of residual effects considers the rate of recurrence of the effects, ranging from once to continuous. The reversibility of residual effects considers the time required for habitat to recover to baseline conditions, or whether the changes to habitat, if identified, are permanent.

Table 5.9-5 Characterization Criteria for Environmental Effects

Characterization	Quantitative Measure or Definition of Qualitative Categories
Magnitude	**N** – the Project is predicted to result in less than 1% direct loss of: • Vegetation and Habitats within the LAA • Wildlife Habitat (inclusive of terrestrial fauna and avifauna) within the LAA • SAR or SOCI Habitat within the LAA **L** – the Project is predicted to result in 1-5% direct loss of: • Vegetation and Habitats within the LAA • Wildlife Habitat (inclusive of terrestrial fauna and avifauna) within the LAA • SAR or SOCI Habitat within the LAA • the loss of habitat is mitigated through reclamation planning and other mitigation measures as determined to be necessary based on flora species and communities present **M** – the Project is predicted to result in 5-25% direct loss of: • Vegetation and Habitats within the LAA • Wildlife Habitat (inclusive of terrestrial fauna and avifauna) within the LAA • SAR or SOCI Habitat within the LAA • the loss of habitat is mitigated through reclamation planning and other mitigation measures as determined to be necessary based on flora species and communities present **H** – the Project is predicted to result in greater than 25% direct loss of: • Vegetation and Habitats within the LAA • Wildlife Habitat (inclusive of terrestrial fauna and avifauna) within the LAA • SAR or SOCI Habitat within the LAA • the loss of habitat is mitigated through reclamation planning and other mitigation measures as determined to be necessary based on flora species and communities present
Geographic Extent	**PA** – direct and indirect effects from Project activities are restricted to the PA **LAA** – Residual effects extend into the LAA **RAA** – not defined for this assessment.
Timing	**A** — seasonal aspects may affect VCs
Duration	**ST** – effects are limited to occur from as little as 1 day to 12 months **MT** – effects can occur beyond 12 months and up to 3 years **LT** – effects extend beyond 3 years **P** – valued component unlikely to recover to baseline conditions
Frequency	**O** – effects occur once **S** – effects occur at irregular intervals throughout the Project **R** – effects occur at regular intervals throughout the Project **C** – effects occur continuously throughout the Project
Reversibility	**RE** – VCs will recover to baseline conditions before or after Project activities have been completed. **PR –** mitigation cannot guarantee a return to baseline conditions **IR** – effects to VCs are permanent and will not recover to baseline conditions

A significant adverse effect on the Terrestrial Environment from the Project is defined as:

- A Project-related effect that is likely to cause a permanent, unmitigated, alteration to habitat that supports flora and fauna species.

An effect that does not cause a permanent alteration to habitats, species distribution, or permanent loss to habitat is not considered a significant adverse effect. Sessile species such as vascular and non-vascular plants and lichens do not have the ability to avoid direct and indirect impacts from the Project. For these species, the loss of an individual or individuals of a SAR species that is important in the context of the province, or that species' overall abundance or distribution, may be considered significant, if appropriate mitigation measures are not implemented. Mortality of a single SAR could, under some circumstances, be considered a significant effect. The loss of an individual SAR due to an accident or malfunction (i.e., wildlife collision) is not incorporated into the magnitude threshold or overall significance of Project activities.

5.9.5.3 Geographic Information System (GIS) Modelling and Analytical Techniques

To quantify impacts to the terrestrial environment, namely, loss of suitable wildlife habitat and vegetation communities, several GIS models and field data were used. These models identified and quantified the abundance and distribution of terrestrial fauna, avifauna habitat, and vegetation communities across the LAA. Modelling tools used in the terrestrial environment effects assessment include the Project Ecological Land Classification (P-ELC), Terrestrial Fauna Assessment, Avifauna Land Use Assessment, Interior Forest and Mainland Moose modelling. Details of the GIS modelling and limitations are described in the following sections. The results of these models are used in Section 5.9.6 to help inform Project Interactions and Potential Effects from the Project to the terrestrial environment.

5.9.5.3.1 Project Ecological Land Classification (P-ELC) Mapping

An assessment of the general vegetation communities and habitat within the LAA was completed by the development of a desktop driven P-ELC. The P-ELC mapping provides an overview of the major vegetation communities and habitats present within the LAA (Fig 5.9-2 A-K). The key objectives of the P-ELC mapping were to:

- Predict the locations and extent of major habitat types within the LAA
- Identify habitats with high potential to support SAR and SOCI
- Provide an environmental effects assessment tool to quantify interactions and residual effects between Project infrastructure and habitat required by various taxa.

The P-ELC was developed using the ELC method in delineating areas of lands with similar ecological patterns and processes. The framework involves a nested hierarchy, where coarser scaled ecosystems are reduced into finer scale units. Before the development of the P-ELC, the following frameworks and guidelines were consulted:

- "Ecological land Classification for Nova Scotia" (Neily et al., 2017)
- "A Procedural Guide for Ecological Landscape Analysis" (Stewart and Neily, 2008)

Development of the P-ELC was primarily desktop driven, but the field data collected during vegetation community assessments (Section 5.9.3.1) were used to supplement the P-ELC for analysis within the PA. The field surveys classified vegetation community data into vegetation types, which are finer scaled ecological units than the P-ELC. Since only broad vegetation groups could accurately be identified by the desktop driven P-ELC, the vegetation type data collected in the PA was categorized into broader units. For example, if there were four observed vegetation types that were all a variation of a mixedwood forest, then the vegetation types would be aggregated into this broader group. Categorizing the data into broader units makes the field data comparable to the P-ELC data and therefore, can be used in conjunction with the desktop driven P-ELC when completing several analyses of Project effects on the terrestrial environment.

The desktop driven P-ELC was created using various GIS datasets, models, and aerial interpretation using QGIS software. The provincial data sets used to develop the P-ELC were:

- NS Department of Natural Resources (NSDNRR) Forestry Layer
- NS Topographic Database (NSTDB) Roads layer
- Wet Area Mapping (WAM) provided by Wetland Specialist, Ian Bryson

The WAM layer, which is the cartographically derived Depth to Water (DTW) index, was crucial in predicting habitat types, particularly forested wetlands that are difficult to identify by aerial imagery alone. The DTW is the modelled water table and predicts soil wetness. It was derived from DEMs with a 5 m grid, and channel networks were created using a 0.25 ha threshold. These channel networks represent where water is at the surface (DTW=0). A DTW threshold of <=0.5 m was selected to represent poorly drained soils (i.e., wetlands) and is an important factor in determining vegetation community composition.

The NSTDB and NSDNRR layers were clipped to the LAA. The NSTDB roads layer was buffered by 10 m (to account for the footprint of the roads) and merged with the NSDNRR forestry layer. Major habitat and land use types were categorized and described below. When applicable, each major vegetation community group description includes forest group names used in the *Forest Ecosystem Classification System* (Neily et al., 2010) or the classification guides used in Section 5.9.2.2.1.

- **Alders** – Areas with >75% alder cover with well drained soils. Vegetation often consists of upland vegetation species and bryophytes such as plume and feather moss.
- **Alder Swamp** – stands with greater than 75% with poorly drained soils (DTW<=0.5 m). These habitats often comprise of three-seeded sedge, cinnamon fern and a variety of other sedge and fern species. Sphagnum is usually the dominant bryoid in these vegetation communities.
- **Cutover and Regenerative Stands** – This group was created by querying the height class of the forest stands. Heights of < 6 meters were selected and represents new growth following a stand level disturbance. These areas often comprise of pioneer vegetation and regenerative woody perennial species. Soils are well drained.
- **Cutover and Regenerative Swamps** – Similar vegetation structure as above but with poorly drained soils (DTW<=0.5 m). The community structure often varies but includes woolgrass, soft rush (*Juncus effusus*) three-seeded sedge, bent grasses (*Agrostis spp.*) and a variety of different members of the aster family (Asteracea). Regenerative shrub and tree species such as black spruce, red spruce, balsam fir and red maple are also common.
- **Barrens** – Barren ecosystems are characterized by harsh climatic and/or edaphic conditions and by low shrub communities (Porter et al., 2021). These communities are largely associated with shrubs from the heath family (*Ericeacea*), shallow soils and often exposed bedrock. These communities can occur in a coastal setting (<500 m from the coastline) or inland (>500 m from the coastline). Barrens are divided into herbaceous, dwarf shrublands and shrubland associations. The NSDNRR forestry layer identifies barrens with at least 50% exposed bedrock or areas with low tree cover.
- **Mixedwood Forests** – This forest group is defined as forests with 26 - 74% softwood tree species by basal area and comprise of early to late successional vegetation types, and these vegetation types can be difficult to characterize due to variation of tree species composition. This forest group is dominated by a mixture of hardwood and softwood species and occur in an upland setting. Early successional stages often consist of red maple, white birch and balsam fir and late successional stages comprise of yellow birch, red spruce and/or hemlock. Herb and bryophyte diversity is often high and extensive consisting of bryophytes such broom moss, knight's plume and Schreber's moss, wild-lily-of-the-valley and star flower and well to imperfectly drained soils. Mixedwood forests include vegetation types associated with Mixedwood Forest Group (Section 5.9.3.1.1).
- **Hardwood Forests –** Forested communities with greater than 75% hardwood species by basal area. These communities are an upland community with well to imperfectly drained soils. Common species include red maple, sugar maple, white birch, yellow birch with sparse cover of softwood species such as balsam fir and spruce. The herbaceous layer varies but common species include sarsaparilla, wild-lily-of-the-valley and bracken fern.
- **Softwood Forests –** Forested communities consisting of 75% softwood or greater by basal area. These communities are often associated with nutrient poor soils and dominated by softwood species such as white pine, red spruce, black spruce and balsam fir. Soils are well to imperfectly drained and often have an herbaceous and bryoid layer consisting of bracken fern, sheep laurel, bunch berry, Schreber's moss and broom moss. This group includes vegetation types belonging to the Spruce-Hemlock, Spruce-Pine and Coastal Forest group described in the FEC (Section 5.9.3.1.1).

- **Mixedwood Forested Swamps** – Forested communities with 26 to 74% softwood tree species by basal area and usually with extensive sphagnum cover and acidic, nutrient poor and poorly drained soils (DTW <=0.5 m). Fern species, such as cinnamon fern (*Osmundastrum cinnamomeum*) and sedges such as the three-seeded sedge (*Carex trisperma*) are usually associated with this vegetation community group. Common sphagnum species associated with this vegetation group are *S. palustre, S. capillifolium* and *S. girgensohnii.* Mixedwood forested swamps encompass the Wet Deciduous Forest Group vegetation types observed within the PA (Section 5.9.3.1.1).
- **Hardwood Forested Swamps** – Forested communities with greater than 75% hardwood species by basal area, usually with extensive sphagnum cover and acidic, nutrient poor and poorly drained soils (DTW <=0.5 m). Fern species, such as cinnamon fern (*Osmundastrum cinnamomeum*) and sedges such as the three-seeded sedge (*Carex trisperma*) are usually associated with this vegetation community group. Common sphagnum species associated with this vegetation group are *S. palustre, S. capillifolium* and *S. girgensohnii.* Mixedwood forested swamps encompass the Wet Deciduous Forest Group vegetation types observed within the PA (Section 5.9.3.1.1).
- **Softwood Forested Swamps** – Forested communities with greater than 75% softwood species by basal area, usually with extensive sphagnum cover and acidic, nutrient poor and poorly drained soils (DTW <=0.5 m). Fern species, such as cinnamon fern (*Osmundastrum cinnamomeum*) and sedges such as the three-seeded sedge (*Carex trisperma*) are usually associated with this vegetation community group. Common sphagnum species associated with this vegetation group are *S. palustre, S. capillifolium* and *S. girgensohnii.* Mixedwood forested swamps encompass the Wet Conifer Forest Group vegetation types observed within the PA (Section 5.9.3.1.1).
- **Open Wetlands –** These are wetland communities with a predominant herbaceous and low shrub layer. This group primarily consists of peatlands and include raised bogs and fen systems. Vegetation often consists of black spruce, tamarack, leather leaf, sheep laurel, and a variety of sedge *(carex spp.*) and cotton grass (*Eriophorum spp.*) species. Due to the inability to distinguish a bog, fen or marsh without ground verification, the P-ELC groups vegetation with low tree and high herbaceous and shrub cover as open wetlands. However, it is estimated that the majority (>80%) of open wetlands identified are bog and fen wetland communities. Open wetlands found adjacent to the coast are more likely tidal marshes or mineral wetlands, however, coastal areas only account for a small portion of the LAA. Vegetation types associated with the Peatland Group (Section 5.9.3.1.1) belong to this community group.
- **Urban/Developed –** These are all anthropogenic disturbance (except for cutovers), and include housing developments, roads, access trails, transmission line corridors and industrial (e.g., quarries) developments.
- **Waterbodies –** Includes all freshwater lakes and ponds.
- **Ocean –** This includes portion of Isaac's harbor and characterized by brackish water.

Accuracy Assessment

The accuracy of the P-ELC was assessed by completing a confusion matrix. The accuracy assessment involved over 100 data points randomly scattered across the PA. The data points overlaid the rasterized version of the field vegetation community results, and raster pixel values were extracted. The P-ELC had an 80% overall accuracy.

5.9.5.3.2 Terrestrial Fauna Habitat Assessment

Habitat types observed within the LAA were determined using the P-ELC mapping methods described in Section 5.9.5.3.2. The results from habitat mapping were then used to quantify terrestrial fauna habitat throughout the LAA and to support an analysis of Project impacts to terrestrial fauna species and associated habitats.

Terrestrial fauna includes a wide range of unrelated species with different habitat requirements, ranging from amphibians to large mammals. As a result, this analysis of terrestrial fauna has been broken down into several major groups based on taxonomic and habitat requirement similarities. Representative species were selected for each group. In instances where groups were diverse, and it was not possible to capture habitat requirements based on one representative species, multiple representative species with different habitat requirements were selected. Selection of representative species was completed by Project biologists and justification provided for each species description below. The following groups and representative species were assessed:

- Large Mammals
  - White-tailed deer (Odocoileus virginianus)
  - American black bear (Ursus americanus)
- Semi-aquatic Mammals
  - Beaver (Castor canadensis)
  - River otter (Lutra canadnesis)
- Small Mammals
  - American red squirrel (Tamaisciurus hudsonicus)
  - Porcupine (Erethizon dorsatum)
- Terrestrial Herpetofauna
  - Garter snake (Thamnophis sirtalis pallidulus)
- Aquatic/Semi-aquatic Herpetofauna
  - Snapping turtles (Chelydra seprentina)
  - Green frog (Rana clamitans)
- Bats
  - Little brown myotis (Myotis lucifugus)
  - Hoary Bat (Aeorestes cinereus)

Terrestrial fauna habitat availability and abundance within the LAA was calculated using the known habitat requirements for each representative species. Terrestrial fauna habitat types were chosen based on a literature review and expert knowledge of the species. Seasonal and specific habitat requirements such as breeding, protection, foraging, and hunting were considered when determining suitable habitat for each species group. If multiple representative species were assessed per group (e.g., large mammals), habitat requirements for each representative species were combined, and a general habitat requirement for that group was created.

Large Mammals

Large mammals include several species known or expected to occur within the PA and LAA. Many species of this group (e.g., coyote, black bears) are generalists, have large home ranges and often found foraging in timber clearings or using existing trails as migration corridors. Habitat for Mainland moose, which is a SAR, was assessed separately using methods described in Section 5.9.5.3.2. American black bear and white-tailed deer were selected as representative species for the large mammal group due to their known presence and available habitat within the PA and LAA. Table 5.9-6 summarizes habitat types preferred by white-tailed deer and American black bear.

White-Tailed Deer

White-tailed deer, which are hoofed ungulates in the Cervidae family, are widespread across Canada. They have a compact torso, long, slender legs, and small tails. White-tailed deer can be found in any forested or shrub dominant habitat, as their diet consists of leafy material, woody plants, grasses, herbs, and forbs. During winter, deer feed on twigs and buds and gather in areas that provide shelter from deep snow or storms (Canadian Wildlife Federation & ECCC nd).

Habitat for white-tailed deer is widespread throughout the PA. Evidence of white-tailed deer, such as browse and tracks, were observed in forested habitats of the PA, along trails, and within forested and open wetland areas.

American Black Bear

American black bear is a medium sized bear of the Ursidae family. Important habitats for black bears include vegetation-rich areas, as well as high forest cover areas. Black bear habitat changes seasonally based on variation in food availability (Davis et al., 2006). In late April to early May, black bears can be found in low-lying areas, where emergent and digestible vegetation is found (Bowyer et al., 1999; Eagle and Pelton, 1983; White et al., 2001). Black bears feed primarily on fruits, graminoids, and forbs, but will also prey on juvenile ungulates (Bastille-Rousseau et al., 2011). Black bears select lowlands areas for den-sites (Linnell et al., 2000). Lowland forests also provide ideal foraging grounds for black bears (Wilton, 1983). Black bears tend to avoid open areas, preferring forested areas with a mix of cover and clearings (Rogers and Allen, 1987). Black bears can be found in open wetlands, open water and anthropogenic habitats, but tend to prefer closed canopy cover (Carter et al., 2010). Habitat connectivity is important for a black bear's range, as they travel long distances and preferentially avoid open areas (Obbard et al., 2010). Black bears will also use cutblocks for foraging.

Habitat for black bears was observed throughout the PA. Evidence of black bears, such as tracks and scat, were observed within forested habitats and wetland areas of the PA.

Table 5.9-6 Habitat Type used by Large Mammals

P-ELC Habitat Type	Habitat Type Used[1]		
	White-tailed Deer	American Black Bear	General Large Mammal Habitat[1]
Mixedwood Forests	X	X	X
Mixedwood Forested Swamps	X	X	X
Softwood Forests	X	X	X
Softwood Forested Swamps	X	X	X
Hardwood Forests	X	X	X
Hardwood Forested Swamps	X	X	X
Cutover/Regenerative Stands	X	X	X
Cutover/Regenerative Swamps	X	X	X
Barrens	X	X	X
Open Wetlands	X	X	X
Alders	X	X	X
Alder Swamps	X	X	X
Waterbodies	X	X	X
Ocean	-	-	-
Anthropogenic	X	X	X

[1] General habitat represents the summation of all habitat types used by the representative species.

Semi-Aquatic Mammals

Semi-aquatic mammals depend on aquatic features for feeding and/or breeding. Species within this group include beavers, muskrats, and otters. River otter and the American beaver were selected as a representative species as they are known in the PA and habitat is present throughout the LAA. Table 5.9-7 summarizes habitats required by river otter, American beaver, and semi-aquatic mammals in general.

River Otter

River otters, carnivorous mammals in the Mustelid family that occur throughout much of Canada, are usually found in water habitats, such as ponds, lakes, and marshes, as well as along riparian zones (National Wildlife Federation nd; Smithsonian National Zoo and Conservation Biology Institute nd). River otter burrows are generally found near water features, with access from both land and water (Nature Conservancy Canada nd). The diet of the river otter is composed of aquatic wildlife, such as fish, frogs, birds, and reptiles, as well as aquatic plants (National Wildlife Federation nd). Otter tracks were observed in the PA during winter surveys close to waterbodies.

American Beaver

Beavers are large rodents in the Castoridae family. They are generally associated with water, and are found in ponds, lakes, and rivers (Allen, 1983). Beaver habitats are typically found in areas that provide adequate forage material, such as aquatic vegetation, shrubs, alders, and hardwoods (Northcott, 1971). Beavers have been showed to preferentially forage aspen and alders for building materials for lodges and dams (Northcott, 1971).

Evidence of beaver activity, including lodges and dams, was observed in large watercourses and waterbodies within the PA.

Table 5.9-7 Habitat Type used by Semi-Aquatic Mammals

P-ELC Habitat Type	Habitat Type Used[1]		
	River Otter	American Beaver	General Semi-Aquatic Mammals Habitat[1]
Mixedwood Forests	-	-	-
Mixedwood Forested Swamps	-	-	-
Softwood Forests	-	-	-
Softwood Forested Swamps	-	-	-
Hardwood Forests	-	-	-
Hardwood Forested Swamps	-	-	-
Cutover/Regenerative Stands	-	-	-
Cutover/Regenerative Swamps	-	-	-
Barrens	-	-	-
Open Wetlands	X	X	X
Alders	-	-	-
Alder Swamps	-	-	-
Waterbodies	X	X	X
Ocean	X	-	-
Anthropogenic	-	-	-
[1]General habitat represents the summation of all habitat types used by the representative species.			

Small Mammals

Small mammals (approximately <10kg) include several species known or expected to occur within the PA and LAA. Species of this group range from forest specialists to generalists, and are often found in a variety of forested, wetland and urban settings. The American red squirrel and porcupine were selected as representative species for this group due to their known presence and available habitat within the PA and LAA and their overlapping habitat requirements with other species within this group. Table 5.9-8 summarizes habitat types preferred by the American red squirrel, porcupine, and small mammals in general.

American red squirrel

The American red squirrel is a small rodent in the Sciruidae family and is found throughout NS in mixedwood and coniferous forests (National Wildlife Federation, nd). American red squirrels are omnivores, with a diet consisting primarily of evergreen tree seeds and cones. They will opportunistically feed on bird eggs and berries (National Wildlife Federation, nd). American red squirrels were observed throughout the PA, primarily in forested areas.

Porcupine

Porcupines are large rodents that live among trees, and can be found in mature forests, particularly mixed hardwood forests, as well as alder thickets beside rivers and dwarfed pine scrubs (Canadian Wildlife Federation, nd; Fergus, nd). Porcupine dens are typically near rocky ledges and rock piles, as well as aspen, hemlock, and other tree stands (Canadian Wildlife Federation, nd). Porcupine diets include inner bark of trees, as well as softwood needles and other vegetation, including currant, rose, and dandelion. Porcupines will preferentially feed on hemlock in winter. In spring, porcupines feed on maples and catkin bark, as well as alder, poplar, and willow leaves (Canadian Wildlife Federation, nd). Porcupine tracks were observed throughout the PA.

Table 5.9-8 Habitat Types used by Small Mammals

P-ELC Habitat Type	Habitat Type Used[1]		
	American Red Squirrel	Porcupine	General Small Mammal Habitat[1]
Mixedwood Forests	X	X	X
Mixedwood Forested Swamps	X	X	X
Softwood Forests	X	X	X
Softwood Forested Swamps	X	X	X
Hardwood Forests	X	X	X
Hardwood Forested Swamps	X	X	X
Cutover/Regenerative Stands	X	X	X
Cutover/Regenerative Swamps	X	-	X
Barrens	-	-	-
Open Wetlands	X	X	X
Alders	X	X	X
Alder Swamps	X	X	X
Waterbodies	-	-	-

Table 5.9-8 Habitat Types used by Small Mammals

P-ELC Habitat Type	Habitat Type Used[1]		
	American Red Squirrel	Porcupine	General Small Mammal Habitat[1]
Ocean	-	-	-
Anthropogenic	X	X	X
[1]General habitat represents the summation of all habitat types used by the representative species.			

Terrestrial Herpetofauna

Terrestrial herpetofauna are a polyphyletic group including any land-based amphibians and reptiles. Terrestrial herpetofauna are often associated with forested areas that provide adequate cover and basking areas. Several terrestrial herpetofauna were observed within the PA and surrounding area. The garter snake was selected as the representative species for this group. Table 5.9-9 summarizes habitat types preferred by the garter snake, and terrestrial herpetofauna in general.

Garter snake

Garter snakes, small to medium sized snakes in the Colubridae family, are widespread in North America (Canadian Geographic, nd). Garter snakes feed primarily on insects, amphibians, and other snakes, as well as mammals, lizards and birds. Within their range, garter snakes can be found in almost every habitat, except in open water and are found in dense foliage in areas with leaves, rocks and logs. Garter snakes were observed, and habitat is found throughout the PA.

Table 5.9-9 Habitat Types used by Terrestrial Herpetofauna

P-ELC Habitat Type	Habitat Type Used
	Garter Snake
Mixedwood Forests	X
Mixedwood Forested Swamps	X
Softwood Forests	X
Softwood Forested Swamps	X
Hardwood Forests	X
Hardwood Forested Swamps	X
Cutover/Regenerative Stands	X
Cutover/Regenerative Swamps	X
Barrens	-
Open Wetlands	-
Alders	X
Alder Swamps	X
Waterbodies	-
Ocean	-
Anthropogenic	X

Aquatic/Semi-aquatic Herpetofauna

Aquatic/semi-aquatic herpetofauna are a polyphyletic group including amphibians and reptiles that reside either permanently or occasionally in aquatic systems. This group of herpetofaunas are often associated with waterbodies, watercourses, and open water wetlands. The snapping turtle and the green frog were selected as representative species for this group, as they are known to inhabit the PAA and LAA. Table 5.9-10 summarizes habitat types preferred by the snapping turtle, green frog, and aquatic/semi-aquatic herpetofauna in general.

Snapping turtle

Snapping turtles are large freshwater turtles typically found in or near shallow water, with muddy substrate and high abundance of leaf litter (Ontario Environment and Energy, nd). Snapping turtles can also be found in small wetlands, ponds and ditches (Ontario Nature, nd). Female snapping turtles will dig a nest in loose, sandy soil to lay their clutch. Nest sites are often roadside or near a shoreline or embankment. Snapping turtles were not observed within the PA but nesting and overwintering habitat was observed throughout the PA (Section 5.9.3).

Green frog

The green frog is a large true frog (Ranidae) native to NS and is found in a range of aquatic habitats. Permanent bodies of water are required for green frogs to breed and hibernate (Canadian Herpetology Society, nd). In wetland and pond habitats, green frogs will preferentially stay closer to shore in areas with denser vegetation (Canadian Herpetology Society, nd; Canadian Wildlife Federation, nd). Green frogs are carnivorous with a diet that consists of terrestrial and aquatic insects and invertebrates (Canadian Wildlife Federation, nd). Green frogs were observed in the open water habitats and areas with standing water throughout the PA.

Table 5.9-10 Habitat Type used by Aquatic/Semi-Aquatic Herpetofauna

P-ELC Habitat Type	Habitat Type Used[1]		
	Snapping Turtle	Green Frog	General Aquatic/Semi-Aquatic Herpetofauna Habitat
Mixedwood Forests	-	-	-
Mixedwood Forested Swamps	-	X	X
Softwood Forests	-	-	-
Softwood Forested Swamps	-	X	X
Hardwood Forests	-	-	-
Hardwood Forested Swamps	-	X	X
Cutover/Regenerative Stands	-	-	-
Cutover/Regenerative Swamps	-	-	-
Barrens	-	-	-
Open Wetlands	-	X	X
Alders	-	-	-
Alder Swamps	-	X	X
Waterbodies	X	X	X

Table 5.9-10 Habitat Type used by Aquatic/Semi-Aquatic Herpetofauna

P-ELC Habitat Type	Habitat Type Used[1]		
	Snapping Turtle	Green Frog	General Aquatic/Semi-Aquatic Herpetofauna Habitat
Ocean	-	-	-
Anthropogenic	X	-	X

[1]General habitat represents the summation of all habitat types used by the representative species.

Bats

Bats were recorded in the ACCDC report and evidence of historical roosting has been seen at a core shack (Section 5.9.3.2). AMOs were searched up to 5 km from the PA and no suitable hibernacula were observed. Therefore, bat hibernacula habitat is not expected to be impacted by the Project. The prediction of bat habitat in this model focuses on roosting habitat for little brown myotis (*Myotis lucifugus*) and hoary bat (*Aeorestes cinereus*). Roosting habitats of little brown myotis and hoary bats are show in in Table 5.9-11.

Little Brown Myotis

The little brown myotis is a widespread bat non-migratory species that weighs between 7 to 9 grams. These bats generally return to the same roosts each year and hibernacula are typically in underground openings, such as caves or abandoned mines with high humidity and warm temperatures. Summer habitats for the little brown myotis include anthropogenic structures, cavities in canopy trees, cliff crevices, and foliage (Environment Canada, 2015). Little brown myotis have been observed in a range of habitats, including forests, urbanized areas, and areas close to wetlands, lakes and streams (Canadian Wildlife Federation and ECCC, nd). Little brown myotis will roost together, with maternity colonies including over a hundred females with young. Maternity roosts tend to occur in large diameter trees and anthropogenic sites (Environment Canada, 2015). White-nose syndrome (WNS) is the greatest threat to the little brown myotis, and hibernacula that is free of WNS spores is declining in eastern Canada.

Hoary Bat

The hoary bat is a large, migratory bat, and is part of the Vespertilionidae family of microbats. Hoary bats live in mature forest habitats near the top of trees and forage in open areas near water. In fall, hoary bats migrate south to the United States and the Caribbean, where they roost in rock crevasses or other nests (Quebec Centre for Biodiveristy Science, nd). Hoary bats are solitary, and do not form large maternity roosts like other bat species (Bat Conservation International, nd).

Table 5.9-11 Roosting Habitat used by Little Brown Myotis and Hoary Bat

P-ELC Habitat Type	Habitat Type Used		
	Little Brown Myotis	Hoary Bat	General Bat Habitat[1]
Mixedwood Forests	X	X	X
Mixedwood Forested Swamps	X	X	X
Softwood Forests	X	X	X
Softwood Forested Swamps	X	X	X
Hardwood Forests	X	X	X

Table 5.9-11 Roosting Habitat used by Little Brown Myotis and Hoary Bat

P-ELC Habitat Type	Habitat Type Used		
	Little Brown Myotis	Hoary Bat	General Bat Habitat[1]
Hardwood Forested Swamps	X	X	X
Cutover/Regenerative Stands	-	-	-
Cutover/Regenerative Swamps	-	-	-
Barrens	-	-	-
Open Wetlands	-	-	
Alders	-	-	-
Alder Swamps	-	-	-
Waterbodies	-	-	-
Ocean	-	-	-
Anthropogenic	X	X	X

[1]General habitat represents the summation of all habitat types used by the representative species.

5.9.5.3.3 Moose Assessment

The Project is within Core Habitat as described in the "Recovery Plan for the Moose (*Alces Alces Americana*) in Mainland Nova Scotia" (NSDNRR, 2021) and evidence of Mainland moose and habitat were observed within the PA. Thus, the Project has potential to interact with moose and their habitat. A moose habitat model was created to determine the overall predicted habitat availability within the LAA and to support the prediction of habitat loss for this species by the Project. The following databases were used to create the model:

- NSDNRR Forest Inventory
- NSECC Wet Area Mapping (WAM)

The moose habitat model was developed using the framework specified in Recovery Plan. Moose Core Habitat (as described in the Recovery Plan) was identified using a HSI, which includes road density and the abundance of five key moose habitat types within a 10 km by 10 km hexagon. The moose habitat model performed in this effects assessment identifies the five key habitats used to create the HSI. Key habitats identified in this model are listed in Table 5.9-12.

