5.6 Surface Water Resources

5.6.1 Rationale for Valued Component Selection

Surface water resources was selected as a VC for its significance to hydrological, ecological, and socioeconomic systems. Surface water provides ecological value in providing habitat for aquatic species, and terrestrial species rely on accessible water sources for their survival. Socially and economically, surface water resources are essential to municipal, agricultural, industrial, and recreational sectors, among others.

Surface water quality and quantity are provincially regulated through the NS *Environment Act* and several of its regulations. The regulations help protect ecological components, as well as the health of the public. During various Project activities there is also a potential for impacts to surface water resources to indirectly impact other VCs including wetlands, fish and fish habitat, and the Indigenous People. Findings of the MEKS completed for the Project (Appendix K.1) revealed that some Mi'kmaq traditional land use activities occur within the PA and are dependent on surface water.

5.6.2 Baseline Program Methodology

Collection of baseline surface water quantity and quality data within the PA began in August 2018 and is on-going at several locations. Surface water quantity and quality monitoring locations are presented in Figure 5.6-1. Surface water monitoring stations are summarized in Table 5.6-1. Further detail on the baseline surface water monitoring program is provided in the 2021 Surface Water Monitoring Report provided in Appendix F.3, and the Fish and Fish Habitat Baseline Report provided in Appendix H.1.

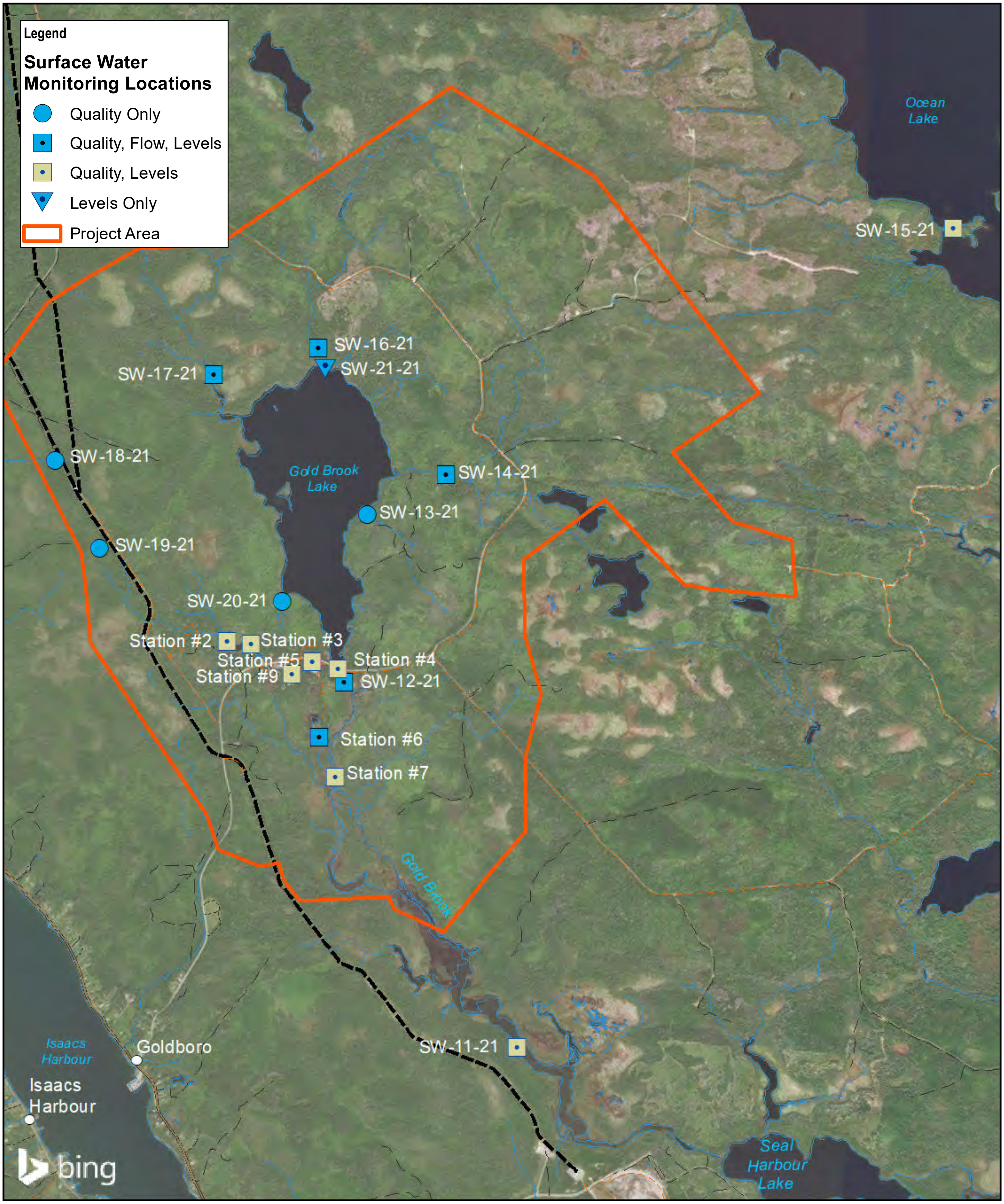
Table 5.6-1 Surface Water Monitoring Summary

Station	Monitoring Duration	Coordinates (UTM 20N)		Watercourse	Monitoring
		Northing	Easting		
Station #1	August 2018 to August 2020	5006478	606580	Mine Extraction Point	Water quality Water level Flow
Station #2	August 2018 to present	5006501	606423	Beaver Pond	Water quality Water level
Station #3	August 2018 to present	5006478	606581	Beaver Pond	Water quality Water level
Station #4	August 2018 to present	5006346	607059	Gold Brook Lake	Water quality Water level
Station #5	August 2018 to present	5006377	606950	Boston-Richardson Shaft	Water quality Water level
Station #6	August 2018 to present	5005956	606956	Settling Pond Outflow	Water quality Water level Flow
Station #7	August 2018 to present	5005731	607041	Gold Brook	Water quality Water level
Station #9	September 2018 to present	5006331	606762	Ore Stockpile Drainage	Water quality Water level

Table 5.6-1 Surface Water Monitoring Summary

Station	Monitoring Duration	Coordinates (UTM 20N)		Watercourse	Monitoring
		Northing	Easting		
SW-11-21	March 2021 to present	5004171	608085	Gold Brook	Water quality Water level
SW-12-21	March 2021 to present	5006262	607098	Gold Brook Lake and Gold Brook	Water quality (Brook) Water level (Lake and Brook) Flow (Brook)
SW-13-21	March 2021 to present	5007224	607226	WC9	Water quality
SW-14-21	March 2021 to present	5007451	607678	WC14	Water quality Water level Flow
SW-15-21	March 2021 to present	5008865	610584	Ocean Lake	Water quality Water level
SW-16-21	March 2021 to present	5008180	606951	WC22	Water quality Water level Flow
SW-17-21	March 2021 to present	5008024	606351	WC20	Water quality Water level Flow
SW-18-21	March 2021 to present	5007536	605437	WC53	Water quality
SW-19-21	March 2021 to present	5007030	605696	WC86	Water quality
SW-20-21	March 2021 to present	5006727	606742	WC8	Water quality
SW-21-21	March 2021 to present	5008058	606990	Gold Brook Lake	Water level

Ocean Lake, located northeast of the PA, was included in the baseline surface water monitoring program as it was initially evaluated as a potential water source for the Project.



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ENVIRONMENTAL ASSESSMENT

BASELINE SURFACE WATER MONITORING LOCATIONS

Project No. 11222385
Revision No. -
Date 25/05/2022

FIGURE 5.6-1

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5.6.2.1 Watercourse Identification and Characterization

Watercourse identification and characterization was completed across the PA between 2017-2021 by GEMTEC and MEL biologists. The NS *Environment Act* defines a watercourse as:

- Any creek, brook, stream, river, lake, pond, spring, lagoon, or any other natural body of water, and includes all the water in it, and also the bed and the shore (whether there is actually any water in it or not).

Qualitative assessment methods varied slightly throughout the various years of watercourse identification; however, each description included a characterization of the flow regime (perennial, intermittent, ephemeral), estimate of gradient and velocity, bankfull width, average water depth; and a description of the composition of the substrate material, habitat types, and overall cover (submergent, emergent, overhanging, etc.).

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*. Open water habitats were typically less than 2 meters (m) deep, less than 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). The term wetland mosaic is used to describe habitats where a watercourse disperses widely into wetland habitat in an undefined channel within a wetland boundary.

5.6.2.2 Surface Water Quantity

Surface water quantity monitoring has been completed in the PA since 2018 by Signal Gold and GHD. Discrete velocity measurements were monitored at five locations: SW-12-21, SW-14-21, SW-16-21, SW-17-21, and Station #6. Velocity measurements were collected using a handheld acoustic Doppler velocity meter (SonTek FlowTracker2). A transect was established at each monitoring location perpendicular to the direction of flow. The width of the stream was divided into equally spaced intervals where velocity readings and water depth were measured. Velocities were measured at 60% of the depth below the water surface, which was assumed to be equal to the average of the vertical velocity profile. A total flow was then calculated by computing the product of area and velocity using an average of the mean and mid flow calculation methods. QA/QC was conducted on all FlowTracker files.

Surface water levels were monitored at 14 locations: SW-11-21, SW-12-21, SW-14-21, SW-15-21, SW-16-21, SW-17-21, SW-21-21, stations #2 to #7, and Station #9. Staff gauges were installed at these monitoring locations and used for discrete surface water level measurements. In addition, continuous water level data from stations SW-11-21, SW-12-21, SW-14-21, SW-15-21, SW-16-21, SW-17-21, and SW-21-21 were collected at 15-minute intervals using Solinst Levelogger (M5) transducers (loggers). Logger data were downloaded during each surface monitoring event and compensated for barometric pressure, which was collected on-site using a Solinst barologger. Continuous surface water levels were corrected using the discrete water levels collected during the monitoring events.

5.6.2.3 Surface Water Quality

Surface water quality monitoring has been completed in the PA since 2018 by Signal Gold and GHD. Discrete Surface water samples were collected by grab sampling, which was conducted by dipping the sample container directly into the stream to collect surface water, unless the sample bottles contained preservatives. If the bottle contained preservatives, sterile unpreserved bottles were used to collect the sample. Samples were collected below the surface with the sample bottles completely submerged. This prevents floating debris from entering the sample bottles, which could result in unrepresentative analytical data. The water sample was then transferred to the appropriate preserved bottles.

Discrete measurements of field parameters were collected at the time of sampling and included: pH, conductivity, DO, Oxidation-Reduction Potential (ORP), turbidity, Total Dissolved Solids (TDS) and temperature. Measurements were collected using a Horiba U52 handheld water quality meter which underwent calibration prior to each sampling event.

Samples were transferred to coolers with ice immediately after they were collected and maintained in cool storage until delivered to BV in Bedford, NS. The Chain of Custody form, which was supplied by the laboratory, was filled out with the sample, time, date, and location, and was signed by field staff before being relinquished to the receiving laboratory.

Surface water samples collected at SW-11-21, SW-12-21, SW-14-21, SW-15-21, SW-16-21, SW-17-21, and SW-21-21 were analyzed for general chemistry, total and dissolved metals, mercury, and methylmercury. Samples collected at stations #2 to #7 and Station #9 were analyzed for general chemistry and total metals.

QA/QC protocols included the collection of field duplicate samples (10%). Field duplicates are incorporated as a blind method of evaluating analytical precision, field precision and sample homogeneity. One surface water field duplicate was collected on-site during each monitoring event.

5.6.3 Baseline Conditions

5.6.3.1 Watershed Characteristics

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 Brook shore direct watershed). The topography 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. The Gold Brook shore direct 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

Gold Brook Lake is the predominant feature within the Gold Brook shore direct watershed. It drains from Oak Hill Lake in the north and Rocky Lakes in the east. Gold Brook flows out of Gold Brook Lake, into Seal Harbour Lake, which has two main mapped outlets. East Brook and West Brook both flow into Warringtons Cove and Long Cove, respectively, approximately 7 km southwest of the outlet of Gold Brook Lake. Crane Lake, Hay Lake, Rush Lake and Three Corner Lake are present within the shore direct watershed as well. The watershed is largely undeveloped, and in natural condition, with the exception of historic mining activity within the PA, and the decommissioned Sable Offshore Energy facility, which is present south of the PA, west of the confluence of Gold Brook into Seal Harbour Lake.

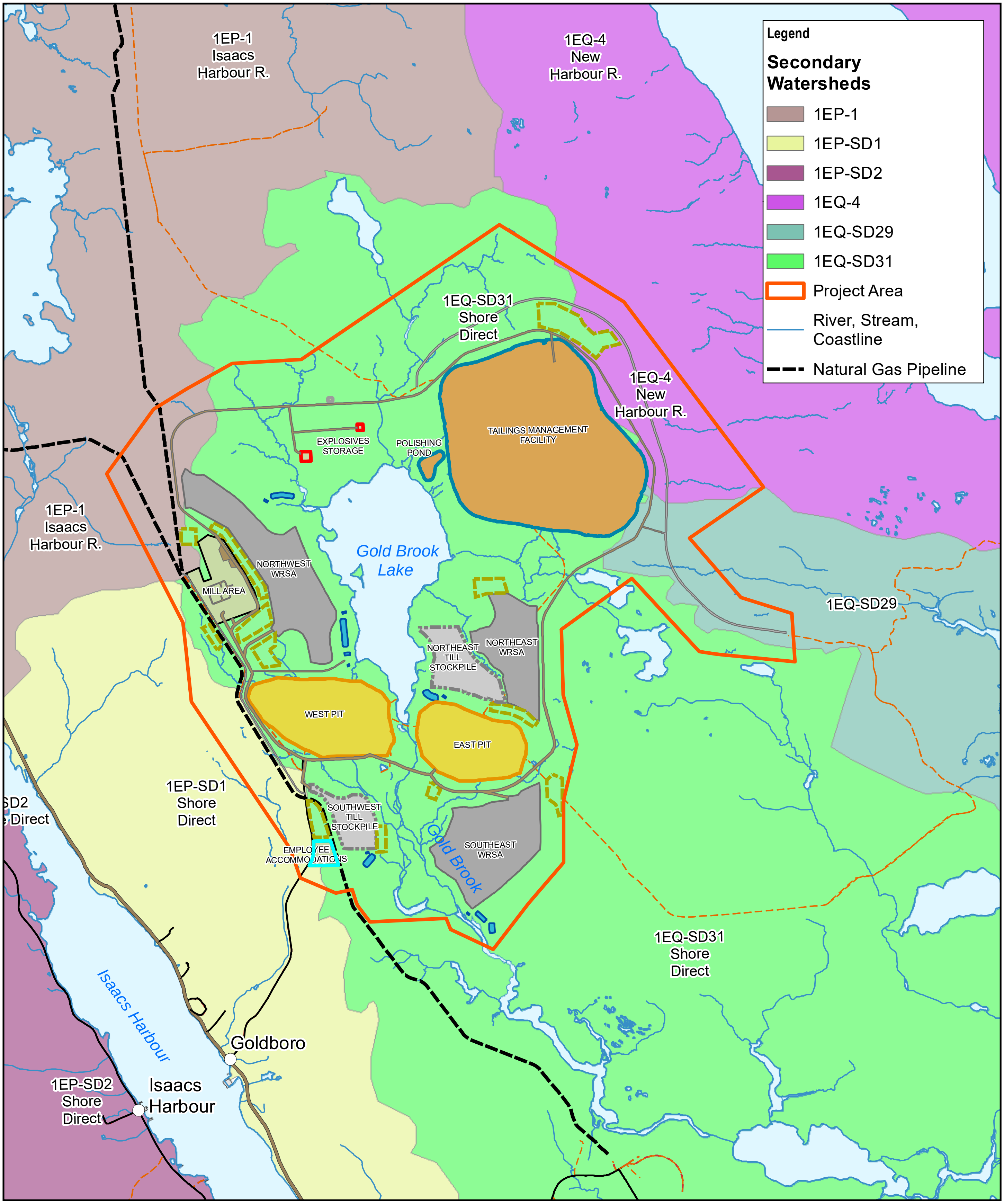
The Country Harbour Primary Watershed (1EP) is located on the western edge of the PA which is further subdivided by two secondary watersheds: a shore direct watershed (1EP-SD1, herein referred to as the Isaacs Harbour shore direct watershed) and the Isaacs Harbour River secondary watershed (1EP-1).

Approximately 17 ha of the northwestern edge of the PA and 0.8 ha of Project infrastructure (a portion of the northwest WRSA and an organic material stockpile) falls within the Isaacs Harbour River secondary watershed (1EP-1). The Isaacs Harbour River secondary 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 upper watershed includes several second and third order streams, and contains more than a dozen lakes, wetlands, and tributaries. Its lower reach is more linear and has a single point discharge to the ocean at Isaacs Harbour via Meadow Lake and the Isaacs Harbour River. Meadow Lake, located near the bottom of the watershed, is the largest lake present in the watershed encompassing an area of roughly 104 ha.

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. Water is directed southwest down a relatively steep gradient towards Isaacs Harbour via a number of unnamed topographically mapped channels. The watershed does not contain any named watercourses or waterbodies.

Approximately 83 ha of the northeastern portion of the PA and 10.6 ha of Project infrastructure (a portion of the TMF and an organic material stockpile) falls within the New Harbour River secondary watershed (1EQ-4). The New Harbour River watershed encompasses 14,963 ha of land draining to New Harbour Cove and New Harbour River. Ocean Lake, approximately 1.3 km northeast of the PA, is located at the western extent of the New Harbour River watershed.

Approximately 49 ha in the eastern portion of the PA and 0.8 ha of Project infrastructure (a portion of the TMF) falls within the 1EQ-SD29 shore direct watershed. This watershed encompasses 2,179 ha and drains to the south toward Coddles Harbour. This watershed contains one main watercourse that starts within the PA and flows southeast through Fowlers Lake and asin Lake before draining into Coddle’s Harbour. Other first and second order streams and lakes lie within this watershed. Secondary watersheds that overlay the PA are shown on Figure 5.6-2.



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GHD

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SECONDARY AND SHORE DIRECT WATERSHEDS

Project No. 11222385
Revision No. -
Date 25/05/2022

FIGURE 5.6-2

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5.6.3.2 Watercourses

Throughout the PA, 66 watercourses were delineated and characterized. The following watercourses were delineated during a previous study and lie outside of the current PA: WC25-38, 40-42, 46, 48, 74-76, 78-80, 84, 89-93, 95, and 97. These watercourses are not discussed further in this report. Watercourses delineated within the PA are shown in Figure 5.6-3.

Physical characteristics of each watercourse are provided in Table 5.6-2. In addition to watercourses, waterbodies within the PA include Gold Brook Lake and Rocky Lake. Other open water features identified include the historic settling ponds (two), the Beaver Pond (which is located within Wetland (WL) 18), and portions of Gold Brook. 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.

Table 5.6-2 Physical Characteristics – Watercourses (2017-2021)

Watercourse*	Stream Order	Bankfull width (m)	Average Depth (m)
1	1	2	0.15
2	1	1	0.05
3	1-2	1.8	0.25
4	1	4	0.1
5	1	4	0.15
6	1	4	0.1
7	1-2	4	0.1
8	2	0.8-4.4	0.15
9.1	1	1.5	0.45
9.2	1	0.5	0.1
9.3	1	0.85	0.1
9.4	1	1.2	0.1
10	1	0.5	0.15
11	1	2.5	0.25
12	1	0.5	0.1
13	1	0.6	0.3
14.1	1-2	1	0.15
14.2	1-2	1.0-2.5	0.2
14.3	1-2	2	0.2
15	1	1	0.08
16	1	0.5	0.1
17	1	1.35-2.25	0.15-0.25
18	1	0.1-2.0	0.08-0.12
19	1	0.8-1.25	0.20-0.10
20	1-2	2-3	0.25-0.30
21	1	0.35-0.45	0.15-0.20
22.1	1	0.2-0.35	0.15-0.20

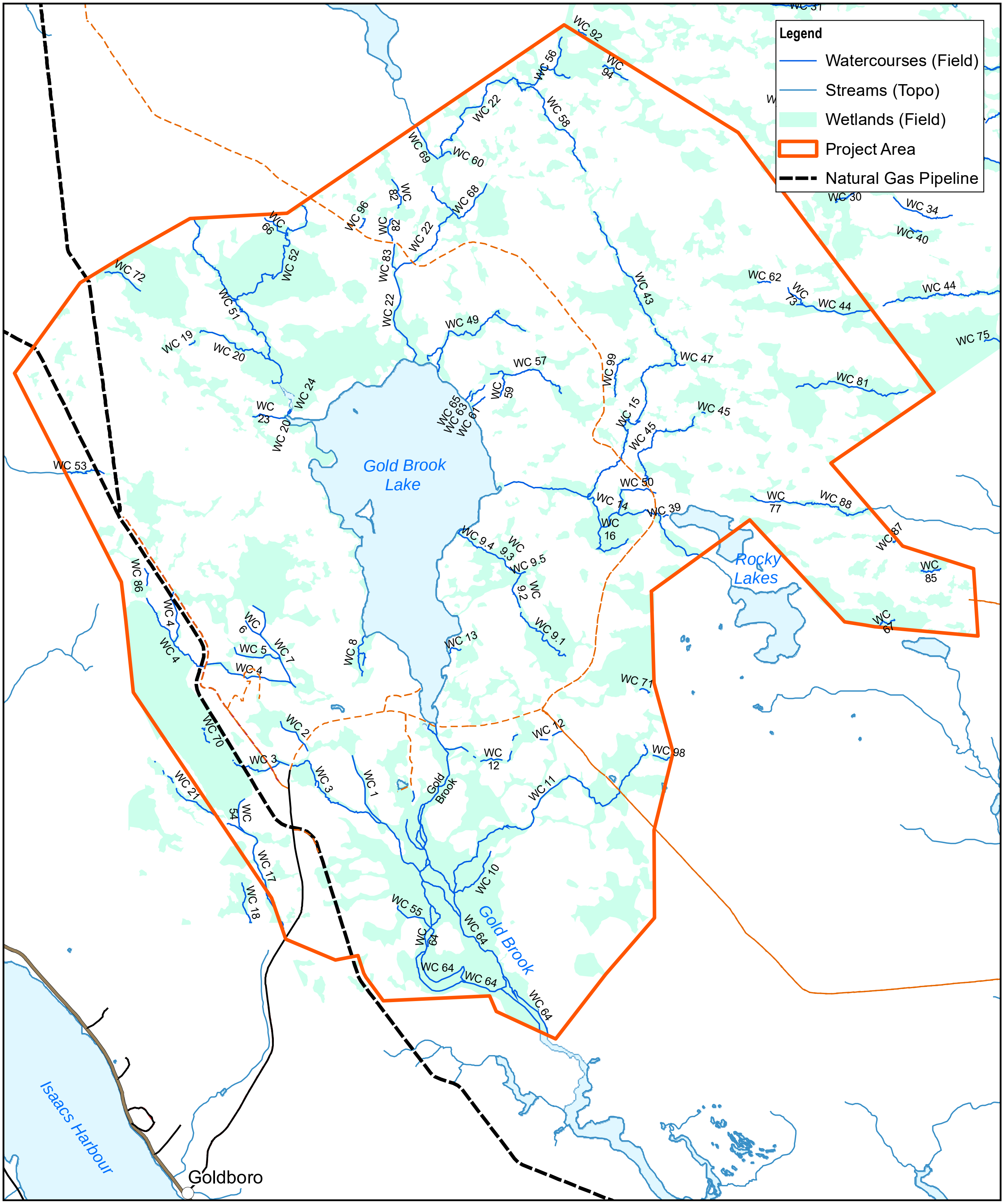
Table 5.6-2 Physical Characteristics – Watercourses (2017-2021)

Watercourse*	Stream Order	Bankfull width (m)	Average Depth (m)
22.2	1	0.3-0.9	0.05-012
23.1	1	1-2	0.35-0.45
23.2	1	1.8	0.45-0.50
24	2	2.5-4	0.15-0.40
39	1	0.3-1.5	0.1-0.2
43	1	0.5-1.6	0.13
44	1	0.2-1.3	0.08-0.35
45	1	0.17-1.3	0.08-0.20
47	1	0.12-0.19	0.08-0.25
49	1	0.5-2.0	0.2-0.8
50	1	0.42-1.35	0.2-0.56
51	1	0.2-1.25	0.08-0.35
52	1-2	0.45-1.0	0.1-0.25
53	1	0.1-1.75	0.02-0.12
54	1	0.20-0.40	0.08-0.15
55	1	0.3-2	0.1-0.3
56	1	0.6-0.7	0.08-0.2
57	1	1-1.5	0.2-0.3
58	1	0.5-2.5	0.15-0.5
59	1	1	0.25
60	1	1-2.5	0.2-0.4
61	1	1	0.35
63	1	0.3-1	0.3-0.5
64 Gold Brook	3	1.9-34	11-32
65	1	1	0.3
66	1	0.3-1	0.1-0.2
67	1	1	N/A
68	1	0.4-1.5	0.09-0.35
69	1	1.7-5.5	0.4
70	1	-	-
71	1	0.6-1.1	0.05
72	1	0.2-2.0	0.03
73	1	0.25-1.0	0.15
77	1	0.5-0.7	0.43
81	1	0.9-2.2	0.15

Table 5.6-2 Physical Characteristics – Watercourses (2017-2021)

Watercourse*	Stream Order	Bankfull width (m)	Average Depth (m)
82	1	0.3-1.4	0.09
83	1	0.3-1.0	0.23
85	1	0.3-0.5	0.06
86	1	0.2-0.9	0.08
87	1	-	-
88	1	0.35-0.75	0.06
94	1	0.3-0.7	0.08
96	1	0.3-0.45	0.08
98	1	-	-
99	1	0.45-1.3	0.19

* The following watercourse numbers lie outside of the current EARD PA: WC25-38, 40-42, 46, 48, 74-76, 78-80, 84, 89-93, 95, and 97.



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FIELD DELINEATED WATERCOURSES

Project No. 11222385
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Date 25/05/2022

FIGURE 5.6-3

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5.6.3.3 Surface Water Quantity

5.6.3.3.1 Regional Climate

A 50-year record of daily precipitation and average temperature values were obtained from the Deming Environment Canada Climate Change (ECCC) climate station (ID 8201410) for the years 1956 to 2005. The Deming climate station is located approximately 37 km from the site, within the Atlantic Coast Ecoregion. Average monthly lake evaporation values were obtained from the Truro ECCC climate station (ID8205990), which is the nearest ECCC climate station to the site that records lake evaporation data and is located approximately 129 km from the site. Table 5.6-3 summarizes the average monthly values of the climate data used in this assessment.

Table 5.6-3 Monthly and Annual Average Climate Data Calculated from the ECCC Deming and Truro Climate Stations

Climate Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation (mm)	116.1	94.8	111.8	119.6	110.1	100.4	109.1	104.2	106.8	137.0	158.7	140.6	1,409.2
Rainfall (mm)	86.3	64.0	86.6	109.7	109.4	100.4	109.1	104.2	106.8	137.0	155.6	117.7	1,286.8
Snowfall (mm)	29.8	30.8	25.2	10.0	0.7	0.0	0.0	0.0	0.0	0.1	3.1	22.9	122.4
Mean Temperature (°C)	-4.1	-4.5	-1.6	2.3	6.3	10.7	14.6	16.9	14.8	9.8	5.0	-0.6	N/A
Lake Evaporation (mm)	0.0	0.0	0.0	0.0	89.9	102.0	117.8	96.1	69.0	40.3	0.0	0.0	515.1

The projected climate change impacts were also assessed by applying climate change factors to the yield values. The historical and projected average annual precipitation totals were obtained for Guysborough, NS from the NSECC Climate Data (NSECC, 2022). The projected average annual precipitation totals are provided for the 2020s, 2050s, and 2080s and were considered representative of the year 2020, 2050, and 2080, respectively. A linear interpolation was performed to estimate the climate change projected precipitation totals for all years in between. Finally, the percent increase from the historical value was calculated for each year to represent the climate change factors that are applied to the yield in the water balance analysis.