Table 5.9-12 Moose Habitat Description and Parameters as per the Recovery Plan

Moose Habitat Type	Description	Habitat Model Parameters
Summer Forage Area (S1A)	Habitats that provide forage needs of moose throughout the spring and summer, including highly palatable and nutritious graminoids, forbs and other herbaceous vegetation. Summer forage areas include upland and wetland mature mixedwood and hardwood forests, as well as regenerative stands within 200 m of cover.	Upland mixedwood or hardwood forests, with crown closure >=60% and height >=12m Wetland mixedwood or hardwood forests, with crown closure >=60% and height >=8m Regenerative stands with heights <=6 m or labelled as clear cut and found within 200 m of winter or summer cover
Winter Forage Area (S1B)	Winter forage areas are habitats that provide forage needs throughout the winter. Forage needs are generally dominated by woody vegetation. Winter forage areas include upland and wetland mixedwood or hardwood mature forests within 200 m of winter cover, or softwood forests	Upland mixedwood or hardwood forests, with crown closure >=60% and height >=12m within 200m of winter cover Wetland mixedwood or hardwood forests, with crown closure >=60% and height >=8m within 200 m of winter cover Regenerative stands with heights <=6 m or labelled as clear cut and is found within 200 m of winter cover Softwood mature stands with crown closure >=60% and height >=8m
Winter Cover (S2)	Areas that provide appropriate cover during the winter. Winter cover areas are described as softwood or softwood dominated mixedwood mature cover stands.	Upland softwood and softwood dominated mixedwood stands, with crown closure >=60% and height >=12m Wetland softwood and softwood dominated mixedwood stands, with crown closure >=60% and height >=8m Stands >= 5 ha
Summer Cover (S3)	Areas that provide appropriate cover during the summer. Summer cover areas are hardwood, mixedwood or softwood mature stands	Upland softwood, mixedwood and hardwood stands, with crown closure >=60% and height >=12m Wetland softwood, mixedwood and hardwood stands, with crown closure >=60% and height >=8m Stands >= 5 ha
Calving Area (S4)	Calving areas tend to be close to open water or in wetlands within 40 m of cover or forage areas	All lakes and lake edges that are found within 40 m of all cover or forage areas

It should be noted that habitat described in this model would provide high suitability for moose and is likely an underrepresentation of suitable habitat for moose within the LAA. For example, summer foraging habitat (consisting of regenerative stands) was only selected in the model when within 40 m of mature cover. Furthermore, only up to 200 m of summer forage from mature cover was included in the model. Considering mainland moose have large home ranges, it is likely moose would use habitats that extend greater than 40 m from mature cover.

Project infrastructure was then overlaid with predicted moose habitats and direct impacts (habitat loss) was calculated. The results were also used to support an analysis of how Project infrastructure will displace habitats and impact moose movement across the LAA.

5.9.5.3.4 Avifauna Habitat Assessment

The habitat types observed within the LAA were determined using P-ELC mapping methods described in Section 5.9.5.3.2. The results from habitat mapping were then used to quantify avifauna breeding habitat throughout the LAA and therefore, predict Project impacts to avifauna species and associated habitats. These results are carried forward to Section 5.9.6 to support the analysis of Project interactions with avifauna and their habitat.

Avifauna species are a diverse group with varying habitat requirements from species to species. To support habitat modeling, avifauna species were grouped into several categories based on habitat requirements, behaviour and often taxonomical relationships. Generally, avifauna species were assigned to their functional group, but in cases where habitat requirements overlapped substantially (e.g., waterbirds and waterfowl), only one group was chosen for the analysis. Avifauna is a diverse taxon, with at least 478 species documented within Nova Scotia. As a result, it was not feasible to assess every avifauna species and representative species were selected for each group. In instances where it was not possible to capture habitat requirements for a group based on one representative species, multiple representative species with different habitat requirements were selected. These habitat requirements for both those species, were grouped together to represent likely habitats to be used by that avifauna group.

Habitat availability and abundance within the LAA was calculated using known habitat requirements for representative species within each defined avifauna group. Avifauna habitat types were chosen based on literature review and expert knowledge. For this assessment, breeding habitat was a key focus and high value habitats were considered (habitat that provides foraging, nesting, and protection) for representative species. Habitats that may be marginally used by the species were not selected in this model as the focus of the assessment was to identify habitats key to reproduction and survival of the species.

Due to the similarity in habitat requirements for species within each avifauna group listed below, it is expected that overall, the habitat requirements for each species within a group would be similar enough that the prediction of habitat availability would be representative to that group, despite there being slight differences in habitat requirements between species. Representative species were selected to provide an estimate of available habitats in the LAA and how avifauna species with similar habitat requirements may potentially be impacted by the Project. When determining the representative species for each group, the following criteria was considered:

- Species were identified through field surveys, the ACCDC report or are likely to occur within the PA and LAA.
- Habitat was identified within the PA and LAA during the field surveys.
- Species which were frequently observed in the biophysical surveys and there was evidence of high use of the PA or LAA by that species (i.e., species with high abundance in the PA were considered as a potential representative species).
- Habitat of that species overlaps substantially with other species of that group.

Although the observed SAR within the PA fall within these groups, and could be well represented, due to their specific habitat requirements and their listed status (NSESA or SARA), a finer scaled assessment for these species were completed, and habitat of the four SAR avifauna observed in the PA were assessed. The representative species and their associated groups are listed below.

- Waterfowl
  - Canada goose (Branta canadensis)
  - American black duck (*Anas rubripes*)
- Shorebirds
  - Spotted sandpiper (*Actitis macularius*)
  - Greater Yellow legs (*Tringa melanoleuca*)
- Diurnal Raptors
  - Northern harrier (*Circus hudsonius*)
  - Osprey (*Pandion haliaetus*)
- Nocturnal Raptors

- Barred owl (*Strix varia*)

- Passerines
  - White-throated sparrow (*Zonotrichia albicollis*)
  - Common Yellowthroat (*Geothylpis trichas*)
- Other Landbirds
  - Spruce grouse (*Canachites canadensis*)
  - Northern flicker (*Colaptes auratus*)
- SAR
  - Canada Warbler (*Cardellina canadensis*)
  - Olive-sided flycatcher (*Contopus cooperi*)
  - Evening Grosbeak (*Coccothraustes vespertinus*)
  - Wood Thrush (*Hylocichla mustellina*)

Passerines

This bird group is one of the most diverse bird groups in NS and its members are commonly referred to as songbirds. Passerines occupy a wide range of habitats, and the white-throated sparrow and common yellowthroat were selected due to the abundance of these species within the PA and their specific habitat requirements. White-throated sparrows were chosen as cutovers and clearings are required for breeding, and represent other species with similar requirements (e.g., dark-eyed junco). Common yellow-throat were chosen to represent the many warblers that require wetlands for breeding and shrub dominant areas. Habitat types are shown in Table 5.9-13.

White-throated sparrow

White-throated sparrows are common, year-round birds in eastern Canada (Sibley, 2017) and are frequently found in flocks, and mix with songbirds and other sparrows. Common habitats for the white-throated sparrow include brushy patches in woodland openings, forests, logging or forest fire regrowth, water edges and thickets (Audubon, 2021; Sibley, 2017). In winter, white-throated sparrows frequent thickets, parks and suburbs (Audubon, 2021).

Common yellowthroat

The common yellowthroat is a member of the New World Warbler family and is widespread across Canada. Males are easily distinguished by their bright yellow throat and black mask (Cornell Lab, 2021). Common yellowthroats will breed and forage in marshes, swamps, wet thickets, and other wet habitats with low growth (Audubon, 2021). The common yellowthroat can also be found in thickets near streams and overgrown fields. The common yellowthroat's diet is primarily composed of insects (Audubon, 2021).

Table 5.9-13 Habitat Type Used by Passerines

P-ELC Habitat Types	Habitat Type Used[1]		
	White-throated sparrow	Common yellowthroat	General Passerine Habitat[2]
Mixedwood Forests	X	-	X
Mixedwood Forested Swamps	-	X	X
Softwood Forests	X	-	-
Softwood Forested Swamps	-	X	X

Table 5.9-13 Habitat Type Used by Passerines

P-ELC Habitat Types	Habitat Type Used[1]		
	White-throated sparrow	Common yellowthroat	General Passerine Habitat [2]
Hardwood Forests	X	-	X
Hardwood Forested Swamps	-	X	X
Cutover/Regenerative Stands	X	-	X
Cutover/Regenerative Swamps	X	X	X
Barrens	-	-	-
Open Wetlands	X	-	X
Alders	-	X	X
Alder Swamps	-	X	X
Waterbodies	-	-	-
Ocean	-	-	-
Anthropogenic	-	-	-

[1] high value habitats (habitat that provides foraging, nesting/breeding and protection) for the representative species were selected. As the focus of the assessment was to identify habitats that are key in the reproduction and survival of the species., habitats that may be marginally used by the species were not selected in this model

[2] General habitat represents the summation of all habitat types used by the representative species.

Waterfowl

This group includes waders, ducks, geese, herons, gulls and other members of ciconiformes, and Gruiformes. This functional group has a dependency on open water features, for at least part of their lifecycle (Sugden, 1973), which is a distinguishing characteristic from the other groups (apart from shorebirds) assessed. Many members of this group breed in vegetated wetlands fringing open water features (Sugden, 1973), although, certain species (i.e., American blackduck) may move inland in dense shrubbed or forested areas to breed. Canada goose and American black duck were selected as representative species for this group because of their abundance within and surrounding the PA and their specific habitat requirements for open water features, which most species within this group require. Habitat types are shown in Table 5.9-14.

Canada Goose

Canada geese are common throughout Canada, with most migrating south in the winter. Habitat for Canada goose is widespread, and includes lakes, rivers, ponds, yards, parks, and farm fields (Cornell Lab, 2021). Canada geese rely on shallow water for foraging and favour peatlands during nesting (Mowbray et al., 2002). Canada geese that do not migrate overwinter in locations where feeding areas are close to water (Audubon, 2021). The diet of the Canada goose is primarily composed of plant material, including grasses, sedges, and aquatic plants (Audubon, 2021).

American black duck

American black ducks are a relative of the mallard and can often be mistaken as a female mallard duck. The black duck typically nests in both freshwater wetlands and saltmarshes (Cornell Lab, 2021). They can also be found in rivers, ponds and lakes (Audubon, 2021). The American black duck migrates south late in the fall and has been known to winter in NS (Audubon, 2021). Nest sites are generally near water and are on the ground among vegetation, under shrubs or trees, or in ground holes (Audubon, 2021). Breeding sites are predominantly in freshwater wetland habitats, including beaver ponds, shallow lakes and wooded swamps (Cornell Lab, 2021).

Table 5.9-14 Habitat Type used by Waterfowl

P-ELC Habitat Types	Habitat Type Used[1]		
	Canada Goose	American Black Duck	General Waterfowl Habitat[2]
Mixedwood Forests	-	-	-
Mixedwood Forested Swamps	-	-	-
Softwood Forests	-	-	-
Softwood Forested Swamps	-	-	-
Hardwood Forests	-	-	-
Hardwood Forested Swamps	-	-	-
Cutover/Regenerative Stands	-	-	-
Cutover/Regenerative Swamps	-	-	-
Barrens	X	X	X
Open Wetlands	-	X	X
Alders	-	-	-
Alder Swamps	X	X	X
Waterbodies	-	-	-

[1] high value habitats (habitat that provides foraging, nesting/breeding and protection) for the representative species were selected. As the focus of the assessment was to identify habitats that are key in the reproduction and survival of the species., habitats that may be marginally used by the species were not selected in this model.

[2]General habitat represents the summation of all habitat types used by the representative species.

Diurnal Raptors

This group includes birds of prey within the families Accipitridae (i.e., hawks, eagles, buzzards, harriers, kites and old-world vultures), Pandidonidae (i.e., osprey), Sagittariidae (i.e., secretary bird), Falconidae (i.e., falcons, caracaras, and forest falcons), Cathartidae (i.e., new world vultures), and one species from the Order Strigiformes (i.e., hawk owl). This group largely feeds on rodents, fish and other small mammals and can occupy a variety of different habitats based on the species. For this group, the northern harrier and osprey were selected based on their presence within the PA and specific habitat requirements. Ospreys were selected to represent diurnal raptors that require open waterbodies for hunting (e.g., eagles) and northern harriers were selected to represent diurnal raptors that require open areas for hunting (e.g., red tailed-hawk). See Table 5.9-15.

Osprey

Ospreys have a wide distribution across Canada (Audubon, 2021). The osprey’s diet is almost entirely composed of fish, and therefore ospreys are typically only found close to water (Audubon, 2021; Cornell Lab, 2021). They are regularly found around large bodies of freshwater but can also inhabit areas near coastal estuaries and salt marshes. Perches and nests of ospreys can be found on isolated trees and poles (Sibley, 2017).

Northern Harrier

Northern harriers belong to the Accipitridae family and are found across Canada. They are distinctive hawks that fly close to the ground in search of prey (Audubon, 2021). Prey is primarily composed of small mammals, including voles and rats (Audubon, 2021). Northern harriers are usually seen in open areas, cutovers, including grasslands, marshes and fields (Audubon, 2021; Cornell Lab, 2021).

Table 5.9-15 Habitat Types used by Diurnal Raptors

P-ELC Habitat Types	Habitat Type Used[1]		
	Northern Harrier	Osprey	General Diurnal Raptor Habitat[2]
Mixedwood Forests	-	X	X
Mixedwood Forested Swamps	-	X	X
Softwood Forests	-	X	X
Softwood Forested Swamps	-	-	-
Hardwood Forests	-	-	-
Hardwood Forested Swamps	-	-	-
Cutover/Regenerative Stands	X	-	-
Cutover/Regenerative Swamps	X	-	-
Barrens	-	-	-
Open Wetlands	X	X	X
Alders	X	-	-
Alder Swamps	X	-	-
Waterbodies	-	X	X
Ocean	-	-	-
Anthropogenic	-	-	-

[1]High value habitats (habitat that provides foraging, nesting/breeding and protection) for the representative species were selected. As the focus of the assessment was to identify habitats that are key in the reproduction and survival of the species., habitats that may be marginally used by the species were not selected in this model

[2]General habitat represents the summation of all habitat types used by the representative species.

Nocturnal Owls

This group includes all nocturnal owl species within the Strigiformes order. Owls typically are associated with mature softwood forests required for breeding, and several species of owl were observed within the PA and surrounding area. The barred owl was selected as the representative species for this group, as most species within this group require mature forested landscapes for breeding. Habitat types of nocturnal raptors are shown in Table 5.9-16.

Barred Owl

Barred owls are relatively large owls common and widespread in NS (Audubon, 2021). Common habitat for the barred owl are large, mature forests with understories ranging from open to dense, including wooded swamps and wooded river bottoms (Cornell Lab, 2021; Sibley, 2017). Small mammals compose much of the barred owl diet, with the barred owl hunting at night-time (Audubon, 2021).

Table 5.9-16 Habitat Types used by Nocturnal Raptors

P-ELC Habitat Types	Habitat Type Used[1]
	Barred Owl
Mixedwood Forests	X
Mixedwood Forested Swamps	X
Softwood Forests	X
Softwood Forested Swamps	X
Hardwood Forests	X
Hardwood Forested Swamps	X
Cutover/Regenerative Stands	-
Cutover/Regenerative Swamps	-
Barrens	-
Open Wetlands	-
Alders	-
Alder Swamps	-
Waterbodies	X
Ocean	-
Anthropogenic	-

[1]high value habitats (habitat that provides foraging, nesting and protection) for the representative species were selected. As the focus of the assessment was to identify habitats that are key in the reproduction and survival of the species., habitats that may be marginally used by the species were not selected in this model.

Other Land Birds

The other land bird group includes species from the Orders Galliformes (i.e., quail, pheasant, and grouse), Columbiformes (i.e., pigeons and doves), Cuculiformes (i.e., cuckoos), Caprimulgiformes (i.e., nighthawks and whip-poor-wills), Apodiformes (i.e., swifts and hummingbirds), and Piciformes (i.e., woodpeckers, flickers, and sapsuckers). This is a catch-all term that includes a diverse group of species with different habitat requirements. Northern flicker and spruce grouse were selected from this group as they are known to inhabit the PA, frequented during the biophysical surveys and habitat is widespread throughout the PA. Northern flickers were chosen to represent woodpeckers (e.g., black backed, pileated) and spruce grouse were chosen to represent ground nesters such as ruffed grouse and woodcocks. Habitat types are shown in Table 5.9-17.

Spruce Grouse

The spruce grouse is part of the Phasianidae family and is common throughout eastern Canada. The diet of the spruce grouse is largely composed of conifer needles, and therefore the spruce grouse's primary habitat is conifer woods with a dense understory (Audubon, 2021).

Northern flicker

Northern flickers belong to the woodpecker family. Northern flickers are commonly found in forests, woodlots, and semi-open country. Norther flickers tend to avoid dense understory as they require open areas for foraging (Audubon, 2021). Nest sites are made in cavities of trees or posts.

Table 5.9-17 Habitat Type used by Other Land Birds

P-ELC Habitat Types	Habitat Type Used[1]		
	Spruce Grouse	Northern Flicker	General Other Land Bird Habitat[2]
Mixedwood Forests	X	X	X
Mixedwood Forested Swamps	X	X	X
Softwood Forests	X	X	X
Softwood Forested Swamps	X	X	X
Hardwood Forests	X	X	X
Hardwood Forested Swamps	X	X	X
Cutover/Regenerative Stands	X	-	X
Cutover/Regenerative Swamps	X	X	X
Barrens	X	-	X
Open Wetlands	X	X	X
Alders	-	-	-
Alder Swamps	-	-	-
Waterbodies	-	-	-
Ocean	-	-	-
Anthropogenic	-	X	X

[1]high value habitats (habitat that provides foraging, nesting/breeding and protection) for the representative species were selected. Habitats that may be marginally used by the species were not selected in this model as the focus of the assessment was to identify habitats that are key in the reproduction and survival of the species.

[2]General habitat represents the summation of all habitat types used by the representative species.

Shorebirds

The Shorebird group includes waders, from the Order Charadriiformes. This species group includes species that are small to medium sized, and often associated along waterbodies and the shoreline. This group usually includes species with long legs, adapted for wading and foraging in water. Some species will breed along the shoreline while others will breed inland. The spotted sandpiper and greater yellow legs were chosen as representative species as they were observed within and surrounding the PA and were the most frequented shorebirds observed during the biophysical surveys. Two representative species for this group were chosen to represent species that require open inland wetlands to breed (greater yellow-legs) and spotted sandpiper were chosen to represent species that are less selective when breeding and can be found around rocky shores, ponds, lakes and marshes. Habitat types used by shorebirds are listed in Table 5.9-18.

<u>Spotted-sandpiper</u>

The spotted sandpiper is the most widespread breeding sandpiper in North America and migrates south to overwinter. They are typically found near water, including rivers, ponds, pebbly lake shores and rocky shores (Cornell Lab, 2021). These habitats are also utilized during breeding season. During migration, spotted sandpipers are found along the coast in mudflats, beaches, sewage ponds and ditches (Audubon, 2021).

Greater Yellow-legs

Greater yellowlegs belong to the sandpiper family and occur throughout North America. They are found in a variety of wetland habitats, including spruce bogs, open marshes. Breeding habitat includes bogs and marshes (Audubon, 2021; Cornell Lab, 2021). The diet of the greater yellowlegs includes insects and small fish (Audubon, 2021).

Table 5.9-18 Habitat used by Shorebirds

P-ELC Habitat Types	Habitat Type Used[1]		
	Spotted Sandpiper	Greater Yellowlegs	General Shorebird Habitats[2]
Mixedwood Forests	-	-	-
Mixedwood Forested Swamps	-	-	-
Softwood Forests	-	-	-
Softwood Forested Swamps	-	-	-
Hardwood Forests	-	-	-
Hardwood Forested Swamps	-	-	-
Cutover/Regenerative Stands	-	-	-
Cutover/Regenerative Swamps	-	-	-
Barrens	-	-	-
Open Wetlands	-	X	X
Alders	-	-	-
Alder Swamps	-	-	-
Waterbodies	X	X	X
Ocean	X	X	X
Anthropogenic	-	-	-

[1] high value habitats (habitat that provides foraging, nesting and protection) for the representative species were selected. Habitats that may be marginally used by the species were not selected in this model as the focus of the assessment was to identify habitats that are key in the reproduction and survival of the species.

[2] General habitat represents the summation of all habitat types used by the representative species.

Species at Risk

Several SAR birds were chosen for the habitat model. Although habitat requirements for SAR can be represented by the functional groups assessed, a finer scale assessment was completed for SAR due to their specific habitat requirements and being listed under federal or provincial legislation (i.e., SARA and NSESA). Four SAR avifauna species were assessed: Canada warbler, evening grosbeak, olive-sided flycatcher and wood thrush. These species were selected because they were documented within and surrounding the PA and suitable breeding habitat was identified. Table 5.9-19 summarizes suitable breeding habitat for these species.

Canada Warbler

Canada warbler is a small brightly coloured songbird; the males have blue-gray upperparts and tail with a contrasting yellow throat and breast. Breeding habitat for the Canada warbler consists of a variety of landscapes, but commonly comprises of moist to wet forests with a dense deciduous shrub layer. Nests may be built on or near the ground on raised hummocks, within root masses, rotting tree stumps, clumps of grass, rock cavities, dense shrubs, and in regenerating forests (COSEWIC, 2020). Within the PA, forested swamps with a well-developed shrub layer suitable for breeding and nesting was observed scattered throughout the PA. Fifteen Canada warbler individuals were observed during the breeding season and often found within treed swamps with a well-developed shrub layer or in dense upland forest near treed swamps. The treed swamp habitats were dominated by softwoods (i.e., balsam fir and black spruce) often with a prominent shrub layer comprising of speckled alder (*Alnus incana*) or mountain holly (*Ilex mucronata* and blanketed with *Sphagnum* mosses. The upland forest habitats where Canada warbler were observed were dominated by balsam fir and black spruce, with a well-developed shrub layer of mountain holly.

Evening Grosbeak

Evening grosbeaks are a member of the true finch family (Fringillidae), are a short stocky, vibrant coloured and equipped with a large yellowish-green bill (COSEWIC, 2016). This species breeds in Mexico, Canada, and the United States. In the winter months, their range can vary widely depending on the food source available and is often found in backyards feeding off feeders. Breeding habitat is typically in open, mature mixedwood upland forests often dominated by balsam fir and white spruce and where their main food source, the spruce budworm (*Choristoneura* spp.) is present (COSEWIC, 2016). Softwood and mixedwood stands are present within the PA and do provide suitable breeding habitat for evening grosbeak, however, this species was only observed in the migration seasons and as a flyover. There was no evidence of evening grosbeak using the PA for breeding but may be using the area as a stop over and foraging. Four observations totalling twenty individuals were made of evening grosbeak during spring migration and incidentally during 2021 (Appendix I.1).

Olive-sided Flycatcher

The olive-sided flycatcher is a small insectivore belonging to the “tyrant flycatchers” (*Tyrannidae*) family, with plumage with deep brownish olive grey above and whitish breast and throat (COSEWIC, 2018). Although members of this family can be strikingly similar, the distinctive three-note song reminiscent of the phrase “quick, three-beers” is often diagnostic (COSEWIC, 2018). The olive-sided flycatcher is a widespread migratory species, with 53% of its breeding range being encompassed in forested areas in Canada. Olive-sided flycatchers are often found on edges of coniferous or mixed forests with tall trees and snags, along open areas, or in burned forests with standing trees and snags (COSEWIC, 2018). Within the PA, two observations of olive-sided flycatcher were observed in softwood swamps (WL 17 and WL 42) adjacent to cutovers (Appendix I.1). The abundance of conifer dominant swamps, forested uplands and edge habitats from forestry activities (cutovers) within the PA provides suitable breeding habitat for olive-sided flycatcher and is widespread throughout the PA and surrounding area.

Wood Thrush

The wood thrush is a medium sized bird, which is generally rusty-brown on the upperparts with white underparts and large blackish spots on the breast and flanks. The wood thrush nests mainly in second-growth and mature deciduous and mixedwood forests. Wood thrush generally prefer large forest mosaics but can also be found in small forest fragments (COSEWIC, 2012). Forested communities in the PA are predominately softwood and heavily fragmented due to historical and on-going forestry activities. Large contiguous forest mosaics are scarce within the PA and therefore, suitable habitat for wood thrushes is limited. One observation of wood thrush was observed outside the PA in the breeding season in 2021 in mixedwood upland forests (Appendix I.1).

Table 5.9-19 Habitat used by Canada Warbler, Olive-sided Flycatcher, Evening Grosbeak and Wood Thrush

P-ELC Habitat Type	Habitat Type Used[1]				
	Canada Warbler	Olive-sided Flycatcher	Evening Grosbeak	Wood Thrush	General SAR bird Habitat[2]
Mixedwood Forests	-	X	X	X	X
Mixedwood Forested Swamps	X	X	-	-	X

Table 5.9-19 Habitat used by Canada Warbler, Olive-sided Flycatcher, Evening Grosbeak and Wood Thrush

P-ELC Habitat Type	Habitat Type Used[1]				
	Canada Warbler	Olive-sided Flycatcher	Evening Grosbeak	Wood Thrush	General SAR bird Habitat[2]
Softwood Forests	-	X	X	-	X
Softwood Forested Swamps	X	X	-	-	X
Hardwood Forests	-	-	-	X	X
Hardwood Forested Swamps	X	-	-	-	X
Cutover/Regenerative Stands	X	-	-	-	X
Cutover/Regenerative Swamps	X	-	-	-	X
Barrens	-	X	-	-	X
Open Wetlands	-	X	-	-	X
Alders	-	-	-	-	
Alder Swamps	X	-	-	-	X
Waterbodies	-	-	-	-	-
Ocean	-	-	-	-	-
Anthropogenic	-	-	X	-	X

[1] High value habitats (habitat that provides foraging, nesting/breeding and protection) for the representative species were selected. Habitats that may be marginally used by the species were not selected in this model as the focus of the assessment was to identify habitats that are key in the reproduction and survival of the species.

[2] General habitat represents the summation of all habitat types used by the representative species.

5.9.5.3.5 Interior Forest Assessment

Interior forests are defined as forested areas that are sheltered from edge effects. Forest edges (usually adjacent to clearings or disturbances) are exposed to higher winds, with sunnier and dryer conditions and are often subject to both natural and anthropogenic disturbances. These conditions result in different vegetative structure and composition then the forest interior. The forest interior provides shelter from these conditions and refuge for many species dependent on these habitats. The purpose of this assessment was to map the potential interior forest patches in the current conditions within the LAA based on the available imagery, the P-ELC and NSTDB roads layer. Two scenarios were run through the model: The first used the definition of interior forest patches as per the Old Forest Policy (NSDNRR, 2012), that says patches must:

- Be greater than 15 ha
- Be greater than 200 meters from disturbance

Edge effects (depth of influence) vary depending on the species and context (climate, forest structure etc.). Species of lichen and plants have shown a depth of influence of up to 200 m (Hannon et al., 2002) but can be up to 500 m for some plants (Michels et al., 2007), birds (Hannon et al., 2002) and lichens (Cameron et al., 2013). Using a 200 m as the universal edge effect for species allows the modelling to conservatively estimate interior conditions within the terrestrial environment (i.e., likely overpredict interior conditions), but to show an alternative scenario, using greater than 500 meters from disturbance, was calculated to predict potential interior forest. These two scenarios were then compared against each other to show potential interior forest availability across the LAA.

The results of the interior forest mapping were then used support the analysis of impact to the terrestrial habitat from the Project (Section 5.9.6). The infrastructure was buffered by 200 m to imitate edge effect (depth of influence) in the first scenario and 500 m in the alternative scenario to align with the different model scenario's determination of distance from disturbance. These buffered areas were used as the impact area.

5.9.5.3.6 Limitations

The models listed above provide tools to support the analysis of Project interactions with the terrestrial environment. Like all models, there are limitations in the accuracy and scale. Limitations of each model are described below.

P-ELC

Habitat types were identified in broad units and does not represent all the variation and communities found within the LAA. Instead, the P-ELC provides an overview of the major habitat types that are found within the LAA. Forested swamp communities were classified by using the modelled water table (DTW index) which at times, overpredicts wetland communities. Therefore, forested swamp habitats identified in the P-ELC may be upland habitats. Cutover and regenerative forests were identified by using tree heights as a proxy to tree age and disturbance (i.e., forested stands <6 m in height were considered either new cutovers or regenerative forests following stand disturbance). However, non-disturbed waterlogged conditions (i.e., wetlands) or areas subject to edaphic stress can result in stunted mature trees, and therefore, may have been identified as a cutover or regenerative forest.

Moose Habitat Assessment

Forest age was determined by using height as a proxy. The moose model represents high quality habitat and does not include moderately suitable habitat that may be used by moose. For example, summer foraging habitat (consisting of regenerative stands) was only selected in the model when within 40 m of mature cover. Furthermore, only up to 200 m of summer forage from the mature cover was included. Considering mainland moose have large home ranges, it is likely moose would use habitats that extend greater than 40 m from mature cover. Therefore, available moose habitat modeled is an underrepresentation of what is available in the LAA.

Terrestrial Fauna and Avifauna Habitat Assessment

Habitats were identified in broad units and does not represent all the variation and communities found within the LAA.

Details on stand structure, such as stand heterogeneity, microtopography and other factors that may be required for certain species could not be considered in this assessment due to the scale of the P-ELC. That said, only broad habitats were assessed and therefore, habitat availability is likely an over prediction for suitable habitat for wildlife. The model focused on the identification of the habitats and did not consider how adjacent human activity may influence the usage of those species (e.g., species may avoid habitat adjacent to well-travelled roads or active quarry pits).

Prediction of habitat suitability and availability for species groups, was accomplished by using representative species identified by expert opinion. The prediction of habitat availability for species groups is a general overview of what species may use those habitats. There are numerous representative and combinations of representative species that could be selected, all yielding slight differences in habitat requirements. It is not expected that overall, the selection of representative species would result in notable differences in habitat availability predictions for each species group.

Interior Forests Assessment

Identification of potential interior forests were limited by the accuracy of the P-ELC and the NSTBD roads database and does not necessarily represent current conditions. The conditions selected are used as a proxy for potential interior forest conditions and it is acknowledged that interior forest habitat can be influenced by many other variables, however this was the chosen methodology to provide a proxy based on the Old Forest Policy.

5.9.6 Project Interactions and Potential Effects

The Project is expected to interact with the terrestrial environment through several pathways. The potential effects have been grouped into two major categories: changes in habitat types and changes in wildlife species. Project related effects can influence the terrestrial environment either directly or indirectly and adversely or positively. A direct effect is defined by interactions that have no intermediates (e.g., mortality by vehicular collision, vegetation community loss) and indirect effects are interactions that have intermediate steps such as edge effects associated with vegetation clearing or changes in predatory-prey dynamics associated with access road/trail development. Table 5.9-20 summarizes the potential effects, potential pathways and measurable parameters as the basis of the environmental effects assessment.

Table 5.9-20 Potential Effects, Pathways and Measurable Parameters for the Terrestrial Environment

Potential Environmental Effect	Potential Effect Pathways	Measurable Parameter
Changes in habitat types including Priority Species	– Direct loss of habitat and vegetation due to Project footprint – Indirect loss of habitat due to edge effects and dust – Potential introduction of invasive species due to construction activities and increased traffic – Vegetation community shifts do to draw down effects from the Project – Rehabilitation and reclamation of habitats during the closure phase	– Area (ha) of direct habitat and/or vegetation loss (ha) – Indirect loss (qualitative) or quantitative based on noise, sound and light modeling.
Changes in Wildlife including Priority Species	– Mortalist risk due to vehicle collisions or other human-wildlife interactions – Direct and indirect habitat loss and habitat fragmentation due to Project footprint and sensory disturbance – Rehabilitation and reclamation of habitats during the closure phase	– Area (ha) of direct wildlife habitat loss – Likelihood of wildlife interactions with the Project

The Project has potential to interact with the terrestrial environment during three Project phases (i.e., construction, operations and closure) and Project activities. Project interactions indicated in the table below are discussed in detail in the context of Project effects, residual effects, and proposed mitigation measures.