5.6.3.3.2 Results of Baseline Surface Water Quantity Monitoring

Discrete and continuous measurements of flows and water surface elevations are presented in the Surface Water Baseline Monitoring Report provided in Appendix F.3. Manual water level and flow measurements were used to generate rating curves for stations SW-12-21, SW-14-21, SW-16-21, and SW-17-21. Rating curves and continuous flow graphs will be continuously updated during the on-going monitoring program as more data is collected and the stage-discharge relationships are further improved.

The 2021 calculated flow measurements at the outlet of Gold Brook Lake (SW-12-21) ranged from 3 L/s on July 20, 2021 to 1,035 L/s on April 1, 2021. Flow measurements collected along WC14 (SW-14-21) ranged from 0 L/s on July 20, 2021 to 534 L/s on December 7, 2021. Flow measurements collected along WC22 (SW-16-21) ranged from 1 L/s on various dates to 893 L/s on December 7, 2021. Flow measurements collected in WC20 (SW-17-21) ranged from 1 L/s on July 20, 2021 to 626 L/s on December 7, 2021.

5.6.3.4 Surface Water Quality

Monthly surface water quality samples have been collected from stations SW-11-21, SW-12-21, SW-14-21, SW-15-21, SW-16-21, SW-17-21, and SW-21-21 since March 2021. Samples have been collected on a quarterly basis from Stations #2 to #5, Station #7, and Station #9 since August 2018, and on a monthly basis from Station #6 since August 2018 as part of the monitoring program for the Goldboro Bulk Sample Site IA (Approval No. 2018-101386-02. Surface water quality parameter results from stations SW-11-21, SW-12-21, SW-14-21, SW-15-21, SW-16-21, SW-17-21, and SW-21-21 were compared to the CCME WQGs for the Protection of FWAL and the NS Tier 1 EQS for Surface Water. Surface water quality results from the IA monitoring program were compared to the CCME WQGs for the Protection of FWAL and to the 95th percentile of the baseline dataset collected in 2018.

Surface water quality results are included in Surface Water Baseline Monitoring Report provided in Appendix F.3 and are summarized below. Background metals concentrations in Gold Brook are likely elevated in comparison to Gold Brook Lake due to the presence of historic tailings in Gold Brook.

Gold Brook

- Exceedances of the CCME and NS Tier 1 EQS guidelines for dissolved aluminum, dissolved arsenic, and dissolved iron were recorded at the downstream water quality monitoring station (SW-11-21) from April to December 2021. Dissolved zinc exceeded applicable guidelines at SW-11-21 in June, August, and October 2021.
- Total aluminum, total arsenic, and total iron exceeded applicable guidelines at SW-11-21 from April to December 2021. Total lead and total mercury exceeded CCME and NS Tier 1 EQS criteria in July 2021. Total zinc exceeded the applicable guidelines during the November sample event.
- pH in samples collected from SW-11-21 was lower than CCME criteria from April to December 2021.
- The pH values measured at Station #7 in 2021 ranged from 4.72 to 6.47 and all values were less than the CCME acceptable range. This is consistent with previous monitoring data.
- Concentrations of total aluminum in samples collected at Station #7 in 2021 ranged from 0.3 mg/L to 0.392 mg/L, and all measured concentrations were greater than the 95th percentile value (0.286 mg/L). This is consistent with previous monitoring data.
- Total copper concentrations at Station #7 in 2021 ranged from less than the laboratory detection limit (0.00050 mg/L) to 0.00455 mg/L. The concentration of total copper in the June 2021 sample (0.0045 mg/L) was greater than the CCME criteria (0.002 mg/L-0.004 mg/L, hardness dependent). This is the first exceedance of the total copper CCME criteria at this location since monitoring began in 2018.
- Concentrations of total zinc in samples collected from Station #7 in 2021 ranged from less than the laboratory detection limit (0.0050 mg/L) to 0.0293 mg/L. The concentration of total zinc in the June and September 2021 samples (0.0128 mg/L and 0.0293 mg/L, respectively) were greater than the CCME criteria (0.007 mg/L, hardness, pH and DOC dependent). This is consistent with previous monitoring data.

Gold Brook Lake

- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of dissolved aluminum and dissolved arsenic were recorded at the lake outlet water quality monitoring station (SW-12-21) from March to December 2021. Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of dissolved iron were recorded at each monthly monitoring event, with the exception of March and June 2021. In addition, an exceedance of dissolved lead was recorded in November 2021 at the SW-12-21 location.
- Exceedances of the CCME and NS Tier 1 EQS guidelines of total aluminum, total arsenic and total iron were recorded at the SW12 location from March to December 2021. Total lead exceeded the applicable guidelines in August and November (field sample duplicate) 2021. Total zinc also exceeded applicable guidelines during the November sample event.
- pH was lower than the CCME range at location SW-12-21 from March to December 2021.
- pH values measured at Station #4 in 2021 ranged from 4.63 to 5.74. The pH values measured were less than the CCME range in all samples collected from Station #4 in 2021. This is consistent with previous monitoring results.

- Total aluminum concentrations in samples collected from Station #4 in 2021 ranged from 0.245 mg/L to 0.388 mg/L in 2021. The total aluminum concentrations in all samples exceeded the 95th percentile total aluminum concentration (0.242 mg/L). This is consistent with previous monitoring results.
- Total arsenic concentrations in samples collected from Station #4 in 2021 ranged from 0.006 mg/L to 0.0748 mg/L. The total arsenic concentration in the September 2021 sample (0.0737 mg/L) exceeded the 95th percentile concentration (0.0324 mg/L). This is consistent with previous results.
- The iron concentration in the September and November 2021 samples collected from Station #4 (0.697 mg/L and 0.555 mg/L, respectively) exceeded the 95th percentile concentration (0.457 mg/L). This is consistent with previous monitoring data.

Ocean Lake

- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of dissolved aluminum were recorded at the Ocean Lake water quality monitoring station (SW-15-21) from March to December 2021. Dissolved cadmium exceeded applicable criteria in March 2021, and an exceedance of dissolved zinc was recorded in July 2021.
- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of total aluminum were recorded at the SW-15 21 location from March to December 2021. Total copper exceeded the CCME and NS Tier 1 guidelines in May 2021 (field sample duplicate).
- General chemistry parameter pH at SW-15-21 was lower than the acceptable CCME range from March to December 2021.

Beaver Pond Inflow

- pH values measured at Station #2 in 2021 ranged from 4.43 to 5.59. This is consistent with previous monitoring data. All values measured were less than the CCME acceptable range.
- Total aluminum concentrations in samples collected from Station #2 in 2021 ranged from 0.393 mg/L to 1.58 mg/L. Samples collected in June, September, and November 2021 (1.58 mg/L, 0.858 mg/L and 0.393 mg/L, respectively) exceeded the 95th percentile total aluminum concentration (0.373 mg/L). This is consistent with previous monitoring data.
- Total arsenic concentrations in samples collected from Station #2 in 2021 ranged from 0.0045 mg/L to 0.209 mg/L. Samples collected in June and September 2021 (0.209 mg/L and 0.0140 mg/L, respectively) exceeded the 95th percentile total arsenic concentration (0.0139 mg/L). These concentrations represent the first exceedances of this parameter at this station since monitoring began in 2018.
- Total iron concentrations in samples collected from Station #2 in 2021 ranged from 0.391 mg/L to 1.86 mg/L. Samples collected in June and September 2021 (1.86 mg/L and 1.54 mg/L) exceeded the 95th percentile total iron concentration (0.863 mg/L). These concentrations represent the first exceedances of this parameter at this station since monitoring began in 2018.
- Total lead concentrations in samples collected from Station #2 in 2021 ranged from 0.00065 mg/L to 0.00158 mg/L. Samples collected in June and September 2021 (0.00123 mg/L and 0.00158 mg/L, respectively) exceeded the CCME criteria (0.001 mg/L). This is consistent with previous monitoring data.

Beaver Pond Outflow

- pH values measured at Station #3 in 2021 ranged from 4.43 to 5.32. The pH values measured were less than the CCME criteria in all four quarterly samples collected during 2021. This is consistent with previous monitoring results.
- The total aluminum concentrations in samples collected from Station #3 in 2021 ranged from 0.341 mg/L to 1.15 mg/L in 2021. This is consistent with previous monitoring results. The samples collected in June and September 2021 (1.15 mg/L and 0.896 mg/L, respectively) exceeded the 95th percentile total aluminum concentration (0.471 mg/L).

- The total iron concentrations in samples collected from Station #3 in 2021 ranged from 0.513 mg/L to 1.49 mg/L. The samples collected in June and September 2021 (1.49 mg/L and 1.44 mg/L, respectively) exceeded the 95th percentile total iron concentration (1.11 mg/L). This is consistent with previous monitoring results.
- Total lead concentrations in samples collected from Station #3 in 2021 ranged from 0.00066 mg/L to 0.00154 mg/L. The total lead concentrations in samples collected in June and September 2021 (0.00130 mg/L and 0.00154 mg/L, respectively) exceeded the CCME total lead criteria (0.001 mg/L to 0.007 mg/L, hardness dependent). This is consistent with previous monitoring data.

Boston-Richardson Shaft

- Total copper concentrations in samples collected from Station #5 in 2021 ranged from 0.00104 mg/L to 0.00275 mg/L and samples collected in February and November 2021 (0.00202 mg/L and 0.00275 mg/L, respectively) exceeded CCME FWAL criteria (0.002-0.004 mg/L, hardness dependent). This is consistent with previous monitoring data.

Settling Pond Outflow

- The pH values measured at Station #6 in 2021 ranged from 5.31 to 6.81. The pH values measured were within the CCME acceptable range in all samples collected during 2021, except for January (6.2), February (5.44), March (5.64), November (5.31) and December (5.95). This is consistent with previous monitoring data.
- Total aluminum concentrations in samples collected from Station #6 in 2021 ranged from 0.0595 mg/L to 0.203 mg/L. The January sample (0.135 mg/L), April sample (0.142 mg/L) and all samples collected from October through December 2021 (0.151 mg/L to 0.203 mg/L) had total aluminum concentrations greater than the 95th percentile value (0.133 mg/L). This is consistent with previous monitoring results.

Drainage from Ore Stockpile

- The pH values measured at Station #9 in 2021 ranged from 6.07 to 6.29 and all values were less than the CCME acceptable range. These values are similar to values measured in previous monitoring periods.
- Total aluminum concentrations in samples collected from Station #9 in 2021 ranged from 0.117 mg/L to 0.257 mg/L and exceeded the CCME criterion (0.005 mg/L to 0.1 mg/L, pH dependent). These concentrations are consistent with previous monitoring results and less than the previously measured maximum concentration of 2.98 mg/L, collected in November of 2019.
- Concentrations of total arsenic in samples collected from Station #9 in 2021 exceeded the CCME threshold value (0.005 mg/L) and ranged from 0.369 mg/L to 2.020 mg/L. This is consistent with previous monitoring data and concentrations measured during the current reporting period are less than the previously recorded maximum concentration of 2.25 mg/L collected in November of 2019.
- Lead concentrations in samples collected from Station #9 in 2021 ranged from 0.0061 mg/L to 0.00199 mg/L. The concentration of lead in the sample collected in September 2021 (0.001991 mg/L) exceeded the CCME threshold value but is consistent with previous monitoring data and less than the previously recorded maximum concentration of 0.0145 mg/L in November of 2019.
- Concentrations of total zinc in samples collected from Station #9 in 2021 ranged from less than the laboratory detection limit (0.0050 mg/L) to 0.008 mg/L. The June and September 2021 sample concentrations (0.0080 mg/L and 0.0072 mg/L, respectively) exceeded the CCME threshold value of 0.007 mg/L but are consistent with previous monitoring data and are less than the previously measured maximum concentration of 0.0229 mg/L measured in November 2019.

Ocean Lake

- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of dissolved aluminum were recorded at the Ocean Lake water quality monitoring station (SW-15-21) from March to December 2021. Dissolved cadmium exceeded applicable criteria in March 2021, and an exceedance of dissolved zinc was recorded in July 2021.

WC8

- Dissolved aluminum and dissolved iron exceeded the applicable CCME and NS Tier 1 EQS at the WC8 water quality monitoring station (SW-20-21) from March to December 2021. Exceedances of the applicable guidelines of dissolved arsenic were recorded at each monthly monitoring event, with the exception of March and December 2021. Dissolved lead exceedances of the guidelines in July, August, September, and November 2021. Additionally, dissolved zinc and dissolved cadmium exceedances in samples from August 2021, with dissolved zinc also exceeding guidelines in September 2021, the following month.
- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of total aluminum and total iron were recorded at the SW-20-21 location from April to December 2021. Exceedances of the applicable guidelines of total arsenic were recorded at each monthly monitoring event, with the exception of December 2021. Additionally, total lead recorded exceedances of the CCME and NS Tier 1 guidelines at each monthly monitoring event with the exception of March, May, June, and December 2021. One exceedance of total zinc was noted in November 2021.
- pH in SW-20-21 samples was lower than the applicable CCME range at location from March to December 2021.

WC9

- WC9 water quality monitoring station (SW-13-21) recorded exceedances of the applicable CCME and NS Tier 1 EQS guidelines of dissolved aluminum from March to December 2021. Dissolved iron samples exceeded applicable guidelines at each monthly monitoring event with the exception of March and December 2021. Dissolved arsenic exceeded the CCME and NS Tier 1 guidelines from samples in SW-13-21 in July and September 2021, and dissolved lead exceedances were recorded in August and September 2021.
- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of total aluminum were recorded at the SW-13-21 location from March to December 2021. Exceedances of the applicable guidelines of total iron were recorded at each monthly monitoring event, with the exception of March 2021. Total arsenic and total lead exceeded the CCME and NS Tier 1 guidelines in July and September 2021, with total lead additionally exceeding in August 2021. One zinc exceedance was recorded in November 2021.
- pH in samples collected from SW-13-21 were lower than the applicable CCME range from March to December 2021.

WC14

- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of dissolved aluminum were recorded at the WC14 water quality monitoring station (SW-14-21) from March to December 2021. Dissolved iron exceeded the applicable guidelines at each monthly monitoring event with the exception of March, May, and December 2021. Dissolved lead and dissolved zinc recorded exceedances of the applicable CCME and NS Tier 1 guidelines in August 2021, with dissolved zinc additionally reporting an exceedance in October 2021.
- Total aluminum exceeded the applicable CCME and NS Tier 1 EQS guidelines at the SW-14-21 location from March to December 2021. Exceedances of the applicable guidelines of total iron were recorded at each monthly monitoring event, with the exception of March, May, and December 2021. Additionally, total lead exceeded guidelines in August and September 2021.
- pH in samples collected from SW-14-21 were lower than the applicable CCME range from March to December 2021.

WC20

- Dissolved aluminum exceedances of the applicable CCME and NS Tier 1 EQS guidelines of at the WC20 water quality monitoring station (SW-17-21) from March to December 2021. Exceedances of the applicable guidelines of dissolved iron were recorded at each monthly monitoring event, with the exception of March, May, and December 2021. Dissolved lead exceeded CCME and NS Tier 1 guidelines in August, September, and November 2021. Additionally, dissolved zinc exceeded guidelines in July and October 2021, and dissolved cadmium exceeded in August 2021.

- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of total aluminum were recorded at the SW-17-21 location from March to December 2021. Exceedances of the applicable guidelines of total iron were recorded at each monthly monitoring event, with the exception of March and December 2021. Total lead recorded exceedances of the applicable guidelines in August, September, and October 2021. One total zinc exceedance was noted in November 2021.
- pH was lower than the applicable CCME range at location SW-17-21 from March to December 2021.

WC22

- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of dissolved aluminum were recorded at the WC22 water quality monitoring station (SW-16-21) from March to December 2021. Dissolved iron recorded exceedances of the applicable guidelines at each monthly monitoring event with the exception of March, May, November, and December 2021.
- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of total aluminum were recorded at the SW-16-21 location from March to December 2021. Exceedances of the applicable CCME guidelines for total iron were recorded at each monthly monitoring event, with the exception of March, May, and December 2021. Total lead exceeded CCME and NS Tier 1 guidelines in August 2021. One exceedance for total zinc was recorded in November 2021.
- pH was lower than the applicable CCME range in samples collected from March to December 2021 at SW-16-21.

WC53

- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of dissolved aluminum were recorded at the WC53 water quality monitoring station (SW-18-21) from March to December 2021. Applicable guidelines of dissolved iron were exceeded at each monthly monitoring event, with the exception of March 2021. Dissolved lead and dissolved zinc exceeded applicable guidelines in July, August and September 2021. An additional dissolved zinc exceedance was also noted in June 2021. Dissolved mercury exceeded the CCME and NS Tier 1 guidelines in September 2021. Exceedances of the applicable CCME guidelines of dissolved manganese were recorded at each monthly monitoring event, with the exception of March, November, and December 2021. Additionally, the August and September 2021 recordings exceeded the applicable NS Tier 1 EQS guidelines. One exceedance of the applicable guidelines was noted for dissolved arsenic in July 2021.
- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of total aluminum and total iron were recorded at the SW-18-21 location from March to December 2021. Exceedances of the applicable guidelines of total lead were recorded at each monthly monitoring event, with the exception of March, May, October, and December 2021. Total manganese exceeded the CCME guidelines at each monthly monitoring event with the exception of March, November, and December 2021. Additionally, the June, August, and September 2021 recordings exceeded the applicable NS Tier 1 EQS guidelines. Total arsenic exceeded the CCME and NS Tier 1 guidelines in June, July, August, and September 2021. Total zinc exceeded applicable guidelines in July, August, September and November 2021. Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of total mercury were recorded in June and August 2021, with methyl mercury exceeding guidelines in August and September 2021. Total cobalt exceeded the applicable NS Tier 1 EQS guidelines for total cobalt in July, August, and September 2021. Total copper exceeded the CCME and NS Tier 1 guidelines in August 2021. Total cobalt exceeded the NS Tier 1 EQS guidelines, but not the CCME criteria in July, August and September 2021.
- pH in samples collected from SW-11-21 was lower than CCME criteria from April to December 2021.

WC86

- CCME and NS Tier 1 EQS guidelines of dissolved aluminum and dissolved iron were exceeded at the WC86 water quality monitoring station (SW-19-21) from May to December 2021. Dissolved lead exceedances were recorded at each monthly monitoring event, with the exception of March, May, and December 2021. Dissolved arsenic and dissolved zinc exceeded the applicable guidelines in July 2021, with dissolved zinc also exceeding in June 2021. An exceedance of the applicable CCME and NS Tier 1 EQS guidelines of dissolved mercury was recorded in November 2021.

- Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of total aluminum and total iron were recorded at the SW-19-21 location from March to December 2021. Exceedances of the applicable criteria of total lead were recorded at each monthly monitoring event, with the exception of March 2021. Samples collected during the May and July 2021 monitoring events were recorded in exceedance of the applicable guidelines in total mercury, total zinc, total arsenic and total copper. Total zinc also exceeded applicable guidelines in November 2021, and total mercury exceeded in December 2021. Exceedances of the applicable CCME and NS Tier 1 EQS guidelines of methyl mercury were recorded in May, August, and October 2021. An exceedance of the applicable CCME guidelines for total cadmium, as well as total manganese was recorded in May 2021, and an exceedance of the applicable NS Tier 1 EQS guidelines for total cobalt was recorded in May 2021.
- pH in samples collected at SW-19-21 was lower than the applicable CCME range at location from March to December 2021.

5.6.4 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. For the Surface Water Resource VC, identified concerns include:

- Changes to water levels in shallow surface features (wetlands, streams)
- Potential water contamination due to proposed Project activity
- Effects due to siltation, blasting, acid mine drainage
- Mobilization of arsenic, mercury, cadmium from TMF
- Effects of cyanide from ore processing
- Effects of water withdrawals for process source water
- Effects of discharges into waterbodies
- Effects on fish and other aquatic species
- Changes to surface water drainage and regime
- Long-term effects of open pits and effects on Gold Brook Lake

5.6.5 Effects Assessment Methodology

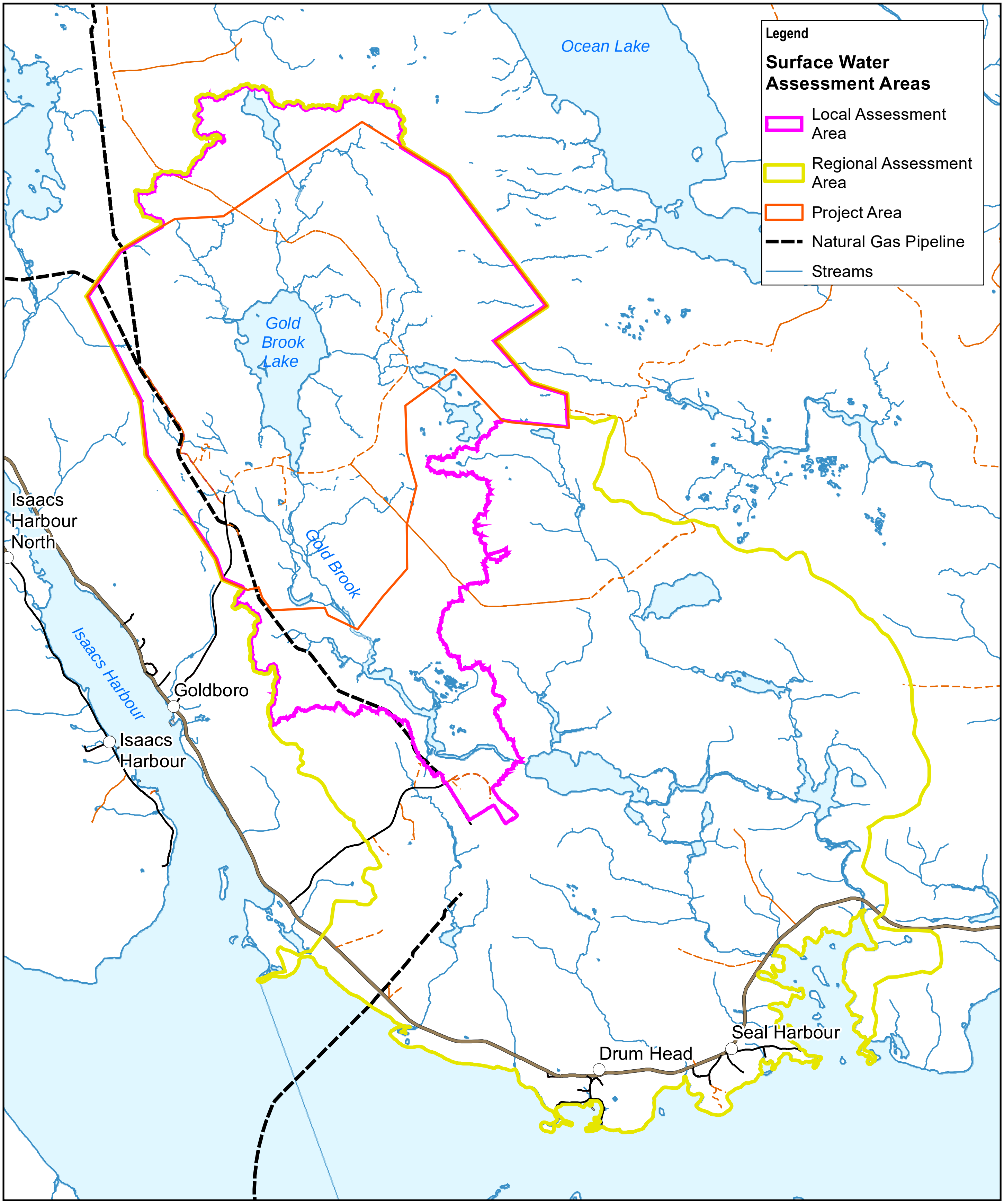
5.6.5.1 Boundaries

5.6.5.1.1 Spatial Boundaries

The spatial boundaries used for the assessment of effects on surface water are defined below:

- The PA encompasses the immediate area in which Project activities may occur and includes the infrastructure associated with the mine site plus a buffer of 100 – 200 m.
- The LAA encompasses the Gold Brook catchment and portions of the Isaacs Harbour River (1EP-1), Isaacs Harbour Shore-Direct (1EP-SD1), New Harbour River (1EQ-4), and Coddles Harbour Shore-Direct (1EQ-SD29) watersheds. The LAA was selected to encompass potential direct and indirect impacts to surface water resulting from the Project.
- The RAA encompasses shore direct watershed 1EQ-SD31, which begins at the headwaters to Gold Brook Lake and extends to the Atlantic Ocean, and portions of the Isaacs Harbour River (1EP-1), Isaacs Harbour Shore-Direct (1EP-SD1), New Harbour River (1EQ-4), and Coddles Harbour Shore-Direct (1EQ-SD29) watersheds.

- As the Project has the potential to cause direct and indirect effects on surface water quantity and quality outside of the PA, the LAA is considered the most appropriate spatial boundary for this assessment. Where portions of watersheds have been included, it is not expected that impacts to the aquatic environment, including wetlands, will extend beyond the PA. Within these four watersheds, Project infrastructure is limited to roads, surface water management structures, organic material stockpiles, and a portion of the mill area (1EP-SD1). Based on the type and location of this infrastructure and considering the planned water management systems, these activities are not expected to impact down-gradient portions of these watersheds. Spatial boundaries defined for the surface water effects assessment are presented in Figure 5.6-4.



Paper Size ANSI B

0 360 720 1,080 1,440

Metres

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Map Projection: Transverse Mercator
Horizontal Datum: North American Datum of 1983 (CSRS) version 6
Grid: NAD 1983 (CSRS) v6 UTM Zone 20N

SIGNAL GOLD INC.
GOLDBORO GOLD PROJECT
ENVIRONMENTAL ASSESSMENT

SPATIAL BOUNDARIES -
SURFACE WATER

Project No. **11222385**
Revision No. **-**
Date **25/05/2022**

FIGURE 5.6-4

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5.6.5.1.2 Temporal Boundaries

The temporal boundaries used for the assessment of effects on surface water are the construction, operations, and closure phases of the Project. To provide a conservative, worst-case evaluation of the operations and closure phases, predictive modelling was completed for the following scenarios:

- East Pit EOM
- West Pit EOM
- East Pit filled
- West Pit filled

5.6.5.1.3 Technical Boundaries

No technical boundaries were identified for the effects assessment of surface water.

5.6.5.1.4 Administrative Boundaries

There are several provincial and federal regulations which oversee the quality of water discharged from a mine site into a natural water body. Specifically, this assessment included comparison to the following criteria:

- MDMER Objectives (MDMER, 2022)
- CCME Water Quality Guidelines for the Protection of Aquatic Life, Freshwater (CCME, 2022)
- NS Tier 1 EQS for surface water (NSECC, 2021)

The MDMER Objectives regulate the concentrations of certain constituents within effluent while the CCME and Tier 1 EQS guidelines are applicable to the concentration of constituents within the receiving water body downstream of the discharge points. The more conservative guideline between CCME and Tier 1 EQS was taken as the applicable regulatory limit between these two guidelines.

In addition to the MDMER, CCME and NS Tier 1 EQS regulatory guidelines, SSWQGs have been established for certain constituents. SSWQG were 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 NS Tier 1 EQS regulatory limit, the 95th percentile background concentration was taken to be the SSWQG. If a SSWQG was established for a given constituent, this was assumed to take precedence over the CCME and Tier 1 EQS regulatory limits.

Regulatory limits applied in this assessment are summarized in Table 5.6-4.

Table 5.6-4 MDMER, CCME, Tier 1 EQS and Site-Specific Water Quality Regulatory Limits

Constituent	MDMER (µg/L)	CCME (µg/L)	Tier 1 EQS (µg/L)	SSWQG Gold Brook Lake (µg/L)	SSWQG Gold Brook (µg/L)	Applicable Downstream Regulatory Criteria (µg/L)
Aluminum	--	5.00[a]	5.00	504	430	504[i] or 430[j]
Antimony	--	20	9.00	--	--	9.00
Arsenic	100	5.00	5.00	61.8	677	61.8[i] or 677[j]
Barium	--	--	1000	--	--	1000
Beryllium	--	--	0.15	0.675	0.500	0.675[i] or 0.500[j]
Cadmium	--	0.04[b]	0.09	0.09[k]	0.09[k]	0.09
Chromium	--	--	1.00	--	--	1.00
Cobalt	--	--	1.00	2.00[k]	2.00[k]	2.00
Copper	100	2.00[c]	2.00	--	--	2.00
Iron	--	300	300	698	1,170	698[i] or 1,170[j]

Table 5.6-4 MDMER, CCME, Tier 1 EQS and Site-Specific Water Quality Regulatory Limits

Constituent	MDMER (µg/L)	CCME (µg/L)	Tier 1 EQS (µg/L)	SSWQG Gold Brook Lake (µg/L)	SSWQG Gold Brook (µg/L)	Applicable Downstream Regulatory Criteria (µg/L)
Lead	80	1.00[d]	1.00	1.42[k]	1.00[k]	1.42 or 1
Manganese	--	190[e]	430	--	--	190
Mercury	--	0.026	0.026	--	--	0.026
Nickel	250	25.0[f]	25.0	--	--	25.0
Selenium	--	1.00	1.00	--	--	1.00
Silver	--	0.25	0.25	--	--	0.25
Thallium	--	0.80	0.80	--	--	0.80
Uranium	--	15.0	15.0	--	--	15.0
Vanadium	--	--	120	--	--	120
Zinc	400	7.00[g]	7.00	92.0[k]	18.0[k]	92.0 or 18.0
Ammonia (µg N/L)	--	69.7[h]	--	--	--	69.7
Un-ionized Ammonia (µg N/L	--	19.0	--	--	--	19.0
Nitrate (µg N/L)	--	13,000	--	--	--	13.0
Nitrite (µg N/L)	--	60.0	--	197[k]	197[k]	197[k]
Cyanide	500	5.00	--	--		5.0

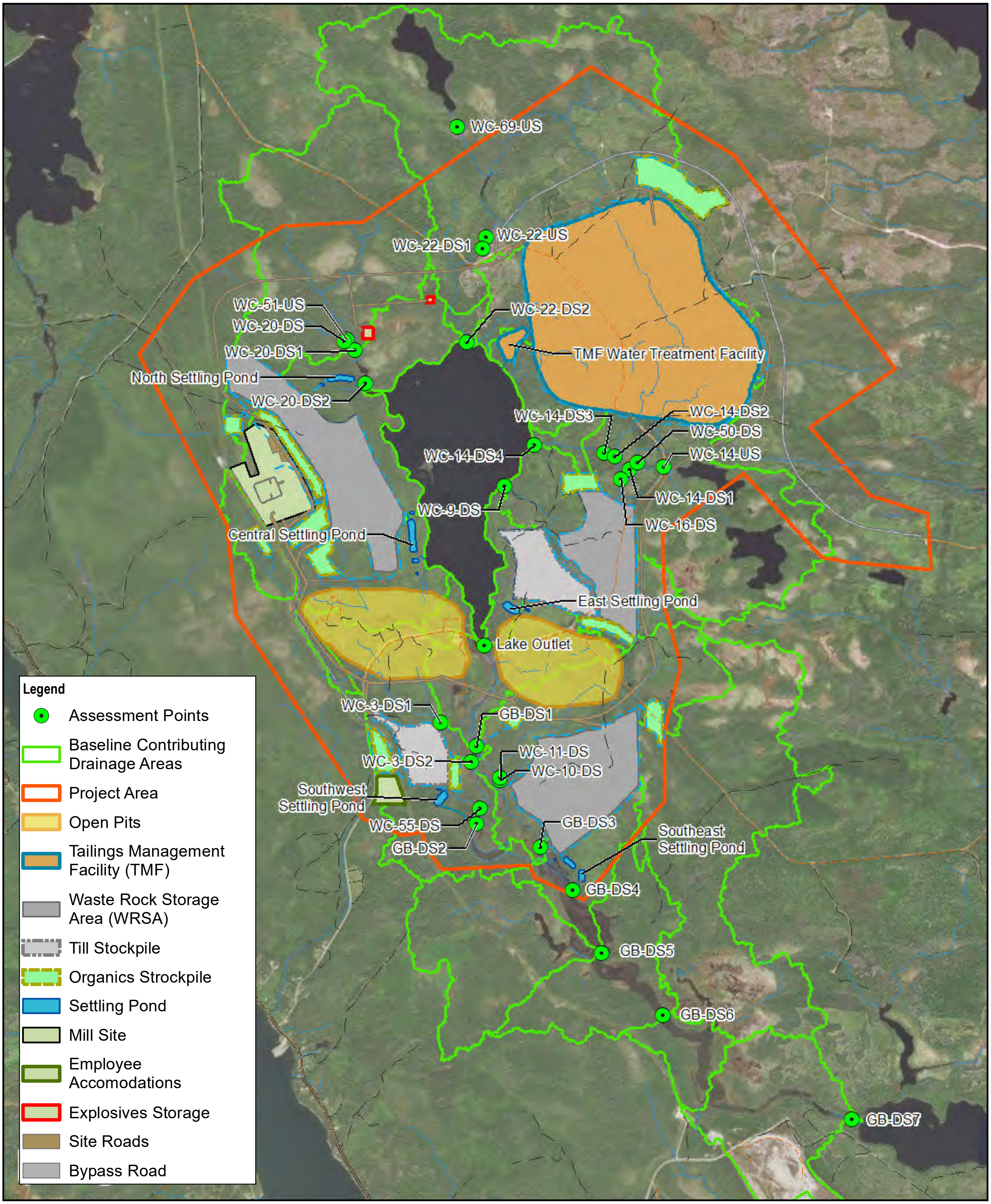
Notes:
[a] The CCME Regulatory limit for aluminum is dependant upon pH of the receiving water body. [Al] = 5 µg/L if pH < 6.5. Receiving water body pH = 4.9 (Gold Brook Lake) and 5.9 (Gold Brook)
[b] The CCME Regulatory limit for cadmium is dependant upon the hardness of the receiving water body. [Cd] = 0.04 µg/L for hardness <17 mg/L CaCO3. Receiving water body hardness = 3.45 mg/L CaCO3 (Gold Brook Lake) and 6.08 mg/L CaCO3 (Gold Brook)
[c] The CCME Regulatory limit for copper is dependant upon the hardness of the receiving water body. [Cu] = 2 µg/L for hardness <82 mg/L CaCO3. Receiving water body hardness = 3.45 mg/L CaCO3 (Gold Brook Lake) and 6.08 mg/L CaCO3 (Gold Brook)
[d] The CCME Regulatory limit for lead is dependant upon the hardness of the receiving water body. [Pb] = 1 µg/L for hardness <60 mg/L CaCO3. Receiving water body hardness = 3.45 mg/L CaCO3 (Gold Brook Lake) and 6.08 mg/L CaCO3 (Gold Brook)
[e] The CCME Regulatory limit for manganese is dependant upon the hardness and pH of the receiving water body. [Mn] = 190 µg/L for hardness = 3.454 mg/L CaCO3 and pH = 4.9 (as per Gold Brook Lake water quality)
[f] The CCME Regulatory limit for nickel is dependant upon the hardness of the receiving water body. [Ni] = 25 µg/L for hardness <60 mg/L CaCO3. Receiving water body hardness = 3.45 mg/L CaCO3 (Gold Brook Lake) and 6.08 mg/L CaCO3 (Gold Brook)
[g] The CCME Regulatory limit for zinc is dependant upon the hardness, pH and DOC of the receiving watercourse. The equation used to calculate the CCME Regulatory limit for zinc is only valid between hardness 23.4 and 399 mg/L CaCO3, pH 6.5 and 8.13 and DOC 0.3 to 22.9 mg/L. A conservative estimated regulatory limit of 7 µg/L (assuming 50 mg/L CaCO3 hardness, pH of 7.5 and 0.5 mg/L DOC) has been applied as the receiving water body hardness and pH both fall outside the applicable range of application of the equation. This assumption is conservative because when hardness and pH decrease the allowable regulatory limit for zinc increases. The assumed values of 50 mg/L CaCO3 and pH of 7.5 both exceed average hardness and pH values from the receiving water body
[h] The CCME Regulatory limit for ammonia is dependant upon the pH and temperature of the water. A conservative estimate of 69.7 µg/L NH_3 has been applied based on a pH of 6.0 and water surface temperature of 15ºC. This assumption is conservative because as the water temperature decreases the allowable regulatory limit for ammonia increases. The assumed value of 15ºC exceeds the recorded water temperature within Gold Brook for the majority of the year
[i] based on 95th percentile background concentrations of samples taken from 2018 to 2021 within Gold Brook Lake
[j] based on 95th percentile background concentrations of samples taken from 2018 to 2021 within Gold Brook, downstream of the proposed discharge point
[k] based on Site-Specific Water Quality Compliance established in Appendix F.7

5.6.5.2 Water Balance Analysis

The water balance analysis completed for this assessment was developed using GoldSim modelling software. GoldSim is a highly graphical program used for carrying out dynamic simulations to support decision making, and is especially well-suited to simulating dynamic, computationally intensive, but well-defined network models such as a water balance. GoldSim can perform simulations, track outputs from those simulations, and provide a graphical interface to facilitate the review and identification of interactions between system components.

The water balance analysis was developed to utilize climate inputs at a daily time-step, allowing the results to be summarized at monthly or annual intervals. The water balance analysis was used to estimate the flow volumes at the proposed mine water management features and at 29 assessment points over the duration of the Project. The locations of assessment points used in the water balance analysis are presented in Figure 5.6-5.

Further detail on the methodology used in the water balance analysis is provided in Appendix F.5.



Paper Size ANSI A

0 300 600 900 1,200

Metres

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Map Projection: Transverse Mercator
Horizontal Datum: North American Datum of 1983 (CSRS) version 6
Grid: NAD 1983 (CSRS) v6 UTM Zone 20N

GHD

SIGNAL GOLD INC.
GOLDBORO GOLD PROJECT
ENVIRONMENTAL ASSESSMENT

WATER BALANCE ASSESSMENT POINT LOCATIONS

Project No. 11222385
Revision No. -
Date 25/05/2022

FIGURE 5.6-5

N:\CA\Halifax\Projects\661\11222385\GIS\Maps\Deliverables\RPT03\11222385-RPT03_GIS-HX5.6-5_SW_WatBal.mxd
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Data source: GeoNova, GHD, Anaconda © 2022 Microsoft Corporation © 2022 Maxar ©CNES (2022) Distribution Airbus DS. Created by: jjparks

5.6.5.2.1 Baseline Hydrology

A soil-water balance working model was used to simulate baseline hydrological processes. The model used the 50-year daily records of rainfall, snowfall, average temperature, and calculated potential evapotranspiration (PET) as inputs, and included models of the snowpack and soil-water storage. A snowpack model was used to calculate yield (i.e., the sum of rainfall and snowmelt) and a soil-water storage model was used to calculate actual evapotranspiration (AET), baseflow, surface runoff, and total runoff depths for application in the water balance.

5.6.5.2.2 Operations and Closure Hydrology

The proposed Project includes a variety of different land cover types, including uncovered WRSAs, till and organics stockpiles, pit wall rock, the TMF, settling ponds, and the mill area and employee accommodations area with impervious surfaces. Hydrologic processes of the uncovered stockpiles and pit wall rock, in particular, are complex, and at this stage of the Project their specific properties are unknown; therefore, the evaporation, infiltration, and direct runoff from these areas were estimated using runoff coefficients from similar project locations in proximity to the PA.

The open water of the settling ponds was assumed to have a runoff coefficient of 1.00, meaning all precipitation is expected to translate to runoff. The settling ponds were modelled as storage elements where lake evaporation is included as an output. The mill area and employee accommodations area were assumed to be comprised of an impervious land cover. Impervious areas were also assigned a runoff coefficient of 1.00. Monthly discharge volumes from the TMF water treatment facility were input directly to the water balance.

In the closure phase, the WRSAs will be covered with the material from the till and organic stockpiles and a portion of the water will be directed to the pits to form the pit lakes.

It is assumed that the WRSAs will be covered with compacted till, topsoil, and seed after they are fully developed. It is assumed that evapotranspiration from the covered WRSAs will be consistent with the evapotranspiration of the natural vegetated land cover that is equal to 0.32 of the annual yield. The direct runoff coefficient from the covered WRSAs was calculated assuming an infiltration factor of 0.4, which is equal to the sum of 0.1 for slope, 0.2 for soil, and 0.1 land cover from Table 3.1 of the Ontario Stormwater Management Planning and Design Manual (MOE, 2003). As a result, evapotranspiration, infiltration, and direct runoff from the covered WRSAs will be 0.32 (equal to 1 – 0.68), 0.27 (0.4 x 0.68), and 0.41 ((1 – 0.4) x 0.68), respectively.

The development of the East and West Pits and lining of the TMF will alter the groundwater flow patterns from baseline conditions, as described in Section 5.5 (Groundwater Resources). Baseflow volume variations to the natural lakes and watercourses were determined using the groundwater model of the Project. The baseflow impacts were incorporated into the water balance analysis as percent changes from baseline conditions at each assessment point.

Groundwater inflow volumes to the East and West Pits were also obtained from the groundwater model. Average groundwater inflow rates to the East Pit increase to a peak rate of 620,000 m^3/year at East Pit EOM and stabilize at 170,000 m^3/year after the pit lake has formed. Average groundwater inflow rates to the West Pit increase to a peak rate of 780,000 m^3/year at West Pit EOM and stabilize at 190,000 m^3/year after the pit lake has formed.

One limitation of the water balance analysis 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.

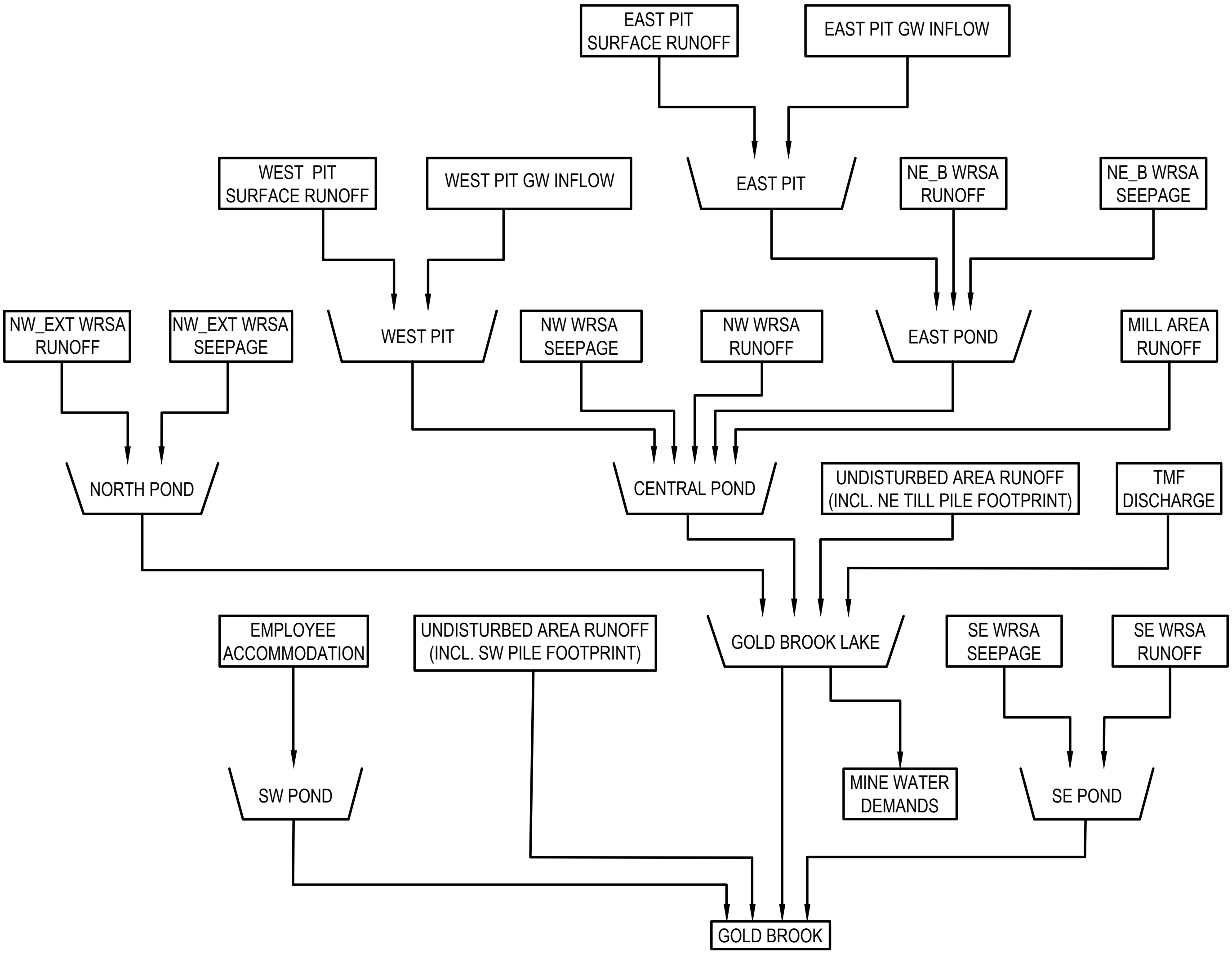
5.6.5.2.3 Water Management

During development of the Project, surface water runoff and groundwater inflows will be directed to specified receiving storage areas and locations prior to discharge into the receiving environment. 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.

East Pit EOM represents the time when the East Pit will be mined to its full potential and will begin to fill with water. It is assumed that the till and organics stockpiles will be removed at this stage and used as cover material for the WRSAs. The till and organics stockpile areas will drain to their baseline receivers. West Pit EOM represents the time when the West Pit will be mined to its full potential and will begin to fill with water.

After the pits have been mined to their full potential, they will begin to fill with water to form pit lakes. During this time, pit inflows include direct precipitation, groundwater inflow, and overflow from adjacent settling ponds to reduce the time required to form the pit lakes and stabilize the groundwater flow patterns. The only outflow from the pits will be evaporation while they are filling. Overflow from the East Pit and West Pit will discharge to Gold Brook Lake after they are filled. The East Pit and West Pit have maximum capacities of 17.4 million m^3 and 29.3 million m^3, corresponding to an elevation of 50.24 and 51.7 masl, respectively. The East Pit will be backfilled with 9.5 million m^3 of waste rock over four years beginning at East Pit EOM. It is assumed waste rock backfill will have a void space ratio of 0.30, which was estimated based on the waste rock properties of similar mining projects. As such, the volume of water required to fill the East Pit is reduced from 17.4 million m^3 to 10.8 million m^3.

Water transfers occurring during the operations and closure phases are detailed in Figures 5.6-6 through 5.6-9.



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Project No. **11222385**
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OPERATIONS FLOW DIAGRAM

FIGURE 5.6-6

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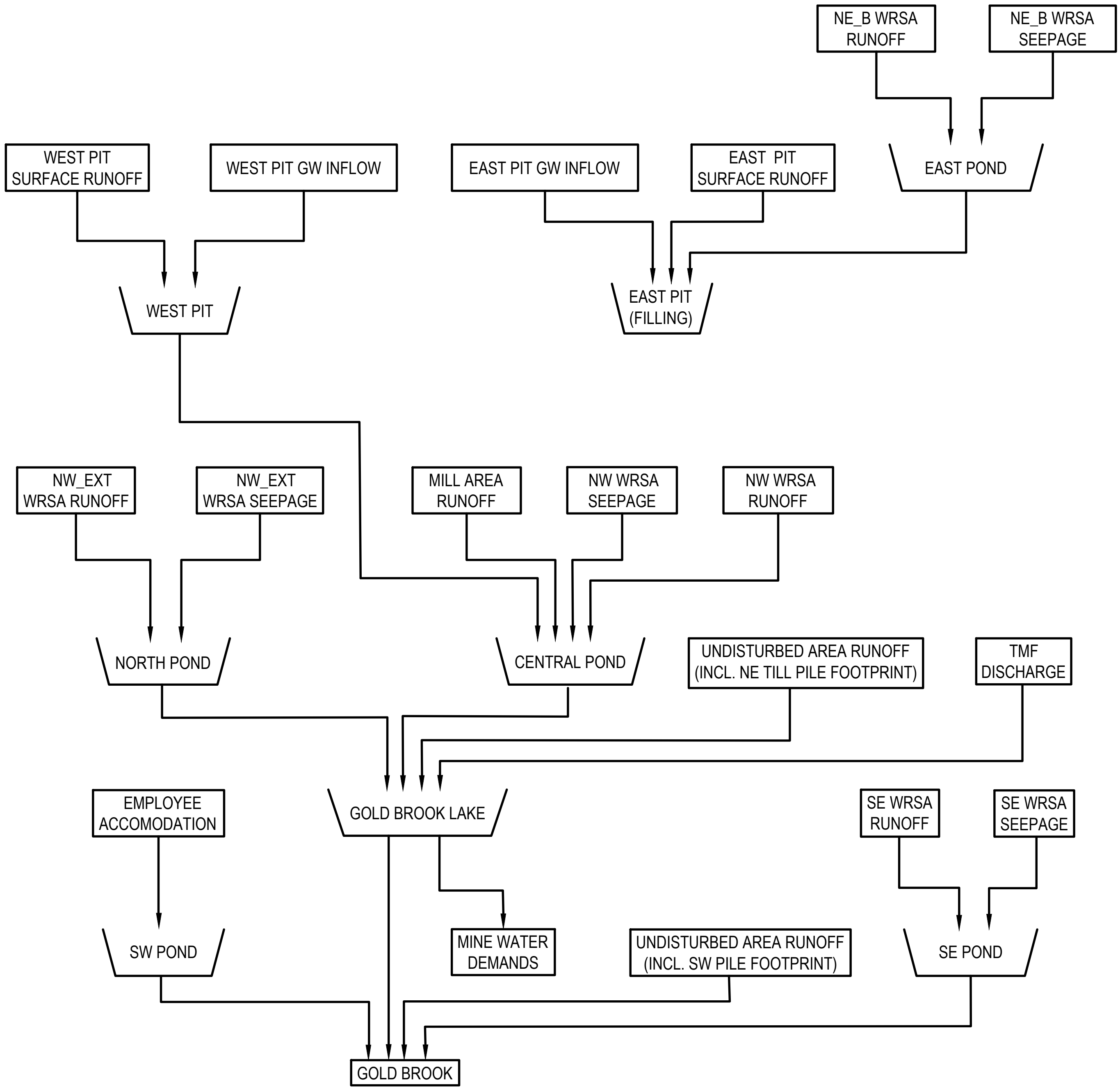

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EAST PIT EOM FLOW DIAGRAM

FIGURE 5.6-7

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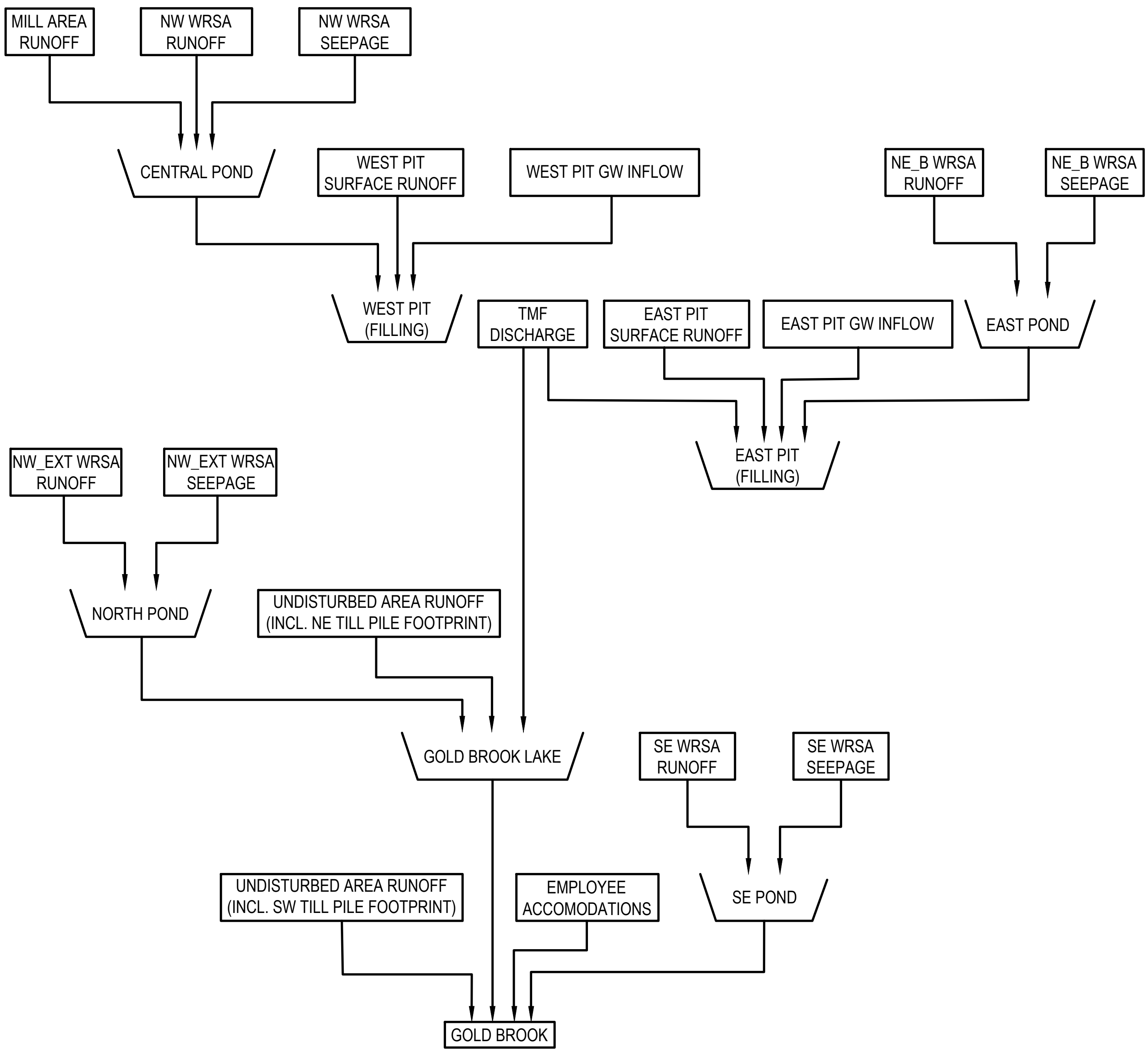

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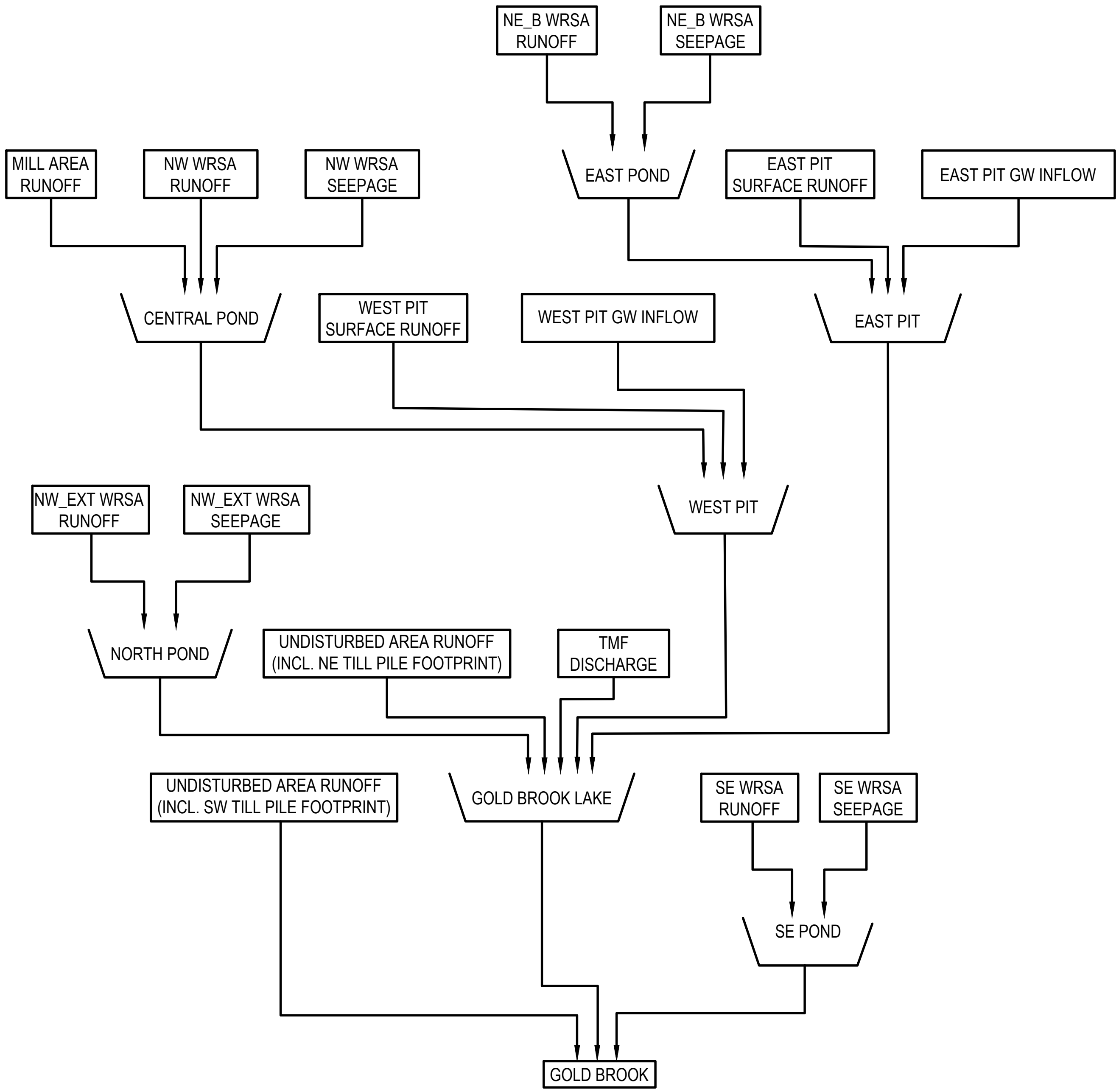
Date **May 2022**

WEST PIT EOM FLOW DIAGRAM

FIGURE 5.6-8



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Project No. **11222385**
Date **May 2022**

POST PIT FILLING DIAGRAM

FIGURE 5.6-9

5.6.5.2.4 Gold Brook Lake Water Levels

The impact of the Project 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-RAS 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 WTS, depending on the scenario. 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 timeseries for each of the baseline and West Pit EOM conditions based on 50 years of the historical climate record. The West Pit EOM scenario 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 light detection and ranging (LiDAR) data for the region. It is assumed that the water surface elevation in the LiDAR represents permanent lake level, which would correspond to the invert elevation of the three 1,800 mm diameter corrugated steel pipe (CSP) culverts that control the outflow from the lake to Gold Brook.