Table 5.9-21 Potential Project Interactions with the Terrestrial Environment

Project Phase	Duration	Relevant Project Activity	Changes in	
			Vegetation and Vegetation Communities including Priority Species	Wildlife including Priority Species
Construction	2 years	Clearing, grubbing, and grading	X	X
		Drilling and rock blasting	X	X
		Topsoil, till, and waste rock management	X	X
		Surface infrastructure installation and construction	X	X
		Haul road construction	X	X

Table 5.9-21 Potential Project Interactions with the Terrestrial Environment

Project Phase	Duration	Relevant Project Activity	Changes in	
			Vegetation and Vegetation Communities including Priority Species	Wildlife including Priority Species
		TMF construction	X	X
		Collection ditch and settling pond construction	X	X
		Watercourse and wetland alteration	X	X
Operations	11 years	Drilling and blasting	X	X
		Open pit dewatering	X	X
		Waste rock management	X	X
		Surface water management	X	X
		Tailings management	-	-
		Water treatment	-	-
		General waste management	-	X
		Drilling and blasting	X	X
Closure	24 years	Demolition	X	X
		Earthworks	X	X
		Water treatment	X	X
		General waste management	X	X

5.9.6.1 Changes in Habitat Types including Priority Species

The Project is expected to result in changes in habitat types (vegetation communities and vegetation) and priority specie via direct and indirect Project related impacts. Direct and indirect impacts to habitat types and flora priority species are described in the following sections.

5.9.6.1.1 Direct Loss

Direct loss to habitat, vascular and non-vascular plants, and priority species, including lichens due to the Project footprint are described below.

Vegetation and Habitat Types

Direct loss to wetland and upland vegetation, vegetation communities and habitat are expected to occur primarily during the construction phase of the Project. The PA consist of fragmented habitats and historical and current timber harvesting, roads and mining activities. Habitat loss and direct impacts to flora species is expected. This habitat loss can result in indirect impacts such as habitat fragmentation, edge effects and changes in wildlife movement (Section 5.9.6.1.2 and 5.9.6.2.4).

It is expected that a total loss of 410.8 ha (2.65% of the LAA) of habitat (including urban/developed) will be directly impacted by Project infrastructure (Table 5.9-22), with a predicted magnitude of effect of negligible to moderate depending on the habitat type (Figure 5.9-2 A-K). These habitat types consist of mature softwood and hardwood forests, forested wetlands, cutovers, peatlands and anthropogenic and disturbed landscapes, all of which provide habitat for multiple species. No rare or uncommon vegetation communities were identified in the baseline surveys

(Section 5.9.3.1). One hundred eighty-seven (187.2) ha of softwood forests, the most common vegetation community within the LAA, is expected to be directly impacted by the Project. Considering the abundance of conifer dominant forests within the LAA, the overall magnitude of impacts to this vegetation community is considered low (3.9% loss). Table 5.9-22 summarizes all P-ELC habitat types identified in the LAA and expected direct impacts of the Project.

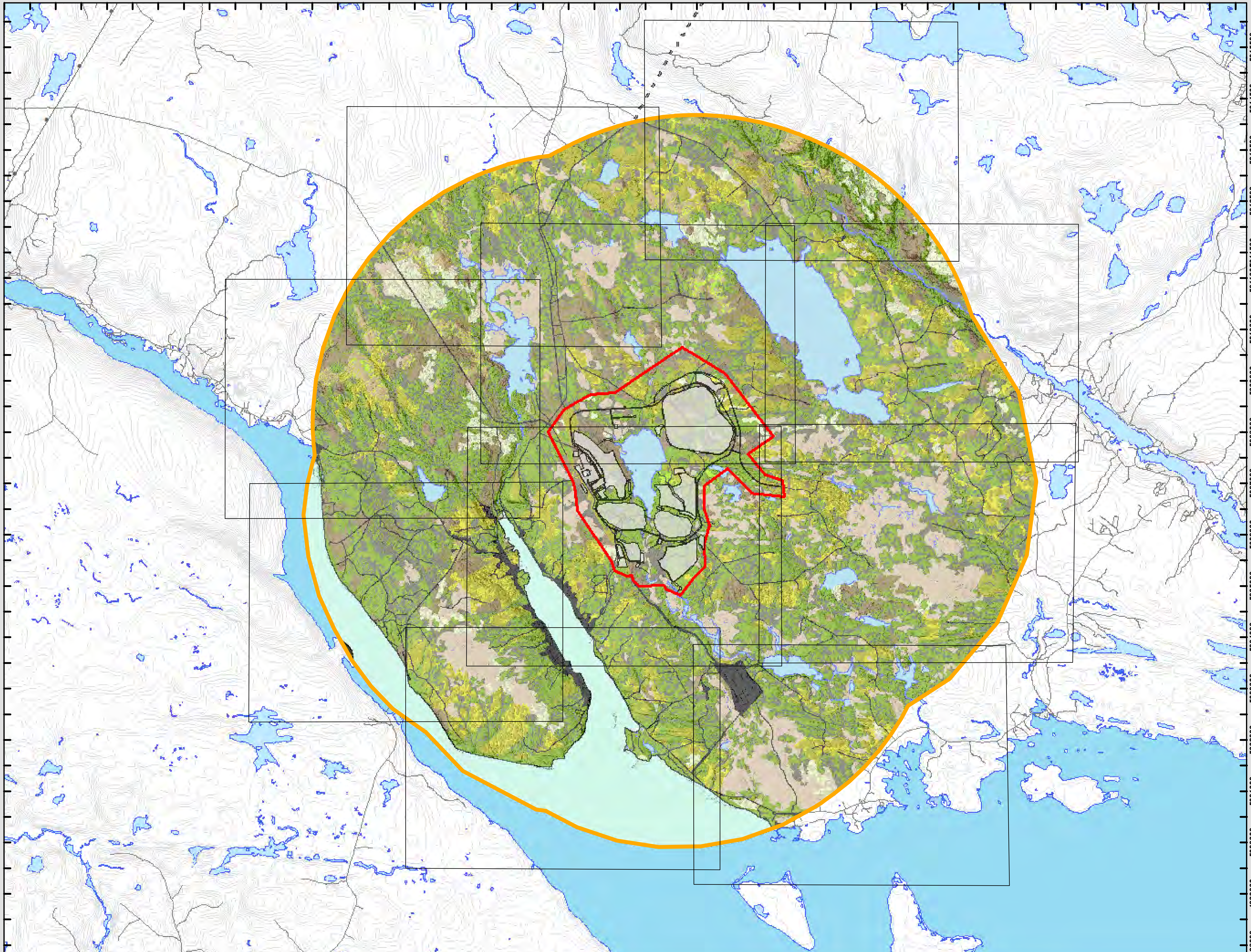

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FIGURE 5.9-2A

Project Ecological Land Classification (P-ELC) Habitat Types Overview

Goldboro, NS

Project Infrastructure

P-ELC Habitat Classification

- Alder
- Barrens
- Cutover/Regen... Forests
- Hardwood Forests
- Mixedwood Forests
- Ocean
- Open Wetlands
- Softwood Forests
- Urban/Developed
- Waterbodes
- Alder Swamp
- Cutover/Regen... Swamp
- Hardwood Forested Swamps
- Mixedwood Forested Swamps
- Softwood Forested Swamps
- Terrestrial Environment LAA
- Project Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 1,000 2,000 4,000 m

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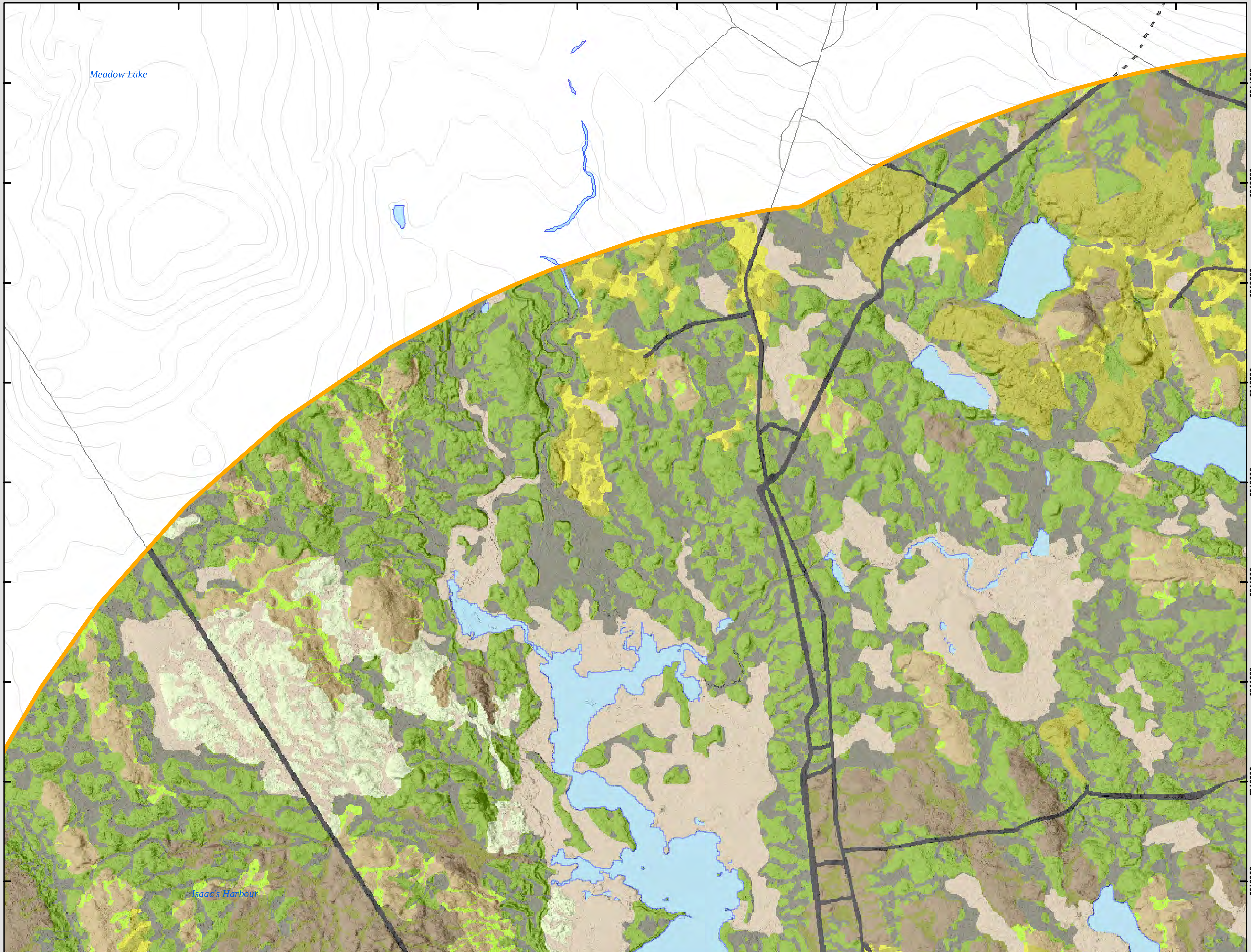
FIGURE 5.9-2B

P-ELC Habitat Types

Goldboro, NS



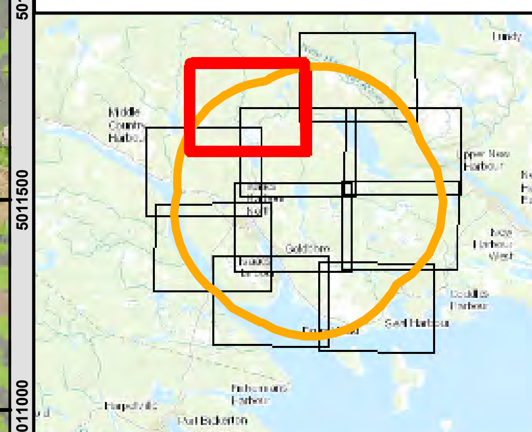
Project Infrastructure

P-ELC Habitat Classification

- Alder
- Barrens
- Cutover/Regenerative Forests
- Hardwood Forests
- Mixedwood Forests
- Ocean
- Open Wetlands
- Softwood Forests
- Urban/Developed
- Waterbodes
- Alder Swamp
- Cutover/Regenerative Swamp
- Hardwood Forested Swamps
- Mixedwood Forested Swamps
- Softwood Forested Swamps

Terrestrial Environment LAA

Project Area



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Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

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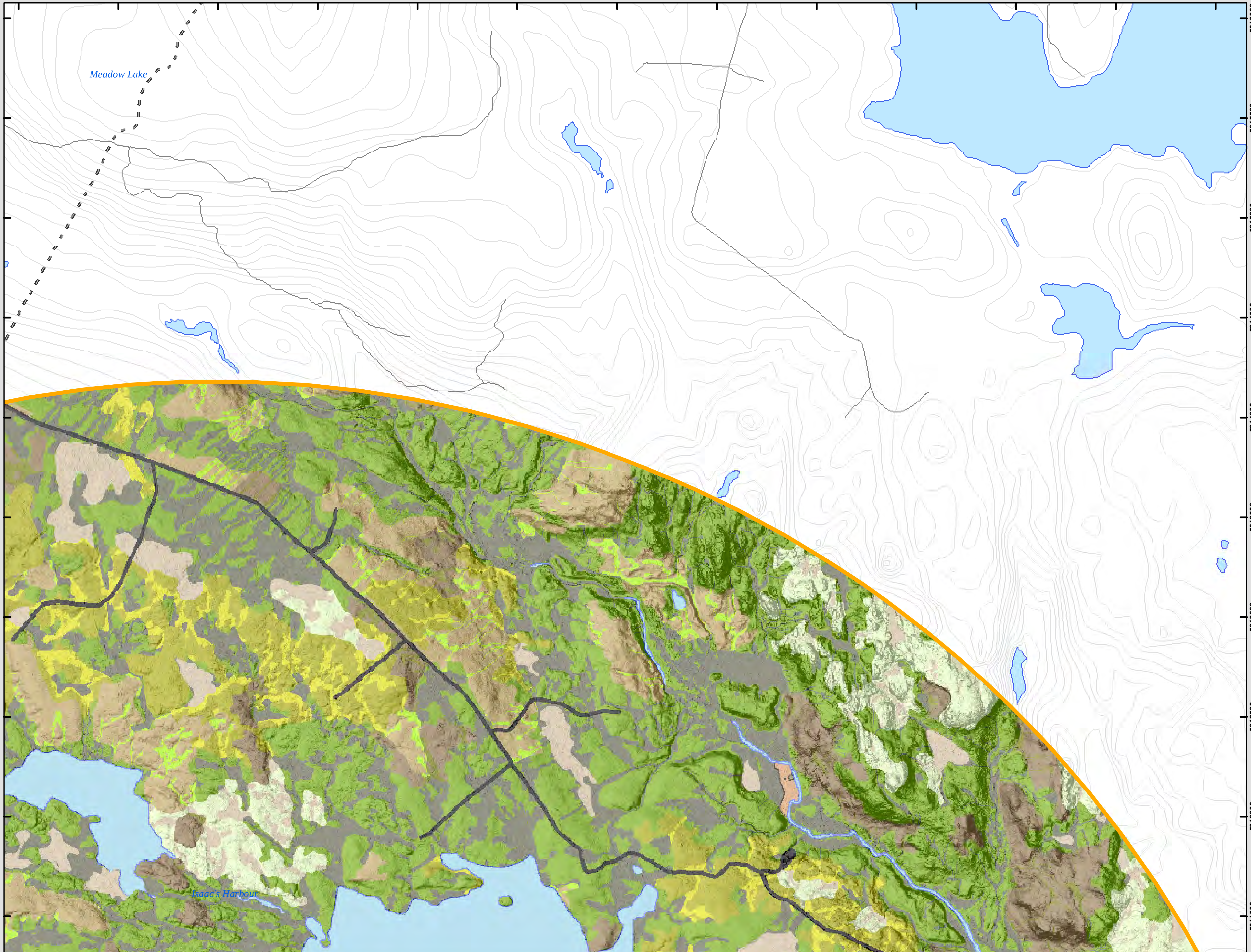
FIGURE 5.9-2C

P-ELC Habitat Types

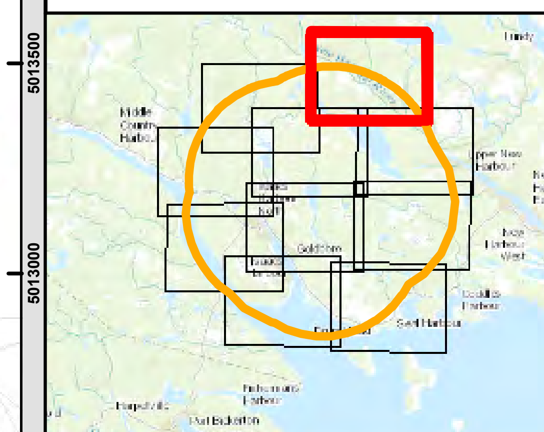
Goldboro, NS



- Project Infrastructure

P-ELC Habitat Classification

- Alder
- Barrens
- Cutover/Regenerative Forests
- Hardwood Forests
- Mixedwood Forests
- Ocean
- Open Wetlands
- Softwood Forests
- Urban/Developed
- Waterbodes
- Alder Swamp
- Cutover/Regenerative Swamp
- Hardwood Forested Swamps
- Mixedwood Forested Swamps
- Softwood Forested Swamps
- Terrestrial Environment LAA
- Project Area



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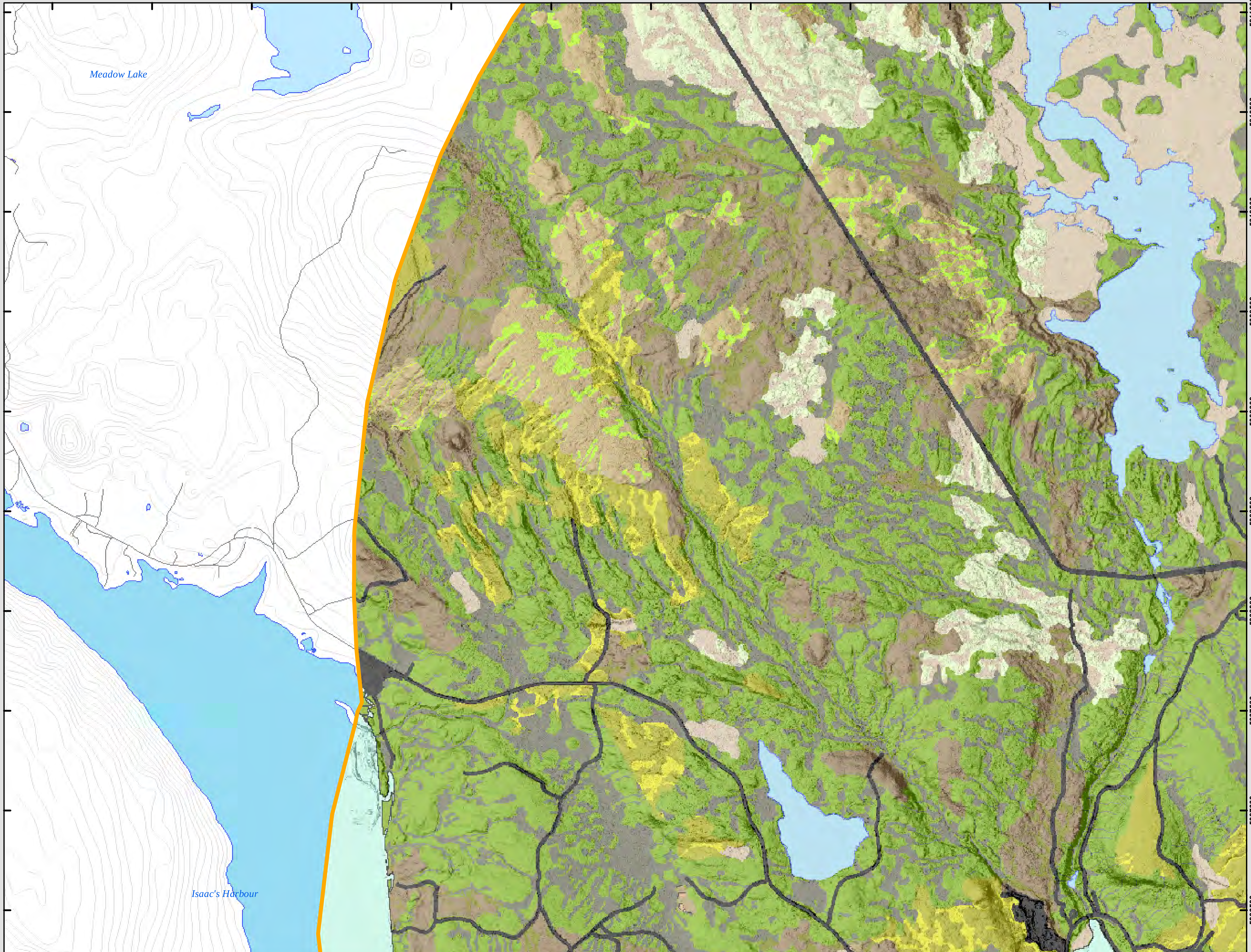

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FIGURE 5.9-2D

P-ELC Habitat Types

Goldboro, NS

Project Infrastructure

P-ELC Habitat Classification

- Alder
- Barrens
- Cutover/Regenerative Forests
- Hardwood Forests
- Mixedwood Forests
- Ocean
- Open Wetlands
- Softwood Forests
- Urban/Developed
- Waterbodes
- Alder Swamp
- Cutover/Regenerative Swamp
- Hardwood Forested Swamps
- Mixedwood Forested Swamps
- Softwood Forested Swamps
- Terrestrial Environment LAA
- Project Area

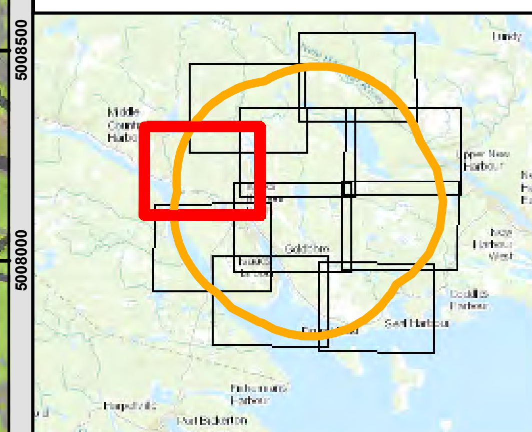

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FIGURE 5.9-2E

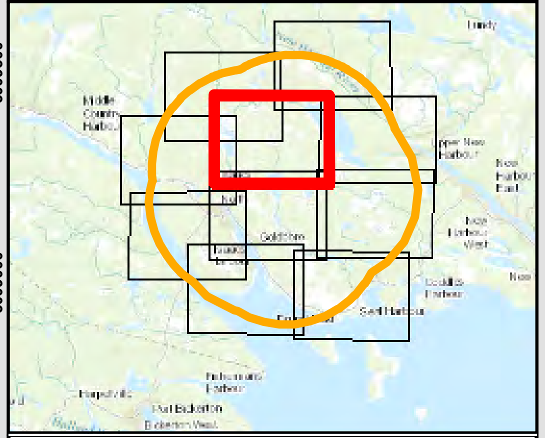
P-ELC Habitat Types

Goldboro, NS

- Project Infrastructure

P-ELC Habitat Classification

- Alder
- Barrens
- Cutover/Regenerative Forests
- Hardwood Forests
- Mixedwood Forests
- Ocean
- Open Wetlands
- Softwood Forests
- Urban/Developed
- Waterbodes
- Alder Swamp
- Cutover/Regenerative Swamp
- Hardwood Forested Swamps
- Mixedwood Forested Swamps
- Softwood Forested Swamps
- Terrestrial Environment LAA
- Project Area



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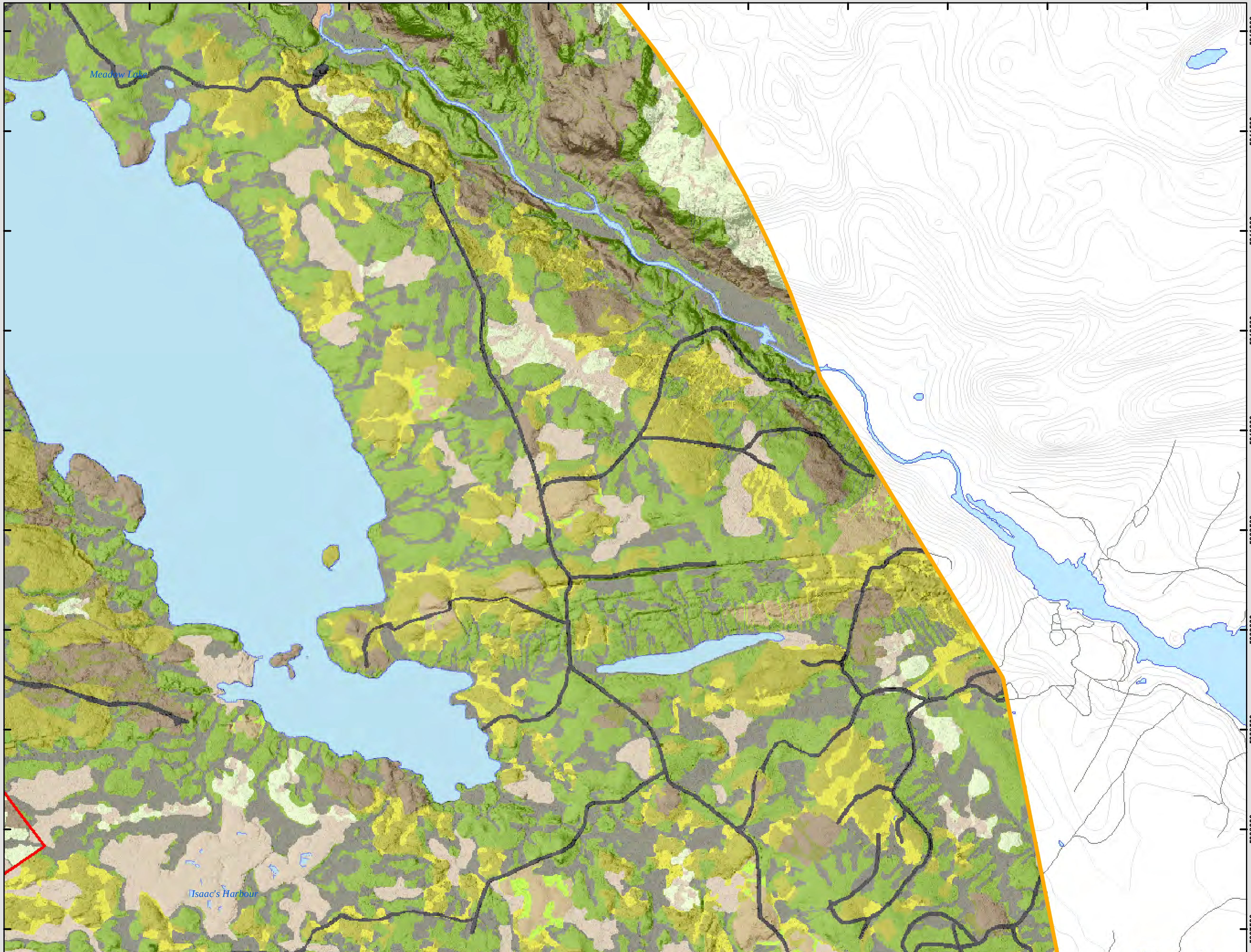

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FIGURE 5.9-2F

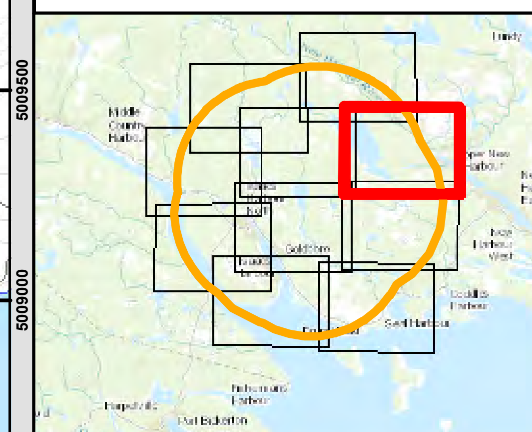
P-ELC Habitat Types

Goldboro, NS

Project Infrastructure

P-ELC Habitat Classification

- Alder
- Barrens
- Cutover/Regenerative Forests
- Hardwood Forests
- Mixedwood Forests
- Ocean
- Open Wetlands
- Softwood Forests
- Urban/Developed
- Waterbodes
- Alder Swamp
- Cutover/Regenerative Swamp
- Hardwood Forested Swamps
- Mixedwood Forested Swamps
- Softwood Forested Swamps
- Terrestrial Environment LAA
- Project Area



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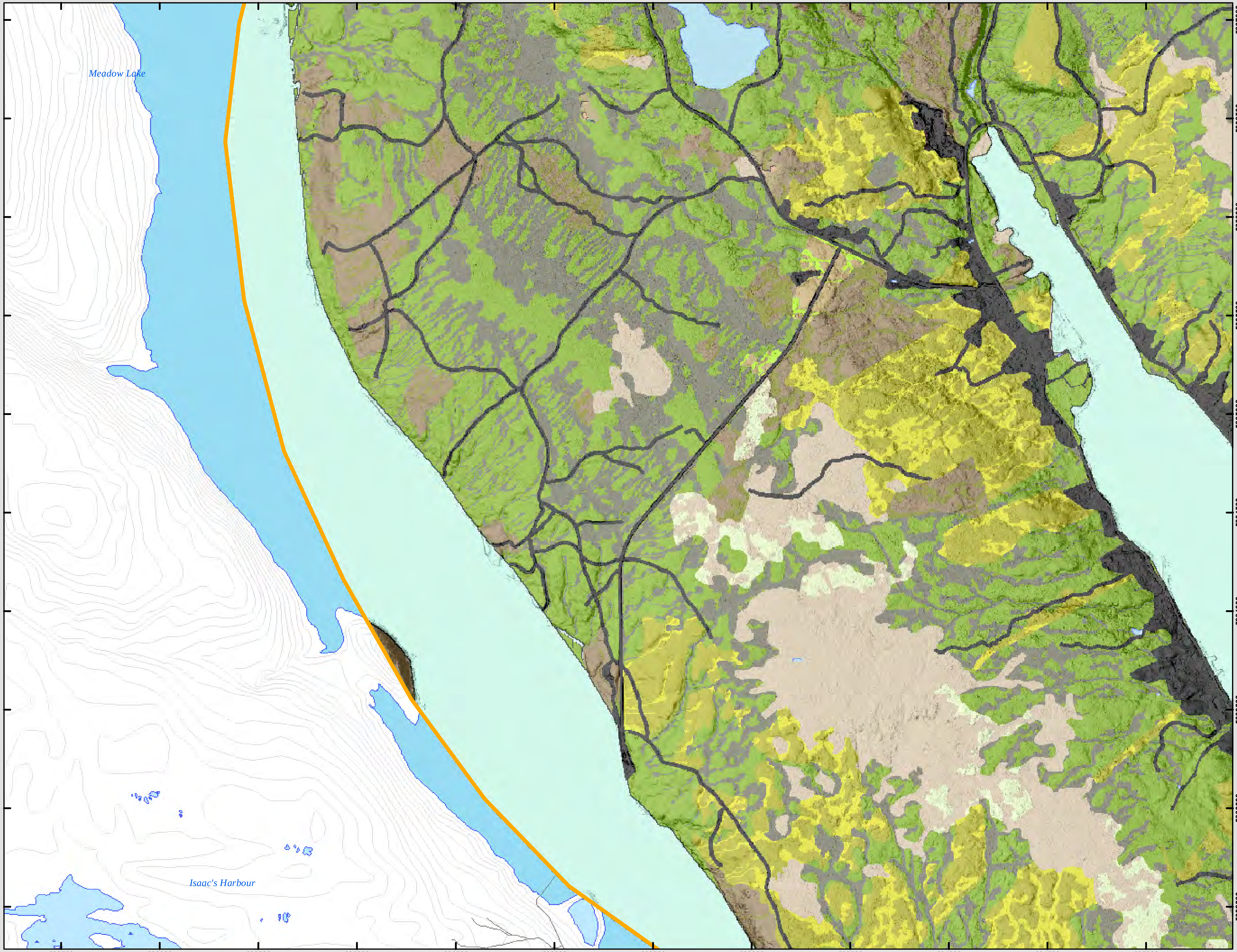