5.6.5.2.5 Gold Brook Water Levels

Hydraulic modelling was completed to estimate the effects of the Project on the hydraulic regime of Gold Brook between Gold Brook Lake (upstream) and Seal Harbour Lake (downstream). A 2-dimensional hydraulic model of Gold Brook was developed using HEC-RAS software, a computer program that models the hydraulics of water flow through natural rivers and is widely used to determine hydraulic parameters such as water surface profiles and flow velocities. Low flow (10^{th} percentile) and average flow conditions were simulated for the baseline and West Pit EOM scenarios.

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 hydrodynamic model also requires upstream and downstream boundary conditions to calculate the hydraulic conditions in the reach. Upstream boundary conditions used in the model were flows derived from the water balance analysis for baseline and West Pit EOM conditions. An assumed normal water level of 29.82 m at Seal Harbour Lake was selected as the downstream boundary condition.

Further discussion of the hydraulic modelling completed for Gold Brook is provided in the Assessment of Impacts to the Hydraulic Regime of Gold Brook memo in Appendix F.6.

5.6.5.3 Predictive Water Quality Assessment

5.6.5.3.1 Source Term Development

To predict the concentration of each constituent in Project effluent, the geochemistry of each material (PAG and NAG waste rock, organic material, and till) were assessed individually. This assessment included both the base case and upper-case concentration scenarios for 37 different constituents for short-term and long-term scenarios. The base case scenario is considered in this assessment as representing the most likely concentration scenario while the upper-case scenario is considered as representing the likely worst-case concentration scenario. Short-term source terms were applied to all materials or infrastructure at the start of mining operations. The source terms for any given material or piece of infrastructure were transitioned from short-term to long-term conditions when the material or infrastructure was in place, with no further changes or re-work, for three years or longer. Long-term source terms were applied in perpetuity. The development of geochemical source terms for the Project is further discussed in Section 5.4 (Geology, Soil, and Sediment) and in the Geochemical Characterization and Source Terms report provided in Appendix E.3.

Due to the nature of Project activities, certain infrastructure components will complete their life cycle prior to others. In addition, reclamation activities are anticipated to begin immediately following the completion of work on a certain piece of infrastructure (e.g., waste rock stockpiles will be capped and seeded immediately following completion). By immediately starting reclamation, the duration of time infrastructure will be exposed (without a cover) has been reduced. It was assumed that once a given piece of infrastructure (e.g., open pit, waste rock stockpile) is untouched for 3 years, the source terms applied to this piece of infrastructure would be transitioned to the long-term source terms as the material in question moves into an acidic phase.

Nitrogen source terms (source terms for ammonia, nitrate, and nitrite) were derived for both base-case and upper-case conditions on a short-term basis. The nitrogen source terms under long-term conditions were derived as a decay rate because nitrogen will decay over time due to natural weathering of the material. The nitrogen source term decay rates are indicated in Table 5.6-5.

Table 5.6-5 Nitrogen Source Terms Decay Rates

Constituent	Waste Rock Stockpile	Decay Equation	Pit Sump	Decay Equation	Pit Lake	Decay Equation
Ammonia	24%	90% Nitrate, 10% Nitrite	80%	90% Nitrate, 10% Nitrite	30%	80% Nitrate, 20% Nitrite
Nitrite		100% Nitrate		100% Nitrate		100% Nitrate
Nitrate		--		--		--

Source terms for the TMF discharge were provided for Years 1 through 18 of the operations phase. The source terms were assumed to remain constant after year 18 as constituent concentrations had either reached stability or were at concentrations below regulatory limits.

The predictive water quality assessment also incorporated groundwater discharge into Gold Brook Lake and Gold Brook, including potential additional loading from Project activities. Loading rates for each modelled constituent were obtained from the groundwater model completed for the Project and used as direct inputs in the GoldSim predictive water quality model. Further detail on the methodology used in the Predictive Water Quality Assessment is provided in Appendix F.7.

5.6.5.3.2 Discharge Points

Five discharge points are proposed within the PA during the operations phase of the Project as indicated in Table 5.6-6, below.

Table 5.6-6 Discharge Locations – Operations Phase

Discharge Location	Receiving Waterbody
TMF	Gold Brook Lake
North Settling Pond	Gold Brook Lake
Central Settling Pond	Gold Brook Lake
Southeast Settling Pond	Gold Brook
Southwest Settling Pond	Gold Brook

The TMF, north settling pond, central settling pond, and southeast settling pond discharge points are the final discharge points for the Project as defined in the MDMER. The southwest settling pond is to receive surface water runoff from the southwest till stockpile and an organic material stockpile and will be monitored for compliance with CCME, NS Tier 1 EQS, and SSWQGs. Monitoring for MDMER compliance will occur during operations and is not a requirement for a recognized closed mine (MDMER, 2022). Water quality monitoring conducted in the closure phase will include comparison to CCME, NS Tier 1 EQS, and SSWQGs.

During the closure phase, the TMF and WRSAs will be covered and vegetated and the till and organic material stockpiles will be removed and used for reclamation activities. Runoff from the reclaimed TMF and WRSAs will continue to be collected in the settling ponds indefinitely.

The north settling pond is to receive runoff from a portion of the northwest WRSA, the mill area, and several till and organic material stockpiles. This pond will begin discharging to Gold Brook Lake in the construction phase and will continue discharging indefinitely.

During operations, the central settling pond will receive the East and West Pits dewatering water, as well as runoff from the northwest WRSA, northeast till stockpile, and organic material stockpiles. The central settling pond will discharge to Gold Brook Lake in the construction and operations phases. During the closure phase the central settling pond will discharge to the West Pit.

The southeast settling pond will receive runoff from the southeast WRSA and an organic material stockpile. This pond will begin discharging to Gold Brook in the construction phase and will continue discharging indefinitely.

The southwest settling pond will receive runoff from the southwest till stockpile and an organic material stockpile. The southwest settling pond will begin discharging to Gold Brook Lake in the construction phase and will continue be decommissioned/reclaimed following removal of the till and organic material stockpiles in the closure phase.

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.

Water quality at four discharge points will be monitored for MDMER compliance during the Project's operations phase: TMF, north settling pond, central settling pond, and southeast settling pond. MDMER compliance criteria are only applicable for operational mines; water quality monitoring conducted in the closure phase will include comparison to CCME, NS Tier I EQS, and SSWQGs.

A near-field mixing zone model was created to determine the extent of the three-dimensional dilution zone around the discharge points where mixing of the effluent (treated mine contact water) and the receiving waters (Gold Brook Lake and Gold Brook) occurs. This is commonly referred to as Near Field Region (NFR) or Initial Dilution Zone (IDZ). The water quality objectives for the receiving water body do not apply within the IDZ, which is the initial portion of a larger effluent dilution zone. The Atlantic Canada Wastewater Guidelines (ACWG) (Environment Canada, 2006) set limits on the size of the mixing zone which have been adopted for this assessment. The guidelines state that a mixing zone be constrained by the following targets:

- Not to exceed 25% of the cross-sectional area or volume of flow in streams/rivers for all flow regimes equal to or exceeding the 7Q20 flow for the area
- Not to exceed 1/3 of the river width at any transect in receiving stream/river
- Not to exceed beyond a 100 m radius from the effluent outfall in a lake

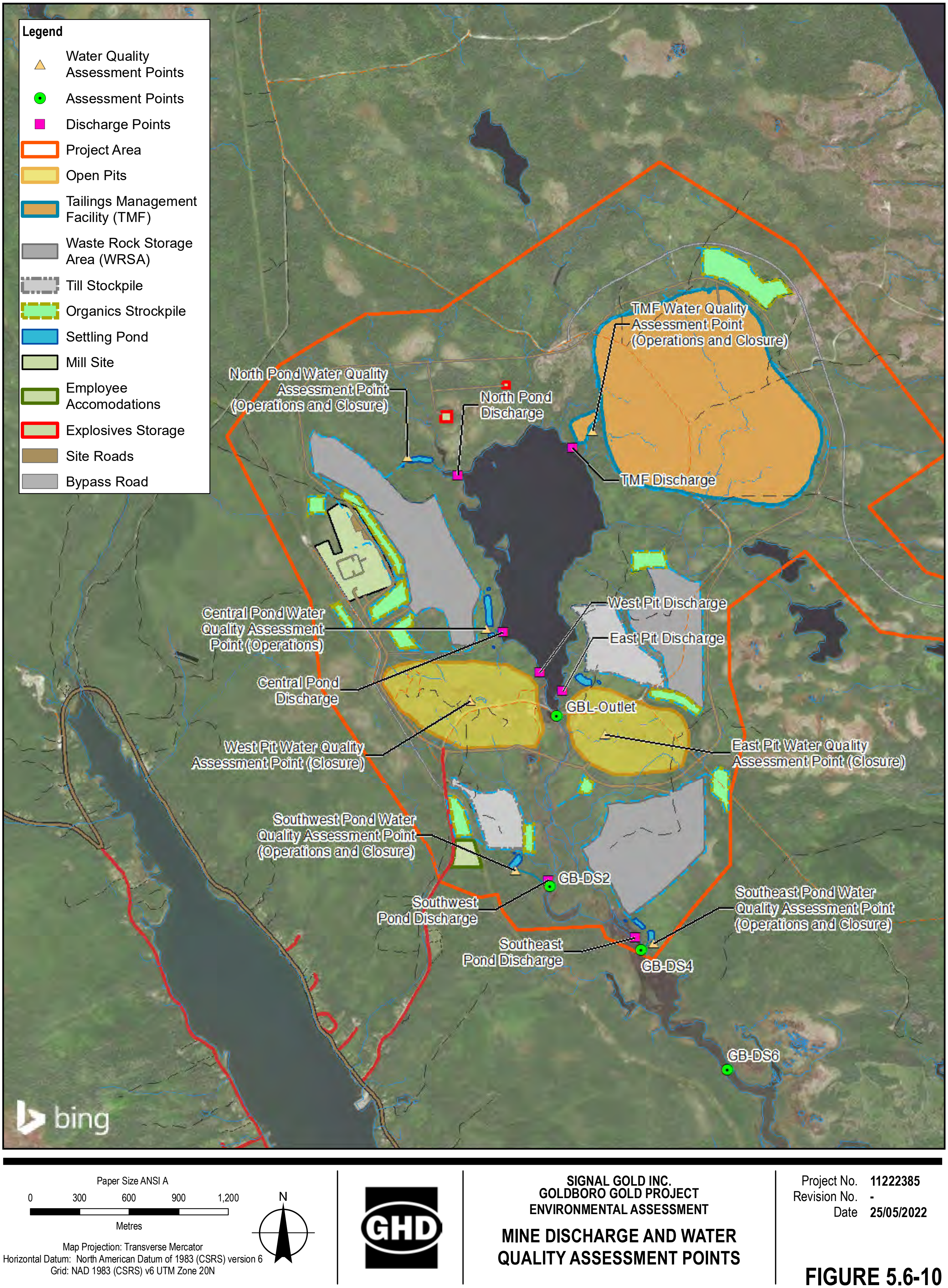
The mixing zone model was created for the NFR using the Cornell Mixing Zone Expert System (CORMIX) modelling software, which solves various equations of turbulence structure and is commonly used for the analysis, prediction, and design of an effluent discharge into a receiving water body. A detailed description of the modelling methodology and results can be found in Appendix F.8.

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 five discharge points: the TMF discharge, North Settling Pond discharge, Central Settling Pond discharge (during operations only), West Pit discharge (once the West Pit has filled with water in the closure phase) and East Pit discharge (once the East Pit has filled with water in the closure phase). The effluent from each of the Gold Brook Lake assessment points were found to fully mix within 100 m of the discharge points. However, 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 concentrations 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.

The predictive water quality assessment points are shown on Figure 5.6-10.



Map Projection: Transverse Mercator
Horizontal Datum: North American Datum of 1983 (CSRS) version 6
Grid: NAD 1983 (CSRS) v6 UTM Zone 20N

SIGNAL GOLD INC.
GOLDBORO GOLD PROJECT
ENVIRONMENTAL ASSESSMENT

MINE DISCHARGE AND WATER QUALITY ASSESSMENT POINTS

Project No. 11222385
Revision No. -
Date 25/05/2022

FIGURE 5.6-10

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5.6.5.4 Thresholds for Determination of Significance

5.6.5.4.1 Surface Water Quantity

The characterization criteria applied in the surface water quantity effects assessment are defined in Table 5.6-7 below.

A significant adverse effect to surface water quantity from the Project is defined as:

- Residual effects have high magnitude, are of potential regional geographic extent and of medium to long term duration, occur at any frequency and are only partially reversible to irreversible.

Table 5.6-7 Characterization Criteria for Residual Effects on Surface Water Quantity

Characterization	Quantitative Measure or Definition of Qualitative Categories
Magnitude	**N** – Change in predicted average monthly discharge is within 1% of baseline conditions **L** – Change in predicted average monthly discharge is greater than 1% but less than 10% below baseline conditions **M** – Change in predicted average monthly discharge is greater than 10% but less than 25% below baseline conditions **H** – Change in predicted average monthly discharge is greater than 25% below baseline conditions
Geographic Extent	**PA** – direct and indirect effects from Project activities are restricted to the PA **LAA** – direct and indirect effects from Project activities are restricted to the LAA **RAA** – direct and indirect effects from Project activities are restricted to the RAA
Timing	**N/A** — seasonal aspects are unlikely to affect VCs **A** — seasonal aspects may affect VCs
Duration	**ST** – effects are limited to the construction phase or operations phase **MT** – effects occur in the construction phase and operations phase **LT** – effects occur in the construction phase and operations phase and persist in closure **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

5.6.5.4.2 Surface Water Quality

The characterization criteria applied in the surface water quality effects assessment are defined in Table 5.6-8 below.

A significant adverse effect to surface water quality from the Project is defined as:

- Residual effects have high magnitude, are of potential regional geographic extent and of medium to long term duration, occur at any frequency and are only partially reversible to irreversible.

Table 5.6-8 Characterization Criteria for Residual Effects on Surface Water Quality

Characterization	Quantitative Measure or Definition of Qualitative Categories
Magnitude	**N** – Predicted average concentrations are below the 95th percentile baseline concentration and the applicable guideline (CCME, NS Tier 1 EQS, or SSWQG) **L** – Predicted average concentrations are greater than the 95th percentile baseline concentration but lower than the applicable guideline (CCME, NS Tier 1 EQS, or SSWQG) **M** – Predicted average concentrations in the upper-case scenario (i.e., 90th percentile source terms) are greater than the 95th percentile baseline concentration and greater than the applicable guideline (CCME, NS Tier 1 EQS, or SSWQG) **H** – Predicted average concentrations in the base case scenario (i.e., median source terms) are greater than the 95th percentile baseline concentration and greater than the applicable guideline (CCME, NS Tier 1 EQS, or SSWQG)
Geographic Extent	**PA** – direct and indirect effects from Project activities are restricted to the PA **LAA** – direct and indirect effects from Project activities are restricted to the LAA **RAA** – direct and indirect effects from Project activities are restricted to the RAA
Timing	**N/A** — seasonal aspects are unlikely to affect VCs **A** — seasonal aspects may affect VCs
Duration	**ST** – effects are limited to the construction phase or operations phase **MT** – effects occur in the construction phase and operations phase **LT** – effects occur in the construction phase and operations phase and persist in closure **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

5.6.6 Project Interactions and Potential Effects

Potential Project interactions with surface water are presented in Table 5.6-9 below.

33 watercourses are anticipated to be directly impacted by Project activities, as detailed in Table 5.6-10. NS watercourse alteration approvals for these watercourses will be required to support Project development.

Table 5.6-9 Project Activities and Surface Water 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 - Environmental monitoring - General waste management
Operations	11 years	- Drilling and blasting - Open pit dewatering - Ore management - Waste rock management - Surface water management - Cyanide and reagent management - Petroleum products management - Site maintenance and repairs - Tailings management - Water treatment - Environmental monitoring - General waste management
Closure	24 years	- Demolition - Earthworks - Water Treatment - Environmental monitoring - General waste management

Table 5.6-10 Direct Impacts to Watercourses

Watercourse	Infrastructure	Length (m)	Area (m^2)
WC1	West Pit, Haul Road	363	660
WC2	West Pit	212	259
WC3	West Pit	957	850
WC4	Haul Road, Ditch, West Pit	1191	1554
WC5	West Pit	260	119
WC6	Ditch	104	69
WC7	West Pit, Haul Road	485	422
WC8	West Pit	534	594
WC9	Northeast Till Stockpile, Ditch	110	9
WC11	Haul Road, East Pit	1073	963

Table 5.6-10 Direct Impacts to Watercourses

Watercourse	Infrastructure	Length (m)	Area (m^2)
WC12	East Pit	389	609
WC13	Flow Reduction	87	83
WC15	TMF	1358	1894
WC22	Haul Road	15	74
WC23	Ditch	169	225
WC43	TMF	684	725
WC45	TMF	640	708
WC47	TMF	47	38
WC49	TMF and flow reduction	858	943
WC51	Haul Road	14	149
WC52	Haul Road	117	117
WC57	TMF	441	460
WC58	Haul Road	12	7
WC59	TMF	120	107
WC61	Flow Reduction	81	67
WC63	Flow Reduction	57	63
WC64	Haul Road	25	127
WC65	Flow Reduction	57	34
WC72	Haul Road	13	26
WC81	Haul Road	13	29
WC88	Haul Road	14	10
WC99	TMF	242	242
Beaver Pond	West Pit	N/A	4060

5.6.6.1 Surface Water Quantity

5.6.6.1.1 Flows

The average of the annual flow volumes for the baseline, East Pit EOM, West Pit EOM, and Closure scenarios at each of the 29 assessment points are presented in Table 5.6-11, below.

The GB-DS7 assessment point represents the downstream limit of the water balance analysis. The maximum average annual flow reduction predicted at GB-DS7 is 15.6% during the West Pit EOM development phase. It is expected that the maximum average annual flow reduction on Gold Brook during the West Pit EOM development phase will be approximately 10% at the outlet of Seal Harbour Lake. This is due to the increased natural drainage of approximately 1830 ha; therefore, it is expected that the impacts of the Project on flow reduction during West Pit EOM are limited to areas upstream of Seal Harbour Lake.

Table 5.6-11 Summary of Average Annual Flow Impacts

Assessment Point	Baseline	East Pit EOM		West Pit EOM		Closure	
	Volume (m^3)	Volume (m^3)	Percent Change from Baseline	Volume (m^3)	Percent Change from Baseline	Volume (m^3)	Percent Change from Baseline
Lake Outlet	8,810,000	7,945,000	-9.8%	7,304,000	-17.1%	9,478,000	7.6%
GB-DS1	9,221,000	8,055,000	-12.6%	7,415,000	-19.6%	9,605,000	4.2%
GB-DS2	2,648,000	2,224,000	-16.0%	2,052,000	-22.5%	2,627,000	-0.8%
GB-DS3	5,334,000	4,281,000	-19.7%	4,023,000	-24.6%	5,236,000	-1.8%
GB-DS4	11,210,000	9,354,000	-16.6%	8,714,000	-22.3%	11,230,000	0.2%
GB-DS5	11,930,000	10,010,000	-16.1%	9,520,000	-20.2%	11,990,000	0.5%
GB-DS6	12,470,000	10,560,000	-15.3%	10,070,000	-19.2%	12,530,000	0.5%
GB-DS7	14,670,000	12,740,000	-13.2%	12,380,000	-15.6%	14,700,000	0.2%
WC-69-US	596,069	591,617	-0.7%	594,643	-0.2%	595,943	0.0%
WC-22-US	1,778,000	1,746,000	-1.8%	1,755,000	-1.3%	1,759,000	-1.1%
WC-22-DS1	1,890,000	1,795,000	-5.0%	1,804,000	-4.6%	1,808,000	-4.3%
WC-22-DS2	2,056,000	1,960,000	-4.7%	1,970,000	-4.2%	1,974,000	-4.0%
WC-50-DS	292,639	140,760	-51.9%	141,527	-51.6%	141,886	-51.5%
WC-14-US	662,460	651,824	-1.6%	657,837	-0.7%	660,619	-0.3%
WC-14-DS1	974,756	809,346	-17.0%	815,471	-16.3%	818,310	-16.0%
WC-14-DS2	1,140,000	815,012	-28.5%	816,795	-28.4%	898,077	-21.2%
WC-14-DS3	1,651,000	858,470	-48.0%	860,713	-47.9%	935,336	-43.3%
WC-14-DS4	1,755,000	946,698	-46.1%	949,428	-45.9%	1,027,000	-41.5%
WC-9-DS	567,162	280,003	-50.6%	317,815	-44.0%	344,327	-39.3%
WC-51-US	1,030,000	1,022,000	-0.8%	1,027,000	-0.3%	1,029,000	-0.1%
WC-20-DS1	1,312,000	1,229,000	-6.3%	1,236,000	-5.8%	1,239,000	-5.6%
WC-20-DS2	1,535,000	1,371,000	-10.7%	1,378,000	-10.2%	1,382,000	-10.0%
WC-20-DS3	257,950	183,553	-28.8%	184,451	-28.5%	185,175	-28.2%
WC-16-DS	132,396	20,995	-84.1%	12,269	-90.7%	66,542	-49.7%
WC-3-US	281,269	30,980	-89.0%	97,937	-65.2%	97,623	-65.3%
WC-3-DS	404,896	119,737	-70.4%	199,930	-50.6%	207,921	-48.6%
WC-55-DS	89,420	73,497	-17.8%	74,198	-17.0%	76,875	-14.0%
WC-10-DS	68,607	27,845	-59.4%	25,623	-62.7%	28,409	-58.6%
WC-11-DS	591,830	499,077	-15.7%	488,747	-17.4%	483,216	-18.4%

The predicted impacts to each assessed watercourse are summarized below. Further detail on the water balance analysis conducted for this assessment is provided in Appendix F.5.

Gold Brook

The greatest reduction in monthly flows predicted for Gold Brook is predicted to be 29.20% at GB-DS3 in February during the West Pit EOM scenario (i.e., high magnitude). Changes in monthly flows in Gold Brook during the Closure scenario range from an 8.1% reduction at GB-DS3 during May to a 28.2% increase at the Lake Outlet in August (i.e., low magnitude).

WC3

The greatest reduction in monthly flows predicted for WC3 in the operations phase of the Project is predicted to be 90.1% at WC-3-US in November during the East Pit EOM scenario (i.e., high magnitude). The greatest reduction in monthly flows predicted for WC3 in the closure phase of the Project is predicted to be 65.5% in August at WC-3-US (i.e., high magnitude).

WC9

The greatest reduction in monthly flows predicted for WC9 in the operations phase of the Project is predicted to be 39.1% at WC-9-DS in January during the East Pit EOM scenario (i.e., high magnitude). The greatest reduction in monthly flows predicted for WC9 in the closure phase of the Project is predicted to be 26.7% in 10 months at WC-9-DS (i.e., high magnitude).

WC10

The greatest reduction in monthly flows predicted for WC10 in the operations phase of the Project is predicted to be 64.1% at WC-10-DS in March during the East Pit EOM scenario (i.e., high magnitude). The greatest reduction in monthly flows predicted for WC10 in the closure phase of the Project is predicted to be 58.9% in December at WC-10-DS (i.e., high magnitude).

WC11

The greatest reduction in monthly flows predicted for WC11 in the operations phase of the Project is predicted to be 19.8% at WC-11-DS in January during the East Pit EOM scenario (i.e., moderate magnitude). The greatest reduction in monthly flows predicted for WC11 in the closure phase of the Project is predicted to be 18.5% in March at WC-11-DS (i.e., moderate magnitude).

WC14

The greatest reduction in monthly flows predicted for WC14 in the operations phase of the Project is predicted to be 49.1% at WC-14-DS3 in July during the West Pit EOM scenario (i.e., high magnitude). The greatest reduction in monthly flows predicted for WC14 in the closure phase of the Project is predicted to be 43.6% in August at WC-14-DS3 (i.e., high magnitude).

WC16

The greatest reduction in monthly flows predicted for WC# in the operations phase of the Project is predicted to be 92.6% at WC-16-DS in November during the West Pit EOM scenario (i.e., high magnitude). The greatest reduction in monthly flows predicted for WC16 in the closure phase of the Project is predicted to be 50.3% in August at WC-16-DS (i.e., high magnitude).

WC20

The greatest reduction in monthly flows predicted for WC20 in the operations phase of the Project is predicted to be 12.5% at WC-20-DS2 in July during the West Pit EOM scenario (i.e., moderate magnitude). The greatest reduction in monthly flows predicted for WC20 in the closure phase of the Project is predicted to be 10.0% in eight months at WC-20-DS2 (i.e., low magnitude).

WC22

The greatest reduction in monthly flows predicted for WC22 in the operations phase of the Project is predicted to be 6.9% at WC-22-DS1 in July during the West Pit EOM scenario (i.e., low magnitude). The greatest reduction in monthly flows predicted for WC22 in the closure phase of the Project is predicted to be 4.4% in nine months at WC-22-DS1 (i.e., low magnitude).

WC50

The greatest reduction in monthly flows predicted for WC50 in the operations phase of the Project is predicted to be 52.8% at WC-50-DS in July during the West Pit EOM scenario (i.e., high magnitude). The greatest reduction in monthly flows predicted for WC50 in the closure phase of the Project is predicted to be 51.6% in May and June at WC-50-DS (i.e., high magnitude).