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FIGURE 5.9-2G

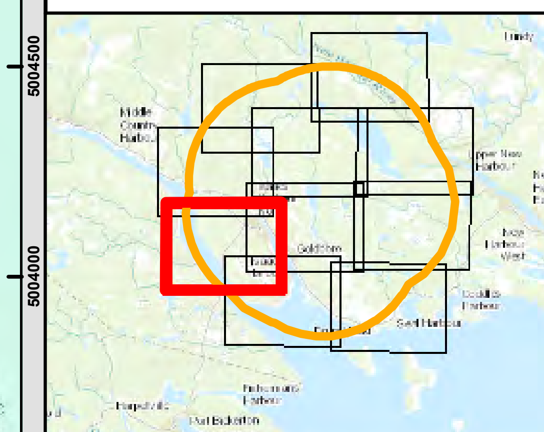
P-ELC Habitat Types

Goldboro, NS

Project Infrastructure

P-ELC Habitat Classification

- Alder
- Barrens
- Cutover/Regenerative Forests
- Hardwood Forests
- Mixedwood Forests
- Ocean
- Open Wetlands
- Softwood Forests
- Urban/Developed
- Waterbodes
- Alder Swamp
- Cutover/Regenerative Swamp
- Hardwood Forested Swamps
- Mixedwood Forested Swamps
- Softwood Forested Swamps
- Terrestrial Environment LAA
- Project Area



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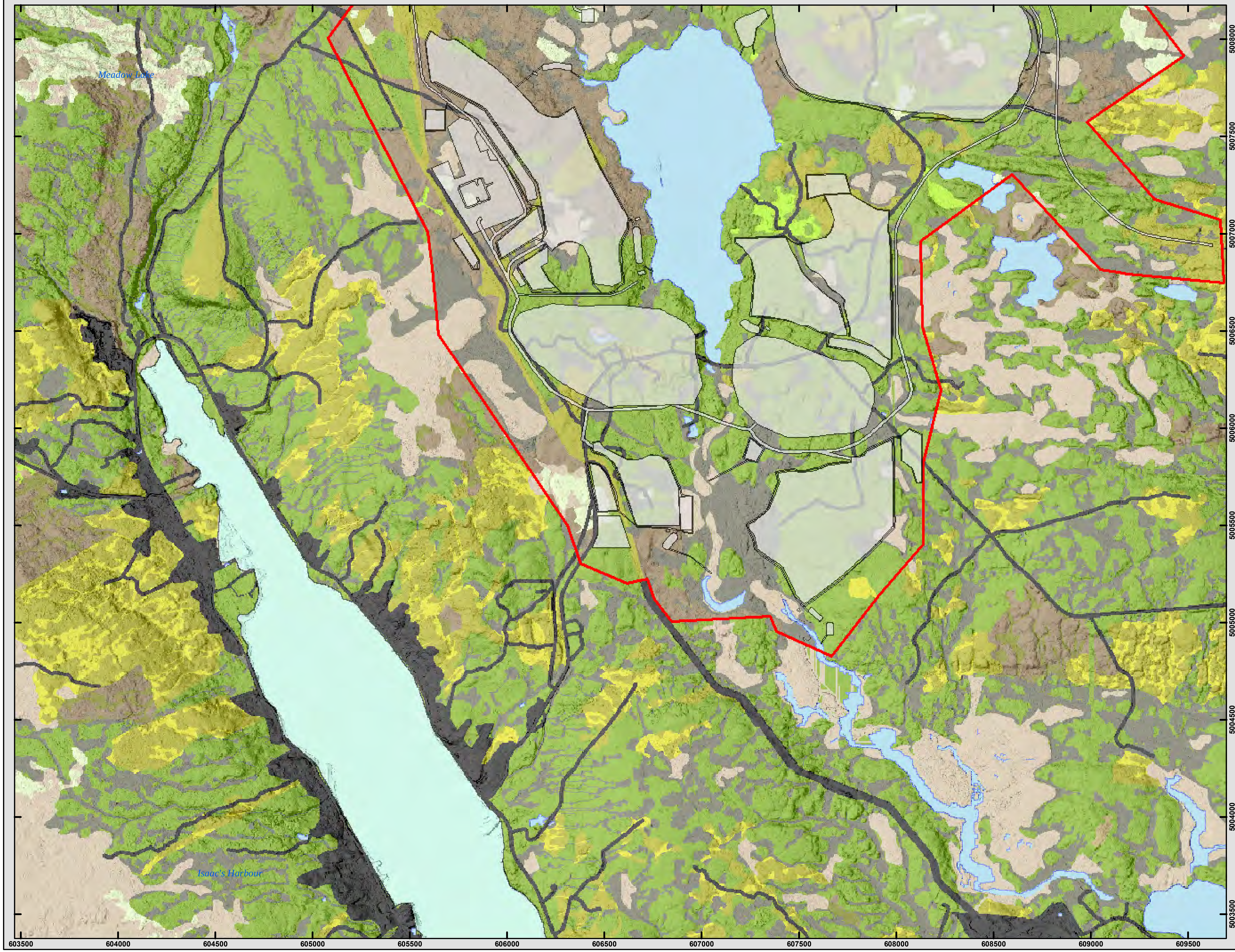

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FIGURE 5.9-2H

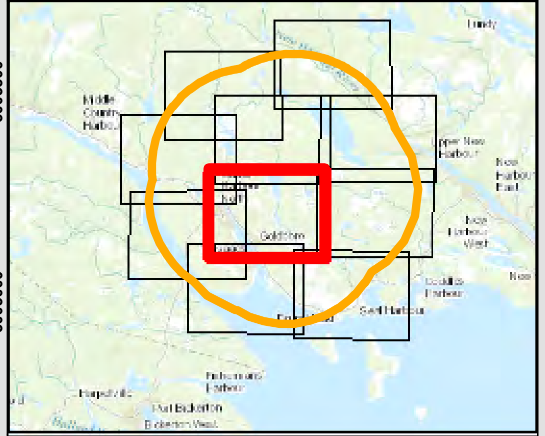
P-ELC Habitat Types

Goldboro, NS

Project Infrastructure

P-ELC Habitat Classification

- Alder
- Barrens
- Cutover/Regenerative Forests
- Hardwood Forests
- Mixedwood Forests
- Ocean
- Open Wetlands
- Softwood Forests
- Urban/Developed
- Waterbodes
- Alder Swamp
- Cutover/Regenerative Swamp
- Hardwood Forested Swamps
- Mixedwood Forested Swamps
- Softwood Forested Swamps
- Terrestrial Environment LAA
- Project Area



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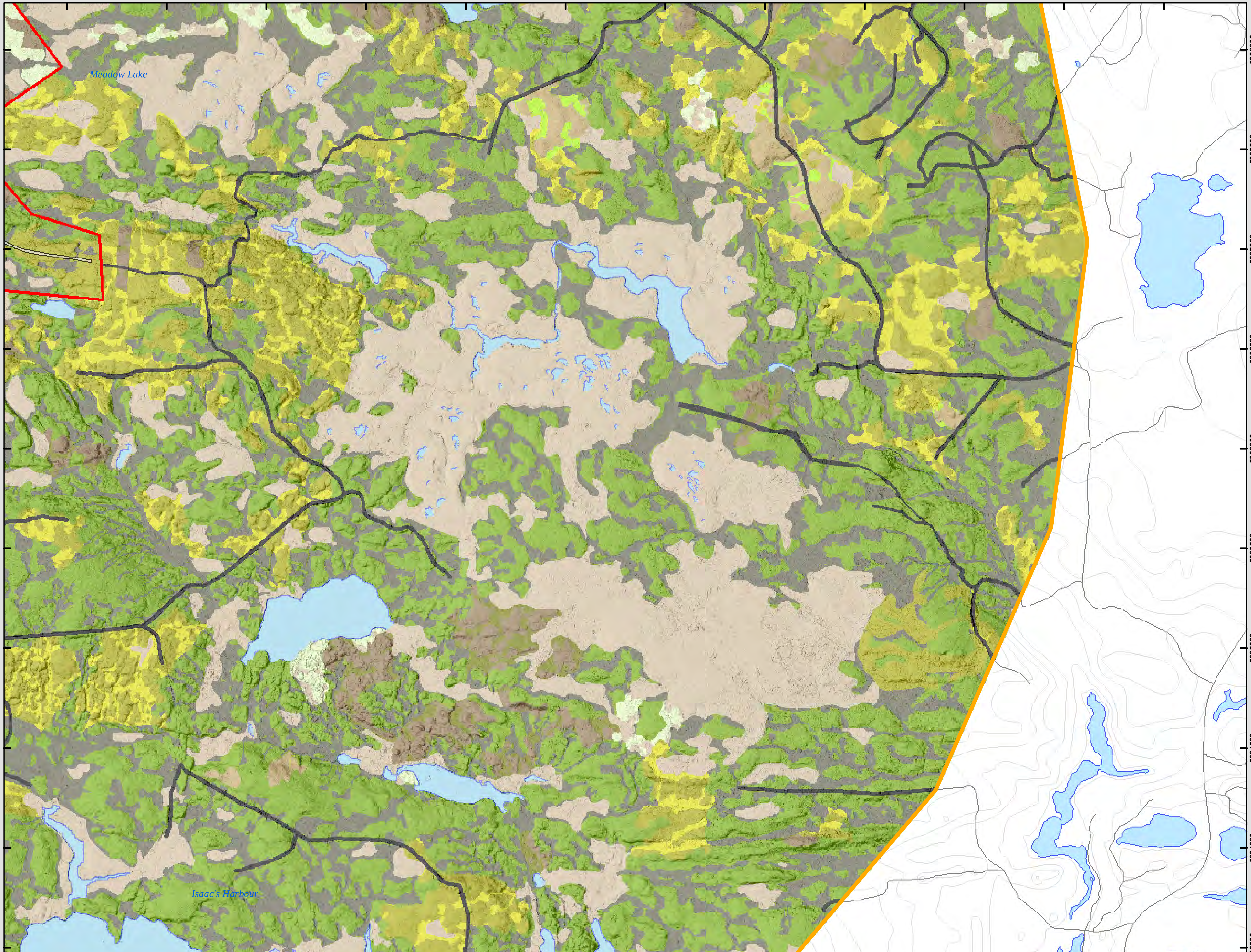

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FIGURE 5.9-2I

P-ELC Habitat Types

Goldboro, NS

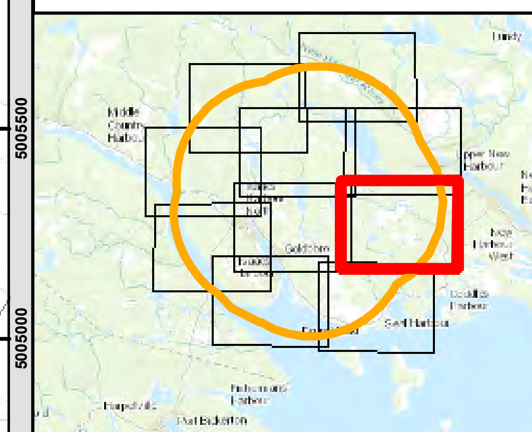
Project Infrastructure

P-ELC Habitat Classification

- Alder
- Barrens
- Cutover/Regenerative Forests
- Hardwood Forests
- Mixedwood Forests
- Ocean
- Open Wetlands
- Softwood Forests
- Urban/Developed
- Waterbodes
- Alder Swamp
- Cutover/Regenerative Swamp
- Hardwood Forested Swamps
- Mixedwood Forested Swamps
- Softwood Forested Swamps

Terrestrial Environment LAA

Project Area



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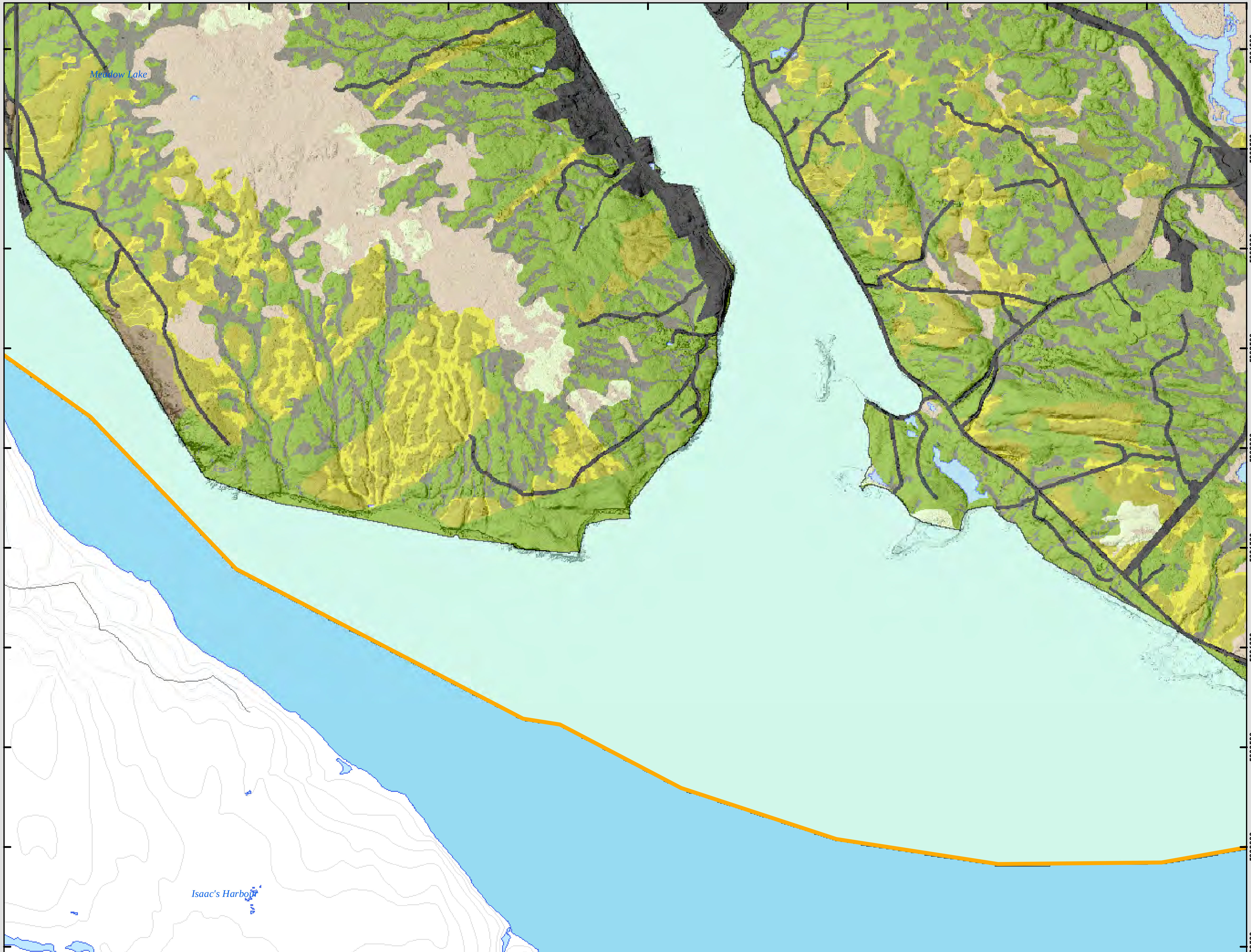

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FIGURE 5.9-2J

P-ELC Habitat Types

Goldboro, NS

Project Infrastructure

P-ELC Habitat Classification

- Alder
- Barrens
- Cutover/Regenerative Forests
- Hardwood Forests
- Mixedwood Forests
- Ocean
- Open Wetlands
- Softwood Forests
- Urban/Developed
- Waterbodes
- Alder Swamp
- Cutover/Regenerative Swamp
- Hardwood Forested Swamps
- Mixedwood Forested Swamps
- Softwood Forested Swamps
- Terrestrial Environment LAA
- Project Area

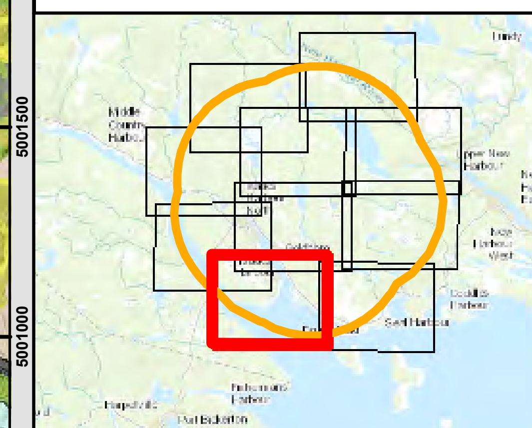

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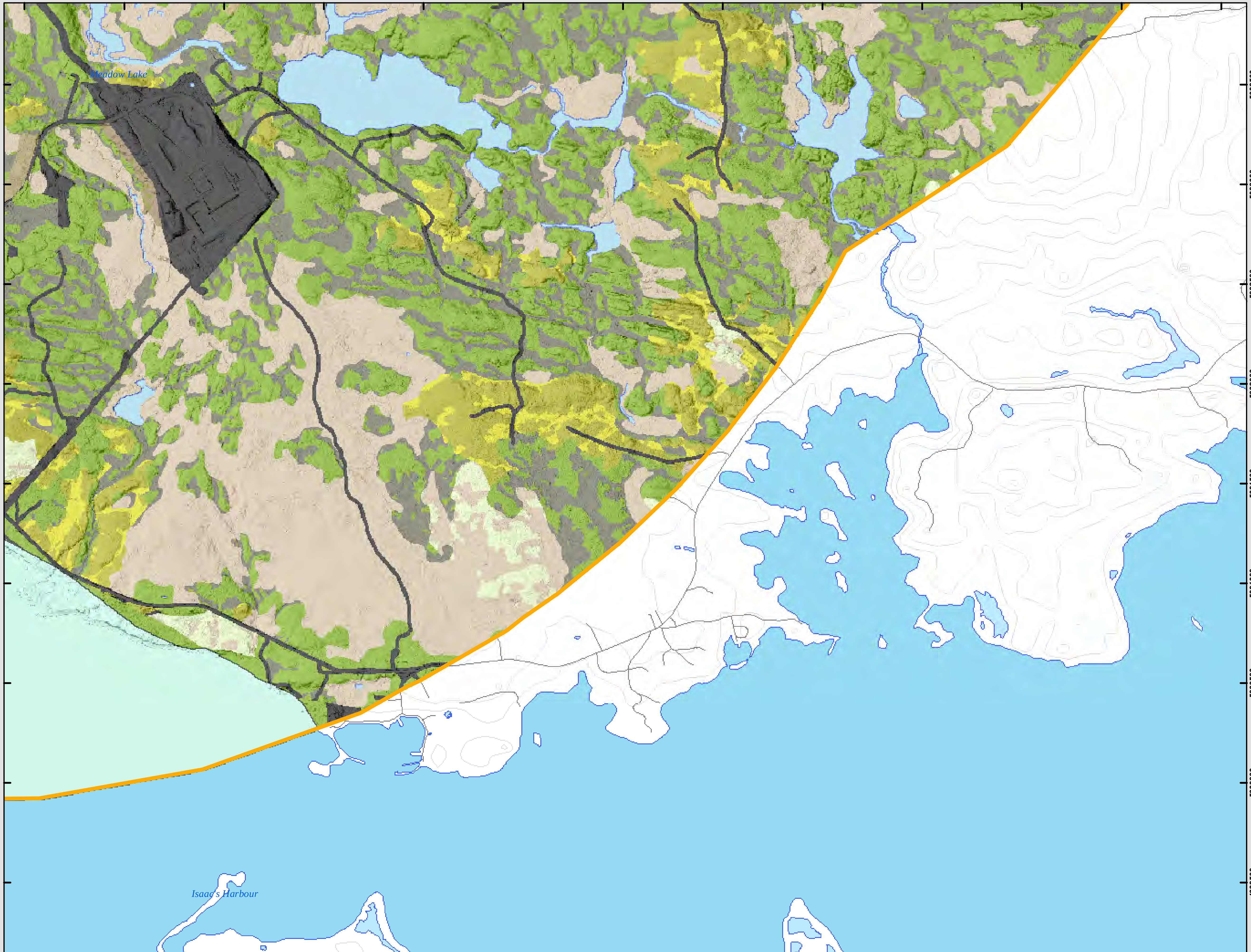
FIGURE 5.9-2K

P-ELC Habitat Types

Goldboro, NS



- Project Infrastructure

P-ELC Habitat Classification

- Alder
- Barrens
- Cutover/Regenerative Forests
- Hardwood Forests
- Mixedwood Forests
- Ocean
- Open Wetlands
- Softwood Forests
- Urban/Developed
- Waterbodes
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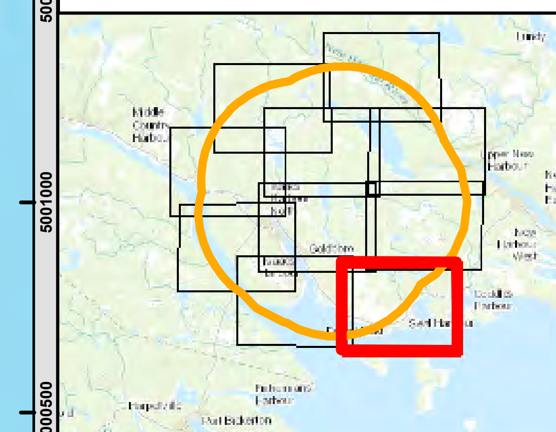
- Hardwood Forested Swamps
- Mixedwood Forested Swamps
- Softwood Forested Swamps
- Terrestrial Environment LAA
- Project Area



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Document Name: 220408_P_ELC

Table 5.9-22 Habitat Types within the LAA, Predicted Habitat Loss and Magnitude of Effects

P-ELC Habitat Type	Direct impact (ha)[1]	Area within the LAA (ha)[1] (% of Habitat Type within the LAA)	% LAA Directly Impacted by the Project[1]	Magnitude of Impacts within the LAA[1]
Softwood Forests	167.8	4,726.5 (30.5%)	3.6	Low
Hardwood Forests	0.0	387.8 (2.5%)	0.00	Negligible
Mixedwood Forests	76.3	877.9 (5.7%)	8.69	Moderate
Softwood Forested Swamps	84.5	2,705.2 (17.5%)	3.12	Low
Hardwood Forested Swamps	2.5	100.5 (0.65%)	2.47	Low
Mixedwood Forested Swamps	0.0	218.4 (1.4%)	0.00	Negligible
Alder	0.0	6.5 (0.04%)	0.00	Negligible
Alder Swamp	0.0	2.0 (0.01%)	0.00	Negligible
Barrens	5.0	304.8 (2.0%)	1.63	Low
Open Wetlands	11.1	1676.5 (10.8%)	0.66	Negligible
Waterbodies	0.3	847.7 (5.5%)	0.04	Negligible
Ocean	0.0	1275.9 (8.2%)	0.00	Negligible
Cutover	41.0	1431.2 (9.2%)	2.86	Low
Cutover/Regenerative Swamp	3.1	391.3 (2.5%)	0.79	Negligible
Urban/Developed	19.2	537.6 (3.5%)	3.58	Low
Total	410.8	15,489.8	3.58	Low

[1]Habitat loss was calculated using the classification of the P-ELC. Classification to the vegetation type, often require site assessments and cannot be identified by aerial interpretation. Therefore, when comparing habitats to the LAA, the broader P-ELC was used.

SOCI vascular plants were avoided by the Project when possible, but several SOCI plants could not be avoided by Project infrastructure. Four locations of NS agalinis (20% of observations of this species within the PA) are expected to be directly impacted by the TMF, open pit, organic stockpile and a ditch associated with the southwest WTS (Figure 5.9-3 A-E). One location and one individual of NS agalinis adjacent to southeast WTS ditch is 3 m away from the footprint, however, due to the inaccuracies of handheld GPS units (+/- 5 m), and potential for minor clearing and disturbance to extend outside the Project footprint design, this occurrence is expected to be directly impacted by the Project. Four locations and four individuals of southern twayblade are also expected to be directly impacted by the organic stockpile (Figure 5.9-3A-E). This loss accounts for 57% of all observations of this species within the PA. Two locations are outside the organic stockpile footprint, but within 5 m, and thus are expected to be impacted. One observation of Weigand's sedge (50% of observations of this species within the PA) is also expected to be directly impacted by the organic stockpile. Two northern comandra individuals (10% of all observations of this species) are within 7 m of the Mill Area and are expected to be directly impacted (Figure 5.9-3 A-E). All variegated horsetail observations have been avoided by infrastructure.

The P-ELC has identified suitable habitats for all observed SOCI vascular plant species and these habitats are found widespread throughout the LAA. Given the size of the LAA and the distributions of these species within the province, it is likely other occurrences of these observed species exist elsewhere in the LAA. Table 5.9-23 summarizes impacts to SOCI vascular plant observed populations and available suitable habitat predictions for these species within the LAA. Based on the P-ELC, and the known and observed habitat types within the PA, magnitude of impacts to these habitats that support these species is predicted to be negligible to low.

Table 5.9-23 SOCI Vascular Plant Impacts and Available Habitat within the LAA

Species[1]	Observed P-ELC Habitat within the PA	# of individuals Directly Impacted by the Project (% of total individuals Impacted)	# of Individuals within the PA (% of total individuals avoided by infrastructure)	Available P-ELC Habitat for the Species within the LAA (ha) (% of Habitat remaining in the LAA after Direct Project Impacts)	Magnitude of Impacts within the LAA[2]
NS agalinis	Open wetlands Urban/Developed Mixedwood Forests Softwood forested swamps Mixedwood forested swamps	4 (20%)	20 (80%)	5,824.5 (96.8%)	Low
Southern twayblade	Softwood forested swamps	4 (57%)	7 (43%)	2,694.1 (99.6%)	Negligible
Northern comandra	Open wetlands	2 (15.4%)	13 (84.6%)	1,670.5 (99.2%)	Negligible
Weigand's sedge	Softwood forested swamps Cutover/Regenerative Forests	1 (50%)	2 (50%)	4,011.0 (97.0%)	Negligible
[1]Only includes SOCI species that are expected to be directly impacted by the Project					

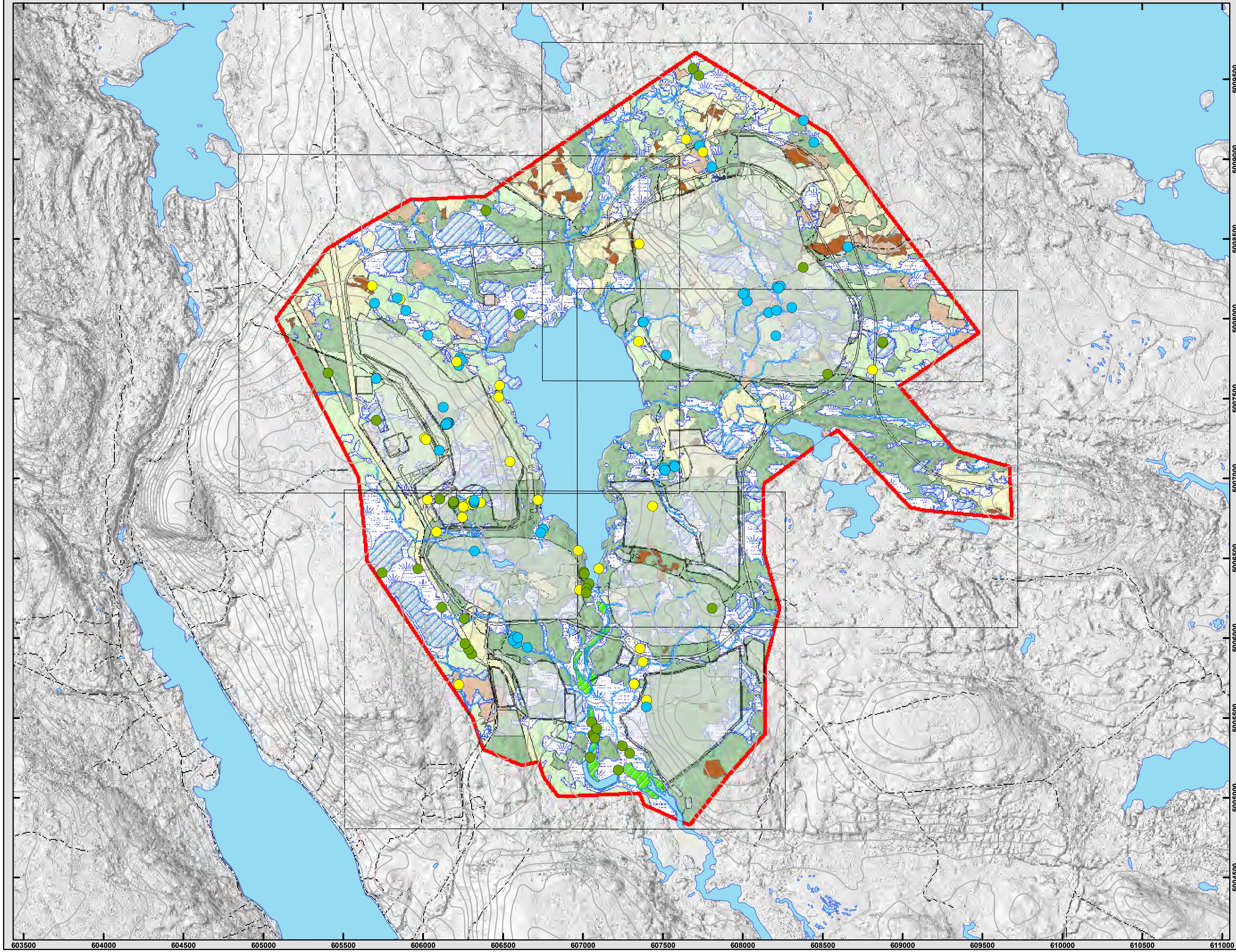

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Figure 5.9-3A

Priority Vascular and Lichen Species Observations and Direct Impacts from Infrastructure Overview

Goldboro, NS

Priority Plant Observations
- SOCI

Priority Lichen Observations
- SOCI
- SAR

- Waterbodies (NSTDB)
- Watercourses (Field Delineated)
- NSTDB Roads
- Gramminoid Dominant Wetland
- Bog/Fens
- Forested Swamps
- Cutover Wetlands
- Softwood Forest
- Cutover/Regenerative Forests
- Mixedwood Forests
- Barrens
- Project Infrastructure
- Project Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