WC51

The greatest reduction in monthly flows predicted for WC51 in the operations phase of the Project is predicted to be 2.7% at WC-51-US in July during the West Pit EOM scenario (i.e., low magnitude). No reduction in monthly flows is predicted for WC51 in the closure phase of the Project (i.e., 0.0% change from baseline, negligible magnitude).

WC55

The greatest reduction in monthly flows predicted for WC55 in the operations phase of the Project is predicted to be 19.1% at WC-55-DS in July during the West Pit EOM scenario (i.e., moderate magnitude). The greatest reduction in monthly flows predicted for WC55 in the closure phase of the Project is predicted to be 14.1% in four months at WC-55-DS (i.e., moderate magnitude).

WC69

The greatest reduction in monthly flows predicted for WC69 in the operations phase of the Project is predicted to be 2.7% at WC-69-US in July during the West Pit EOM scenario (i.e., low magnitude). No reduction in monthly flows is predicted for WC69 in the closure phase of the Project (i.e., 0.0% change from baseline, negligible magnitude).

5.6.6.1.2 Groundwater-Surface Water Interaction

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, based on the Baseflow Index (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. Reductions in baseflow as result of the Project may result in changes in temperature in WC-14.

There will be no baseflow contributions to Gold Brook at the GB-DS1 assessment point due to the proximity of the East and West Pits. 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. Reductions in baseflow as result of the Project may result in changes in temperature in Gold Brook.

5.6.6.1.3 Gold Brook Lake Water Levels

As described in Section 5.6.5.2.4, the impact of the Project 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. The results presented on Figure 5.6-11 show 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 graph plots the Gold Brook Lake active storage depths on the y-axis and probability of exceedance is on the x-axis. Low probabilities of exceedance correspond to higher lake depths and high probabilities of exceedance correspond to lower lake depths. This curve shows that during the wet periods the lake water level for West Pit EOM conditions will be lower than in baseline conditions, and more importantly during low flow conditions the impacts are negligible.

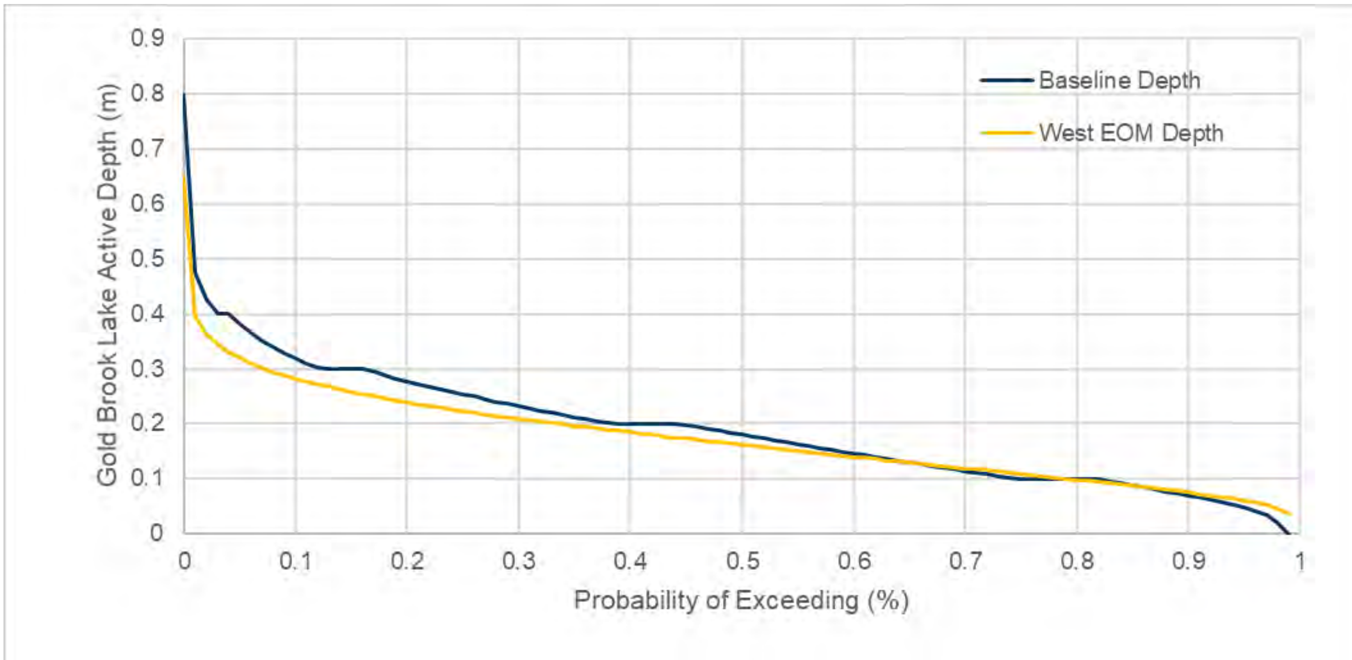


Figure 5.6-11 Comparison of Gold Brook Lake Active Depths between Baseline and West Pit EOM Scenarios

5.6.6.1.4 Gold Brook Water Levels

As discussed in Section 5.6.5.2.5, hydraulic modelling was completed to estimate the effects of the Project on the hydraulic regime of Gold Brook between Gold Brook Lake (upstream) and Seal Harbour Lake (downstream). Figure 5.6-12 and Figure 5.6-13 below present the Water Surface Elevation (WSE) longitudinal profiles for the 10^{th} percentile and average flow conditions, as well as the difference in elevation from baseline to West Pit EOM conditions. The channel stationing presented in these longitudinal profiles is shown in Figure 5.6-14, below.

As shown in these figures, a maximum difference of approximately 15 cm (increase) occurs for the 10^{th} percentile flow conditions. For low flow conditions (10^{th} percentile), there is an expected increase of flows from baseline to West Pit EOM conditions. This increase in water level 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).

For average flow conditions, the maximum difference in water levels between baseline and West Pit EOM conditions is an approximate 4 cm decrease. This decrease is considered negligible.

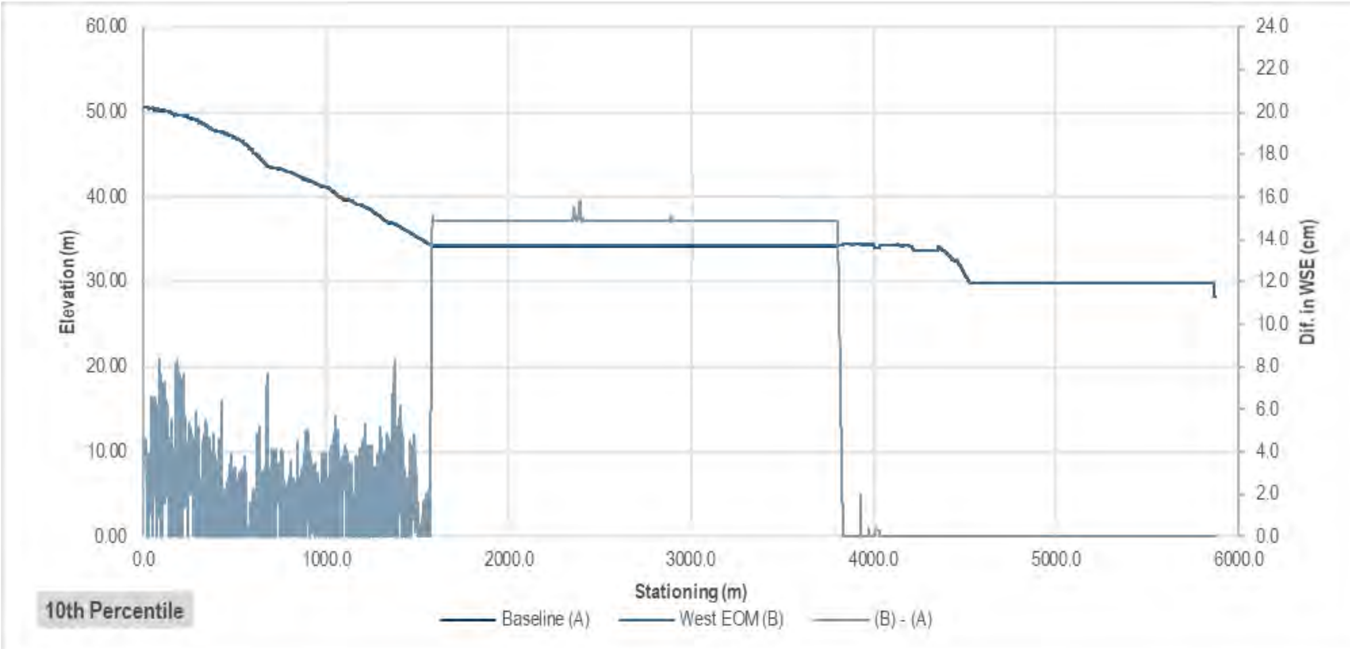


Figure 5.6-12 Longitudinal Profile of Water Surface Elevations and Difference and Water Levels - 10th Percentile Flow Conditions

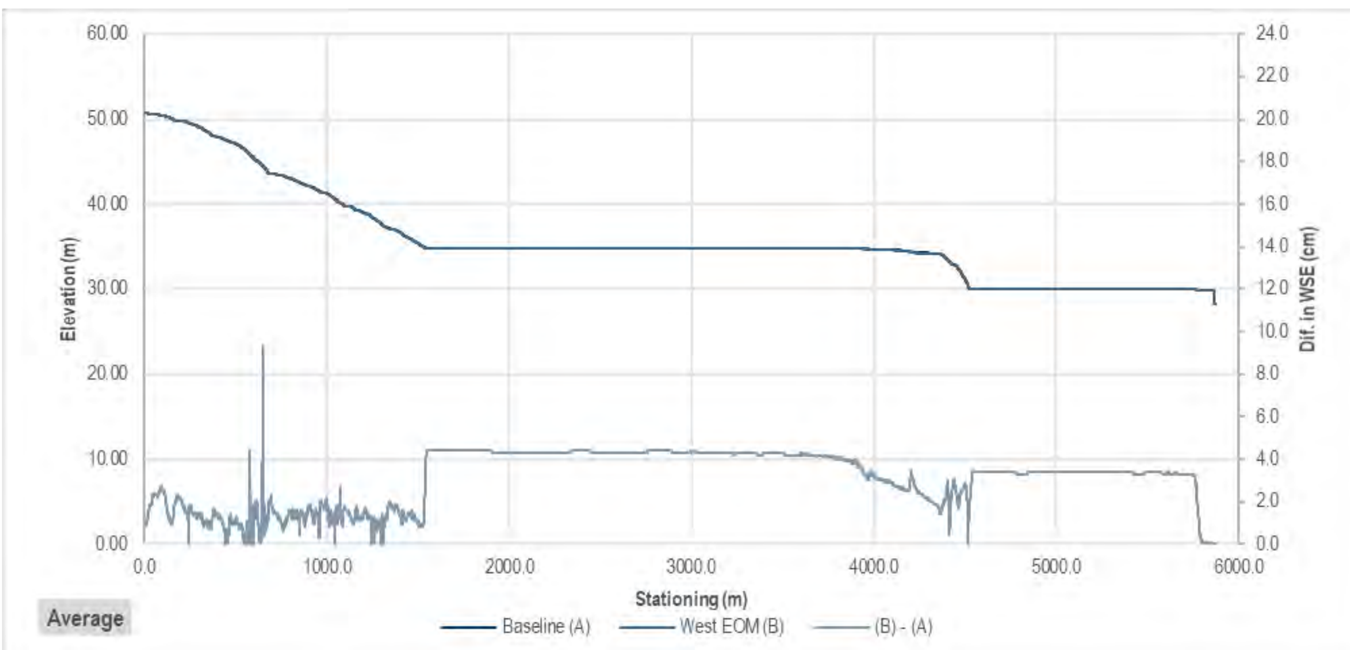


Figure 5.6-13 Longitudinal Profile of Water Surface Elevations and Difference and Water Levels - Average Flow Conditions

Figure 5.6-14   Gold Brook Channel Stationing

5.6.6.1.5   Historic Tailings

Mine tailings produced from historic mining operations were deposited in Gold Brook between 1893 and 1958 (Parsons et al., 2012). Historic tailings within Gold Brook have been sampled and characterized in baseline studies conducted between 2003 and 2021 and are discussed further in Section 5.4 (Geology, Soil, and Sediment) and in the Phase I/II ESA provided in Appendix E.2.

As discussed in Section 5.6.6.1.5, there is an expected increase of water levels in Gold Brook from baseline to West Pit EOM based on the hydraulic modelling completed for the low flow condition (10th percentile). The maximum difference between baseline and West Pit EOM under low flow conditions is an approximate 15 cm increase occurring the 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 as shown in Figure 5.6-14). For average flow conditions, the maximum difference in water levels between baseline and West Pit EOM is an approximate 4 cm decrease, which is considered negligible. Considering the predicted increase in water levels at West Pit EOM under low flow conditions, it is unlikely that any new areas of historic tailings within the sediments of Gold Brook will be exposed as a result of the Project.

Geochemical analysis performed on historic tailings samples suggests the material has undergone weathering in the past 64 to 129 years. Six historic tailings samples collected in 2021 underwent acid-base accounting analysis, as described in the Geochemical Characterization and Source Terms report provided in Appendix E.3. Five of the six samples contained moderate total sulphur (> 0.20 wt.%), which is present primarily as sulphide sulphur. These results indicate sulphide oxidation in the tailings is relatively slow and that sulphide grains may develop oxidation rims inhibiting further degradation over time. Alternatively, this finding may also be a result of the development of an oxidation front within the tailing deposits below which oxidation is limited. Nevertheless, the presence of sulphate S at concentrations higher than those seen in the Master Composite tailings samples or in mine rock, suggests that these materials have undergone some weathering. Furthermore, field investigations conducted by the Geological Survey of Canada indicate the tailings are oxidized within the upper 20-30 cm, with the tailings below 30 cm remaining in reducing conditions (Parsons et al., 2012).

Considering the results of the hydraulic modelling completed for Gold Brook, and the current state of the surface layer of the tailings deposited in Gold Brook, Project activities are not anticipated to result in a significant change in reduction and oxidation (redox) conditions within the historic tailings. NSLI is currently undertaking a Phase I and Phase II ESA and remedial action plan for all historic tailings located on Crown land within the Upper Seal Harbour Gold District and Lower Seal Harbour Gold District, including the PA.

5.6.6.2 Surface Water Quality

5.6.6.2.1 Predictive Water Quality Assessment Results

Predictive water quality results were calculated for base case and upper-case conditions are the following five scenarios:

- East Pit EOM
- West Pit EOM
- East Pit filled
- West Pit filled
- Perpetuity

The results of the predictive water quality analysis were compared to MDMER regulatory limits (at each discharge point during operations) as well as CCME, Tier 1 EQS and SSWQGs within the receiving watercourse upon full mixing (refer to Table 5.6-4 in Section 5.6.5.1 for details on the applicable regulatory limits). A summary of which regulatory limits are applicable at which discharge locations is shown in Table 5.6-12. MDMER criteria are applicable at all discharge points during operations while CCME and Tier 1 EQS guidelines are applicable at assessment points within Gold Brook Lake and Gold Brook itself during all Project phases. SSWQGs have been established individually for Gold Brook Lake and Gold Brook due to changes in background water quality between the two waterbodies.

Table 5.6-12 Applicable Regulatory Limits Summary

Location	Regulatory Criteria									
	MDMER		CCME		Tier 1 EQS		Gold Brook Lake SSWQG		Gold Brook SSWQG	
	During Operations	After Closure	During Operations	After Closure	During Operations	After Closure	During Operations	After Closure	During Operations	After Closure
North Settling Pond	X	--	--	--	--	--	--	--	--	--
TMF	X	--	--	--	--	--	--	--	--	--
Central Settling Pond	X	NA	--	NA	--	NA	--	NA	--	NA
West Pit	NA	--	NA	--	NA	--	NA	--	NA	--
East Pit	NA	--	NA	--	NA	--	NA	--	NA	--
Southeast Settling Pond	X	--	--	--	--	--	--	--	--	--
Southwest Settling Pond	X	--	--	--	--	--	--	--	--	--
Gold Brook Lake	--	--	X	X	X	X	X	X	--	--

Table 5.6-12 Applicable Regulatory Limits Summary

Location	Regulatory Criteria									
	MDMER		CCME		Tier 1 EQS		Gold Brook Lake SSWQG		Gold Brook SSWQG	
	During Operations	After Closure	During Operations	After Closure	During Operations	After Closure	During Operations	After Closure	During Operations	After Closure
Gold Brook DS2	--	--	X	X	X	X	--	--	X	X
Gold Brook DS4	--	--	X	X	X	X	--	--	X	X
Gold Brook DS6	--	--	X	X	X	X	--	--	X	X

NA - No discharge from this location during this scenario
-- - Regulatory Limits are not applicable to this location during this scenario
X - Regulatory Limits are applicable to this location during this scenario

A summary of the predicted exceedances in each scenario are shown in Table 5.6-13. Further detail on the predictive water quality assessment completed for the Project is provided in Appendix F.7.

Table 5.6-13 Predictive Water Quality Assessment Results Summary

Location	East Pit EOM		West Pit EOM		East Pit Filled		West Pit Filled		Perpetuity	
	Base Case	Upper Case	Base Case	Upper Case	Base Case	Upper Case	Base Case	Upper Case	Base Case	Upper Case
North Settling Pond	Arsenic	Arsenic	--	Arsenic	NA	NA	NA	NA	NA	NA
TMF	Arsenic	Arsenic, Cyanide	Arsenic	Arsenic, Cyanide	NA	NA	NA	NA	NA	NA
Central Settling Pond	Arsenic	Arsenic	NA	NA	NA	NA	NA	NA	NA	NA
West Pit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
East Pit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Southeast Settling Pond	--	Arsenic	--	--	NA	NA	NA	NA	NA	NA
Southwest Settling Pond	--	--	--	--	NA	NA	NA	NA	NA	NA
Gold Brook Lake	Arsenic, Cobalt, Ammonia, Cyanide	Arsenic, Cobalt, Ammonia, Unionized Ammonia, Nitrite, Cyanide	Arsenic, Cobalt, Copper, Cyanide	Arsenic, Cobalt, Copper, Ammonia, Cyanide	--	--	--	--	--	--
Gold Brook DS2	Cobalt, Ammonia, Cyanide	Cobalt, Ammonia, Un-ionized Ammonia, Nitrite, Cyanide	Cobalt, Copper, Cyanide	Cobalt, Copper, Ammonia, Cyanide	--	Lead[1]	--	--	--	--
Gold Brook DS4	Ammonia, Cyanide	Ammonia, Cyanide	Cyanide	Cyanide	--	--	--	--	--	--
Gold Brook DS6	Ammonia, Cyanide	Ammonia, Cyanide	Cyanide	Cyanide	--	--	--	--	--	--

NA - No discharge from this location during this scenario
-- - No predicted exceedances from this location
[1] The maximum predicted concentration of lead at Gold Brook DS2 is 1.09 µg/L and marginally exceeds the SSWQG of 1.0 µg/L established for Gold Brook. However, this predicted maximum concentration is within the Data Quality Objectives (DQO) set by laboratories for acceptable variation between duplicate samples based on Relative Percent Differences of 20% or an absolute difference of less than 1 times the detection limit.

5.6.6.2.2 Predicted Treatment Requirements

As presented in Table 5.6-13, certain constituents are predicted to exceed regulatory limits either in effluent discharge or within the receiving watercourse due to impacts of 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 entering as well as the fully-mixed concentrations in the receiving water body are below regulatory limits.

To determine the predicted water treatment requirement, the life of the Project was broken into 11 different time periods where the treatment requirements are relatively similar, as summarized in Table 5.6-14. Representative years for each time period were chosen to determine the treatment requirements as it relates to constituents requiring treatment and the amount of treatment required to meet regulatory limits. The representative year was chosen as the year with the largest number of months of exceedances of constituents of concern during upper case source term conditions.

Table 5.6-14 Predicted Treatment Segments

Mine Life Period	Years	Representative Water Quality Year	Total Months of Exceedance – Upper Case Conditions
Early Operations	0-8	7	57
Late Operations	9 - 11	10	26
East Pit Filling – 1	12	12	39
East Pit Filling – 2	13	13	22
East Pit Filling – 3	14 - 18	15	23
East Pit Filling – 4	19-20	19	No Exceedances
West Pit Filling – 1	21- 27	21	No Exceedances[a]
West Pit Filling – 2	28 – 30	28	No Exceedances
West Pit Filling – 3	31 – 36	31	No Exceedances
Pits Filled – 1	37	37	No Exceedances
Pits Filled – 2	>38	38	No Exceedances

[a]Lead concentrations in 2 months of the year are predicted to exceed applicable regulatory limits, however, as discussed in Appendix F.7, these concentrations are within the set DQO for acceptable variation. As such, no exceedances are predicted during this period of mine life

Treatment requirements have been broken into three different categories: metals, nitrogen species and cyanide treatment requirements. During each stage of the mine life established in Table 5.6-14, the treatment requirements were calculated for each of these three categories based on the predictive water quality assessment results for the upper-case conditions. The predicted treatment requirements are summarized in Table 5.6-15.

While the results presented in Table 5.6-13 are representative of the worst-case conditions for these 5 scenarios, it was determined that COCs which could require treatment fluctuated through out the course of mine development. To ensure all water treatment requirements were assessed, additional years were evaluated to determine the predicted COCs requiring treatment. As indicated in Table 5.6-15, active treatment will be required for the first 13 years of the mine life (beginning in operations). Following 13 years of active treatment, passive treatment is predicted to be required for the following 5 years for a total treatment period of 18 years. No treatment is predicted to be required following Year 18. Potential treatment methods during each segment of Project life are discussed the Goldboro Impacted Water Treatment System memorandum provided in Appendix F.9.

Table 5.6-15 Predicted Treatment Requirements

Constituent	Early Operations	Late Operations	East Pit Filling - 1	East Pit Filling - 2	East Pit Filling - 3	East Pit Filling - 4	West Pit Filling - 1	West Pit Filling - 2	West Pit Filling - 3	Pits Filled - 1	Pits Filled - 2
	Years 0-8	Years 9-11	Year 12	Year 13	Years 14-18	Years 19-20	Years 21-27	Years 28-30	Years 31-36	Year 37	>Year 38
Arsenic	X	X	X	X							
Beryllium				X							
Chromium					X						
Cobalt	X	X	X	X							
Copper	X	X	X		X						
Zinc					X						
Ammonia	X	X	X								
Unionized Ammonia	X										
Nitrite	X										
Cyanide	X	X	X	X							
Treatment Requirements											
Metals Treatment Removal Efficiency Required	70-80% Removal	50-55% Removal	70-80% Removal	50-55% Removal	80-85% Removal	NA	NA	NA	NA	NA	NA
Nitrogen Series Treatment Removal Efficiency	98-99% Removal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyanide Treatment Removal Efficiency	90-95% Removal	90-95% Removal	96-97% Removal	90-95% Removal	NA	NA	NA	NA	NA	NA	NA
Treatment Methodology											
Active Treatment	X	X	X	X							
Passive Treatment					X						
Note: The maximum predicted concentration of lead at Gold Brook DS2 is 1.09 µg/L and marginally exceeds the SSWQG of 1.0 µg/L established for Gold Brook. However, this predicted maximum concentration is within the DQO set by laboratories for acceptable variation between duplicate samples based on Relative Percent Differences of 20% or an absolute difference of less than 1 times the detection limit. Lead was removed from the treatment requirements											

5.6.6.2.3 Post-Treatment Water Quality

Following treatment of the effluent, the concentrations of constituents of concern present will meet or will be below the MDMER criteria. In addition, concentrations of constituents of concern will be fully-mixed into the receiving water body within 100 m of the discharge points and will meet or be below the applicable regulatory limit (more conservative limit between CCME and Tier 1 EQS, over-ridden by SSWQG if developed) for Gold Brook Lake or Gold Brook. However, certain constituents may exceed the 95th percentile baseline concentrations recorded in Gold Brook Lake and/or Gold Brook. Therefore, impacts to water quality in Gold Brook Lake and Gold Brook in all Project phases are predicted to be of low magnitude as defined in Section 5.6.5.4.2, and are not considered significant.

5.6.7 Mitigation

Project mitigation measures protective of surface water resources are detailed in Table 5.6-16 below.

Table 5.6-16 Surface Water Mitigation Measures

Project Activity	Mitigation Measure
Construction	Road and site grading will be directed away from wetlands and watercourses, where possible.
	Organic material and till stockpiles will be developed with appropriate buffers (30 m) to wetlands and watercourses where practical. Ditching around stockpiles will collect all run-off for treatment of TSS prior to discharge.
	Sediment control fences will be installed in areas (e.g., slopes and embankments) where organic materials and till are exposed to potential erosion and siltation. Sediment control fences will be inspected and maintained until the disturbed areas have stabilized and revegetation has occurred.
	Duration of instream work will be minimized. Any instream work will be completed free of flowing water (i.e., temporary cofferdam to allow for work in the dry) to minimize TSS. When possible, machinery will be operated above the high-water mark or inside isolated areas.
	All ditching will be designed to reduce erosion and sedimentation through use of rock check dams, silt fences, plunge pools, and grading as appropriate. All contact water ditching will be lined to mitigate contaminant leaching into the receiving environment.
	Perimeter grading will divert non-contact water from entering the open pits to reduce the amount of dewatering required.
	Design of stockpiles will include perimeter ditches to direct water to settling ponds prior to discharge.
	Existing drainage patterns will be maintained to the extent feasible with the use of culverts and bridges.
	Disturbed areas will be graded and/or scarified, covered with organic material and till, where required, and seeded with native seed mix to promote natural plant colonization and succession.
	Passive water quality treatment technologies, including engineered wetlands to treat site seepage and runoff, will be employed as required for closure.
	The TMF will be covered in the closure phase with a combination of a geosynthetic reinforcement layer, NPGA waste rock, till, and organic material.
	The WRSAs will be covered with till and organic material immediately following completion.

Table 5.6-16 Surface Water Mitigation Measures

Project Activity	Mitigation Measure
Construction and Operations	Disturbed areas will be limited to the extent practical.
	Clearing associated with road construction will be limited, where possible, to the width required for the road embankment and drainage areas.
	Blasting will be conducted by a certified contractor who will develop a Blast Management Plan and Blast Designs for review and approval prior to carrying out the work. Blasts will be designed to meet vibration and overpressure limits at appropriate distances from any existing structures (i.e., pipeline, residential receptors), Project infrastructure, and fish habitat. A monitoring plan will be implemented to record vibration and overpressure for each blast.
	Surfaces of organic material and till stockpiles will be stabilized during extended periods between usage by means of vegetating or covering exposed surfaces.
	Reagents will be stored and handled within designated containment areas. Where required, reagent storage will be located within a designated containment area to avoid mixing of incompatible chemicals. Storage tanks will be equipped with level indicators, instrumentation, and alarms to prevent spills.
Construction, Operations, and Closure	Erosion and sediment control measures will be established around all disturbed areas.
	Disturbed areas will be monitored to ensure erosion and sediment control measures are maintained/effective and to identify if additional mitigation is required.
	A ML/ARD Management Plan (Appendix E.4) will be implemented, including mitigation and monitoring procedures to address potential ML/ARD impacts.
	Seepage and surface runoff from the WRSAs, till stockpiles, organic material stockpiles, East Pit, and West Pit will be collected in six settling ponds located throughout the PA and will be treated as required prior to being discharged to Gold Brook Lake and Gold Brook.
	All surface water discharges from settling ponds to the natural environment will be sampled as per requirements listed in IA and MDMER to ensure water quality conforms to applicable regulations and guidelines.
	Progressive water management will be implemented over the life of Project. This includes construction of water management infrastructure as areas are developed.
	Erosion and sediment controls will be implemented throughout the PA and in all Project phases as per the Erosion and Sediment Control Plan provided in Appendix F.10.
	An Emergency Response and Spill Contingency Plan will include information on incident prevention, response procedures, and response training in the case of accidental spills.
	A maintenance schedule will be developed and implemented to provide for regular maintenance and inspection of Project mine water management infrastructure.
	Spill kits will be available in the vehicles and machinery circulating in the Project area and at various places throughout the PA to facilitate the management of accidental spills. Spill kits will include a quantity of sufficient absorbent materials as well as watertight containers intended to collect petroleum products and other hazardous residual materials.
	Petroleum products (hydrocarbons) will be handled in such a way as to prevent and control leaks and spills. Hydrocarbon absorbents will be kept at all times on the premises of storage or use of oil products.
	Disposal and handling of waste oils and hazardous waste will be as recommended by the suppliers and/or manufacturers in compliance with federal and provincial regulations.
	An Emergency Response and Spill Contingency Plan will include information on incident prevention, response procedures, and response training in the case of accidental spills.
	Fuel will be obtained from a licensed contractor who will be required to comply with federal and provincial regulations.

Table 5.6-16 Surface Water Mitigation Measures

Project Activity	Mitigation Measure
Operations	Runoff from mine pit walls and groundwater seepage will be collected, with water pumped to the water treatment unit associated with the northwest WRSA prior to entering the settling pond and discharging.
	Water pumped to dewater the open pits will be treated and discharged to Gold Brook Lake to mitigate surface water flows.
Operations and Closure	Effluent from the TMF will be treated to applicable discharge criteria via a WTS and polishing pond prior to being discharged to Gold Brook Lake.
	A seepage collection system will be implemented at the TMF.

5.6.8 Monitoring and Follow-up

Monitoring will be completed over the life of the Project to validate the predicted impacts to surface water quantity and quality and the efficacy of planned mitigation measures. The potential impact of the Project on surface water conditions is anticipated to change over the course of the Project lifecycle; therefore, a phased approach is proposed for the surface water monitoring program to observe potential impacts in the construction, operations, and closure phases.

Further details on the proposed surface water monitoring program, including monitoring locations, frequencies, and parameters, are provided in the Water Monitoring Plan in Appendix F.3.

5.6.8.1 Construction

The proposed surface water locations, to be monitored during (but not necessarily for the entire duration of) the construction phase, are presented in Figure 5.6-15. During the construction phase, nine water quality surveillance locations are proposed to be sampled weekly for the first three months of construction, and then monthly from thereon. SW-15-21 will be discontinued from the water quality monitoring network during the construction phase, as no impact from mine operations is anticipated at this location.

During the construction phase and onward, monitoring location SW-12-21 will need to be decommissioned due to ease of access, and monitoring location SW-22-21 located just downstream will be commissioned and monitored in its place.

Water quality and levels are monitored currently at SW-11-21, which acts as the furthest downstream monitoring location for the Project. However, due to the width and depth of Gold Brook, streamflow data collection at this location was not feasible and therefore SW-11-21 will be decommissioned during the construction phase and SW-24-21 (upstream, to a more confined portion of Gold Brook) should be implemented and streamflow monitoring will be incorporated. Therefore, during construction five locations will include streamflow monitoring.

The collection of continuous water levels only (without streamflow) is proposed to continue at only one station (SW-21-21) during construction (and through to the end of closure).

During the second year of the construction phase, select MDMER and CCME/EQS compliance monitoring locations will need to be commissioned for several of the settling ponds as well as the TMF.

5.6.8.2 Operations

The proposed surface water locations, to be monitored during (but not necessarily for the entire duration of) the operations phase, are presented in Figure 5.6-16.

During the operations phase, surface water monitoring locations will adapt to accommodate the phased approach of site operations and as adaptive water management activities require. Following site construction, monitoring at SW-20-21 will no longer be admissible due to the proposed location of the West Pit and will therefore be decommissioned.

Five water quality monitoring locations have been identified (TMF-Pond, SE-Pond, CTR-Pond, SW Pond, and NW-Pond) to monitor settling and polishing pond locations, upstream of their discharge to receiving water bodies and watercourses. Note that there is no proposed discharge into a receiving waterway for the east settling pond, as it will be pump to the central settling pond prior to discharge and therefore no compliance location is proposed. Water quality at four of these locations (TMF-Pond, SE-Pond, CTR-Pond, and NW-Pond) will be monitored for MDMER compliance. The SW Pond location will be monitored for surveillance water quality parameters and TSS, as contact water being treated at this facility is only anticipated to be in contact with an organic material stockpile and a till stockpile.

Five water quality monitoring locations have been identified (SW-23, SW-24, SW-25, SW-26, and SW-27) to monitor downstream of discharge points, within the receiving waterbody. Samples at four of these locations (all but SW-26) will be monitored for CCME and NS Tier 1 EQS compliance. SW-26, located downstream of the SW Pond location will only be monitored for surveillance water quality parameters and TSS.

5.6.8.3 Closure

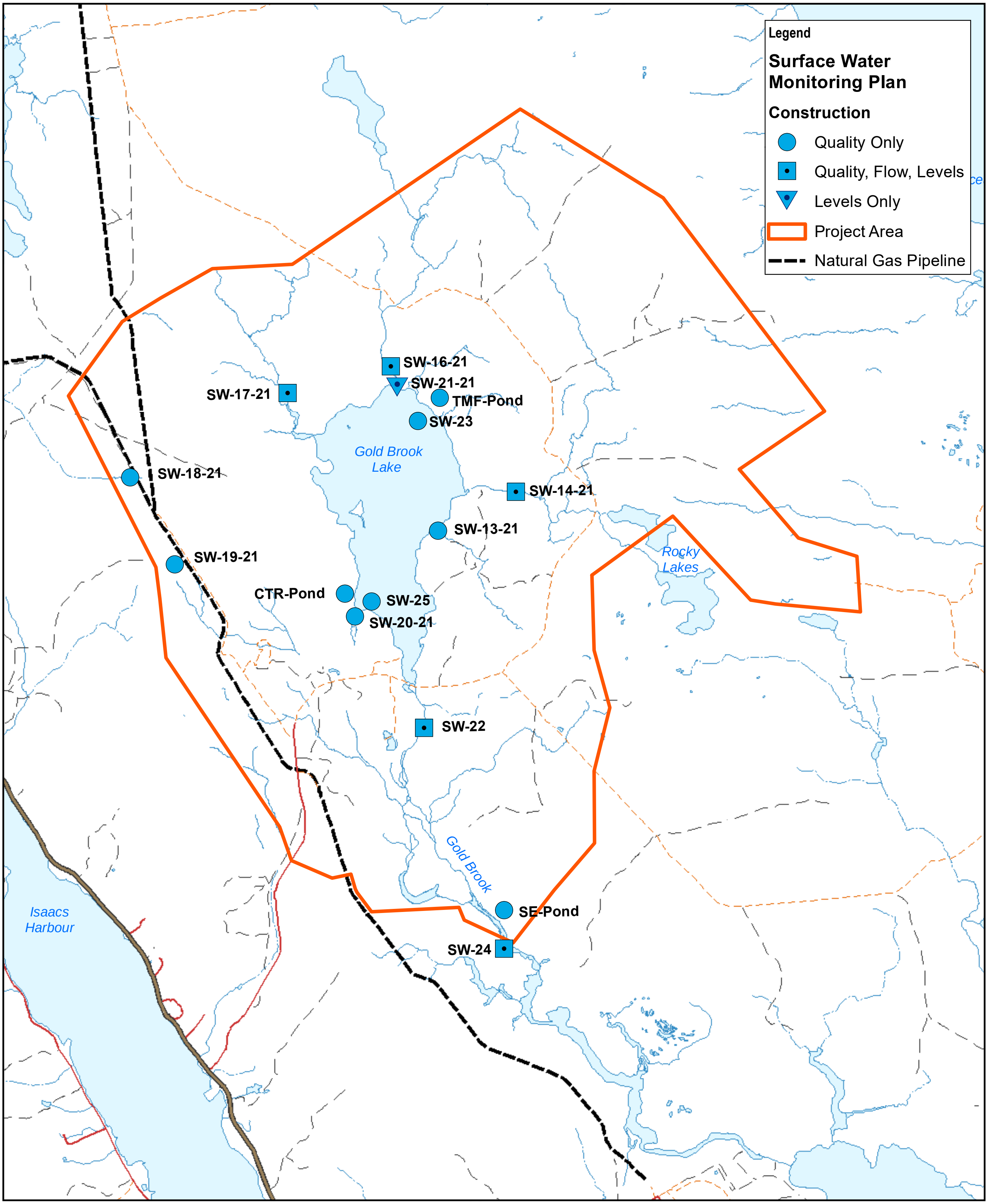
The proposed surface water locations to be monitored during (but not necessarily for the entire duration of) the closure phase are presented in Figure 5.6-17.

Surface water quality and quantity monitoring will continue at four locations (SW-14-21, SW-21-21, SW-22, and SW-24) following the completion of the operations phase. SW-14-21 will be monitored for three years after operations is complete, while the remainder will be monitored throughout the pit filling period and will be terminated once water quality and quantity stabilize and following consultation with applicable regulators.

Monitoring at MDMER compliance locations can be decommissioned following completion of the operations phase. CCME/EQS monitoring locations at the settling and polishing pond discharge points (in the receiving water bodies) will likely continue for another three years, to confirm compliance.

Discharge to the receiving waterbody from the East Pit is anticipated to begin in Year 14 (2 years following operations phase is completed). SW-28 will be commissioned at this time to confirm CCME/EQS compliance and will be monitored for three years.

Discharge to the receiving waterbody from the West Pit is anticipated to begin in Year 35. SW 29 will be commissioned at this time to confirm CCME/EQS compliance and will be monitoring for three years.



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Metres

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GHD

SIGNAL GOLD INC.
GOLDBORO GOLD PROJECT
ENVIRONMENTAL ASSESSMENT

SURFACE WATER MONITORING LOCATIONS CONSTRUCTION

Project No. 11222385
Revision No. -
Date 25/05/2022

FIGURE 5.6-15

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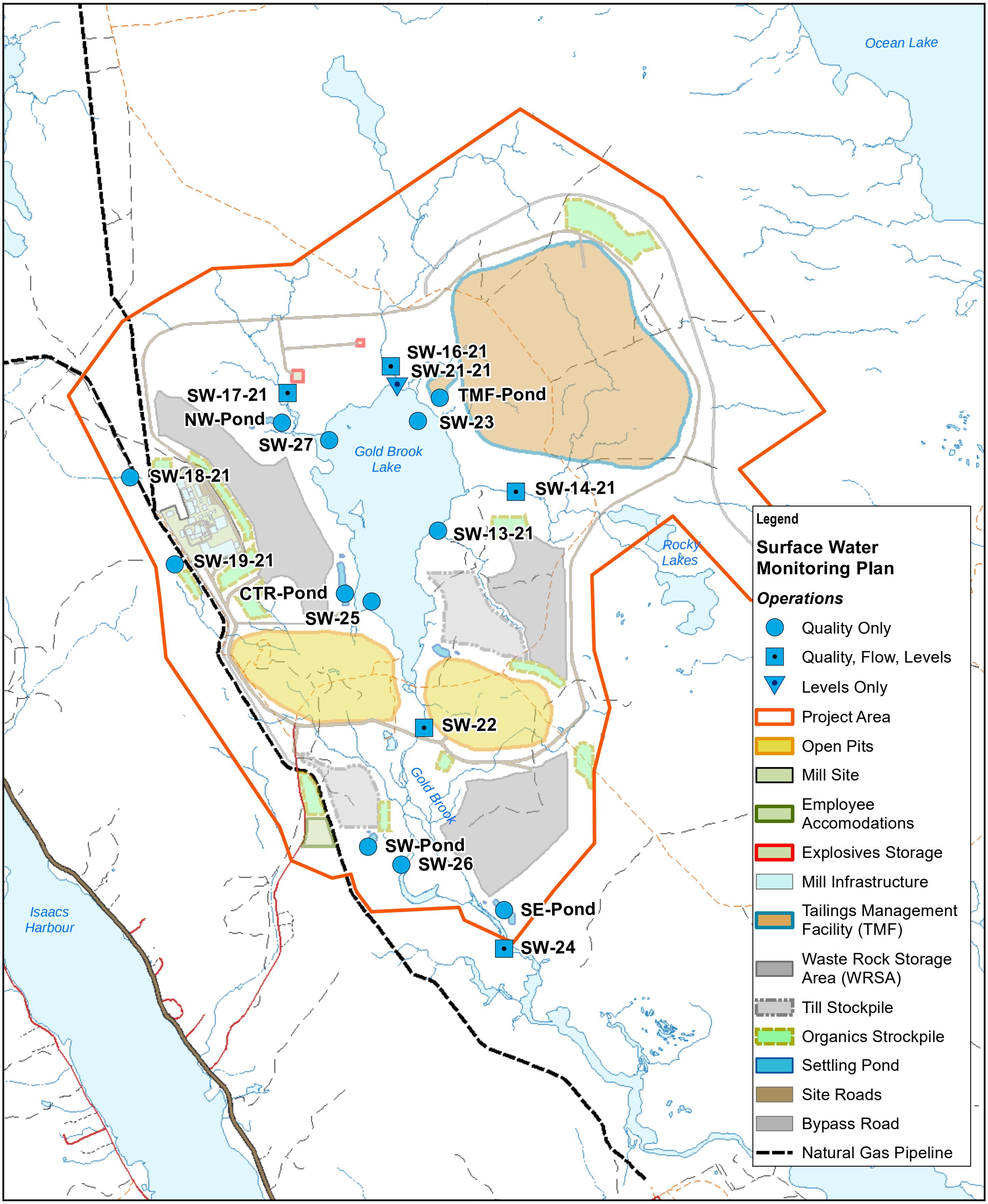

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GHD

SIGNAL GOLD INC.
GOLDBORO GOLD PROJECT
ENVIRONMENTAL ASSESSMENT

SURFACE WATER MONITORING LOCATIONS OPERATIONS

Project No. 11222385
Revision No. -
Date 25/05/2022

FIGURE 5.6-16

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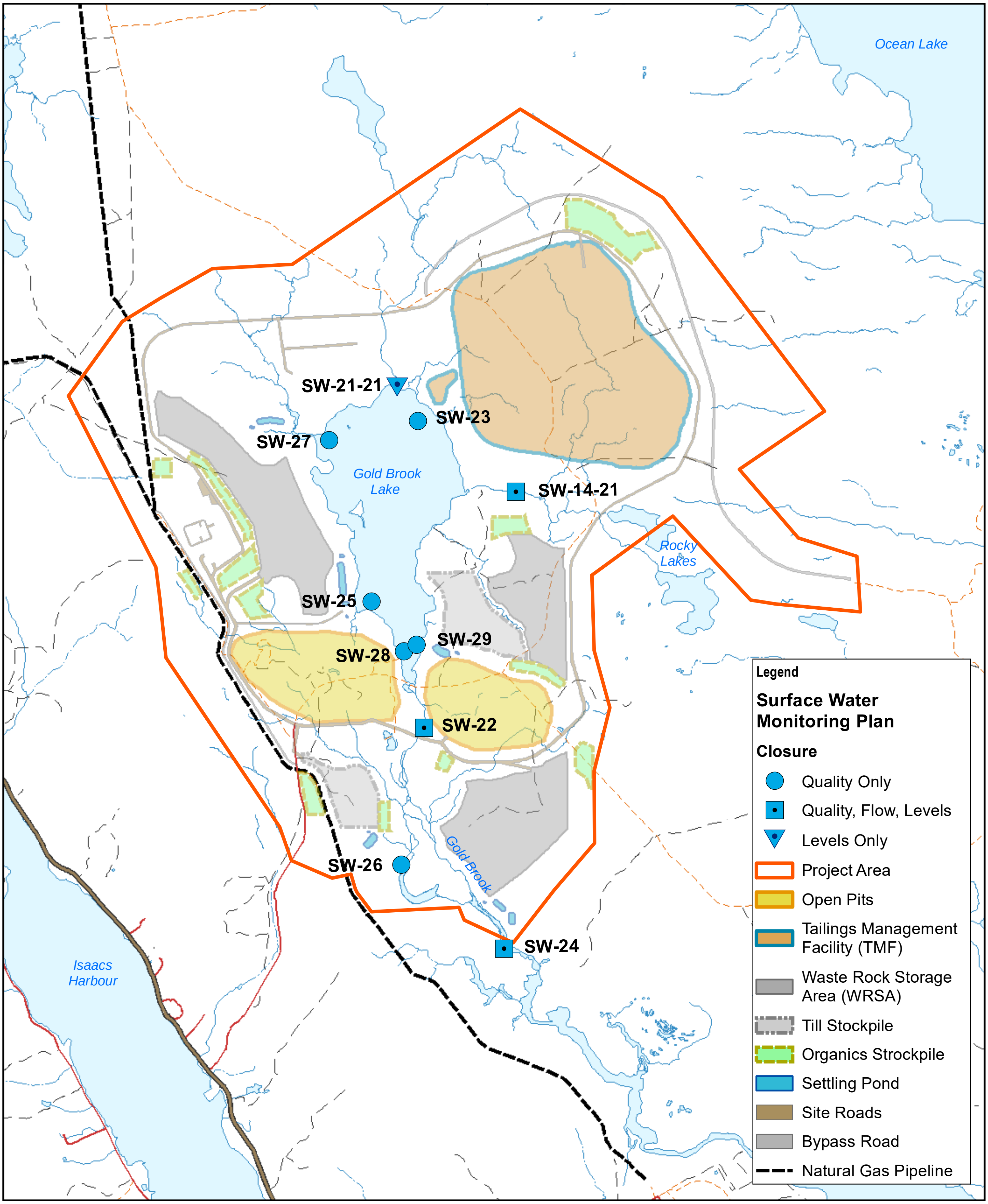

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Map Projection: Transverse Mercator
Horizontal Datum: North American Datum of 1983 (CSRS) version 6
Grid: NAD 1983 (CSRS) v6 UTM Zone 20N

GHD

SIGNAL GOLD INC.
GOLDBORO GOLD PROJECT
ENVIRONMENTAL ASSESSMENT

SURFACE WATER MONITORING LOCATIONS CLOSURE

Project No. 11222385
Revision No. -
Date 25/05/2022

FIGURE 5.6-17

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5.6.9 Company Commitments

No company commitments related to surface water are proposed for the Project beyond the mitigation and monitoring described herein.

5.6.10 Residual Effects and Significance

A significant adverse effect to the Surface Water Resources (quantity and quality) VC was defined in Section 5.6.6 as:

- Project-related residual effects have high magnitude, are of potential regional geographic extent and of medium to long term duration, occur at any frequency and are only partially reversible to irreversible.

The predicted residual environmental effects of the Project on surface water resources are assessed to be adverse, but not significant. The overall residual effect of the Project on surface water is assessed as not likely to have significant adverse effects after appropriate mitigation measures have been implemented as summarized in Section 5.6-7. Residual effects to surface water resources are summarized in Table 5.6-17, and are further addressed in Sections 5.7 (Wetlands) and 5.8 (Fish and Fish Habitat).

Table 5.6-17 Residual Effects on Surface Water

Component	Project Interactions	Mitigation and Compensation Measures	Nature of Effect	Residual Effects Characteristics						Residual Effect	Significance
				Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility		
Surface Water Quality	Construction – Clearing, grubbing, and grading; infrastructure construction	Erosion and sediment controls	A	L Erosion and sediment controls are expected to minimize impacts to receiving waterbodies	PA	A	ST	S	PR	Change in water quality	Not significant
	Operations – Effluent discharge to Gold Brook Lake	Contact water collection and treatment	A	L Post-treatment water quality concentrations are greater than the 95th percentile baseline concentration but below applicable guidelines	PA	A	P	C	IR	Change in water quality	Not significant
	Operations – Effluent discharge to Gold Brook	Contact water collection and treatment	A	L Post-treatment water quality concentrations are greater than the 95th percentile baseline concentration but below applicable guidelines	PA	A	P	C	IR	Change in water quality	Not significant
	Closure – Effluent discharge to Gold Brook Lake	TMF and WRSA covers Water treatment	A	L Post-treatment water quality concentrations are greater than the 95th percentile baseline concentration but below applicable guidelines	LAA	A	P	C	IR	Change in water quality	Not significant
	Closure – Effluent discharge to Gold Brook	TMF and WRSA covers Water treatment	A	L Post-treatment water quality concentrations are greater than the 95th percentile baseline concentration but below applicable guidelines	LAA	A	P	C	IR	Change in water quality	Not significant
Surface Water Quantity	Construction – Direct impacts to watercourses	Micro-siting Project infrastructure away from watercourses where possible Fish Habitat Offset Plan	A	H Watercourses will be directly altered by Project infrastructure	PA	A	P	C	IR	Watercourse alteration	Not significant
	Operations – Reduction in flow in Gold Brook	Dewatering West Pit to Gold Brook Lake between East Pit EOM and West Pit EOM	A	H Flow reductions from baseline conditions greater than 25% predicted from January to May in West Pit EOM scenario	LAA	A	MT	C	IR	Reduction in flow Dewatering of historic tailings in Gold Brook	Not significant
	Operations – Reduction in flows in watercourses 22, 51, and 69	None	A	L Flow reductions from baseline conditions between 1 and 10%	PA	A	MT	C	IR	Reduction in flow	Not significant

Table 5.6-17 Residual Effects on Surface Water

Component	Project Interactions	Mitigation and Compensation Measures	Nature of Effect	Residual Effects Characteristics						Residual Effect	Significance
				Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility		
	Operations – Reduction in flows in watercourses 11, 20, and 55	None	A	M Flow reductions from baseline conditions between 10 and 25%	PA	A	MT	C	IR	Reduction in flow	Not significant
	Operations – Reduction in flows in watercourses 3, 9, 10, 14, 16, and 50	None	A	H Flow reductions from baseline conditions greater than 25%	PA	A	MT	C	IR	Reduction in flow	Not significant
	Closure – Reduction in flow in Gold Brook	East Pit and West Pit lakes full and discharging to Gold Brook Lake	A	L Flow reductions from baseline conditions between 1 and 10%	LAA	A	P	C	IR	Reduction in flow Dewatering of historic tailings in Gold Brook	Not significant
	Closure – Reduction in flows in watercourses 51 and 69	None	A	N Flow reductions from baseline conditions less than 1%	PA	A	P	C	IR	Reduction in flow	Not significant
	Closure – Reduction in flows in watercourses 20 and 22	None	A	L Flow reductions from baseline conditions between 1 and 10%	PA	A	P	C	IR	Reduction in flow	Not significant
	Closure – Reduction in flows in watercourses 11 and 55	None	A	M Flow reductions from baseline conditions between 10 and 25%	PA	A	P	C	IR	Reduction in flow	Not significant
	Closure – Reduction in flows in watercourses 3, 9, 10, 14, 16, 20, and 50	None	A	H Flow reductions from baseline conditions greater than 25%	PA	A	P	C	IR	Reduction in flow	Not significant

Legend (refer to Tables 5.6-7 and 5.6-8 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 R – Reversible IR – Irreversible PR – Partially Reversible

5.7 Wetlands

Wetlands provide important ecological value and functions, such as habitat for aquatic and terrestrial flora and fauna (including priority species), managing water storage and flow, and improving downstream water quality. The socioeconomic importance of wetlands from a recreational and resource perspective is also considered and further discussed in Section 5.10.

5.7.1 Rationale for Valued Component Selection

In NS, wetlands are protected under the *Activities Designation Regulation* of the *Environment Act* and the Wetland Conservation Policy (NSE, 2019). The *Environment Act* defines a wetland as "land referred to as a marsh, swamp, fen, or bog that either periodically or permanently has water table at, near, or above the land surface or that is saturated with water, and sustains aquatic processes as indicated by the presence of poorly drained soils, hydrophytic vegetation, and biological activities adapted to wet conditions".

The NS Wetland Conservation Policy (NSE, 2019) applies to all freshwater and certain tidal wetlands with the objectives to prevent net loss of wetland area or function, promote wetland protection and net gain, and enhance impact mitigation efforts. Under this policy and the *Environment Act*, approvals are required to alter wetlands, with certain exceptions (e.g., area <100 m^2, specific linear developments).

5.7.2 Baseline Program Methodology

Detailed wetland assessment methodologies, timing, and limitations are presented in the Wetland Baseline Report provided in Appendix G.1. The baseline report was prepared to support the Project's wetland effects assessment and submission of the EARD. Baseline wetland surveys were completed with the key objectives of facilitating mitigation and avoidance of wetlands where practical, assessing wetland function (including habitat provisions for species at risk), understanding the potential Project interactions with wetlands, and supporting wetland regulatory applications and permitting.

A review of background desktop resources was completed to aid in the determination and in-field assessment of wetland habitat (e.g., topographic mapping, aerial imagery, NSECC predicted wetland and Wetland of Special Significance (WSS) datasets, flow accumulation data set, LiDAR). Wetland delineation surveys were completed by GEMTEC (2017) and MEL (2020 to 2022) in accordance with the Corps of Engineers Wetland Delineation Manual (Environmental Laboratory, 1987) and the Regional Supplement to the United States Army Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (United States Army Corps of Engineers, 2012). Wetland functional assessments were completed for each wetland within the PA using the Wetland Ecosystem Services Protocol – Atlantic Canada (WESP-AC) wetland evaluation technique. Further baseline surveys were conducted to assess the suitability of wetland habitat for wetland-specific species, especially those considered to be SAR and/or SOCI. Species-specific methodologies are presented in the respective Fish and Fish Habitat, Avifauna, and Flora and Fauna Baseline Reports provided in Appendices H.1, I.1, and I.1, respectively.

5.7.3 Baseline Conditions

Baseline wetland conditions within the PA are summarized here and further detailed in the Wetland Baseline Report (Appendix G.1).

A total of 222 freshwater wetlands are present within the PA, totaling 329.033 ha and representing a land cover of 27% of the PA. Delineated wetlands range in size from 0.010 ha to 72.470 ha and are predominantly soft or mixedwood treed wetlands. Various wetlands within the PA have been subject to historic anthropogenic disturbances, most notably historic mining activities (e.g., setting ponds, waste rock), timber harvesting, associated road networks, and cutlines. However, many wetlands are largely intact and were observed to retain natural functions.

While only 13% of the delineated wetlands are complexes, comprising of swamp, fen, and bog components, complexes equate to 74% of the total wetland area in the PA. The largest wetland complex is Wetland 1, associated with Gold Brook. Evidence of historic mine tailings was observed in portions of Wetland 1, notably in northern lobes near historic mine operations and at the outflow of Gold Brook Lake immediately south of Goldbrook Road, where reduced vegetative cover is observed. While changes to vegetation composition and cover likely impacts habitat type and qualify for wetland associated wildlife, further physical impacts to wetland functions were not observed or predicted as a result of tailings presence (e.g., water quality was not assessed).

Observed individual wetland classes are described below and presented in the Wetland Baseline Report (Appendix G.1):

- Swamps: Swamps represent the most abundant wetland class in the PA, accounting for 71% of all wetlands (not including wetland complexes). Swamps identified in the PA are predominantly coniferous dominant or mixedwood, with few deciduous dominant swamps. 75% of swamps had a prominent shrub layer which primarily consisted of saplings including black spruce (*Picea marian*a), balsam fir (*Abies balsamea*), red maple (*Acer rubrum*), and tamarack (*Larix laricina*), as well as woody shrubs such as wild raisin (*Vibernum nudum*), mountain holly (*Ilex mucronatus*) and speckled alder (*Alnus incana*). The majority of swamps delineated within the PA (91%) are under 1 ha in size, and collectively they account for only 17% of the total wetland area. However, this is likely slightly underrepresented, as all wetland complexes contain a swamp component. 70% of swamps delineated within the PA are isolated, 20% are in a throughflow position, 9% are in a headwater (outflow) position, and less than 1% receive surface water inflow but lack a defined outflow.
- Bogs: Bogs account for 12% of all wetlands within the PA and 8% of the total wetland area, ranging in size from 0.023 to 5.720 ha. This does not include the bog components found in 89% of the wetland complexes. Treed bogs are typically limited to coniferous trees, namely black spruce and tamarack, which was consistent with what was found in the PA. Mixed-wood bogs were rare and deciduous trees found in bogs within the PA were limited to red maple. Low shrub bogs, whose tree layers are sparse or absent, are characterized by ericaceous shrubs like leatherleaf (*Chamaedaphne calyculata*), sheep laurel (*Kalmia angustifolia*), and Labrador tea (*Rhododendron groenlandicum*), which are adapted to the acidic and nutrient poor soils indicative of bogs. 63% of bog habitats in the PA have a prominent shrub layer. Herbaceous layer diversity within bogs is greatly lower than that of swamps.
- Fens: Fens account for 4% of the wetlands within the PA, ranging in size from 0.041 to 3.100 ha, and occupy 2% of the total PA wetland area. Additionally, 29% of wetland complexes contain a fen component. All fens are associated with a waterbody or watercourse, 75% are directly associated with Gold Brook Lake, and the rest with throughflow watercourses. Most fens found within the PA are dominated by graminoid species and 25% have a prominent shrub layer. Tree species are mainly limited to black spruce, red maple, and balsam fir.
- Marshes: While some wetland complexes may have marginal marsh components, no marshes were distinctly observed within the PA.