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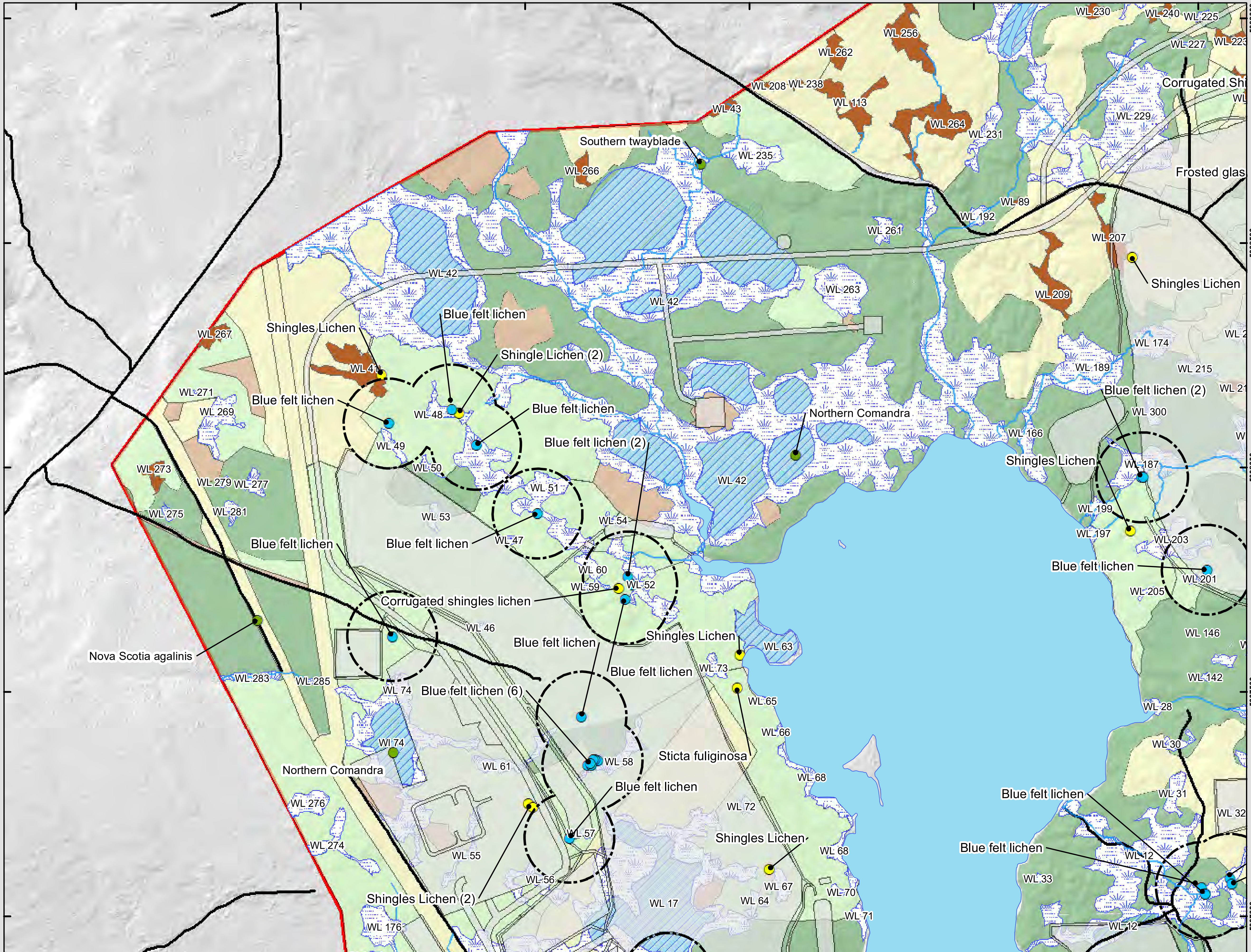

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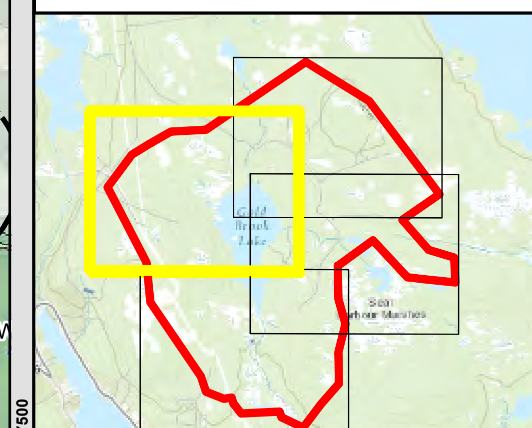
FIGURE 5.9-3B

Priority Vascular and Lichen Species Observations and Direct Impacts from Infrastructure

Goldboro, NS

SAR SMP buffer (100m)
Watercourses (Field Delineated)
Roads (NSTDB)
Priority lichen Observations
SOCI
SAR
Priority Plant Observations
SOCI
Bog/Fens
Forested Swamps
Cutover Wetlands
Softwood Forests
Cutover/Regenerative Forests
Mixedwood Forests
Barrens
Waterbodies (NSTDB)
Project Infrastructure
Project Area



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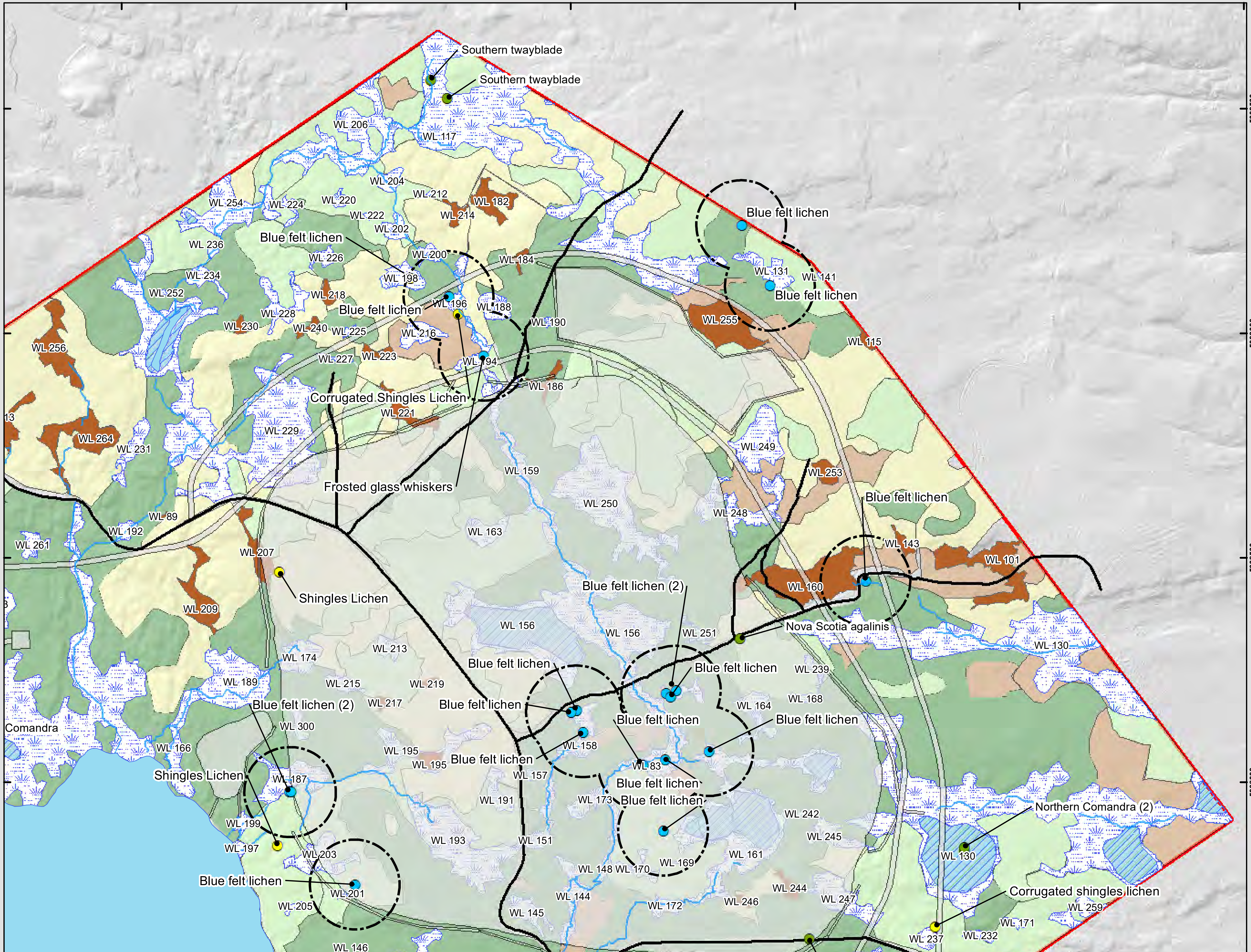

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FIGURE 5.9-3C

Priority Vascular and Lichen Species Observations and Direct Impacts from Infrastructure

Goldboro, NS

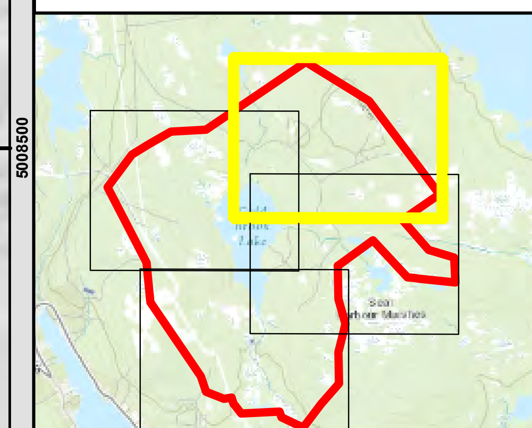
- SAR SMP buffer (100m)
- Watercourses (Field Delineated)
- Roads (NSTDB)

Priority lichen Observations

- SOCI
- SAR

Priority Plant Observations

- SOCI
- Bog/Fens
- Forested Swamps
- Cutover Wetlands
- Softwood Forests
- Cutover/Regenerative Forests
- Mixedwood Forests
- Barrens
- Waterbodies (NSTDB)
- Project Infrastructure
- Project Area



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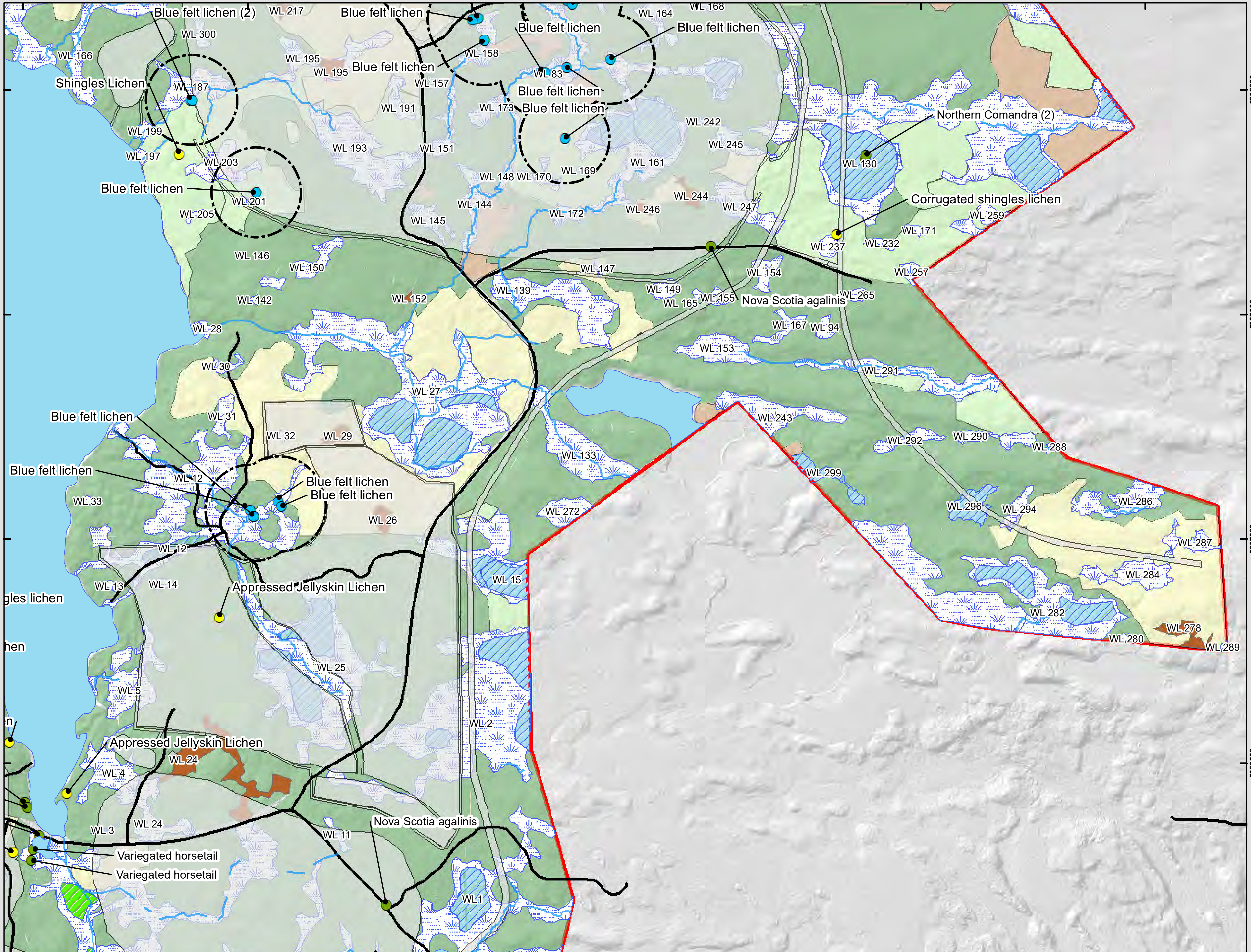

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FIGURE 5.9-3D

Priority Vascular and Lichen Species Observations and Direct Impacts from Infrastructure

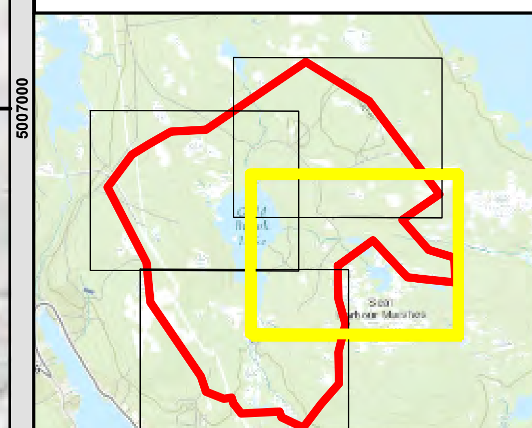
Goldboro, NS

SAR SMP buffer (100m)
Watercourses (Field Delineated)
Roads (NSTDB)

Priority lichen Observations
SOCI
SAR

Priority Plant Observations
SOCI
Gramminoid Dominant Wetland
Bog/Fens
Forested Swamps
Cutover Wetlands

Softwood Forests
Cutover/Regenerative Forests
Mixedwood Forests
Barrens
Waterbodies (NSTDB)
Project Infrastructure
Project Area



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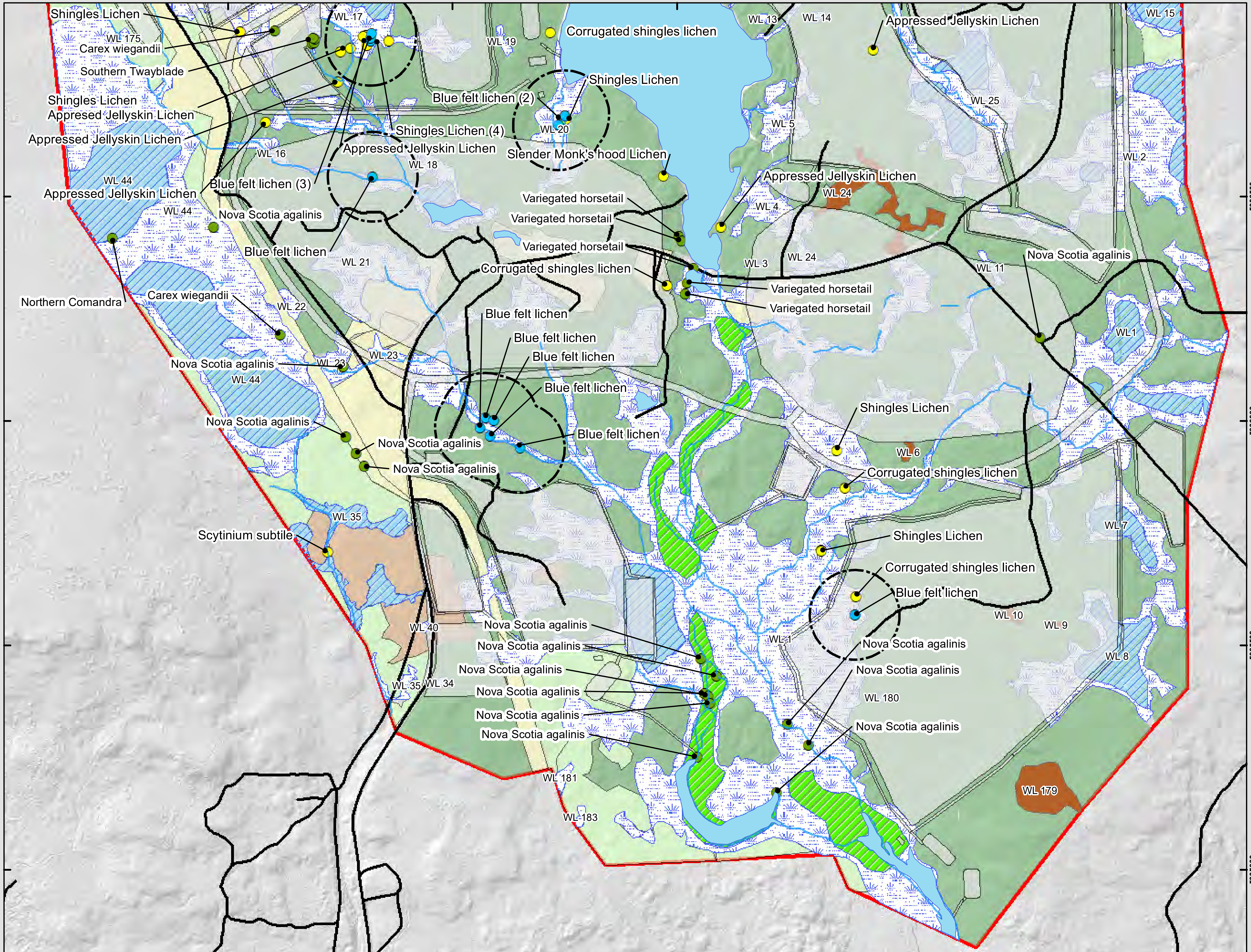

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FIGURE 5.9-3E

Priority Vascular and Lichen Species Observations and Direct Impacts from Infrastructure

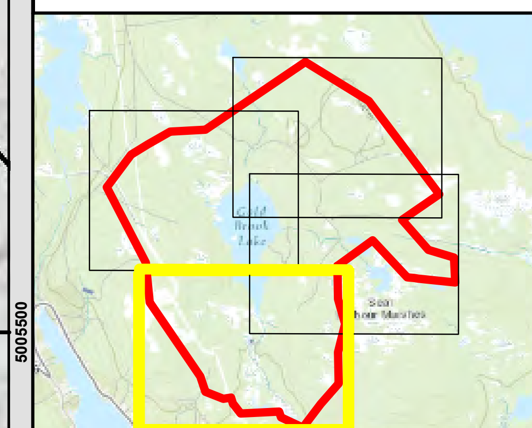
Goldboro, NS

SAR SMP buffer (100m)
Watercourses (Field Delineated)
Roads (NSTDB)

Priority lichen Observations
- SOCI
- SAR

Priority Plant Observations
- SOCI
- Gramminoid Dominant Wetland
- Bog/Fens
- Forested Swamps
- Cutover Wetlands

- Softwood Forests
- Cutover/Regenerative Forests
- Mixedwood Forests
- Barrens
- Waterbodies (NSTDB)
- Project Infrastructure
- Project Area



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Lichens

Vegetation clearing and earth workings for the development of the Project will result in the direct loss of epiphytic, terricolous and saxicolous lichen species. In total, 189 priority lichen thalli of four lichen species (one SAR and three SOCI) are expected to be directly impacted by the Project. The Project will directly impact blue felt lichen, shingle lichen, appressed jellyskin lichen, and corrugated shingles lichen (Figure 5.9-3 A-E).

It is expected that 178 thalli of the SAR blue felt lichen (79.1% of all blue felt lichen thalli observed) are expected to be directly impacted by the Project. Blue felt lichen thalli are expected to be directly impacted by the TMF, Open Pit, northwest and the southeast WRA.

One observation of SAR frosted glass whiskers is currently 17 m from a proposed haul road (Figure 5.9-3 A-E). Detailed design for this road has not been completed and during this design phase, Signal Gold will work to maximum the setback from the road to this species location. For further details on Project micro-siting to reduce impacts to SAR epiphytic lichens, refer to Section 0.

In general, mature forested swamps and adjacent upland forests have an elevated potential to support epiphytic SAR and SOCI lichen species and are usually targeted habitat types during rare lichen surveys. Mature forested swamp habitat types which are considered high quality lichen habitat have been identified throughout the LAA and account for 19.5% of all habitat types within the LAA. Mature upland forests are also considered quality habitat for lichen species and account for 38.6% of the LAA.

The Project is expected to directly impact 3.6% of suitable epiphytic lichen habitat (includes the area of all forested swamps and upland types and excludes cutovers and regenerative stands, urban/developed and waterbodies identified in the P-ELC) within the LAA. The magnitude of direct impact to lichen habitat is predicted to be low. Table 5.9-24 summarizes expected direct impacts to SAR and SOCI lichen species and priority species habitat availability within the LAA.

Table 5.9-24 Direct impacts to Observed SAR and SOCI Lichens and Habitat Availability within the LAA

Species[1]	Observed P-ELC Habitat within the PA[2]	# of individuals Directly Impacted by the Project (% of total individuals Impacted)	# of Individuals within the PA (% of total individuals avoided by infrastructure)	Available P-ELC Habitat for the Species within the LAA (ha) (% of Habitat remaining in the LAA after Direct Project Impacts)[3]	Magnitude of Impacts within the LAA[2]
Blue felt lichen	Mixedwood Forests Softwood Forests Hardwood forested swamps Softwood forested swamps	178 (79.1%)	225 (20.9)	8,079.1 (96.1%)	Low
Shingle Lichen	Mixedwood Forests Softwood Forests Wet Softwood Forests	5 (17.9%)	28 (82.1%)	7,981.1 (96.0%)	Low
Appressed jellyskin lichen	Softwood Forests Wet Softwood Forests	1 (16.7%)	6 (83%)	8,569.7 (96.7%)	Low

Table 5.9-24 Direct impacts to Observed SAR and SOCI Lichens and Habitat Availability within the LAA

Species[1]	Observed P-ELC Habitat within the PA[2]	# of individuals Directly Impacted by the Project (% of total individuals Impacted)	# of Individuals within the PA (% of total individuals avoided by infrastructure)	Available P-ELC Habitat for the Species within the LAA (ha) (% of Habitat remaining in the LAA after Direct Project Impacts)[3]	Magnitude of Impacts within the LAA[2]
Corrugated shingles lichen	Mixedwood Forests Softwood Forests Softwood Forested Swamps	5 (45.4%)	11 (54.6%)	9,371.3 (96.2%)	Low

[1]Only includes priority lichen species expected to be directly impacted by the Project.

[2]Suitable epiphytic lichen habitat across the LAA are estimates only and do not consider potential edge effects or pollution impacts by adjacent cutovers, developments and other factors that may influence the survival and habitat suitability for lichen species.

[3]Habitat area was calculated using all P-ELC habitat types the lichens were observed within the PA.

5.9.6.1.2 Indirect Impacts to Vegetation and Habitat Types

Removal of vegetation and habitat loss during the construction and operation of the Project can result in indirect effects through edge effects. The effects include changes in microclimate, increased light availability and changes in vegetation communities. Clearing of habitats could also result in the potential of invasive plant species to establish an area.

Lichens and non-vascular plants are notably sensitive to edge effects and air quality due to being poikilohydric organisms with an inability to regulate and maintain their water content (Boudreault et al, 2008; COSEWIC, 2002; Nash III, 2008). Edge effects can result in the desiccation and death of lichen species and is one of the biggest threats to SAR and SOCI lichens. The extent in which lichens and plants are impacted by edge effects (referred as depth of influence) have been well documented, however, the depth of influence is context-dependent (e.g., dependent on size of the clearings, substrate, type of climate etc.). Multiple studies show depth of influence can vary from 60 m to 80 m and for some species greater than 240 m (Haughian & Harper, 2020; Gauslaa, Bartemucci & Solhhaug, 2018). For simplicity, and consideration that not all lichens, vascular and non-vascular plants respond the same to edge effects, a conservative depth of influence of 500 m was chosen (Figure 5.9-4). Observed priority lichen species within the depth of influence by edge effects, has potential for adverse effects from the Project, and has been considered when developing the Lichen Management Plan (Section 5.9.9 and Appendix I.4).

Studies, such as Neitlich et al. (2017), Naeth and Wilkinson (2008), Loppi and Frati (2005) and Farmer (1993), present the primary drivers of atmospheric contamination to lichen from mine operations: sulfur dioxide and nitrous oxide emissions, metal mobilization and dust generation. The Project is predicted to result in localized particulate and metal mobilization through dust generation during construction and operations (i.e., mining and hauling ore). Dust deposition may result in increased alkalinity in substrate pH composition (e.g., bark of host tree) and bioaccumulation in lichen tissue which can impact lichen health and species richness (Degtjarenko, 2016; Naeth and Wilkinson 2008; Farmer, 1993). Farmer (1993) observed that bryophytes and lichens along a gravel road (traffic and distance unknown) were unaffected within two years of operation. Significant changes to the communities were noted after 10 years. Species decline was noted at dust deposition levels of 1.0-2.5 g/m^2/day. Effects to lichens were still observed at levels 0.07 g/m^2/day. Modelled particulate deposition rate is expected to have a maximum dust deposition of 3.41 g/m2/day concentrated immediately adjacent to the East and West Pit and associated haul roads. Dust levels generally fall below 0.07 g/m2/day ranging from 300 m to 1,800 m from the haul roads and the East and West Pits. In general, edge effects are expected to be the primary driver to negative impacts to lichens and encompass modelled dust deposition extents.

Vascular plants could also be affected by dust deposition onto vegetation, which can cover the leaves, block stomata and cellular respiration and reduce the overall efficiency of photosynthesis (Farmer, 1993). Dust can be absorbed through the soil resulting in overall decline in plant health and even lead to necrosis (Hosker & Lindberg, 1982).

Interior forests, as defined in Section 5.9.5.3.5, provide refuge and shelter to species from disturbances and continuous forest. These habitats have an important role for species sensitive to edge effects and human disturbances. In the first scenario, using an edge effect of 200 m, a total of 4886 ha of interior forest are predicted within the LAA. There are three predicted interior forest patches that are predicted to be impacted by the Project (Figure 5.9-5), that would result in 317 ha (6.5%) of predicted interior forest lost within the LAA.

The second scenario, using an edge effect of 500 m, predicted 11 interior forest patches totalling 2263 ha withing the LAA and two patches totalling 80 ha are expected to be impacted (Figure 5.9-6). This would result in 3.5% of predicted interior forest lost within the LAA in this scenario. This is showing that using the 200 m edge effect predicts over twice as much predictive interior forest and almost twice as much impact as the 500 m edge effect impact suggesting it is the more conservative option for predicting impact. Considering the two scenarios of edge effects and influence to interior forests based on available literature, it is expected that 3.5 – 6.5% of interior forests are predicted to be impacted, with a magnitude of impact of low.

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FIGURE 5.9-4

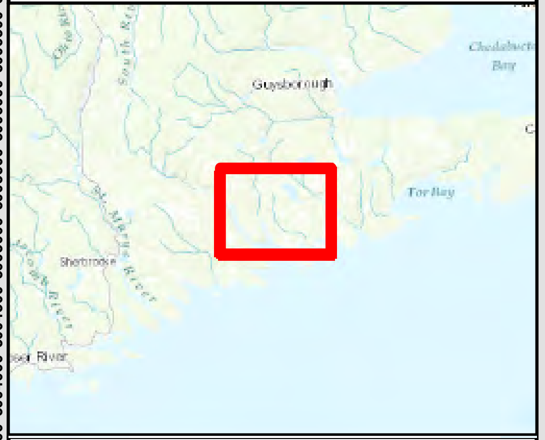
Vascular and Non-Vascular Plant and Lichen Edge Effects

Goldboro, NS

- Radius of Influence (500 m)

P-ELC Habitat Classification

- Alder
- Barrens
- Cutover/Regenerative Forests
- Hardwood Forests
- Mixedwood Forests
- Ocean
- Open Wetlands
- Softwood Forests
- Urban/Developed
- Waterbodies
- Alder Swamp
- Cutover/Regenerative Swamp
- Hardwood Forested Swamps
- Mixedwood Forested Swamps
- Softwood Forested Swamps
- Project Infrastructure
- Terrestrial Environment LAA
- Project Area



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Datum: North American 1983 CSRS
Units: Meter

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Date: 2022-04-11

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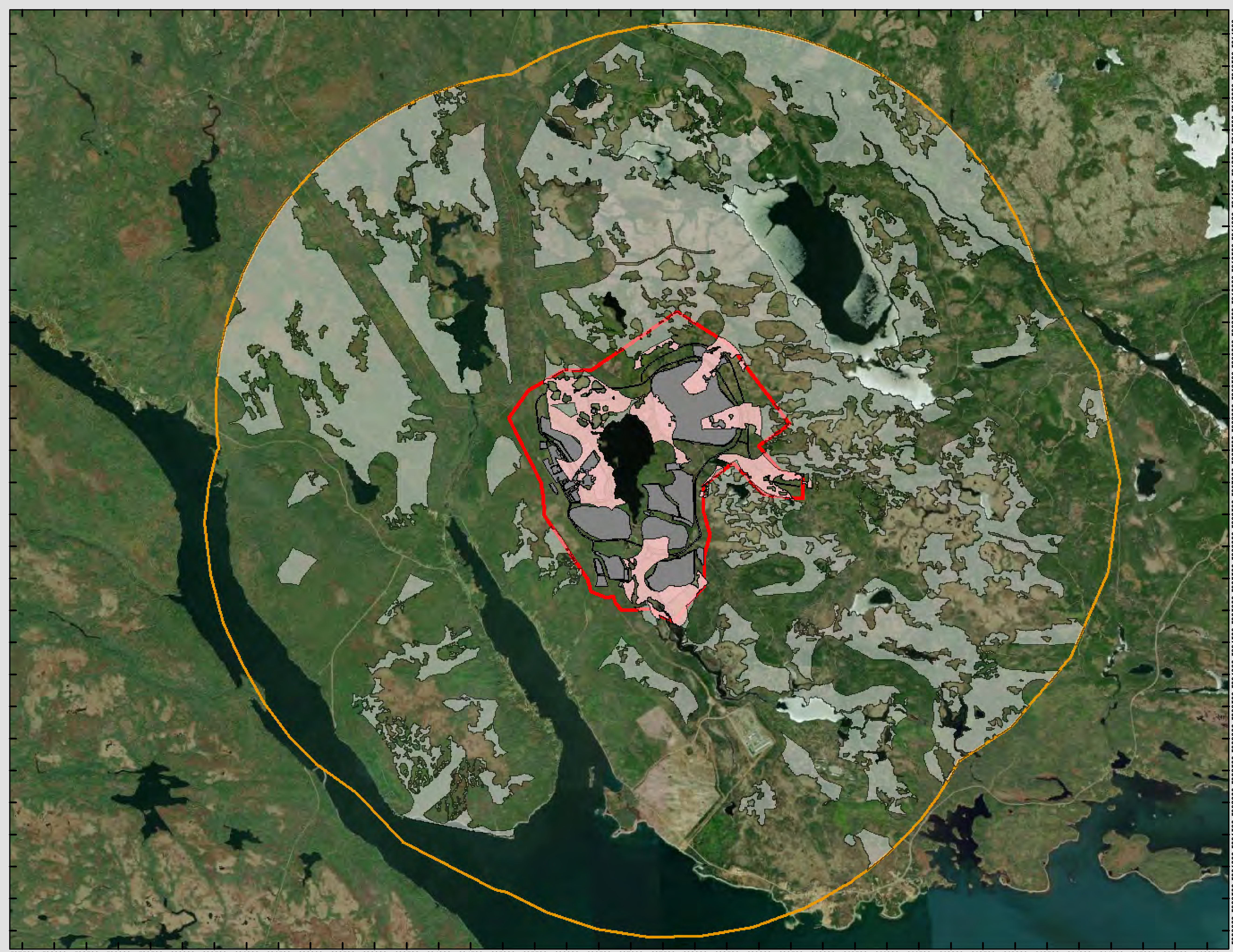
Figure 5.9-5

Interior and Mature Forest 200 m Influence

Goldboro, NS



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Date: 2022-04-08

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Document Name: 220408_InteriorForest_200m

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Figure 5.9-6

Interior and Mature Forest Polygons
500 m Influence

Goldboro, NS

- Predicted Interior Forest Impacted by Project
- Predicted Interior Forest in Local Assessment Area
- Proposed Infrastructure
- Local Assessment Area
- Project Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

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Document Name: 220408_InteriorForest_500m

Groundwater drawdown from the operation and closure phase can have impacts on vegetation communities, notably communities with a high-water table (i.e., wetlands). This drawdown effect could result in a hydrophytic community shift to an upland community. These changes in communities could have a secondary effect and result in changes to lichens and wildlife species that are dependent on wetland conditions for their survival (Section 5.7).

Additional indirect impacts to native plant communities include the potential for introduction of invasive species to the PA. Seeds and roots of invasive species can be transferred from construction equipment, transportation vehicles, or workers (footwear and clothing) into adjacent habitat during construction and operational activities. Introduction of invasive species can occur when equipment or people enter vascular plant communities, or indirectly via runoff or dust from the roads. Invasive species, inclusive but not limited to purple loosestrife (*Lythrum salicaria*), Japanese knotweed (*Fallopia japonica*), common reed (*Phragmites australis*) and glossy buckthorn (*Frangula alnus*) can severely degrade habitat quality and outcompete many native species, particularly along roadsides. Impacts to the PA and surrounding area by the possible introduction of invasive species during construction and operation is planned to be reduced by implementing mitigation measures described in the Wildlife Management Plan (Appendix I.5).

Contamination of vegetation and habitat can occur during all Project phases by accidental spills involving the deposition of deleterious substances, including fuel, lubricants, and engine oils. This could result in altering vegetation communities and death of certain plant species.

In the reclamation phase, a positive effect to the terrestrial environment may occur, and the revegetation and rehabilitation may result in increased habitat availability compared to the operation phase. Although the habitat may differ baseline conditions, useable habitat for a variety of lichens and plants will be present. Shortly after closure, the landscape will likely be open, with low lying vegetation, primarily herbaceous and shrubs. Due to the absence or lack of trees in this stage, the reclaimed PA would be devoid of epiphytic lichens dependent on mature tree species for survival, although, some corticolous lichen species could exist on shrubs. Habitat for terricolous lichen species (e.g., cladonia) would be present in this stage. Over time, the landscape will also likely consist of shrubs and trees and there may be more stand heterogeneity to provide habitats for flora and fauna species. Mature forested landscapes would take much longer to develop (50-70 years), and it is unlikely reclamation will result in the complete reversal of some of the Project effects. Wetlands impacted by the Project, such as bogs and fens which are characterized by the slow accumulation of peat, may not be able to be fully restored to baseline conditions.

5.9.6.2 Changes in Wildlife Including Priority Species

The Project is expected to result in changes in wildlife and priority specie via direct and indirect Project related impacts. Direct and indirect impacts to wildlife and priority species are described in the following sections.

5.9.6.2.1 Direct Loss to Avifauna Habitat due to Project Footprint

Direct loss to avifauna habitat is expected to occur primarily during the construction phase of the Project. These habitats have the potential to provide foraging, hunting, protection, and breeding habitat for avifauna species. Habitat loss to avifauna species could also occur during the closure phase to species that may have occupied anthropogenic structures (e.g., employee accommodations) during operations but most habitat loss for avifauna will be during the construction phase of the Project (Figure 5.9-7 A-F).

Direct habitat loss to all bird functional groups assessed is predicted, with certain groups or species experiencing lower relative loss than others. Direct loss to avifauna habitat ranges from negligible to moderate magnitude of impact are shown in Table 5.9-25

Table 5.9-25. Wood thrush habitat is expected to have the highest impacts (6.0%) with a moderate magnitude of impact. The magnitude of impacts to SAR habitat in general (combining all habitat requirements for all SAR) is low (3.4%). Predicted avifauna habitat loss per assessed functional group is described below.

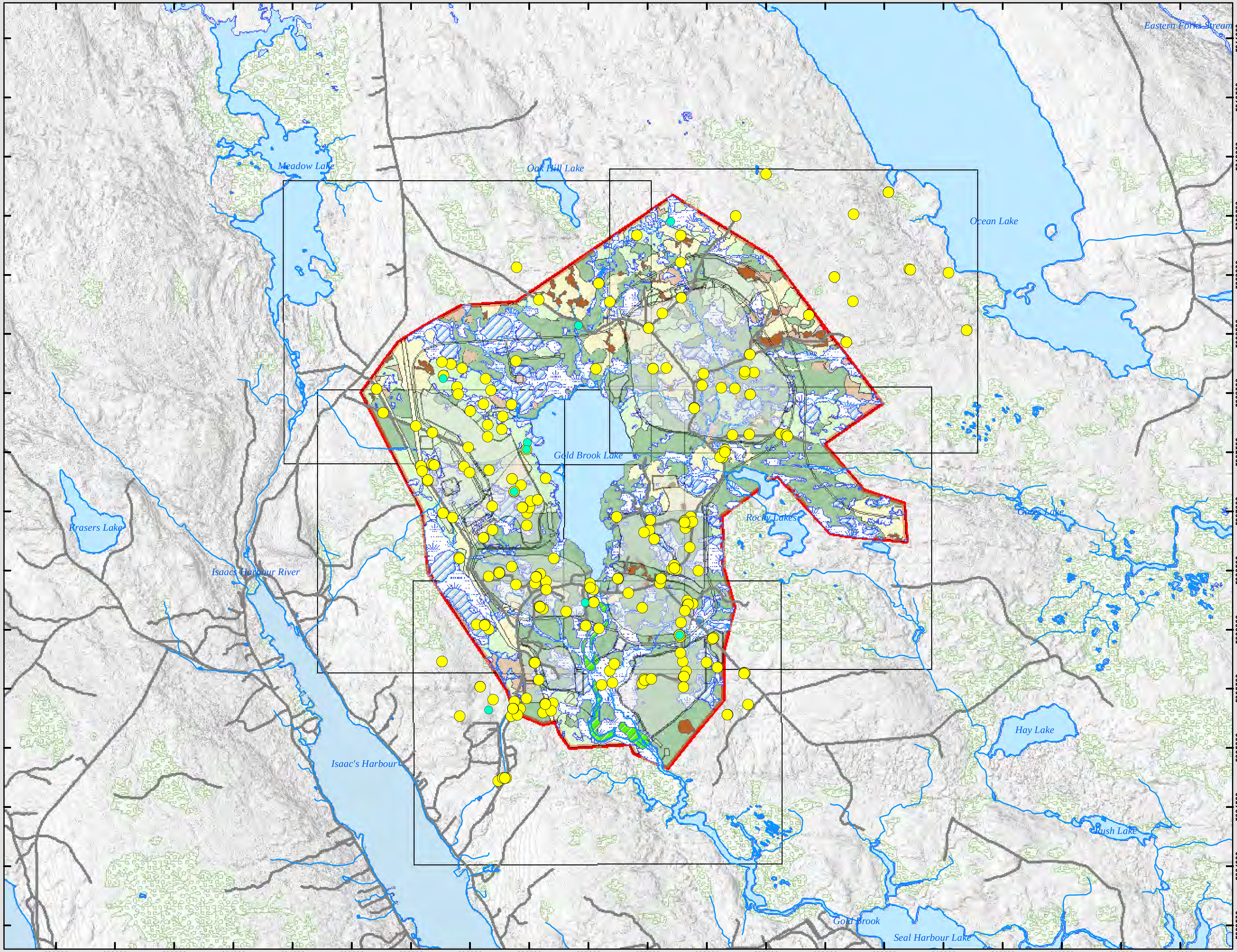

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FIGURE 5.9-7A

SAR SOCI Avifauna Observations Overview

Goldboro, NS

- SAR Observations
- SOCI Observations
- Watercourses
- Watercourses (Field Delineated)
- Roads (NSTDB)
- Graminoid Dominant Wetland
- Bog/Fens
- Forested Swamps
- Cutover Wetlands
- Softwood Forests
- Cutover/Regenerative Forests
- Mixedwood Forests
- Barrens
- Waterbody
- Wetlands outside PA (NSECC)
- Project Infrastructure
- EARD Project

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Units: Meter

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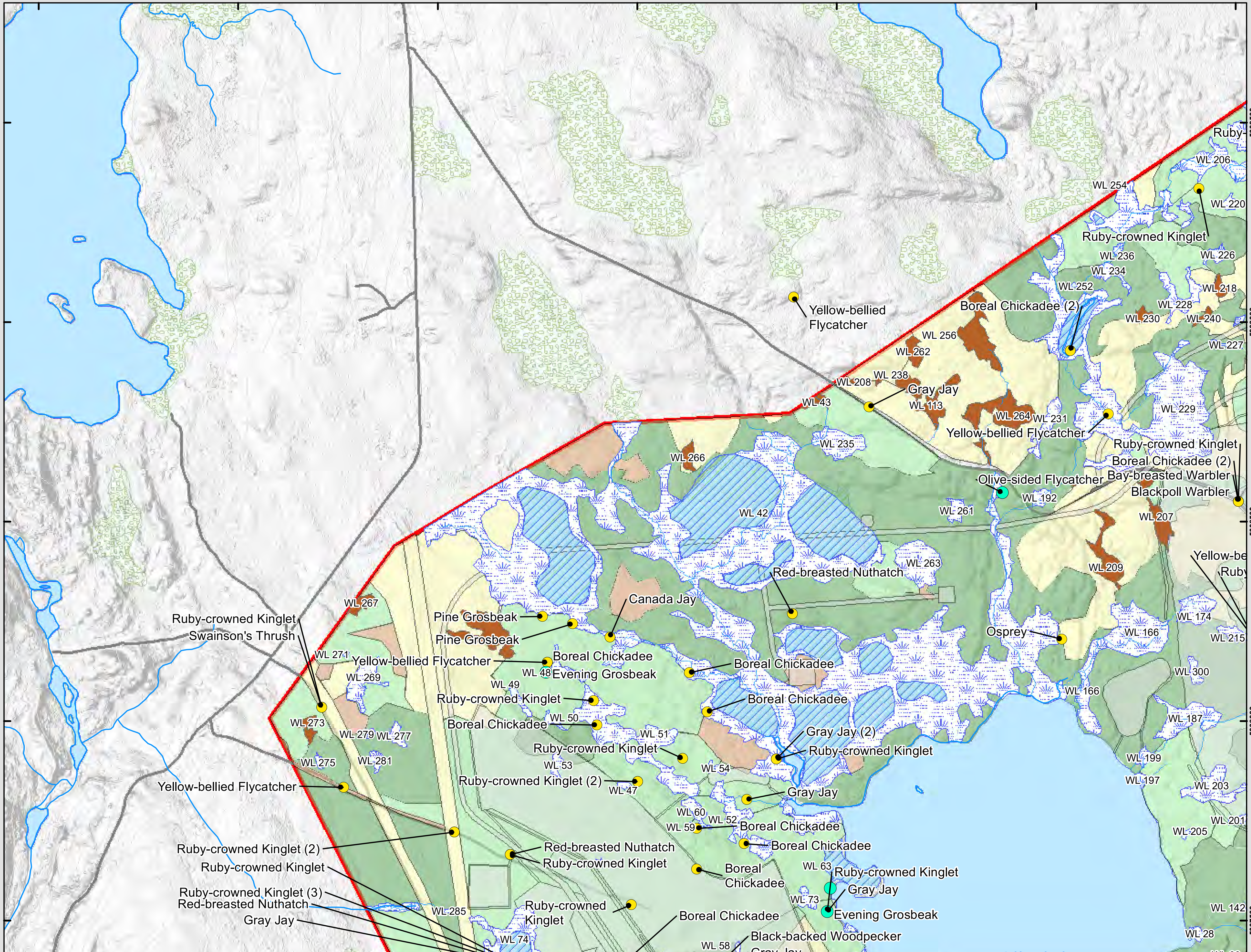

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FIGURE 5.9-7B

SAR SOCI Avifauna Observations

Goldboro, NS

- SAR
- SOCI
- Watercourses (NSTDB)
- Watercourses (Field Delineated)
- Roads (NSTDB)
- Graminoid Dominant Wetland
- Bog/Fens
- Forested Swamps
- Cutover Wetlands
- Softwood Forests
- Cutover/Regenerative Forests
- Mixedwood Forests
- Barrens
- Waterbody
- Wetlands outside PA (NSECC)
- Project Infrastructure
- Project Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 125 250 500 m

1:9,000 Scale when printed @ 11" x 17"

Drawn By: MQ
Reviewed By: JG
Date: 2022-04-11

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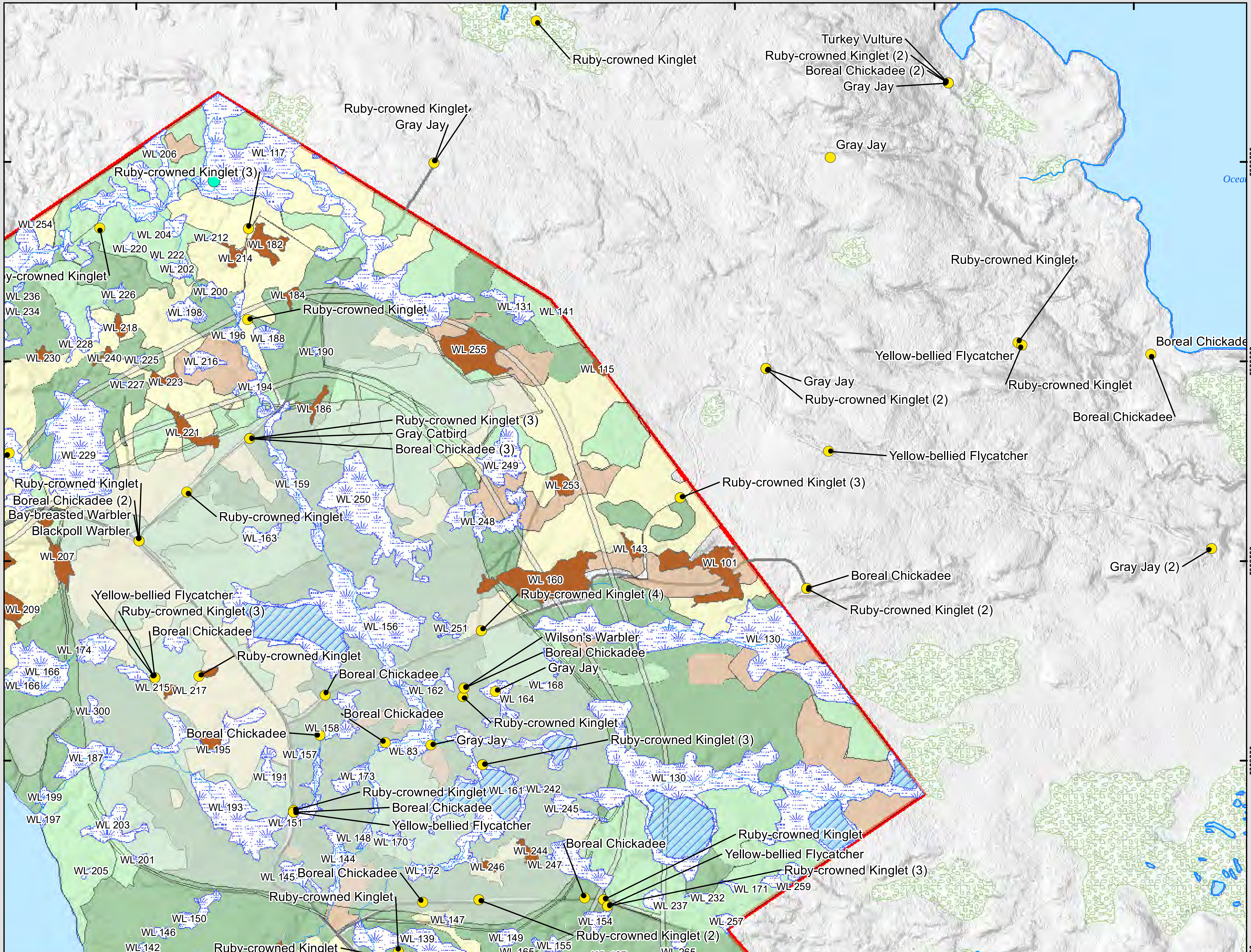
Document Name: 220408_SARSOCI_Avi



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SIGNAL GOLD

FIGURE 5.9-7C

SAR SOCI Avifauna Observations

Goldboro, NS

Legend	
SAR	Cutover Wetlands
SOCI	Softwood Forests
Watercourses (NSTDB)	Cutover/Regenerative Forests
Watercourses (Field Delineated)	Mixedwood Forests
Roads (NSTDB)	Barrens
Graminoid Dominant Wetland	Waterbody
Bog/Fens	Wetlands outside PA (NSECC)
Forested Swamps	Project Infrastructure
	Project Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
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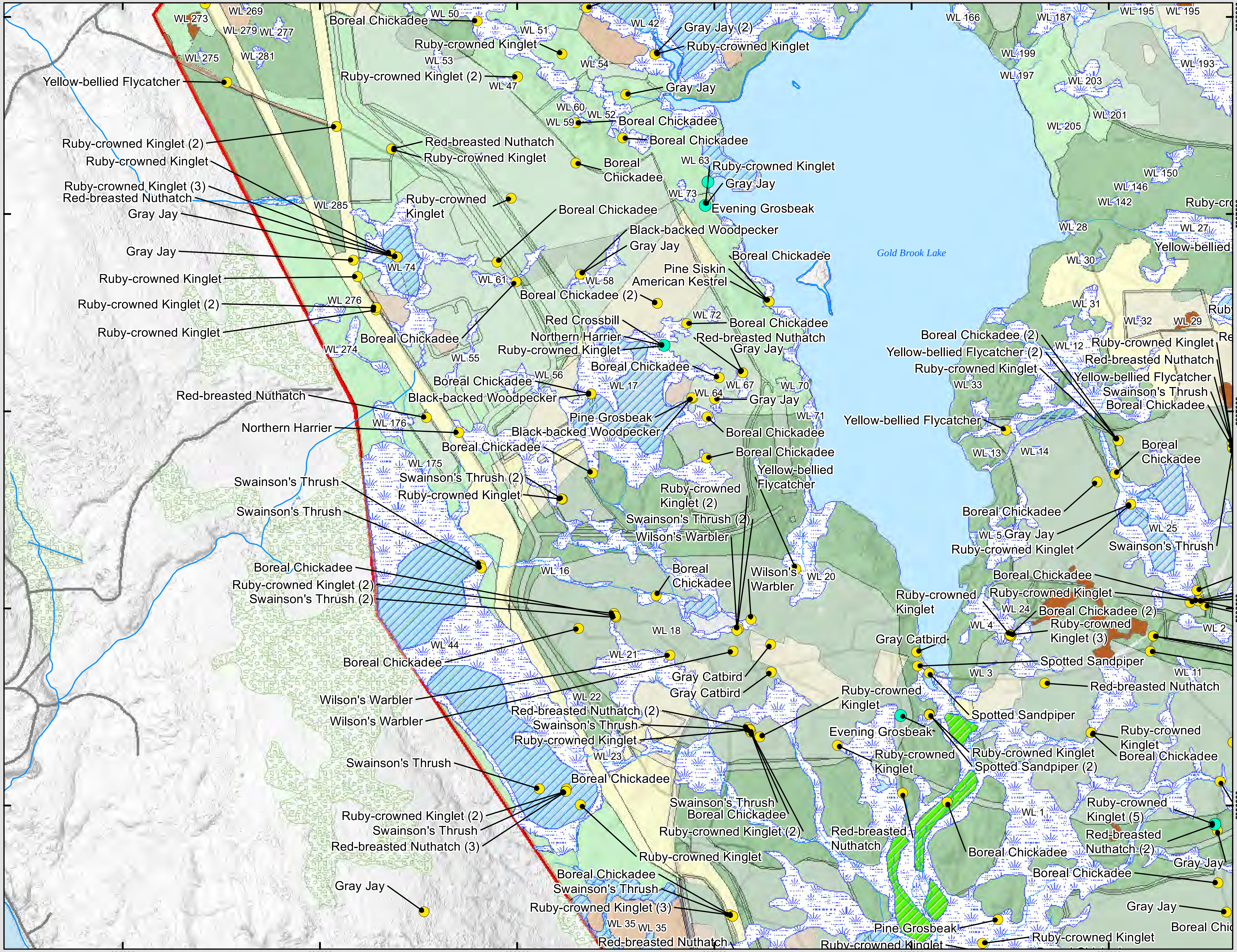

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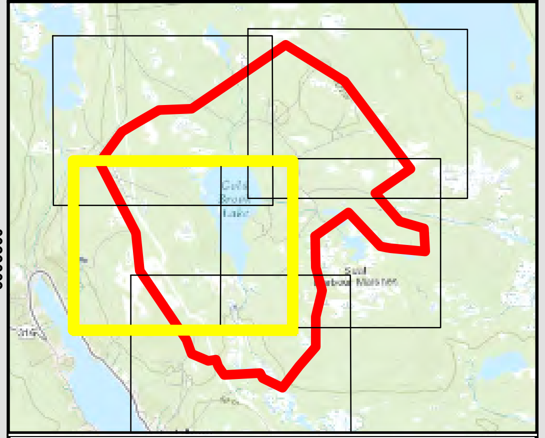
FIGURE 5.9-7D

SAR SOCI Avifauna Observations

Goldboro, NS

- SAR
- SOCI
- Watercourses (NSTDB)
- Watercourses (Field Delineated)
- Roads (NSTDB)
- Graminoid Dominant Wetland
- Bog/Fens
- Forested Swamps
- Cutover Wetlands
- Softwood Forests
- Cutover/Regenerative Forests
- Mixedwood Forests
- Barrens
- Waterbody
- Wetlands outside PA (NSECC)
- Project Infrastructure
- Project Area



Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

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Drawn By: MQ
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Date: 2022-04-11

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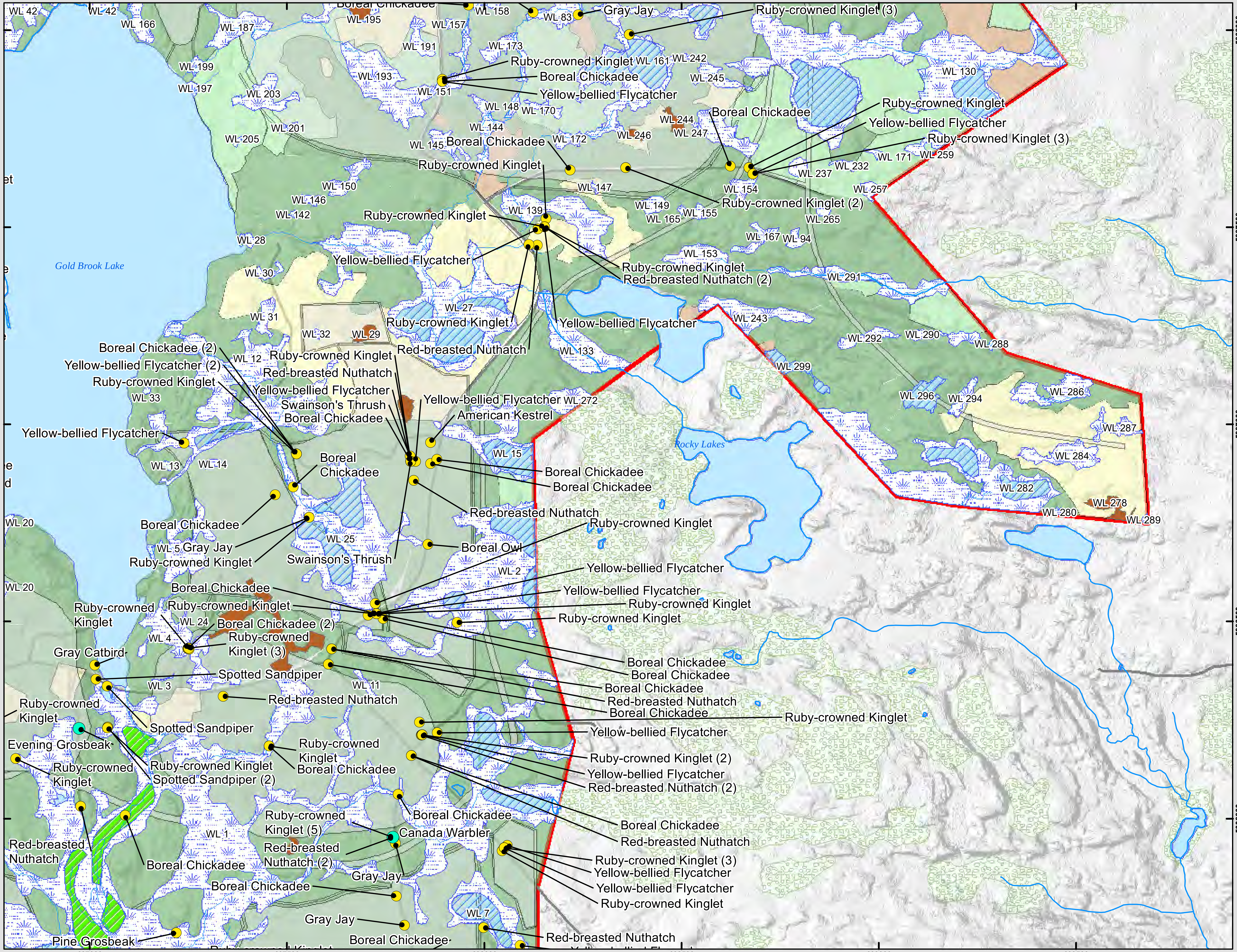
Document Name: 220408_SARSOCI_Avi



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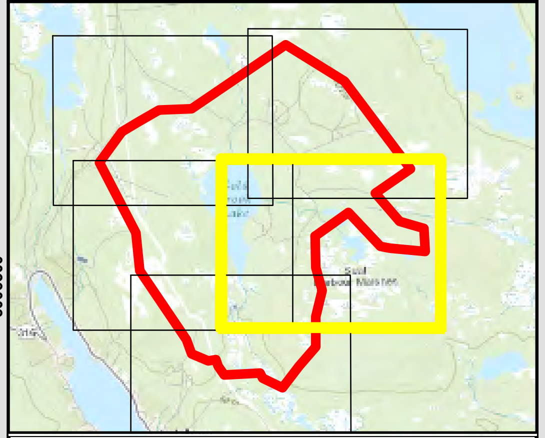
SIGNAL GOLD

FIGURE 5.9-7E

SAR SOCI Avifauna Observations

Goldboro, NS

- SAR
- SOCI
- Watercourses (NSTDB)
- Watercourses (Field Delineated)
- Roads (NSTDB)
- Graminoid Dominant Wetland
- Bog/Fens
- Forested Swamps
- Cutover Wetlands
- Softwood Forests
- Cutover/Regenerative Forests
- Mixedwood Forests
- Barrens
- Waterbody
- Wetlands outside PA (NSECC)
- Project Infrastructure
- Project Area



Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

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Date: 2022-04-11

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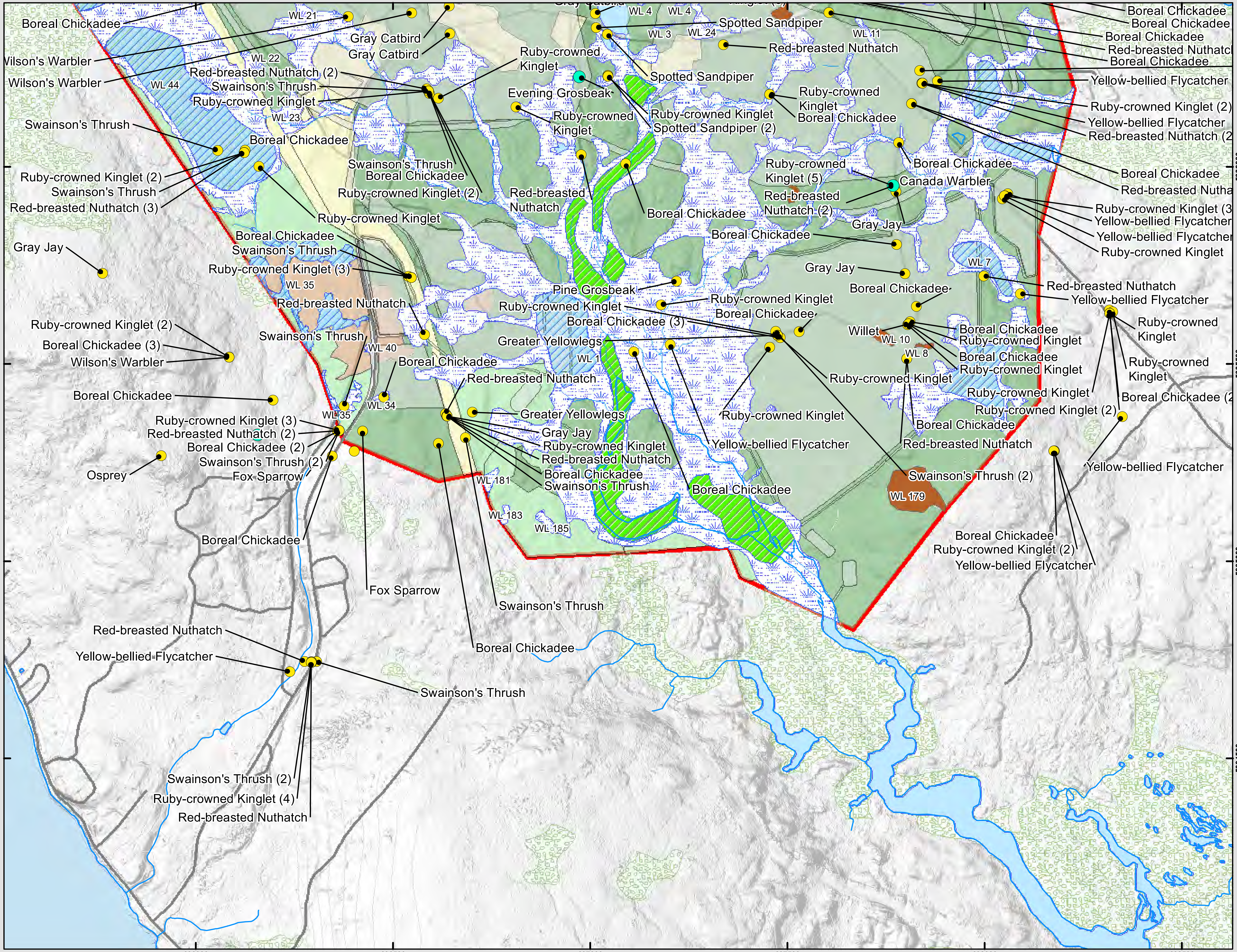
Document Name: 220408_SARSOCI_Avi



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SIGNAL GOLD

FIGURE 5.9-7F

SAR SOCI Avifauna Observations

Goldboro, NS

- SAR
- SOCI
- Watercourses (NSTDB)
- Watercourses (Field Delineated)
- Roads (NSTDB)
- Gramminoid Dominant Wetland
- Bog/Fens
- Forested Swamps
- Cutover Wetlands
- Softwood Forests
- Cutover/Regenerative Forests
- Mixedwood Forests
- Barrens
- Waterbody
- Wetlands outside PA (NSECC)
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Coordinate System: NAD 1983 CSRS UTM Zone 20N
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Document Name: 220408_SARSOCI_Avi

Passerines

White-throated sparrows are associated with six P-ELC habitats (mixedwood forests, softwood forests, hardwood forests, cutover stands, cutover swamps, open wetlands), which account for 61.4% (9,491.2 ha) of the LAA. The Project is estimated to result in a loss of 299.3 ha of suitable habitat for this species, resulting in 3.2% loss within the LAA. Common yellowthroat habitat is associated with six P-ELC habitats (mixedwood forested swamps, softwood forested swamps, hardwood forested swamps, cutover swamps, alders, and alder swamps) which account for 221% (3,423.9 ha) of the LAA. The Project is estimated to result in a loss of 90.0 ha of suitable habitat for this species, resulting in 2.6% loss within the LAA. General passerine habitat (combining habitat requirements for the two species) accounts for 12,523.8 ha (81.0%) within the LAA, and the Project is expected to impact 3.1% of suitable habitat for the passerines as a functional group within the LAA, with a predicted low magnitude of impact.