In general, water flows from north to south within the PA, primarily through Gold Brook Lake, largely originating in headwater wetland systems, and exiting the PA at Gold Brook through Wetland 1. Hydrological flow from the northern portion of the PA into Gold Brook Lake is predominantly influenced by large wetland complexes consisting of swamp, bog, and fen components, such as Wetland 42. Gold Brook Lake is also hydrologically fed by district topographic gradients from the east and west via headwater and throughflow wetlands. Hydrological flow paths east of Gold Brook Lake are also influenced by a topographic divide which generally runs north-southeast of Watercourse 43. Hydrological inputs east of this divide primarily exit the PA towards Ocean Lake and other off-site waterbodies. Local wetland hydrology is highly dependent on wetland type and position on the landscape. Most individual wetlands are hydrological isolated swamps and bogs, in the sense that they do not have defined surface water connections (inlets/outlets/throughflow). Many large wetland complexes are hydrologically connected via throughflow watercourses and Gold Brook Lake.

While historic tailings are delineated along the length of Gold Brook (mapped from Gold Brook Lake to south of Seal Harbour Lake), and associated riparian wetlands, there is no visual evidence of impacts to this wetland system beyond the lake outflow.

The WESP-AC evaluation results and functional scores for all wetlands with the PA are provided in the Wetland Baseline Report (Appendix G.1). These results show that, on average, the grouped function and benefit scores of wetlands within the PA are Lower to Moderate, with the exception of the Water Quality, Aquatic Support and

Transitional Habitat groups which score higher. The descriptions and their functional significance of each group are provided in the Wetland Baseline Report (Appendix G.1). No functional WSS were identified through the WESP-AC assessments.

There are 22 wetlands within the PA in which sessile or non-mobile SAR (i.e., blue felt lichen (*Pectenia plumbea,* SARA/Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Special Concern, NSESA Vulnerable) or frosted glass-whiskers lichen (*Sclerophora peronella*, SARA/COSEWIC Special Concern, S3S4) were observed. One additional wetland contained a confirmed observation of a mobile SAR (i.e., Canada warbler (*Cardellina canadensis*) in Wetland 25). Other wetlands with SAR observations in proximity to (but not within) their boundaries are discussed in the Wetland Baseline Report (Appendix G.1) but are not considered as potential WSS herein. It is anticipated that the 22 wetlands with observations of SAR lichen will be classified as WSS and are presented as such herein. All (23) wetlands with confirmed SAR (mobile or sessile) will be reviewed with NSECC. Final WSS designation will be made by NSECC.

The NSECC predictive WSS layer also identified Wetland 1 as a potential WSS based on species designation. The Project's ACCDC report (Appendix I.2) identified an observation of a short-eared owl (*Asio*, *flammeus*, SARA Special Concern, COSEWIC Special Concern, S1S2B) approximately 1 km south of the PA boundary in 2008. Short-eared owl was not identified during field surveys. No other NSECC predicted WSS fall within the PA. Wetland 1 contains observations of SAR lichen and will be carried forward as a potential WSS based on these occurrences.

5.7.4 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 wetlands include:

- Effects of construction (e.g., sedimentation, water quality, and quantity) on wetlands.
- Loss of wetland habitat.
- Wetland compensation.
- Recreational use, and uses by Mi'kmaq, for hunting, fishing, trapping, and gathering.

Results of the Project-specific public and Mi'kmaq engagement, as well as generally recognized environmental concerns, have been updated and considered in the environmental effects assessment. Signal Gold commits to wetland mitigation, monitoring measures and compensation to alleviate communicated concerns, as well as a broader commitment for ongoing public and Mi'kmaq engagement (see Section 3).

5.7.5 Effects Assessment Methodology

This section describes the effects assessment methodology used to assess potential Project related environmental effects to wetlands.

5.7.5.1 Boundaries

The scope of the Project's wetland effects assessment is defined by spatial (i.e., geographical extent of Project effects), temporal (i.e., the timing of potential effects), administrative, and technical boundaries. The spatial boundaries were defined based on the expected maximum extent of indirect and direct impacts to wetlands. The temporal boundaries are based on the anticipated duration and timing of Project activities. The assessment boundaries are described below.

5.7.5.1.1 Spatial Boundaries

The spatial boundaries used for the assessment of effects on wetlands are defined below:

- The PA encompasses the immediate area in which Project activities may occur and includes the infrastructure associated with the mine site plus a buffer of 100 – 200 m.
- The LAA encompasses the entirety of the PA and adjacent areas outside of the PA where Project related effects to wetlands are reasonably expected to occur. The LAA for wetlands consist of secondary watersheds, or portion of, that intersect with the PA, and includes the Gold Brook Shore-Direct watershed (1EQ-SD31) where Project activities are predominantly located, and portions of four other watersheds which fall within the PA: Isaacs Harbour River (1EP-1), Isaacs Harbour Shore-Direct (1EP-SD1), New Harbour River (1EQ-4), and Coddles Harbour Shore-Direct (1EQ-SD29) watersheds. The wetlands LAA is consistent with other aquatic VCs including Surface Water Resources and Fish and Fish Habitat.
- A RAA has not been defined for this VC, as the maximum extent of indirect impacts is expected to be within the LAA.

As the Project has potential to cause indirect effects to wetlands outside of the PA, the LAA is the appropriate boundary for evaluation of this VC. LAA boundaries were defined considering the maximum expected extent of direct and indirect impacts to wetlands, as well as the type and location of Project activities in each watershed (see Section 5.7.6).

Spatial boundaries defined for the wetlands effects assessment are presented in Figure 5.7-1.

5.7.5.1.2 Temporal Boundaries

The temporal boundaries used for the assessment of effects on surface water are the construction, operations, and closure phases of the Project. In order to provide a conservative, worst-case evaluation, predictive modelling was completed for two scenarios within the operations phase: East Pit Extraction will occur between Years 1 and 8, while West Pit Extraction will occur through Years 1 and 11. The indirect effects to wetlands are evaluated through these two scenarios within the overall operations phase.

The evaluation of the closure phase also consisted of two modelling scenarios: East Pit filling (Years 9 through 19) and West Pit filling (Years 12 through 35). With respect to the wetlands effects assessment, East and West Pit filling is assessed as occurring simultaneously.

5.7.5.1.3 Technical Boundaries

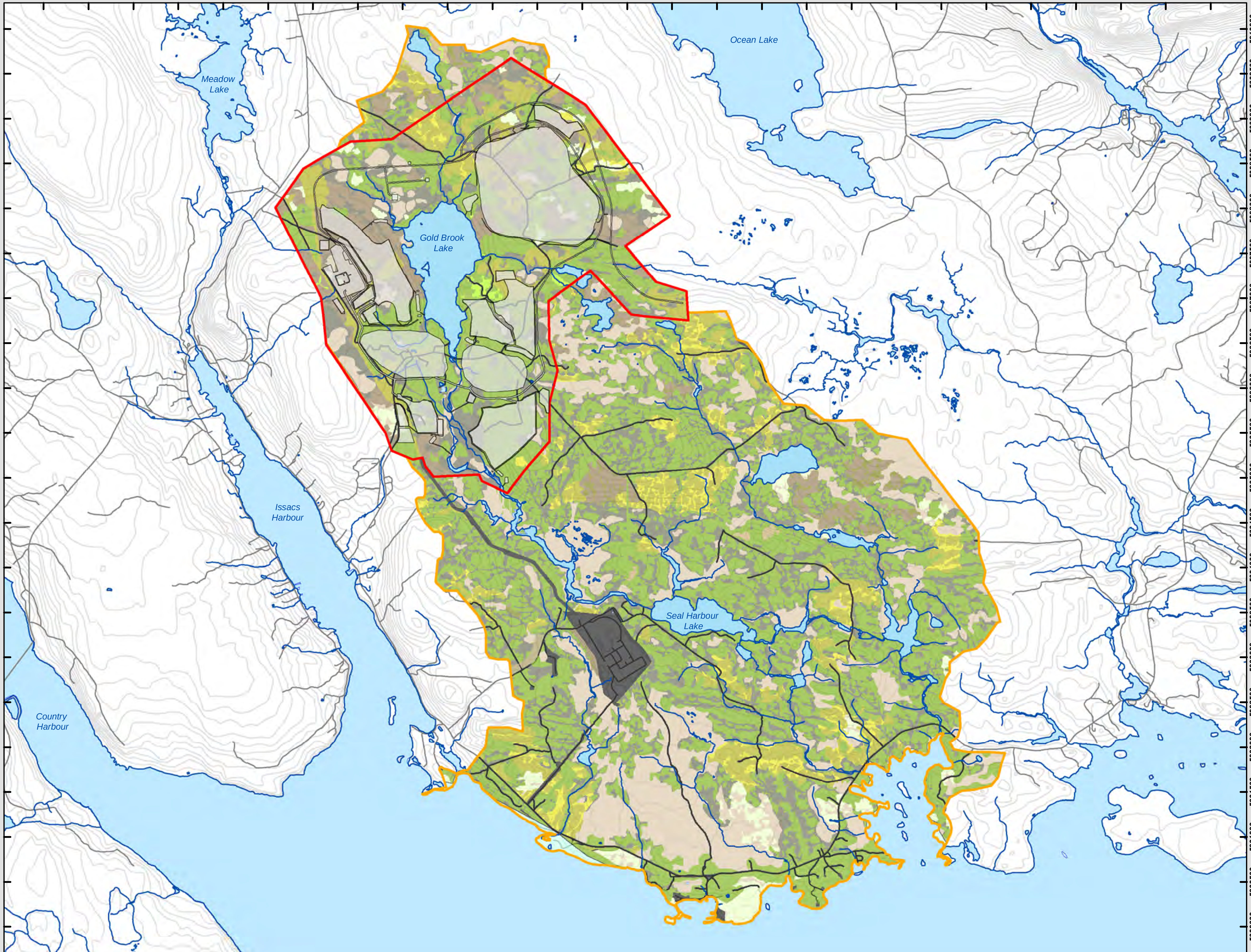
Prediction of wetland habitat within the LAA was constrained by the limitations of the habitat model developed for the Project and the available GIS inputs, detailed in Section 5.9.5.3.1. Unlike within the PA, modeled LAA habitats were not calibrated through in-field verification. The model may conservatively over-predict habitat types within the LAA, notably forested swamps which were modelled based on the cartographically derived Depth to Water index. An accuracy assessment of the habitat model is presented in Section 5.9.5.3.1.

Technical limitations of the baseline wetland delineation methodologies are described in the Wetland Baseline Report (Appendix G.1).

5.7.5.1.4 Administrative Boundaries

Administrative boundaries for the protection and conservation of wetland habitat in NS include the NS Wetland Conservation Policy (NSE, 2019), the *Environment Act* (1994), and its *Activities Designation Regulations* (1995). Further wetland protection is provided on a federal level by the Federal Policy of Wetland Conservation (1991).

The NS Wetland Conservation Policy (NSE, 2019) also provides a mechanism for the Province to designate WSS, which may include wetlands known to support at-risk species. Species, and their residences, with legal protection under the federal SARA include those listed as extirpated, endangered, or threatened. These same protections apply to endangered and threatened species listed under the NSESA. These legal protections are not afforded to SARA Special Concern and NSESA Vulnerable listed species (e.g., blue felt lichen). Protection for these species may be managed under other policies, such as the At-risk Lichens – Special Management Practices (NSDNRR, 2018).



Prepared For:

SIGNAL GOLD

FIGURE 5.7-1

Goldboro Gold Project

Wetland Spatial Boundaries and P-ELC Habitat Types

Goldboro, NS

Proposed Infrastructure
EARD Project Area
Wetland Local Assessment Area

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

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

0 550 1,100 2,200 m

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

Drawn By: SS
Reviewed By: MM
Date: 2022-05-24

McCallum Environmental Ltd.

Document Name: 220524_Fig5.7-1_WL LAA

5.7.5.2 Project Ecological Land Classification Mapping

Project-specific Geographic Information System (GIS) spatial models were developed to quantify direct impacts to wildlife habitat and vegetative communities. An evaluation of the general vegetation communities and habitat within the defined Project assessment areas was completed through the development of a desktop driven Project Ecological Land Classification (P-ELC). The P-ELC models the major vegetation communities and habitats present within relevant Project assessment areas, including wetlands.

The P-ELC, methodologies and limitations are detailed in Section 5.9 (Terrestrial Environment). A key objective of the P-ELC is to predict the location and extent of major habitat types, which includes identifying primary vegetation communities at the sub-wetland class level (e.g., unique vegetation communities are mapped in wetlands classified as complexes). The P-ELC was categorized into units based on their ecological value and includes the following wetland habitat types:

- Open Wetlands – Includes bogs, fen and marsh communities.
- Alder Swamps – Does not include tree dominant swamps with a predominant shrub layer, which are included in the Forested Swamps habitat type.
- Forested Swamps – Includes hardwood, softwood and mixedwood dominant treed swamps.
- Cutover/Regenerative Wetlands – Often comprise of pioneer and regenerative woody perennial species.

For Project effects comparison purposes, the P-ELC was completed at the PA and wetland LAA (Figure 5.7-1). Model results were calibrated within the PA using field delineated wetland boundaries and ground-truthed vegetation community assessment points. The P-ELC was verified at the LAA level through desktop review. The P-ELC was used to assess wetland impacts in greater detail, at the habitat and vegetation community level, which will be used to inform community specific Project impacts and significance thresholds, as well as appropriately tailor mitigation and compensation approaches.

5.7.5.3 Thresholds for Determination of Significance

The characterization criteria for environmental effects to wetlands are outlined in Table 5.7-1 below.

Table 5.7-1 Characterization Criteria for Environmental Effects to Wetlands

Characterization	Quantitative Measure or Definition of Qualitative Categories
Magnitude	**N** – a loss of <1% of wetland area for all modeled habitat type in the LAA, and no direct or indirect impact to identified potential WSS **L** – a loss up to 5% of wetland area for one or more modeled habitat type in the LAA, and no direct impact to identified potential WSS **M** – a loss of up to 10% of wetland area for one or more modeled habitat type in the LAA, and direct impact to identified potential WSS **H** – a loss of >10% of wetland area for one or more modeled habitat type in the LAA, including direct impacts to identified potential WSS
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 VC
Timing	**N/A** — seasonal aspects are unlikely to affect VC **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

Table 5.7-1 Characterization Criteria for Environmental Effects to Wetlands

Characterization	Quantitative Measure or Definition of Qualitative Categories
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

The wetland types and direct impacts within the PA were compared to the Project modeled wetland habitats within the LAA to assess magnitude of predicted change. This assessment is completed recognizing the modeled wetland habitat within the LAA is an estimate of wetland area with an 80% accuracy (see Terrestrial Environment, Section 5.9).

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

- An effect that results in an unmitigated or uncompensated net loss of wetland habitat, including WSS, as defined under the NSECC Wetland Conservation Policy (NSE, 2019), and its associated no-net loss policy. An adverse effect that does not cause a permanent loss of wetland habitat, in consideration of wetland functions, WSS and proposed mitigation/compensation, is not considered a significant adverse effect.

5.7.6 Project Interactions and Potential Effects

The placement of infrastructure related to the Project attempted to avoid and mitigate impacts to wetland whenever possible. Project infrastructure has undergone multiple design iterations, as described in the alternatives assessment process detailed in Section 2.8, in an attempt to reduce impacts to the environment, including wetlands, while considering other valued components such as, engineering constraints and regulatory requirements for example.

After the careful consideration of design options, Project activities will result in direct and potential indirect effects to wetlands, primarily through the construction phase (direct impacts) and operations phase (indirect impacts). The following sections describe the expected Project interactions and potential effects pathways to wetlands. An overview of Project infrastructure interactions with wetland is provided in Figure 5.7-2. Alternative locations for Project infrastructure were considered, where practical, focusing on reducing impacts to wetland habitat, specifically potential WSS. Wetland avoidance and mitigation is further discussed in Section 5.7.7. Project effects on wetlands were assessed in consideration of the effects of the Project on groundwater and surface water. As a result, this section of the EARD is informed by conclusions presented in Sections 5.5 (Groundwater Resources) and 5.6 (Surface Water Resources) and should be reviewed following those sections.

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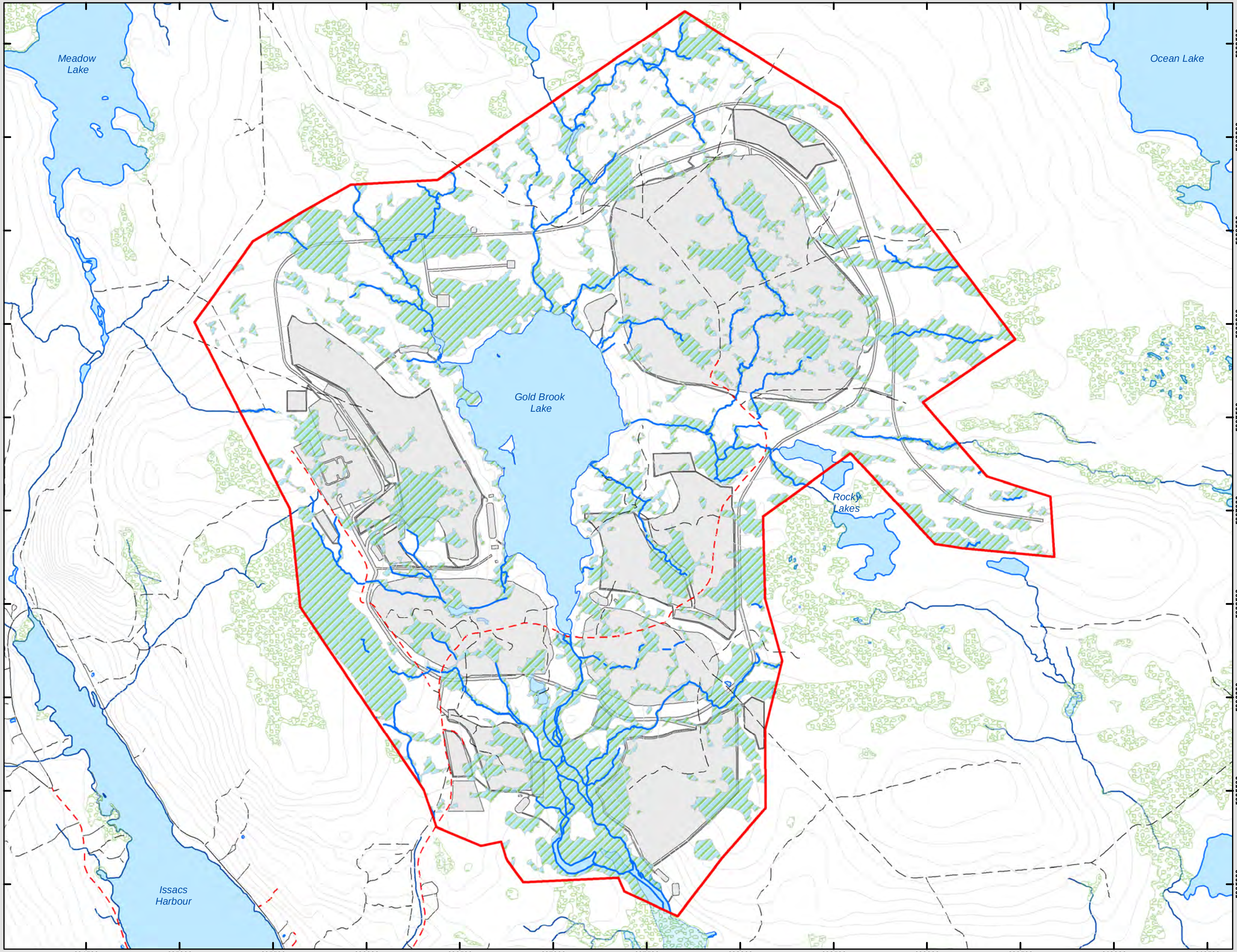
FIGURE 5.7-2

Goldboro EARD Project Area

Field Delineated Wetlands Overview

Goldboro, NS



Legend:
- Field Delineated Watercourses
- NSTDB Watercourses Outside Project Area
- Field Delineated Wetlands
- NSECC Wetland Inventory
- Open Water
- Proposed Infrastructure
- EARD Project Area

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

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Table 5.7-2 provides a summary of potential effects, effects pathways and measurable parameters used throughout the wetlands effects assessment.

Table 5.7-2 Potential Effects to Wetlands, Effects Pathways, and Measurable Parameters

Potential Effect	Effect Pathway	Measurable Parameter(s)
Change in wetland habitat quantity	- Direct impacts to wetland area through infrastructure, roads, infill and/or excavation	- Area of direct impacts to wetlands
Changes in wetland habitat quality	- Clearing of wetland vegetation and resultant changes to habitat - Accidental release of deleterious substances (e.g., petroleum products) - Introduction of invasive flora species through vehicles - Dust and/or sediment accumulation from Project construction and operations	- Changes to wetland health and integrity - Lichen monitoring (Appendix I.4) - Dust mitigations and monitoring
Change in wetland hydrology	- Change in contributing catchment area by Project infrastructure and resultant changes in flow and hydrological inputs - Groundwater drawdown due to pit construction - Inadvertent drainage or impoundment of unaltered wetland areas by up or down gradient Project alterations/infrastructure	- Reduction in catchment contributing areas and flow - Groundwater drawdown ROI - Changes to baseline wetland hydrology

The Project has potential to interact with wetlands during Project phases (i.e., construction, operations, and closure) and activities presented in Table 5.7-3. Direct impacts to wetlands will primarily occur during the construction phase through ground disturbance (e.g., excavation, infilling) and development of the East and West Pits and associated infrastructure. Other indirect impacts are likely to occur as a by-product of direct impacts associated with the construction activities, as well as from operations activities (e.g., dewatering, flow reduction, accidents and malfunctions, etc.). Wetland alteration permitting will be required where avoidance is not possible. The Project interactions indicated in the table below are discussed in detail in the context of Project effects, proposed mitigations and monitoring and residual effects. Where an interaction between the Project and wetlands is not expected, that Project activity is not included in Table 5.7-3 and the following effects assessment (i.e., general waste management, site maintenance and repairs).

Table 5.7-3 Project Activities and Wetland 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
		Environmental monitoring

Table 5.7-3 Project Activities and Wetland Interactions

Project Phase	Duration	Relevant Project Activity
Operations	11 years	Drilling and blasting
		Open pit dewatering
		Ore management
		Waste rock management
		Surface water management
		Accidents and malfunctions
		Tailings management
		Water treatment
		Environmental monitoring
Closure	24 years	Demolition
		Earthworks
		Water treatment
		Environmental monitoring

The PA lies in the headwater portion of the LAA. The Project infrastructure lies predominantly within the Gold Brook shore direct watershed (1EQ-SD31). Predicted changes to flow down-gradient of the PA, along Gold Brook, are presented in Appendix F.6 and are within the natural variability of the associated riparian wetlands. This change is not expected to result in impacts to wetlands down-gradient of the PA.

Where portions of the four additional watersheds listed in Section 5.7.5.1.1 have been included in the LAA, it is not expected that impacts to the aquatic environment, including wetlands, will extend beyond the PA into these watersheds. Table 5.7-4 provides a summary of potential catchment area and flow reduction impacts based on Project infrastructure in the adjacent watersheds. 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. Based on the extent, type and location of this infrastructure and considering the planned water management systems, Project activities are not expected to impact down-gradient portions of the watersheds presented in Table 5.7-4. No Project-related wetland effects are expected in the headwater portions of the watersheds.

Table 5.7-4 Summary of Potential Catchment Area Impacts to Adjacent Watersheds

Watershed[1]	Watershed Area (ha)	Infrastructure	Infrastructure Area (ha)	Total Area (ha)	Watershed Area Impact (as %)	Effect to Wetlands Predicted?
Isaac's Harbour River (1EP-1)	7,876.8	Northwest Wasterock Area	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

[1] Catchment area boundaries and impacts were assessed based on the Project defined local catchment areas, verified by field delineation of watercourses and flow paths, which may differ slightly from the provincial 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.

No protected areas are located downstream of the PA (i.e., Ramsar sites, Provincial Wildlife Management Areas, Provincial Parks, Nature Reserves, Wilderness Areas, known lands owned or legally protected by non-governmental charitable conservation land trusts, intact or restored wetlands under the North American Waterfowl Management Plan, or protected water areas). The nearest protected area is the Loon Lake Nature Reserve, approximately 4 km to the northeast of the PA, beyond the LAA.

5.7.6.1 Direct Impacts

The direct impact to wetlands expected during the Project, are presented in Table 5.7-5. Indirect hydrological wetland impacts to adjacent wetlands within the PA that may be expected as a result of the Project are discussed separately (Section 5.7.6.2). The following table provides expected direct impacts only. Direct loss includes physical loss of wetland area as the result of infrastructure construction.

Direct impacts are categorized as either partial or complete. Where a partial alteration is proposed (based on a direct footprint impact from infrastructure), in some cases, remaining portions of a wetland may not be maintained in a natural condition or function and is thus considered a complete alteration. Therefore, a wetland is considered completely altered when 100% of the wetland is directly impacted by Project development or the remaining wetland area will not be self-sufficient. As a result, the direct impact area of some wetlands has been expanded to include wetland fragments which lie outside of proposed infrastructure (e.g., wetland areas isolated between stockpiles and water management ditches or roads). Each wetland proposed for alteration was assessed on a case-by-case basis by the Project team of wetland biologists. When determining direct impact extent, the hydrologic regime, wetland type and morphology, alteration type, indirect effects (e.g., edge effects) and particularly the relative size of the wetland compared to alteration area are considered. Predicted alteration extent will be refined at the permitting stage and during detailed design, development of water management systems, and engineering.

Figures 5.7-3A through 5.7-3C present the proposed direct Project impacts to wetlands within the PA.