Waterfowl

Canada goose are associated with two P-ELC habitats (open wetlands, waterbodies), which accounts for 16.3% (2,524.3 ha) of the LAA. The Project is estimated to result in a loss of 11.4 ha of suitable habitat for this species, resulting in 0.5% loss within the LAA. American black duck is associated with three habitats (open wetlands, alders, waterbodies), which accounts for 16.4% (2,530.8 ha) of the LAA. The Project is estimated to result in a loss of 11.04 of suitable habitat for this species for a 0.5% loss within the LAA. General waterfowl habitat (combining habitat requirements for the two species) accounts for 2,530.8 ha (16.4%) within the LAA, and the Project is expected to impact 0.5% of suitable habitat for waterfowl functional group within the LAA, with a predicted negligible magnitude of impact.

Diurnal Raptors

Northern harriers are associated with five P-ELC habitats (cutover stands, cutover swamps, open wetlands, alders, alder swamps), which accounts for 22.7% (3,507.5 ha) of the LAA. The Project is estimated to result in a loss of 55.2 ha of suitable habitat for this species, resulting in 1.6% loss within the LAA. Ospreys are associated with five habitats (mixedwood forests, mixedwood forested wetlands, softwood forests, open wetlands, waterbodies), which accounts for 54.0% (8,347.1 ha) of the LAA. The Project is estimated to result in a loss of 255.5 ha of suitable habitat for this species, resulting in 3.1% loss within the LAA. General diurnal raptor habitat (combining habitat requirements for the two species), accounts for 10,178.1 ha (65.8%) within the LAA and the Project is expected to impact 2.9% of suitable habitat for the diurnal raptor function group within the LAA, with a predicted low magnitude of impact.

Nocturnal Raptors

Barred owls are associated with seven P-ELC habitats (mixedwood forests, mixedwood forested swamps, softwood forests, softwood forested swamps, hardwood forests, hardwood forested swamps, waterbodies), which accounts for 63.8% (9,864.0 ha) of the LAA. The Project is estimated to result in a loss of 331.4 ha of suitable habitat for this species, resulting in 3.4% loss within the LAA. Habitat loss for nocturnal owls within the LAA is to have predicted low magnitude of impact

Other Land Birds

Spruce grouse are associated with ten P-ELC habitats (mixedwood forests, mixedwood forested swamps, hardwood forests, hardwood forested swamps, softwood forests, softwood forested swamps, cutover stands, cutover swamps, barrens, open wetlands), which account for 82.9% (12,820.2 ha) of the LAA. The Project is estimated to result in a loss of 391.2 ha of suitable habitat for this species, resulting in 3.1% loss within the LAA. Northern flickers are associated with eight habitats (mixedwood forests, mixedwood forested swamps, softwood forests, softwood forested swamps, hardwood forests, hardwood wet forests, cutover swamps, open wetlands), which account for 75.2% (11,621.7) of the LAA. The Project is estimated to result in a loss of 364.5 ha of suitable habitat for this species, resulting in 3.1% loss within the LAA. General other land bird habitat (combining habitat requirements for both species) accounts for 13,357.8 ha (86.4%) within the LAA, and the Project is expected to impact 3.1% of suitable habitat for passerines as a functional group within the LAA, with a predicted low magnitude of impact.

Shorebirds

Spotted sandpipers are associated with two P-ELC habitats (waterbodies, ocean), which account for 13.7% (2,123.6 ha) of the LAA. The Project is estimated to result in a loss of 0.3 ha of suitable habitat for this species, resulting in 0.01% loss within the LAA. Greater yellowlegs have been identified to be associated with three P-ELC habitats (open wetlands, waterbodies, ocean), which account for 24.6% (3,800.1 ha) of the LAA. The Project is estimated to result in a loss of 11.4 ha of suitable habitat for this species, resulting in 0.34% loss within the LAA. General shorebird habitat (combining habitat requirements for the two species) accounts for 3,802.2 ha (24.6%) within the LAA, and the Project is expected to impact 0.3% of suitable habitat for the passerines as a functional group within the LAA, with a predicted negligeable magnitude of impact.

Species at Risk (SAR)

Canada warbler, olive-sided flycatcher, evening grosbeak and wood thrush habitat are anticipated to be directly impacted by the Project.

Canada warblers are associated with five P-ELC habitats (mixedwood forested swamps, softwood forested swamps, hardwood forested swamps, cutover swamps, alder swamps), which occupies 3,323.6 ha (21.5%) of the LAA and the Project is expected to directly impact 104.3 ha (3.1%). One CAWA observation occurred near WL17, which is proposed to be directly impacted by the organics stockpile. WL17 is also impacted by the culvert water management, haul road, northwest WRSA, ditches, central settling pond.

Olive-sided flycatchers are associated with six P-ELC habitats (mixedwood forests, mixedwood forested swamps softwood forests, softwood forested swamps, barrens, open wetlands), which occupies 10,494.5 ha (67.9%) of the LAA and the Project is expected to directly impact 344.0 ha (3.3%). One observation of olive-sided flycatcher was observed near WL17 and adjacent to a cutover and softwood forests, which is proposed to be directly impacted by the northwest waste rock pile. WL17 is also impacted by the culvert water management, haul road, northwest WRSA, ditches, central settling pond and organics stockpile.

Evening Grosbeaks are associated with three P-ELC habitats (mixedwood forest, softwood forest, anthropogenic), which occupies 6,198.4 ha (40.1%) of the LAA, and the Project is expected to directly impact 287.9 ha (4.6%). One observation of evening grosbeak occurred on a road surrounded by softwood forest, which is proposed to be directly impacted by the West Pit.

Wood thrush are associated with two P-ELC habitats (mixedwood forests, hardwood forests), which occupies 11,276.7 ha (8.3%) of the LAA and the Project is expected to directly impact 80.0 ha (6.3%). Using these four SAR avifauna species as representative species for SAR, SAR habitat accounts for 11,900.0 ha (77.0%), and the Project is expected to impact 3.4% of the LAA.

Habitat that supports several SAR and SOCI avifauna species observed within the PA (Section 5.9.3.3) are expected to be directly impacted by the Project. Predicted impacts to these species' habitat are represented by their associated bird group (e.g., American kestrel habitat within the LAA is captured in the diurnal raptor group).

Table 5.9-25 Avifauna Habitat within the LAA, Predicted Habitat Loss and Magnitude of Effects

Bird Group	Representative Species	Direct impacts to Habitat (ha)[1]	Habitat within the LAA (ha)	% of Habitat within the LAA Directly Impacted by the Project	Magnitude of Impacts within the LAA[1]
Passerines	White-throated sparrow	299.3	9,491.2	3.2	Low
	Common yellowthroat	90.0	3,423.9	2.6	Low
	General Passerine	386.2	12,523.8	3.1	Low
Waterfowl	Canada Goose	11.4	2,524.3	0.5	Negligible
	American Black duck	11.4	2,530.8	0.5	Negligible
	General Waterfowl	11.4	2,530.8	0.5	Negligible
Shorebird	Spotted Sandpiper	0.3	2,123.6	0.0	Negligible
	Greater Yellowlegs	11.4	3,800.1	0.30	Low
	General Shorebird	11.4	3,800.1	0.3	Negligible
Diurnal Raptors	Northern harrier	55.2	3,507.5	1.6	Low
	Osprey	255.5	8,347.1	3.1	Low
	General Diurnal Raptor	299.6	10,178.1	2.9	Low
Nocturnal Raptors	Barred Owl	331.4	9,864.0	3.4	Low
	General Nocturnal Raptor	331.4	9,864.0	3.4	Low
Other Landbirds	Spruce grouse	391.2	12,820.2	3.1	Low
	Northern flicker	364.5	11,621.7	3.1	Low
	General Other Land Bird	410.4	13,357.8	3.1	Low
SAR	Canada Warbler	131.0	3,417.4	3.8	Low
	Olive-sided Flycatcher	344.7	10,509.4	3.3	Low
	Wood thrush	76.3	12,65.7	6.0	Moderate
	Evening Grosbeak	263.3	6,142.0	4.3	Low
	General SAR	410.4	11,928.6	3.4	Low

[1]Magnitude includes direct habitat loss only

5.9.6.2.2 Direct Loss of Terrestrial Fauna Habitat due to Project Footprint

Direct loss to terrestrial fauna habitat which has potential to provide foraging, hunting, protection, and breeding for terrestrial fauna species will occur primarily during the construction phase of the Project. The current conditions of the PA consist of fragmented habitats and historical and current timber harvesting, roads and mining and intact forests. The Project activities will result in habitat loss, fragmentation, and decreased habitat quality, and the interior forest condition (Section 5.9.6.2.4).

The Project will result in impacts to habitat that support large mammals (including mainland moose), semi-aquatic mammals (e.g., beaver), small mammals (e.g., red squirrel), terrestrial herpetofauna (e.g., garter snake), aquatic/semi-aquatic herpetofauna (e.g., snapping turtles) and bats (e.g., little brown myotis). The Project is expected to directly impact habitat of all terrestrial taxa assessed, with certain groups experiencing higher relative loss than others. Magnitude of direct impacts to terrestrial fauna range from negligeable to low. Bat roosting and terrestrial herpetofauna species are predicted to have the greatest impact from the Project (3.5-3.7%) but the magnitude of direct impacts is low. Predicted terrestrial fauna habitat loss per assessed group is described below.

Large Mammals

White-tailed deer habitat is associated with 14 P-ELC habitats (mixedwood forests, mixedwood forested swamps, softwood forests, softwood forested swamps, hardwood forests, hardwood forested swamps, cutover stands, cutover swamps, barrens, open wetlands, alders, alder swamps, waterbodies, anthropogenic), which account for 91.9% (14,214.0 ha) of the LAA. The Project is estimated to result in a loss of 410.7 ha of suitable habitat for this species, resulting in (2.9%) loss within the LAA. American black bear use the same P-ELC habitats identified, and the same predicted habitat loss as white-tailed deer is expected for this species. General large mammal habitat (combining habitat requirements for the two species) accounts for 14,214.0 ha (91.9%) of the LAA, and the Project is expected to impact 2.9% of suitable habitat large mammals as a group within the LAA, with a predicted low magnitude of impact.

Semi-Aquatic Mammals

River otters are associated with three P-ELC habitats (waterbodies, open wetlands, ocean), which account for 24.6% (3,800.1 ha) of the LAA. The Project is estimated to result in a loss of 11.4 ha of suitable habitat for this species, resulting in (0.3%) loss within the LAA. American beavers are associated with two habitats (open wetlands, waterbodies), which accounts for 16.3% (2,524.3 ha) of the LAA. General semi-aquatic mammal habitat (combining the habitat requirements for the two species), accounts for 3,800.1 ha (24.6%) within the LAA, and the Project is expected to impact 0.3% of suitable habitat for semi-aquatic mammal group within the LAA, with a predicted negligible direct impact.

Small Mammals

Porcupines are associated with eleven P-ELC habitats (mixedwood forests, mixedwood wet forests, softwood forests, softwood wet forests, hardwood forests, hardwood wet forests, cutover stands, open wetlands, alders, alder swamps, anthropogenic), which account for 84.5% (13,061.4) of the LAA. The Project is estimated to result in a loss of 405.5 ha of suitable habitat for this species, resulting in 3.1% loss within the LAA. Porcupines are associated with eleven P-ELC habitats (mixedwood forests, mixedwood wet forests, softwood forests, softwood wet forests, hardwood forests, hardwood wet forests, cutover stands, open wetlands, alders, alder swamps, anthropogenic), which account for 82.0%% (12,670.1) of the LAA. The Project is estimated to result in a loss of 402.4 ha of suitable habitat for this species, resulting in 3.2% loss within the LAA. General small mammal habitat (combining the habitat requirements for the two species) accounts for 13,061.4 ha (84.5%) within the LAA, and the Project is expected to impact 3.1% of suitable habitat for small mammals within the LAA, with a predicted low magnitude of direct impacts.

Terrestrial Herpetofauna

The representative species for terrestrial herpetofauna was the garter snake. Garter snakes, and therefore the general terrestrial herpetofauna habitat, are associated with eleven P-ELC habitats (mixedwood forests, mixedwood wet forests, softwood forests, softwood wet forests, hardwood forests, hardwood wet forests, cutover stands, cutover swamps, alders, alder swamps, anthropogenic), which occupies 11,384.9 ha (73.6%) of the LAA, and the Project is expected to directly impact 394.3 ha (3.5%). The Project magnitude of direct impacts to terrestrial herpetofauna habitat is predicted to be low.

Semi-Aquatic/Aquatic Herpetofauna

Green frogs are associated with six habitats (mixedwood forested swamps, softwood forested swamps, hardwood forested swamps, open wetlands, alder swamps and waterbodies) which account for 35.9% (5,550.4 ha) of the LAA. The Project is estimated to result 1.4% habitat loss within the LAA for this species. Snapping turtles are associated with two P-ELC habitats (waterbodies, anthropogenic), which account for 8.96% (1,385.3 ha) of the LAA. General semi-aquatic herpetofauna habitat (combining the habitat requirements for the two species) accounts for 6088.0 ha (39.4%) within the LAA, and the Project is expected to impact 1.9% of suitable habitat for semi-aquatic/aquatic herpetofauna within the LAA, with a predicted low magnitude of direct impacts.

Bats

The two representative species for bats are little brown myotis and hoary bat. Both the little brown myotis and hoary bat are associated with seven P-ELC habitats (mixedwood forests, mixedwood wet forests, softwood forests, softwood wet forests, hardwood forests, hardwood wet forests, anthropogenic), which occupies 9,553.9 ha (61.8%) of the LAA, and the Project is expected to directly impact 350.3 ha (3.7%). Using these species as representative species for bats, bat habitat accounts for 9,553.9 ha (61.8%) of the LAA, and the Project is expected to directly impact 350.3 ha (3.7%) of the IAA. The Project magnitude of direct impact to bat habitat is predicted to be low.

Table 5.9-26 Terrestrial Fauna Habitat within the LAA, Predicted Habitat Loss and Magnitude of Effects

Terrestrial Fauna	Representative Species	Direct impacts to Habitat (ha)[1]	Habitat within the LAA (ha)	% of Habitat within the LAA Directly Impacted by the Project	Magnitude of Impacts within the LAA[1]
Large Mammal	White-tailed Deer	410.7	14,214.0	2.9	Low
	American Black Bear	410.7	14,214.0	2.9	Low
	General Large Mammal	410.7	14,214.0	2.9	Low
Semi-Aquatic Mammal	Beaver	11.4	2,524.3	0.5	Negligible
	River Otter	11.4	3,800.1	0.3	Negligible
	General Semi-Aquatic Mammals	11.4	3,800.1	0.3	Negligible
Small Mammal	American Red Squirrel	405.5	13,061.4	3.1	Low
	Porcupine	402.4	12,670.1	3.2	Low
	General Small Mammal	405.5	13,061.4	3.1	Low
Terrestrial Herpetofauna	Garter Snake	394.3	11,384.9	3.5	Low
	General Terrestrial Herpetofauna	394.3	11,384.9	3.5	Low

Table 5.9-26 Terrestrial Fauna Habitat within the LAA, Predicted Habitat Loss and Magnitude of Effects

Terrestrial Fauna	Representative Species	Direct impacts to Habitat (ha)[1]	Habitat within the LAA (ha)	% of Habitat within the LAA Directly Impacted by the Project	Magnitude of Impacts within the LAA[1]
Semi-Aquatic/Aquatic Herpetofauna	Snapping Turtle	19.5	1,385.3	1.4	Low
	Green Frog	98.4	5,550.4	1.8	Low
	General Aquatic/Semi-Aquatic Herpetofauna	117.6	6,088.0	1.9	Low
Bats	Little Brown Myotis	350.3	9,553.9	3.7	Low
	Hoary Bat	350.3	9,553.9	3.7	Low
	General Bat	349.2	9,553.9	3.7	Low
[1]Magnitude includes direct loss only.					

Mainland Moose

The PA encompasses habitat for moose foraging, shelter and thermoregulation in the winter and summer months, and calving (Section 5.9.5.3.2). The Project is expected to directly impact winter and summer cover and summer and winter forage (Figure 5.9-8). Gold Brook Lake has been identified as calving habitat but direct impacts to this lake are not anticipated. It is likely that although this habitat will not be directly lost, sensory disturbances from the Project (i.e., noise and light) will result in avoidance and making the habitat not available for moose (Section 5.9.6.2.6). It is predicted that 17.2 ha (4.6% and 3.5%) of winter and summer cover for moose will be directly lost by the Project and summer forage (35.7 ha; 2.8%) and winter forage (35.7 ha; 3.0%) habitat is predicted to be directly impacted by the Project. The overall magnitude of direct impact to moose habitat is low within the LAA.

This loss of habitat could result in changes of moose movement to other suitable habitats located in the LAA (Section 5.9.6.2.4). Although habitat will be lost, as shown in Table 5.9-27, overall, only a small portion (2.6%) of modeled habitat is expected to be impacted. Calving areas are found in the north, south, east, and west of the PA as well as winter and summer cover, and summer and winter forage. Although changes to movement of moose within the LAA will likely occur due to the Project, habitat availability within the LAA is abundant and widespread. Due to mainland moose having large home ranges, it is expected that adjacent habitats within the LAA will provide suitable habitat and meet the seasonal requirements for moose.

As described in Section 5.9.5.3.2, the moose modelling is expected to underpredict available habitat and represents high quality habitat only. General mainland moose habitat (including moderate and high-quality habitat) may be better represented by the large mammal habitat predictions. Although direct loss to moose habitat is expected, at the broader scale of the LAA, the magnitude of direct impacts to moose is predicted to be low.

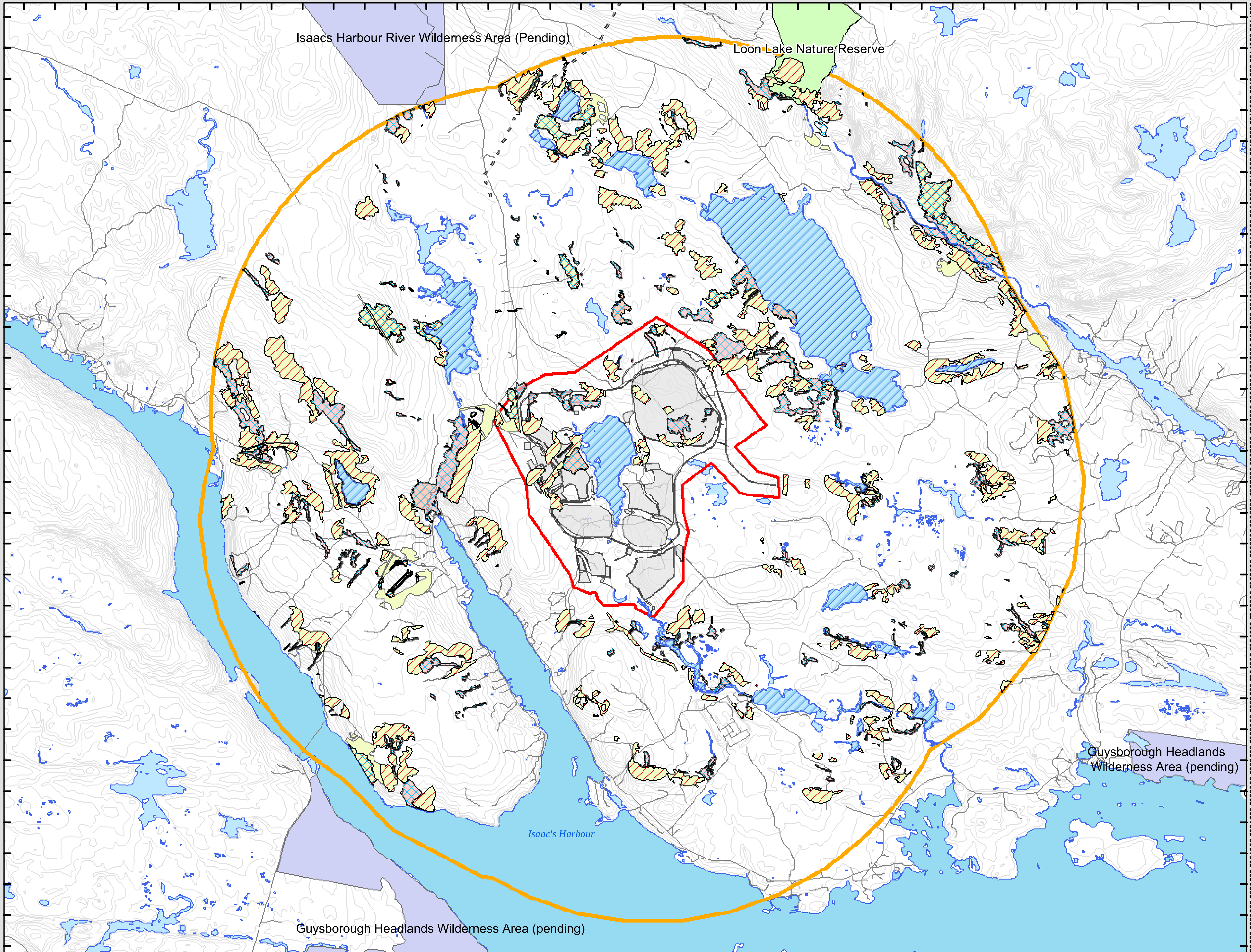

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FIGURE 5.9-8

Moose Habitat Areas

Goldboro, NS

- Summer Forage Area (S1A)
- Winter Forage Area (S1B)
- Winter Cover (S2)
- Summer Cover (S3)
- Calving Area (S4)
- Nova Scotia Existing Protected Areas
- Project Infrastructure
- Terrestrial Environment LAA
- Project Area
- Nova Scotia Protected Areas (Pending)

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 750 1,500 3,000 m

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Reviewed By: LP

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McCallum Environmental Ltd.

Document Name: 220419_Moose_Areas

Table 5.9-27 Moose Habitat within the LAA, Predicted Habitat Loss and Magnitude of Effects

	Habitat Types	Direct impacts to Habitat (ha)1	Habitat within the LAA (ha)	% of Habitat within the LAA Directly Impacted by the Project	Magnitude of Impacts within the LAA
Moose Habitat Requirements	Winter Cover	17.2	375.2	4.6	Low
	Summer Cover	17.2	497.0	3.5	Low
	Summer Forage Area	35.7	1,263.0	2.8	Low
	Winter Forage Area	35.7	1,174.9	3.0	Low
	Calving Area	0.0	755.0	0.0	Negligible
Total Modelled Habitat		**105.8**	**4,065.1**	**2.6**	**Low**

5.9.6.2.3 Mortality Risk to Wildlife Species

Direct mortality of wildlife species could result from Project activities, particularly due to the increase in traffic during construction and operation of the Project. Increased traffic within the PA could potentially increase the risk of wildlife and vehicle collisions.

According to Fahrig and Rutwinski (2009), road construction can have greater impacts on amphibians and reptiles, and large mammals, compared with small mammals and birds. Road infrastructure and traffic have a negative impact on those species which are attracted to roads but lack the speed or reaction time to avoid traffic (e.g., turtles attracted to gravel roadsides for nesting). Small mammals and birds are generally able to avoid collisions with vehicles. Amphibians can benefit from culvert installation where wetlands and watercourses intersect roads, as an alternative to crossing the roads, because this group can experience high mortality (Bouchard et al. 2009).

The TMF may attract migratory bird species dependent on waterbodies (i.e., waterfowl, waterbirds and shorebirds) during operations. Hudson and Bouwman (2018) found that multiple species were utilizing the shoreline of the TMF and exhibiting normal feeding behaviours, which could result in an increased mortality risk by the ingestion of tailings. However, mitigations such as bird deterrents may be proposed to reduce avifauna using TMF as stopover and foraging sites.

There is potential that Project infrastructure may attract certain species for nesting. Barn swallows often construct nests in anthropogenic structures such as buildings and under bridges, and bank swallows may nest along soil stockpiles with steep slopes. Generalist bird species such as crows and ravens may nest on structures and equipment not being used. The changes in the overall landscape and habitat, can result in changes in wildlife and increased risk in mortality. In the closure phase, avifauna species which have utilized structures for nesting may result in direct mortality.

5.9.6.2.4 Indirect impacts to Wildlife due to Habitat Fragmentation and Interior Forests

Direct habitat loss can result in several indirect impacts including edge effects, fragmented habitats, loss of connectivity and interior forests and ultimately species behavioural changes and movements across the landscape.

Connectivity can be defined as the basic ecological requirement to be able to move freely within areas that provide critical functions for a species, and habitat fragmentation is the disturbance of this movement. Connectivity is critical for maintaining biodiversity and healthy species populations and interior forests are often an important feature that supports this movement (NSDNR, 2015b).

Interior forests, as defined in Section 5.9.5.3, provide refuge and shelter to species from disturbances. These habitats have a particular important role for avifauna species that are dependent on the interior forest condition. The Project is predicted to impact between 3.6 to 6.5% of predicted interior forests as described in further detail in Section 5.9.6.1.2. Overall impact to interior forests is of a low magnitude based on the availability of predicted interior forest modelled at the LAA spatial boundary.

Common migratory avifauna species that are dependent on interior forest habitats for at least part of their lifecycle include: ovenbird, wood thrush, hermit thrush, magnolia warbler, black-throated green warbler. Project related activities have potential to impact priority avifauna species that require interior forests for reproduction, forage and/or protection. The priority interior forest species observed in the PA and the priority species are listed below**Error! Reference source not found.**.

Table 5.9-28 Interior Forest Birds Observed or Has Potential to Occur within the PA

Common Name	COSEWIC	SARA	NSESA	S Rank	Habitat Requirements
Bay-breasted Warbler	-	-	-	S3S4B	Coniferous and mixedwood forests
Black-backed Woodpecker	-	-	-	S3S4	Softwood forests
Black-billed Cuckoo	-	-	-	S3B	Large, dense forests, prefers dense vegetation cover during migration
Black-throated Green Warbler	-	-	-	S5B	Softwood Forests
Blackpoll Warbler	-	-	-	S3S4B	Breeds in softwood forests
Boreal Chickadee	-	-	-	S3	Mature, coniferous forests
Canada Jay	-	-	-	S3	Mixedwood and softwood forests
Canada Warbler	SC	T	E	S3B	Dense understory of vegetation in mature mixedwood forests
Evening Grosbeak	SC	SC	V	S3S4B, S3N	Mature, open mixedwood forests
Magnolia Warbler	-	-	-	S5B	Softwood Forests
Oven Bird	-	-	-	S5B	Softwood or Mixedwood Forests
Pine Grosbeak	-	-	-	S2S3B, S5N	Breeds in softwood forests, overwinters in hardwood to softwood forests
Pine Siskin	-	-	-	S2S3	Open coniferous forests, mixed forest and deciduous forests
Pine Warbler	-	-	-	S1B	Pine and mixed pine-deciduous forests
Red Crossbill	-	-	-	S3S4	Softwood forests
Wood Thrush		T		SUB	Mixedwood forests
Red-breasted Nuthatch	-	-	-	S3	Deciduous and coniferous forests
Ruby-crowned Kinglet	-	-	-	S3S4B	Softwood and mixedwood forests, taller, older stand

Table 5.9-28 Interior Forest Birds Observed or Has Potential to Occur within the PA

Common Name	COSEWIC	SARA	NSESA	S Rank	Habitat Requirements
Rusty Blackbird	SC	SC	E	S2B	Wet coniferous forests, rely on wooded wetlands during migration
Scarlet Tanager	-	-	-	S2B	Large hardwood forest tracts primarily during breeding season
Swainso's Thrush	-	-	-	S3S4B	Closed canopy forests with dense understory
Hermit Thrush	-	-	-	S5B	Closed canopy forests with dense understory
Yellow-bellied Flycatcher	-	-	-	S3S4B	Conifer forests and wetlands, deciduous forests and thickets during migration

Habitat fragmentation can result in changes of wildlife use and movement of a species (Blume et al., 2015). Road density has been identified as an excellent indicator of ecological integrity and potential predictor of habitat suitability for large mammals, like moose, as roads are closely correlated with human development (Snaith et al., 2002). Mainland moose are particularly susceptible to habitat fragmentation as it constrains their movement and habitat use, while increasing other pressures like predator and human interference (Snaith et al., 2002). Snaith et al. (2002) found that road density had a significant negative correlation with the probability of mainland moose observations in NS, and potentially more indicative of habitat selection than habitat composition alone.

Blum et al. (2015) reports avoidance of highly disturbed portions of a gold mine by mule deer (*Odocoilus heminous*) during migration. This avoidance can result in large mammals taking longer migratory paths, and thus resulting in an increased energy expenditure and potential fitness consequence.

As shown in literature, changes to wildlife movement due to the Project are expected by habitat fragmentation and loss of interior forests. The loss of habitats required for the survival of moose (i.e., summer and winter cover, summer and winter forage) by the Project will occur, and Project activities around Gold Brook Lake (including sensory disturbances) will likely result in avoidance by large ungulates (moose and deer) and other wildlife. These fragmented habitats will result in changes in wildlife movement across the LAA. With respect to moose in particular, the direct loss of habitats required for their survival, will result in moose requiring alternative habitats. As described in Section 5.9.6.2.2, however, these habitats are widespread across the LAA, and the magnitude of impacts to moose habitat is expected to be low.

As Blum et al. (2015) described above, the Project footprint and conjunction with sensory disturbances (Section 5.9.6.2.6), will likely be avoided by moose and deer, which may result in longer paths taken by ungulates and wildlife in general, to reach suitable habitat. Connectivity of movement from the PA and adjacent areas to Loon Lake Nature Reserve and the pending Isaacs Harbour River Wilderness Area (Figure 5.9-8), located over 4.4 km north of the PA may also be affected by the Project. If mainland moose were to migrate from suitable habitat south of the Project to the north, the Project would result in a reduction of connectivity for moose to travel. However, alternative routes, east and west of the Project could be used as travelling corridors by moose and other wildlife to access these nature reserves and wilderness areas. Although direct impacts to moose and other wildlife habitat are expected, the low human activities (3.58% urban/developed including the Project), and suitable forested areas within the LAA could provide alternative wildlife corridors and provide connectivity to habitats in the north and south of the LAA as well as Loon Lake Nature Reserve and Isaacs Harbour River Wilderness Area (pending).

Based on the biophysical surveys conducted from 2017 to 2021, limited moose sign was observed and there is no evidence that suggests the LAA supports concentrations of moose. Therefore, impacts to moose populations are predicted to be low.

Loss of interior forests will result in displacement of species and will result in changes to wildlife movement as described above. Interior forest availability will be reduced within the LAA and abundance of habitat will decrease, however, availability of habitat is present across the LAA as described in detail through Section 5.9.6.2.2 and, it is likely avifauna species and other wildlife that require the interior forest condition for survival, will inhabit these locations in the LAA during the life of the mine. It is predicted the magnitude of impact to interior forests to be low.

For some species (e.g., porcupine), the construction can be beneficial by providing new foraging opportunities, while species that rely on interior forest conditions (e.g., fisher) are likely to avoid areas with new construction in favour of more undisturbed habitats. Local level changes in abundance and distribution of species may occur as the result of Project activities.

In the reclamation phase, a positive effect to the terrestrial environment may occur, and the revegetation and rehabilitation may result in increased habitat availability and could result in wildlife using and moving through the PA. Although the habitat quality and quantity will not be the same as baseline conditions, useable habitat for a variety of fauna species will be available and with time, will mature and provide more complexity of habitats for all wildlife. Shortly after closure, the PA will likely consist of low-lying vegetation, primarily herbaceous and shrubs, which could provide foraging habitat for species, particularly moose and deer. Gold Brook Lake would also be available for habitat use by wildlife species as there will be no expected Project-related sensory disturbance from this phase (other than when actively reclaiming the site). Over time, the landscape will also likely consist of shrubs and trees and there may be more stand heterogeneity to provide habitats for avifauna species and other wildlife. Mature forested landscapes would take much longer to develop (50 to 70 years), and it is difficult to predict whether interior forests will be restored. Signal Gold is committed to working with local community groups, Mi'kmaq of Nova Scotia, and other interested parties to explore reforestation opportunities during active reclamation, including evaluating partnerships with Forests without Borders or a similar organization, to help facilitate faster maturity of the habitat quality during the closure phase.

5.9.6.2.5 Indirect impacts to Wildlife due to Habitat Fragmentation and Interior Forests Summary

Indirect effects to habitat loss, including habitat fragmentation, edge effects and loss of interior forests and changes in wildlife movement and habitat usage is expected. Due to the low developed/urban land cover identified in the LAA (3.58% urban/developed including the Project) and a variety of different habitat types identified in the P-ELC, alternative available habitat is present within the LAA for wildlife species. The overall magnitude of impacts, considering the reclamation of the Project, is low. Connectivity to the Loon Lake Nature Reserve and Isaacs Harbour River Wilderness Area (pending) is present within the LAA, although, movement patterns from these areas south of the PA may change due to the Project. Reclamation of the Project will restore some of the baseline habitat, however, not all habitats will likely be restored to the baseline conditions. In early stages of reclamation, low-lying herbaceous and shrub species may exist and will likely provide suitable foraging habitat for moose, deer and other wildlife species. As time progresses, and vegetation communities shift and change, heterogenic stands of trees and shrubs can provide more complex habitats for avifauna and other species.

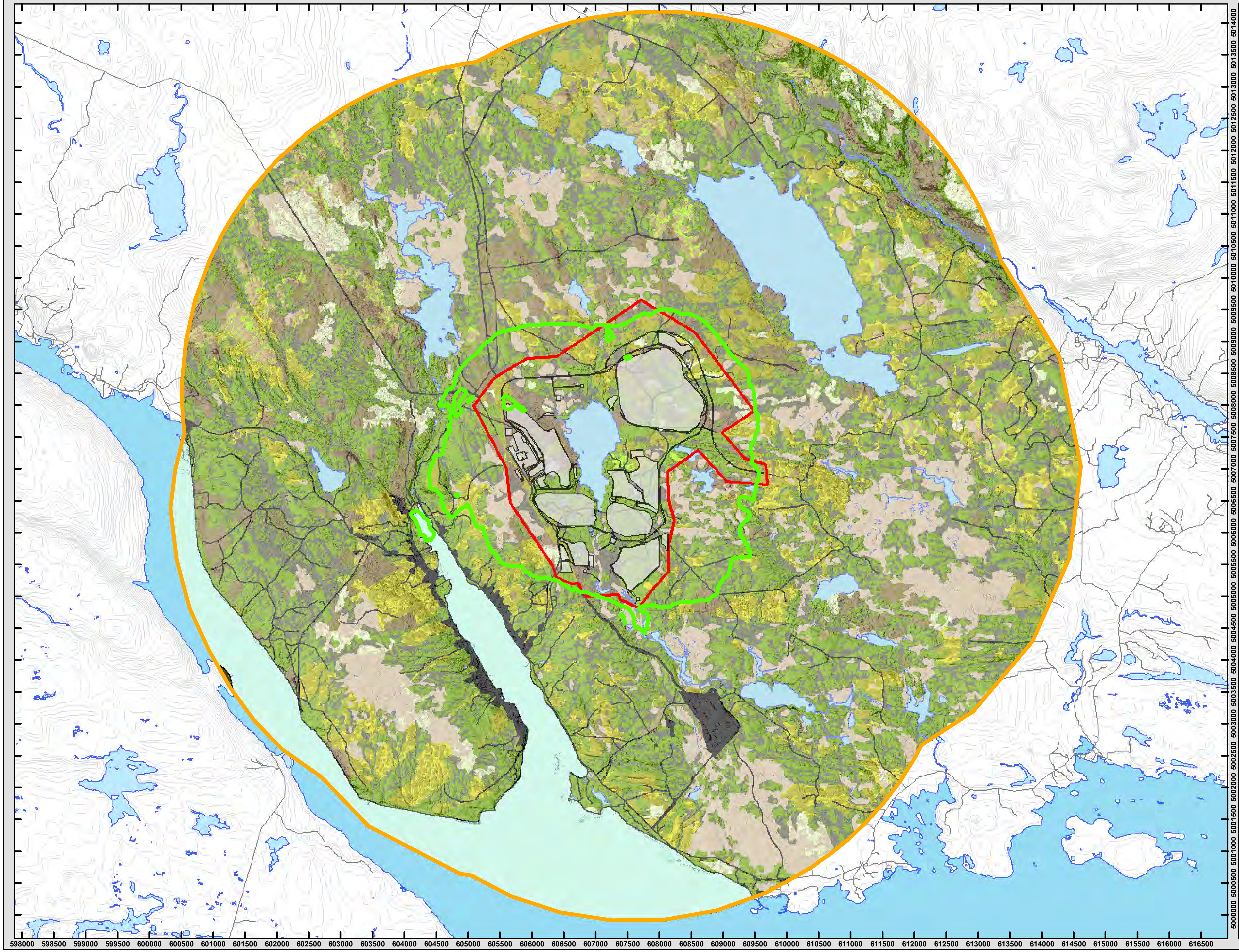
5.9.6.2.6 Indirect Impacts to Wildlife due to Sensory Disturbance

The indirect effects of the Project to wildlife can largely be attributed to decreased habitat quality through sensory disturbance, especially noise and light. Sensory disturbance will result from rock blasting, clearing and grubbing, infrastructure construction, lighting and operations, and internal mine traffic. This along with other construction, operational and closure (active reclamation) activities will increase sensory disturbance and will, as described above, reduce the habitat quality for some species.

Sensory disturbance will likely result in the localized wildlife avoidance of the PA. Overall, Project activities will likely cause a change in usage of the PA by wildlife, with some species tending to avoid the area, while others may be attracted to the increased activity, including opportunistic species such as coyotes, raccoons, skunks, or black bears.

Noise

Changes to ambient noise levels and presence of periodic vibrations from blasting have the potential to adversely affect wildlife migration patterns and behaviour. Modelling completed (Section 5.3) predicted noise levels of 55 dBA are expected within the PA and 45 dBA at 1.3 km distance from the Project. Background levels of 26 dBA are expected approximately 8 km from the Project. Zones within noise of 45 – 55 dBA are areas with a higher likelihood to impact wildlife and their habitat (Figure 5.9-9). This area near the mine site may observe a change or decline in wildlife throughout the life of the mine due to elevated noise levels.



Prepared For:

SIGNAL GOLD

FIGURE 5.9-9

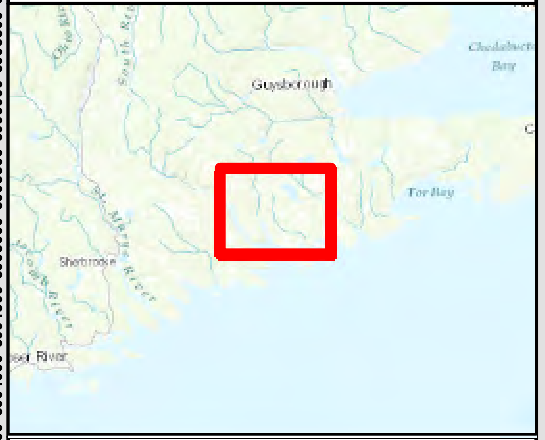
Noise Modeling and the Terrestrial Environment

Goldboro, NS

Noise Model - (45dBA)
Terrestrial Environment LAA
Project Infrastructure

P-ELC Habitat Classification

Alder
Barrens
Cutover/Regen... Forests
Hardwood Forests
Mixedwood Forests
Ocean
Open Wetlands
Softwood Forests
Urban/Developed
Waterbodes
Alder Swamp
Cutover/Regen... Swamp
Hardwood Forested Swamps
Mixedwood Forested Swamps
Softwood Forested Swamps
Project Area



Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 750 1,500 3,000 m

1:55,000 Scale when printed @ 11" x 17"

Drawn By: JG
Reviewed By: MM

Date: 2022-04-08

McCallum Environmental Ltd.

Document Name: 220401_Sound_Overview

Noise above 55 dBA during the day and 45 dBA at night-time have been shown to cause physiological stress and behavioural changes to wildlife (Environment Canada 2012). Changes in avifauna song characteristics, reproduction, abundance, stress levels and species richness when sound levels commenced at greater than 45 dBA have been documented. Noise pollution from the Project can result in behavioural changes, lead to changes in wildlife communities and alter species interactions (Francis et al, 2009; Patthey et al, 2008). It was also found that noise tolerant species had increased avifauna nest success through decreasing nest predation (Francis et al, 2009). Conversely, noise can affect the efficiency of landbirds to find breeding partners (Barber et al. 2010).

Impacts can also differ between acute and chronic noise sources. Chronic exposure may degrade auditory cues, feedback, and vocal development over time, which is important for predator/prey detection, communication and orientation (Shannon et al., 2016; Bickley and Patricelli, 2010; Marler et al., 1973). A direct physiological impact causing a temporary decrease in auditory sensitivity can occur at acute noise levels above 93 dBA, while permanent damage to avian auditory systems is not recorded until 125 to 140 dBA (Bickley and Patricelli, 2010). Routine Project operations are not predicted to reach these noise levels. Flydal et al. (2001) observed that sounds at 46 dBA and 60 dBA elicited responses in caribou and reindeer, respectively. While Drolet et al. (2016) report no changes to density of white-tailed deer when a simulated drilling noise was played at 55 to 65 dBA. A literature review conducted by Shannon et al. (2016) found that an increase in stress and decrease in reproductive success in terrestrial mammals has the potential to occur at noise levels ranging from 52 to 68 dBA. Levels from these studies are higher than those cited by Environment Canada (2012).

Vibrations from blasting has potential to result in disturbance of hibernating species such as American black bear and species of bats. The vibrations, if strong enough, could result in the collapse of hibernacula. Vibrations from blasting could also result in the disruption of the hibernation of these species during the winter months and burning limited fat reserves (West Virginia Department of Environmental Protection, 2006). Baseline bat surveys (Section 5.9.3.2.2) involved visiting AMOs to identify potential bat hibernacula within a 5 km radius and none were observed. Therefore, impacts from blasting to bat hibernacula is not expected.

Light

Light emissions from the Project have been modelled and details are provided in the Light Impact Assessment (Section 5.2). Although the calculated light levels are below the limits recommended by the Institute of Light Engineers (ILE) guidelines, light emissions from the Project still have potential to indirectly impact wildlife. The Light Impact Assessment shows that light is estimated to reach approximate background levels (0.1 Lux) at 4,073 m from the Project. Increased risk of impacts to wildlife from light is primarily in the construction and operation phase.

Light is fundamental for the survival of most flora and fauna species, and is crucial for the orientation, development, vision and adaption to diurnal and seasonal changes (Jagerbrand and Bouroussis, 2021). Artificial light can disrupt the circadian rhythm and behaviour of a species and impact foraging or hunting success, reproduction and vocalization of wildlife (including avifauna species) (Langcore and Rich, 2004; Da Silva et al., 2014). These potential impacts could ultimately influence the individual fitness or reproductive success of species (Da Silva et al., 2014).

Artificial light has the potential to attract species or prevent them from interacting with the Project. Small mammals, including mice, have been shown to avoid artificially lit areas. Conversely, bats have been documented feeding around artificial lights, which attract flying insects (ECCC, 2015).

Effects on light and wildlife are well documented, however, artificial light thresholds (e.g., duration, intensity, spectrum etc.) are not well defined. Light is traditionally quantified from human perception, which only accounts for a small percentage of the full spectrum of light perceived by other organisms (Schroer and Holker, 2016). Light perception of an organism is specific to its niche requirements and activity patterns (Schroer and Holker, 2016). For example, human vision has evolved to survive diurnal activity, and thus vision is specialized in daylight vision but limited in low-light visual cues (Schroer and Holker, 2016), conversely, Ultraviolet (UV) light, which is invisible to humans, is visible by avifauna species, and has a role in foraging and prey detection (Rajchard, 2009).

Wildlife is generally more sensitive to short, high-energy UV/violet/blue wavelengths, particularly nocturnal species. Short wavelength light also scatters more in the atmosphere than long wavelength light, increasing the effects of sky glow (DEE, 2020; Pauwels, 2018). Yellow-orange light is typically associated with long wavelength lights (e.g., High Pressure Sodium, Low Pressure Sodium, Amber LED).

Light impacts from the Project have been modelled in the Light Impact Assessment (Appendix D.4) show that, impacts from light are more likely to occur within 1,288 km of the Project, with modelled illumination of 1 lux (equivalent to moonlight). Background levels (0.1 lux) are expected to occur 4,073 m from the Project. Distances of impact may vary based on the type of lighting used, for example, lighting with blue shortwaves (e.g., LEDs, metal halides) show greater impacts to fauna at night then lighting with less blue shortwaves (DEE, 2020; Pauwels, 2018). Mitigations proposed to reduce impacts to the terrestrial environment is described in Section 5.9.8.

5.9.6.2.7 Indirect Impacts to Wildlife by Sensory Disturbance Summary

In summary, sensory disturbance (noise and light) to wildlife is expected to occur by the Project, however, how a species may respond to this disturbance is often species or species group specific. An overall negative effect to wildlife by the Project is expected to occur as species approach the PA. This sensory disturbance, as well as noise could result in behavioural changes and changes in wildlife movement as described in further details in Section 5.9.6.2.4. Due to the proportion of the habitats proposed to be impacted by the Project and habitat availability in the LAA, available suitable habitat for many species is present. Although movement of species may change, habitats required for their survival are present within the LAA. Wildlife corridors would still exist and movement of species from north, south, east and west are present. The overall magnitude of impact to wildlife from sensory disturbances is predicted to be low and are temporary in nature.

5.9.7 Micro-siting and Sensitive Feature Considerations in the Project Design

Signal Gold has considered environmental features observed during the biophysical surveys in the final Project design. Avoidance of Species at Risk habitat, primarily SAR blue felt lichen and frosted glass whiskers lichen, was attempted wherever possible. The regulated setbacks for these two species, as described in the *At-Risk Lichens – Special Management Practices* (NSDNRR, 2018) were applied when micro-siting was possible.

In total, 225 blue felt lichen thalli and one occurrence (100+ thalli) of frosted glass whiskers were observed within the PA. The Project layout has avoided 20.9% of the observed blue felt lichen and 100% of frosted glass whiskers. Lichen surveys extended to the northeast of the PA to support earlier iterations of Project engineering and infrastructure placement. Based on this extended study area, multiple blue felt lichen thalli were also observed in this extended study area. Given that there were numerous blue felt lichen occurrences within and surrounding the PA, it is reasonable to assume that this species is relatively abundant in the local area. The project team has, nonetheless, worked to avoid the blue felt lichen wherever practical during infrastructure placement.

The ability to microsite the open pit was limited however, Signal Gold designed the pits to avoid direct disturbance of Gold Brook Lake and Gold Brook. Other infrastructure with more ability to be micro-sited (i.e., organic stockpiles, till stockpile and WRSAs) was adjusted to reduce impacts to SAR lichens under all practical scenarios. Every Project-related infrastructure was evaluated from an environmental and engineering perspective when determining the final Project layout. The location of the open pits cannot be adjusted, based on the location of the resource/host rock. The TMF is the single largest aspect of Project infrastructure and there are many factors that are considered when determining its placement including: watershed position, direct impacts to fish and fish habitat, water quantity and quality implications resulting in indirect impacts to fish and fish habitat and wetlands, noise, dust and light considerations, proximity to residences, baseline land and resource use (ATV trails, local traffic and land use), Indigenous use of the land, archaeological resources, geotechnical and other engineering considerations, dam integrity and safety, cost, and other technical considerations. MEL was contracted to undertake an alternatives assessment to optimize placement of the TMF. Thirteen sites were initially considered which were then narrowed down to four TMF locations for full multiple accounts analysis. Avoidance of impacts to SAR lichens was considered in the MAA. As a result of these multiple factors that must be considered during TMF siting, complete avoidance of blue felt lichen was difficult to achieve. See Section 2.8 for further detail on additional options considered for placement of the TMF. However, many other aspects of infrastructure have a shorter list of considerations during placement, and thus, have more ability to micro-site to avoid species at risk, especially the blue felt lichen for this Project.

The northwest WRSA was redesigned several times to reduce overall impact to blue felt lichen and its habitat. The habitat directly to the north of the final design of this WRSA, where multiple occurrences of blue felt lichen and other SOCI lichens are present, was originally included in the design. The engineering team was able to re-distribute waste rock to reduce direct impact to this habitat. Furthermore, the southern extent of this WRSA was also adjusted to avoid another occurrence of the Blue Felt Lichen and its associated setback.

The northeast WRSA was redesigned several times to reduce impacts to fish and fish habitat and blue felt lichen. The habitat to the north of the final design of this WRSA, where multiple occurrences of blue felt lichen are present within wetland habitat, was originally impacted by waste rock placement. The engineering team was able to re-distribute and increase the height of the stockpiles across the Project to avoid direct impact to this habitat and the species.

Finally, the southwestern till stockpile has also been re-designed and moved south to avoid fish and fish habitat, multiple occurrences of blue felt lichen, and associated wetland habitat. The Project team will continue to work to micro-site infrastructure to further limit impacts to blue felt lichen and other rare lichens during detailed project design and permitting, wherever practical. Detailed design has not yet been completed for aspects of this Project, including road design, so there are still opportunities to potentially avoid additional species and/or increase species setbacks.

5.9.8 Mitigation

Several management plans addressing standard mitigation measures and common practices as it relates to the terrestrial environment will be provided prior to commencement of the Project. Table 5.9-29 lists the proposed specific terrestrial environment mitigation measures to reduce overall direct and indirect impacts from the Project.

Table 5.9-29 Mitigation Measures of the Terrestrial Environment

Project Phase	Mitigation Measure
Construction, Operation	Provide wildlife awareness training to site personnel to reduce interactions between site personnel and wildlife.
	Avoidance of SAR lichen occurrences where possible and maintain 100 m setback as per At-risk Lichens SMP.
	Intact forest stands and wetlands will be avoided wherever possible during detailed Project planning and design in favour of previously disturbed areas (e.g., stands disturbed by timber harvesting, roads, or other development).
	Where natural, intact habitat cannot be avoided, maintain existing vegetation cover whenever possible and minimize overall areas of disturbance.
	Clearing of vegetation will occur outside the breeding bird window (April 15th – August 31st) where possible. If this is not possible, then nest sweeps will be completed by a qualified biologist prior to clearing. The proponent will work with NSDNRR and NSECC to develop nest sweep protocols.
	For those species reliant on wetland habitat, a wetland alteration application will be submitted during Project planning and design to request an authorization to alter wetland habitat and to address loss of wetland function, specifically lost wetland function for species at risk.
	Compensation for permanent loss of wetland function will be completed through wetland restoration activities to support no net loss of wetland function, subject to NSE approval, specifically lost wetland function for species at risk.
	Habitat fragmentation will be reduced by limiting the area of new roads, favouring upgrading of existing roads where possible instead.

Table 5.9-29 Mitigation Measures of the Terrestrial Environment

Project Phase	Mitigation Measure
	Alternatives to traditional hydroseeding methods will be reviewed to advance vegetation re-establishment and reclamation methods. Consideration will be given to native species with Indigenous significance.
	Employ measures to reduce the spread of invasive species (particularly by vehicles) into wetlands and retain habitat integrity (see Wildlife Management Plan, Appendix I.5). Inspect vehicles regularly, particularly vehicles arriving from outside the PA. If necessary, cleaning will be undertaken at a designated cleaning station, away from wetlands and watercourses.
	Monitor dust conditions and implement dust suppression mitigation (refer to air mitigation) when normal precipitation levels are not enough to suppress fugitive dust. In addition to water suppression, provincially approvable chemical dust suppressants may be used.
	Site infrastructure will be fenced in, where practical, to reduce interactions between Project infrastructure and wildlife.
	A speed limit of 40 km/hr within the Project site.
	Install signage where specific wildlife concerns have been identified. Vehicles will yield to wildlife on roads.
	Monitor and manage road conditions through dust suppression and traction control (sand on icy roads) to reduce potential for collisions with wildlife. Implement Fugitive Dust Best Management Practice Plan (Appendix D.3)
	An un-vegetated buffer along roadsides will be maintained, where possible, to improve visibility along roadsides and reduce the potential for collisions with wildlife.
	Erosion and sediment control planning will be completed to ensure site runoff is not directed towards unaltered habitat. Implement Erosion and Sediment Control Plan.
	Implement Emergency Response and Spill Contingency Plans to protect fauna and their habitat from accidental spills.
	Store hazardous and non-hazardous waste in designated locations, in appropriate containers to reduce potential for spills, and to prevent attracting wildlife (e.g., food waste in bear proof containers).
	Follow the Pit and Quarry Guidelines to reduce impact of noise and vibration on wildlife
	Limit use of lights to the amount necessary to ensure safe operation within the PA, with the recognition that excessive lighting can be disruptive to wildlife. Install lights facing downward and wherever practical using motion-sensing lights.
	Consider limiting use of lights that emit more blue shortwave light (e.g., LEDs, metal halides) which have greater impacts to wildlife at night, where practical and considering operational safety.
	Restrict blasting to a specific and regular daytime schedule during weekdays to allow time for wildlife to recover from potential noise disturbance.
	Implement Wildlife Management Plan (Appendix I.5)
	Site-specific measures to protect wildlife will be addressed in the EPP.
Closure	Implement remediation plans to restore natural habitat and food source re-establishment to support fauna
	Install signage where specific wildlife concerns have been identified. Vehicles will yield to wildlife on roads.

5.9.9 Monitoring and Follow-up

Several monitoring and management plans have been developed to assess the accuracy of the predicted environmental effects and effectiveness of the mitigation measures outlined in Section 5.9.6 and Section 5.9.8. The management and monitoring plans are in draft form and subject to modifications after consultation with NSDNRR and NSECC. The following plans have been developed as part of the Project's commitment to monitoring and mitigation of adverse effects to the Terrestrial Environment:

- Wildlife Management Plan – The primary goals of this plan is to provide strategies in reducing human-wildlife interactions, promote safety of both wildlife and site personnel and best management practices for vegetation management including invasive species management. This plan will also include a Mainland Moose monitoring plan and will occur during the duration of the construction and operation phase of the Project.
- Lichen Monitoring and Management Plan – The purpose of this plan is to monitor select occurrences of SAR lichens surrounding Project infrastructure and monitor potential indirect effects to lichens from the Project. The plan will also propose translocation as an option for blue felt lichen species that could not be avoided by infrastructure. Signal Gold will consult with NSECC and NSDNRR and adjust the specifics of the plan if necessary.
- Fugitive Dust Best Management Practices Plan – Provides details about best management practices to control potential fugitive dust emissions, as well as planned strategies for dealing with potential fugitive dust issues.
- Wetland Monitoring Plan – The monitoring of vascular plants will occur during the Wetland Monitoring Plan program. Monitoring of select wetlands proposed to be partially altered will occur during baseline/pre-construction conditions and continue through operational and closure phases (if required). The monitoring program will be focused on wetland vascular plant communities and document if any shifts in vascular plant communities or introduction of invasive species occur.

5.9.10 Residual Effects and Significance

A significant adverse effect on the Terrestrial Environment VC was defined in Section 5.9.6 as:

- A Project-related effect that is likely to cause a permanent, unmitigated, alteration to habitat that supports flora and fauna species.

Vegetation clearing and grubbing during the construction phase will result in the direct loss of habitat. The magnitude of habitat loss varies by species and their habitat requirements. However, the overall magnitude for direct loss of habitat and habitat for species is estimated to be low (<5% direct habitat loss) and summarized in Table 5.9-22 and

Table 5.9-25. The predicted residual environmental effects of the Project on the terrestrial environment have been assessed as adverse but not significant after the appropriate mitigation measures have been implemented (Table 5.9-30).

A significant adverse environmental effect for the terrestrial environment has not been predicted for the Project for the following reasons, with consideration of the ecological and social context of the LAA surrounding the Project and the results of modelling:

- During Construction:
  - Direct impacts on the terrestrial environment are expected but will be minimized through on-going Project design and micro-siting of infrastructure footprints wherever practical.
  - Based on conservative modelling, less than 5% of the suitable habitat for wildlife in the LAA will be directly impacted by Project development. Habitat loss will be mitigated in the long term through reclamation planning.
  - Construction work will be considerate of the breeding bird season wherever practical.
- During Operations:
  - Noise will be elevated above baseline during this period and may cause a displacement of wildlife species.
- During Closure:
  - Appropriate mitigation (e.g., wildlife deterrents) will be implemented to deter wildlife species from entering the TMF and open pits during operations and closure.

During closure, a positive effect to the terrestrial environment may occur, as revegetation and rehabilitation may result in increased habitat availability and could result in wildlife using and moving through the PA. Although the habitat quality and quantity will differ from baseline conditions, valuable habitat for a variety of fauna species may be available. Signal Gold is committed to working with local community groups, Mi'kmaq of Nova Scotia, and other interested parties to explore reforestation opportunities during active reclamation. This includes exploring opportunities like partnerships with Forests Without Borders or similar groups, to help facilitate accelerated maturity of the habitat during the closure phase.

Table 5.9-30 Residual Effects on the Terrestrial Environment

Project Phase – VC interaction	Mitigation and Compensation Measures	Nature of Effect	Residual Effects Characteristics						Residual Effect	Significance
			Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility		
Construction – Habitat loss from clearing and grubbing)	Limit habitat disturbance and minimize Project footprint during detailed design Reduce speed limit and implement dust control measures Maintain SAR lichen setbacks as per the At-risk Lichens SMP where practical Re-establish habitat and associated vegetation communities during closure.	A	L <5% direct loss of habitat types observed in the LAA	LAA Potential adverse effects to vegetation and vegetation communities outside the PA	A Although clearing and grubbing will occur outside the sensitive species for wildlife, other activities will not	LT Effects occur beyond 3 years	O Effects occur once during the construction phase	PR Mitigation and reclamation cannot guarantee a return to baseline conditions.	Disturbance, habitat loss	Not Significant
Construction – Sensory disturbance [noise, light, dust deposition] and wildlife vehicle collisions from construction activities)	Limit habitat disturbance and minimize Project footprint during detailed design Implement speed limits and minimize lighting, best management practices and spill preparedness	A	M	LAA Potential adverse effects to wildlife outside the PA	A Although clearing and grubbing will occur outside the sensitive species timing window for wildlife, other activities will not	MT Effects occur within 1.5 years of the construction period	R Effects occur at regular intervals during the construction phase	RE VC will recover to baseline conditions	Disturbance	Not Significant
Operations – Sensory disturbance (noise, light, dust deposition) and wildlife vehicle collisions from construction activities	Reduce speed limit and implement dust control measures Minimize lighting	A	M	LAA Potential adverse effects to wildlife outside the PA	A Although clearing and grubbing will occur outside the sensitive species timing window for wildlife, other activities will not	LT Effects may extend beyond 3 years	R Effects occur at regular intervals during the construction phase	RE VC will recover to baseline conditions	Disturbance	Not Significant
Operations – Tailings deposition	Best management practices Bird deterrent Program Implementation	A	L	PA VC interactions confined to the PA	A VC interaction may occur during sensitive period for avifauna	LT Effects may extend beyond 3 years	R VC interaction will occur at regular intervals	PR Mitigation cannot guarantee a return to baseline conditions	Creation of potential open water habitat; decreased water quality	Not Significant
Closure – Reclamation, re-vegetation	N/A	P	L Minor change from baseline conditions.	LAA Potential effects beyond the PA.	N/A VC is not expected to be affected by timing.	LT Effects extend beyond active closure phase.	O Effects occur once during the closure phase.	PR Mitigation and reclamation cannot guarantee a return to baseline conditions.	Habitat Reclamation	Not Significant

Legend (refer to Table 5.9-5 for definitions)

Nature of Effect	Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility
A – Adverse P – Positive	N – Negligible L – Low M – Moderate H – High	PA – Project Area LAA – Local Assessment Area RAA – Regional Assessment Area	N/A – Not Applicable A – Applicable	ST – Short-Term MT – Medium-Term LT – Long-Term P – Permanent	O – Once S – Sporadic R – Regular C – Continuous	RE – Reversible IR – Irreversible PR – Partially Reversible