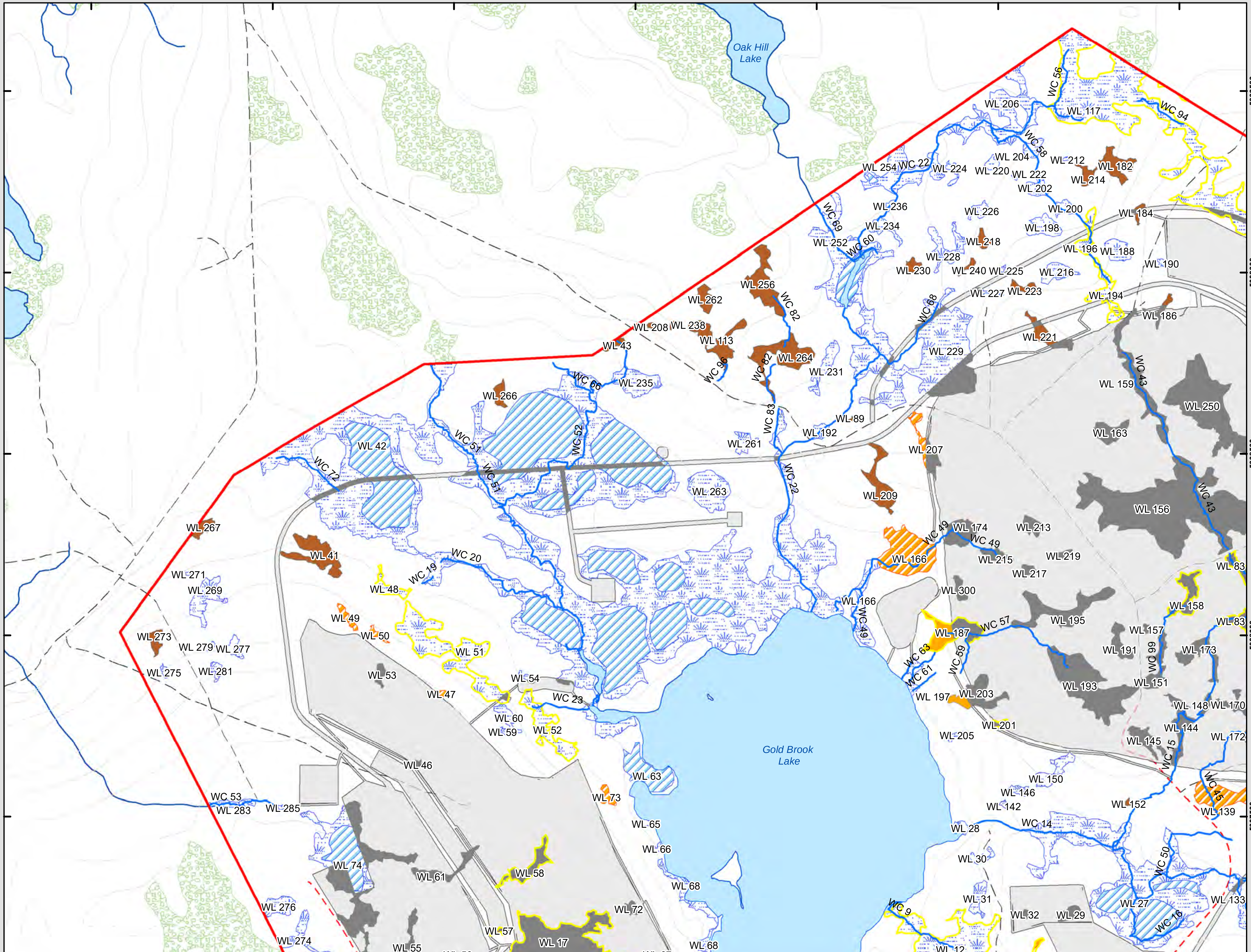

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FIGURE 5.7-3A

Goldboro Gold Project

Direct and Indirect Wetland Impacts

Goldboro, NS

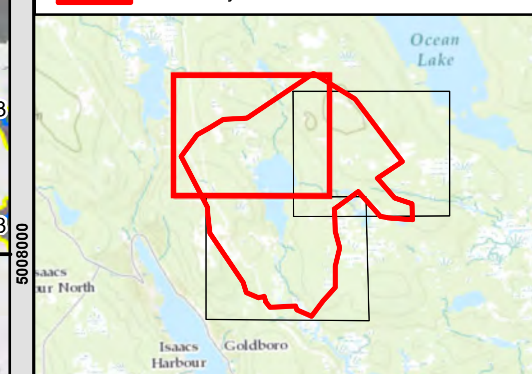
- Field Delineated Watercourses
- NSTDB Watercourses Outside PA
- Direct Impact

Indirect Impacts

- Potential Impact
- Predicted Alteration

Field Delineated Wetlands by Habitat

- Open Wetlands - Gramminoid Dominant
- Open Wetlands - Bog/Fens
- Forested Swamps
- Cutover Wetlands
- NSECC Wetland Inventory
- Potential WSS
- Open Water
- Proposed Infrastructure
- EARD Project Area



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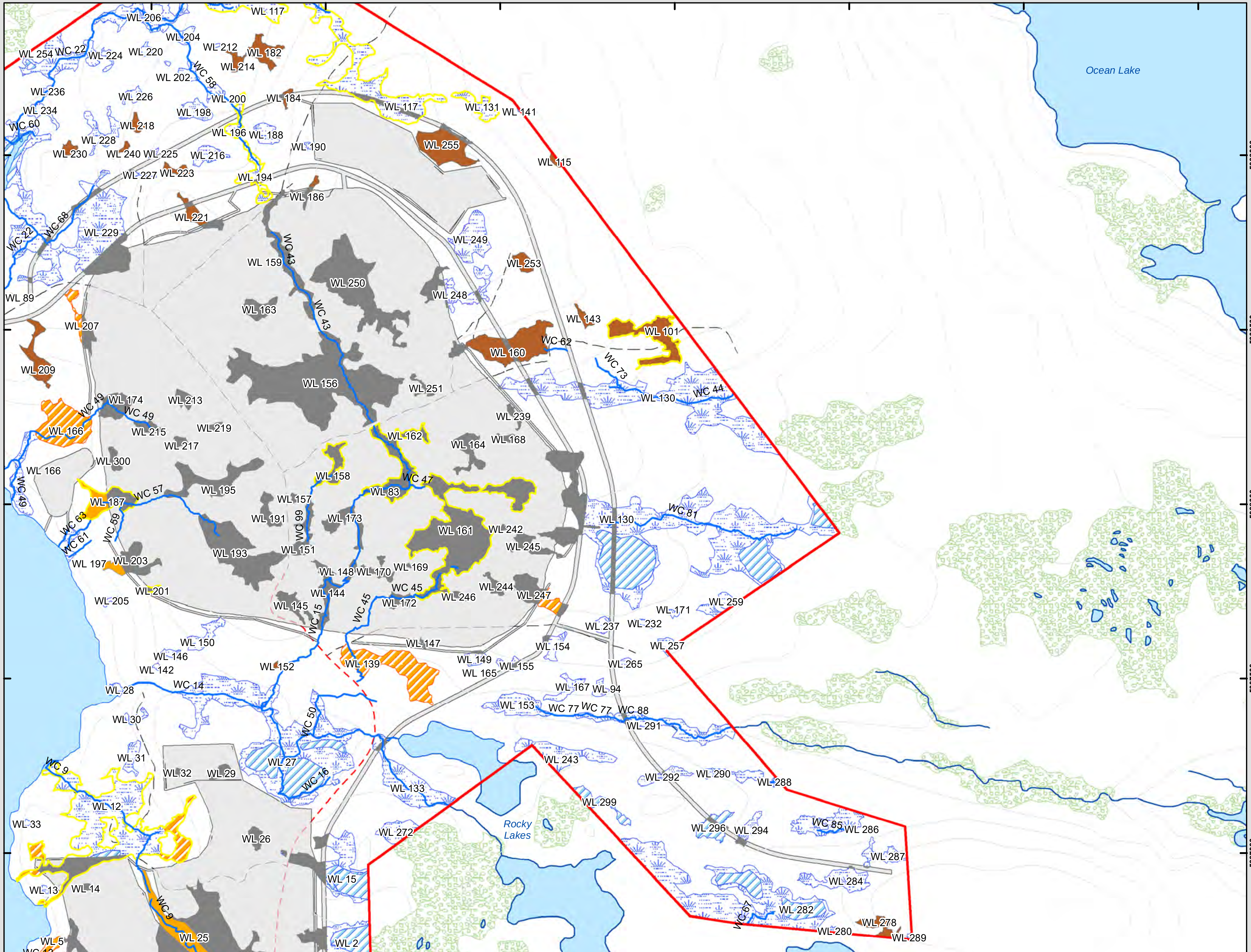

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FIGURE 5.7-3B

Goldboro Gold Project

Direct and Indirect Wetland Impacts

Goldboro, NS

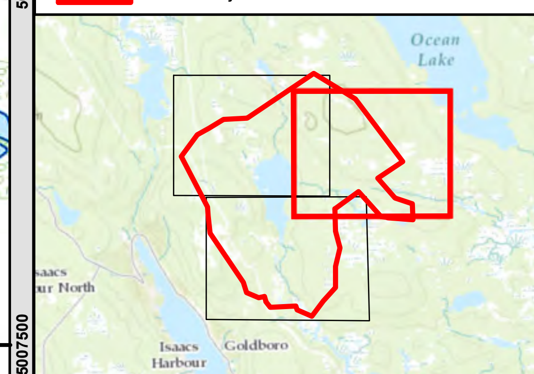
- Field Delineated Watercourses
- NSTDB Watercourses Outside PA
- Direct Impact

Indirect Impacts

- Potential Impact
- Predicted Alteration

Field Delineated Wetlands by Habitat

- Open Wetlands - Gramminoid Dominant
- Open Wetlands - Bog/Fens
- Forested Swamps
- Cutover Wetlands
- NSECC Wetland Inventory
- Potential WSS
- Open Water
- Proposed Infrastructure
- EARD Project Area



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Reviewed By: MM
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Document Name: 220524_Fig5.7-3_WLImpacts

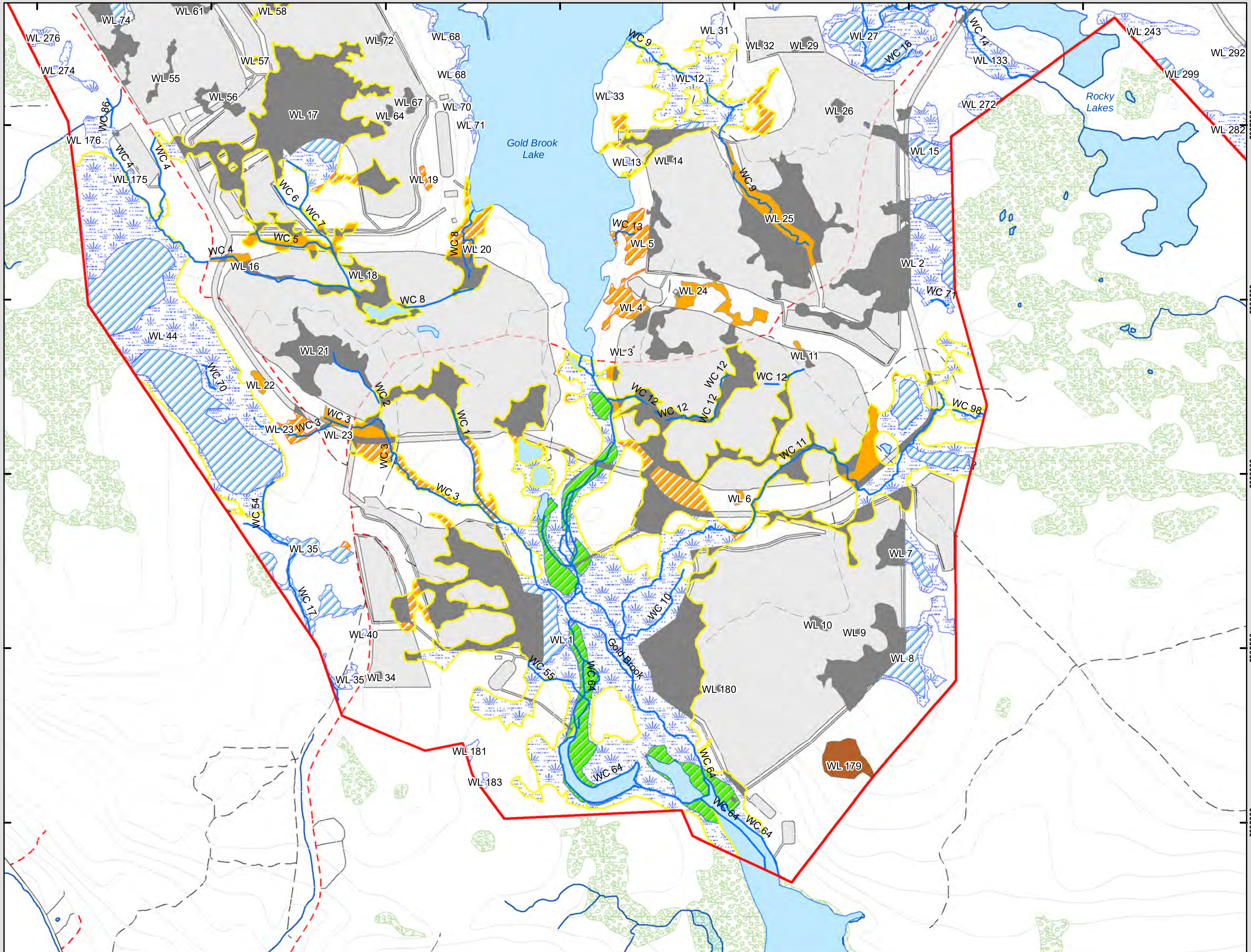

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FIGURE 5.7-3C

Goldboro Gold Project

Direct and Indirect Wetland Impacts

Goldboro, NS

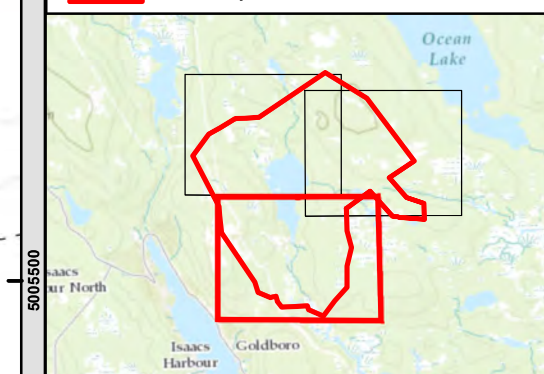
- Field Delineated Watercourses
- NSTDB Watercourses Outside PA
- Direct Impact

Indirect Impacts

- Potential Impact
- Predicted Alteration

Field Delineated Wetlands by Habitat

- Open Wetlands - Gramminoid Dominant
- Open Wetlands - Bog/Fens
- Forested Swamps
- Cutover Wetlands
- NSECC Wetland Inventory
- Potential WSS
- Open Water
- Proposed Infrastructure
- EARD Project Area



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Units: Meter

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Date: 2022-05-24

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Document Name: 220524_Fig5.7-3_WLImpacts

Table 5.7-5 Expected Direct Wetland Impacts within the PA

Wetland ID	Wetland Type	Wetland Area (m^2)[1]	Estimated Direct Impact Area (m^2)	% Direct Impact Area	Infrastructure	Alteration Type[2]
1	**Complex**	**724700**	**224924**	**31.0%**	Employee Accommodations, East Pit, West Pit, Haul Road, Organics Stockpile, Southeast WRSA, Southeast Settling Pond, Southwest Till Stockpile, Water Management	P
2	Complex	75100	37936	50.5%	Northeast WRSA, Organics Stockpile	P
3	Swamp	260	260	100.0%	East Pit	C
4	Swamp	10330	2050	19.8%	East Pit, East Settling Pond	P
5	Swamp	13460	5375	39.9%	Northeast Till Stockpile, Water Management	P
6	Bog	840	12	1.4%	East Pit	P
7	Bog	19440	8124	41.8%	Southeast WRSA, Water Management	P
8	Bog	50880	27769	54.6%	Southeast WRSA, Water Management	P
9	Swamp	510	510	100.0%	Southeast WRSA	C
10	Bog	1440	1440	100.0%	Southeast WRSA	C
11	Swamp	1240	853	68.8%	East Pit	P
12	**Complex**	**58050**	**7432**	**12.8%**	Northeast Till Stockpile, Northeast WRSA, Water Management	P
14	Bog	760	760	100.0%	Northeast Till Stockpile	C
15	Bog	21480	5313	24.7%	Haul Road, Northeast WRSA, Water Management	P
16	Swamp	4500	2591	57.6%	Haul Road, West Pit	P
17	**Complex**	**119300**	**99446**	**83.4%**	Haul Road, Northwest WRSA, Organics Stockpile, Water Management, West Pit	P
18	**Fen**	**30960**	**22078**	**71.3%**	Haul Road, Organics Stockpile, Water Management, West Pit	P
20	**Swamp**	**16740**	**6789**	**40.6%**	Water Management, West Pit	P
21	Bog	23590	23601	100.0%	West Pit	C
22	Swamp	2000	123	6.1%	Haul Road	P
23	Swamp	7090	735	10.4%	Haul Road	P

Table 5.7-5 Expected Direct Wetland Impacts within the PA

Wetland ID	Wetland Type	Wetland Area (m^2)[1]	Estimated Direct Impact Area (m^2)	% Direct Impact Area	Infrastructure	Alteration Type[2]
24	Swamp	19900	10394	52.2%	East Pit, East Settling Pond, Northeast Till Stockpile, Water Management	P
25	Complex	61960	47900	77.3%	Northeast Till Stockpile, Northeast WRSA, Water Management	P
26	Swamp	1830	1830	100.0%	Northeast WRSA	C
29	Swamp	1800	1800	100.0%	Organics Stockpile	C
32	Swamp	330	330	100.0%	Organics Stockpile	C
34	Swamp	710	710	100.0%	Employee Accommodations	C
42	Complex	485200	12161	2.5%	Explosives Storage, Haul Road, North Settling Pond, Pond1 Outlet Ditch Water Management, TMF Pipeline Emergency Catchment	P
46	Swamp	250	250	100.0%	Northwest WRSA	C
47	Swamp	480	35	7.3%	Northwest WRSA, Water Management	P
51	**Swamp**	**21170**	**403**	**1.9%**	North Settling Pond, Water Management	P
52	**Swamp**	**7970**	**103**	**1.3%**	North Settling Pond	P
53	Swamp	1170	1170	100.0%	Northwest WRSA	C
54	Swamp	780	221	28.4%	North Settling Pond	P
55	Swamp	2900	2900	100.0%	Haul Road, Mill Area	C
56	Swamp	4470	4470	100.0%	Haul Road, Water Management	C
57	**Swamp**	**500**	**500**	**100.0%**	Organics Stockpile, Water Management	C
58	**Swamp**	**4440**	**4440**	**100.0%**	Northwest WRSA, Water Management	C
61	Swamp	3910	3910	100.0%	Haul Road, Mill Area, Northwest WRSA, Organics Stockpile, Water Management	C
64	Swamp	1200	1200	100.0%	Northwest WRSA	C
67	Complex	1800	1800	100.0%	Northwest WRSA	C
72	Swamp	830	830	100.0%	Northwest WRSA	C

Table 5.7-5 Expected Direct Wetland Impacts within the PA

Wetland ID	Wetland Type	Wetland Area (m²)[1]	Estimated Direct Impact Area (m²)	% Direct Impact Area	Infrastructure	Alteration Type[2]
74	Swamp	37180	18401	49.5%	Haul Road, Mill Area	P
83	**Swamp**	**10790**	**10790**	**100.0%**	TMF	C
117	**Complex**	**70340**	**2565**	**3.6%**	Bypass Road	P
130	Complex	166470	18661	11.2%	Bypass Road, Haul Road, TMF, Water Management	P
133	Swamp	15930	499	3.1%	Haul Road	P
144	Swamp	5290	5290	100.0%	TMF	C
145	Swamp	3570	3570	100.0%	TMF	C
147	Swamp	230	230	100.0%	TMF, Water Management	C
148	Swamp	1080	1080	100.0%	TMF	C
149	Bog	2230	255	11.4%	Water Management	P
150	Bog	3760	8	0.2%	Water Management	P
151	Swamp	3940	3940	100.0%	TMF	C
154	Bog	2870	390	13.6%	Haul Road	P
155	Swamp	1220	446	36.5%	Haul Road	P
156	Complex	62450	62450	100.0%	TMF	C
157	Swamp	370	370	100.0%	TMF	C
158	**Swamp**	**5050**	**5050**	**100.0%**	TMF	C
159	Swamp	9040	9040	100.0%	TMF, Water Management	C
160	Complex	17730	2219	12.5%	Haul Road, TMF, Water Management	P
161	**Complex**	**42840**	**42840**	**100.0%**	TMF	C
162	**Swamp**	**1820**	**1820**	**100.0%**	TMF	C
163	Bog	3850	3850	100.0%	TMF	C
164	Swamp	4610	4610	100.0%	TMF	C
168	Bog	1150	1150	100.0%	TMF	C

Table 5.7-5 Expected Direct Wetland Impacts within the PA

Wetland ID	Wetland Type	Wetland Area (m²)[1]	Estimated Direct Impact Area (m²)	% Direct Impact Area	Infrastructure	Alteration Type[2]
169	Swamp	110	110	100.0%	TMF	C
170	Swamp	2020	2020	100.0%	TMF	C
172	Swamp	2150	2150	100.0%	TMF	C
173	Swamp	4700	4700	100.0%	TMF	C
174	Swamp	5050	5050	100.0%	TMF	C
176	Swamp	5960	182	3.0%	Organics Stockpile, Water Management	P
180	Swamp	310	310	100.0%	Southeast WRSA	C
184	Swamp	830	316	38.1%	Bypass Road	P
186	Swamp	1590	1135	71.4%	TMF, Water Management	P
187	**Swamp**	**8330**	**3978**	**47.8%**	Polishing Pond, TMF, Water Management	P
191	Bog	3020	3020	100.0%	TMF	C
193	Swamp	21380	21380	100.0%	TMF	C
194	**Swamp**	**4360**	**292**	**6.7%**	Haul Road, TMF, Water Management	P
195	Swamp	10210	10210	100.0%	TMF	C
196	**Swamp**	**2930**	**139**	**4.8%**	Bypass Road	P
199	Swamp	1270	29	2.3%	Water Management	P
201	**Swamp**	**760**	**760**	**100.0%**	TMF, Water Management	C
203	Swamp	6550	4987	76.1%	TMF, Water Management	P
207	Swamp	4140	2322	56.1%	Haul Road, TMF, Water Management	P
209	Swamp	5860	6	0.1%	Haul Road	P
213	Swamp	2050	2050	100.0%	TMF	C
215	Swamp	1910	1910	100.0%	TMF	C
217	Swamp	840	840	100.0%	TMF	C
219	Swamp	790	790	100.0%	TMF	C

Table 5.7-5 Expected Direct Wetland Impacts within the PA

Wetland ID	Wetland Type	Wetland Area (m^2)[1]	Estimated Direct Impact Area (m^2)	% Direct Impact Area	Infrastructure	Alteration Type[2]
221	Swamp	3920	1488	38.0%	Haul Road, TMF, Water Management	P
227	Swamp	750	122	16.2%	Bypass Road	P
229	Complex	72370	10273	14.2%	Bypass Road, Haul Road, TMF, Water Management	P
237	Complex	1780	84	4.7%	Bypass Road	P
239	Swamp	950	950	100.0%	TMF	C
242	Swamp	410	410	100.0%	TMF	C
244	Swamp	1490	1490	100.0%	TMF	C
245	Swamp	3840	3840	100.0%	TMF, Water Management	C
246	Swamp	710	710	100.0%	TMF	C
247	Complex	7960	5856	73.6%	Haul Road, TMF, Water Management	P
248	Swamp	9820	3761	38.3%	Haul Road, TMF	P
249	Bog	9670	5	0.1%	Haul Road	P
250	Complex	27720	27720	100.0%	TMF	C
251	Swamp	1170	1170	100.0%	TMF	C
255	Bog	11930	926	7.8%	Bypass Road	P
284	Swamp	7680	93	1.2%	Bypass Road	P
287	Swamp	3330	63	1.9%	Bypass Road	P
291	Swamp	12620	388	3.1%	Bypass Road	P
292	Swamp	3170	264	8.3%	Bypass Road	P
294	Swamp	2610	467	17.9%	Bypass Road	P

Table 5.7-5 Expected Direct Wetland Impacts within the PA

Wetland ID	Wetland Type	Wetland Area (m²)[1]	Estimated Direct Impact Area (m²)	% Direct Impact Area	Infrastructure	Alteration Type[2]
296	Complex	5180	802	15.5%	Bypass Road	P
300	Swamp	1420	1420	100.0%	TMF	C
Total		2,567,700 m² (256.770 ha)	905,988 m² (90.599 ha)		Total complete wetland alterations	56
					Total partial wetland alterations	56

Notes: Predicted WSS are in **bold**, as defined in the Wetlands Baseline Report (Appendix G.1). Impacts to these wetlands are discussed in Section 5.7.6.1.1. TMF = tailings management facility

[1] Wetland area within the PA.

[2] P – Partial wetland alteration, C – Complete wetland alteration

The Project will directly impact 112 wetlands of which 56 are expected to be completely altered, and 56 will be partially altered (Table 5.7-5). Table 5.7-6 indicates the Project infrastructure that interacts with each wetland. The Project's total wetland direct impact area is expected to be 90.599 ha (partial and complete), which represents 27.5% of total wetland area within the PA (329.033 ha, see Appendix G.1 (Wetland Baseline Report)). The 90.599 ha of expected Project-related direct wetland impacts represents 5.8% of the total (modeled) wetland area in the LAA. The resultant magnitude of effect based on wetland habitat type and WSS is discussed in the Sections 5.7.6.1.1 and 5.7.6.1.2. The remaining 110 wetlands, which account for 49.5% of wetlands or 72.5% of wetland area within the PA, will not be directly impacted as a result of the Project.

Infrastructure has been planned to avoid wetland impacts wherever possible, in consideration of other environmental and engineering constrains. Further infrastructure micro-siting will be conducted and infrastructure-specific buffers will be applied as required during the wetland permitting and detailed Project design processes to further avoid and mitigate impacts to wetlands. Wetland avoidance efforts and mitigation measures are further discussed in Section 5.7.7. The impacts of the Project on fish and fish habitat within wetlands is discussed is Section 5.8. Wetland areas that are confirmed potential fish habitat are included in the drafted Fisheries Offsetting Plan provided in Appendix H.3.

5.7.6.1.1 Direct Impacts to Wetlands of Special Significance

As presented in the Wetlands Baseline Report (Appendix G.1) and discussed in Section 5.7.3, a total of 22 wetlands have been assessed as potential WSS within the PA based on SAR lichen observations and carried forward into the effects assessment as such (Table 5.7-6). One additional wetland contained a confirmed observation of a mobile SAR (i.e., Canada warbler (*Cardellina canadensis*) in Wetland 25), but at this time, is not presented as potential WSS. All (23) wetlands with confirmed SAR (mobile or sessile) will be reviewed with NSECC. Final WSS designation will be made by NSECC.

Of the 22 potential WSS, 18 are proposed to be directly impacted by Project activities and infrastructure (Table 5.7-5, Table 5.6-7, Figure 5.7-3A-C). Seven WSS are proposed for complete alteration by the TMF, WRSAs, or stockpiles, whereas 11 WSS will be partially impacted by the infrastructure identified in Table 5.7-5. In total, 43.438 ha of WSS, 31% of total WSS area within the PA, are proposed for direct alteration. As the Project proposes to impact potential WSS, the magnitude of effects will be at minimum moderate, depending on impacts to individual wetland habitat type as presented in the following Section 5.7.6.1.2. Wetlands 44, 48, 101 and 131 will be completely avoided by Project infrastructure. Potential indirect impacts are discussed in Section 5.7.6.2.

Measures to avoid, mitigate and compensate effects to WSS are discussed in Section 5.7.7.

Table 5.7-6 Direct Impacts to Potential WSS

Wetland ID	Wetland Area (m²)[1]	Estimated Direct Impact Area (m²)	Infrastructure	Alteration Type[2]
1	724700	224958	Employee Accommodations, East Pit, West Pit, Haul Road, Organics Stockpile, Southeast WRSA, Southeast Settling Pond, Southwest Till Stockpile, Water Management	P
12	58050	7432	Northeast Till Stockpile, Northeast WRSA, Water Management	P
17	119300	99446	Haul Road, Northwest WRSA, Organics Stockpile, Water Management, West Pit	P
18	30960	22078	Haul Road, Organics Stockpile, Water Management, West Pit	P
20	16740	6789	Water Management, West Pit	P
44	247500	0	-	-
48	2680	0	-	-
51	21170	403	North Settling Pond, Water Management	P

Table 5.7-6 Direct Impacts to Potential WSS

Wetland ID	Wetland Area **(m^2)**[1]	Estimated Direct Impact Area (**m^2**)	Infrastructure	Alteration **Type**[2]
52	7970	103	North Settling Pond	P
57	500	500	Organics Stockpile, Water Management	C
58	4440	4440	Northwest WRSA, Water Management	C
83	10790	10790	TMF	C
101	12180	0	-	-
117	70340	2565	Bypass Road	P
131	4060	0	-	-
158	5050	5050	TMF	C
161	42840	42840	TMF	C
162	1820	1820	TMF	C
187	8330	3978	Polishing Pond, TMF, Water Management	P
194	4360	292	Haul Road, TMF, Water Management	P
196	2930	139	Bypass Road	P
201	760	760	TMF, Water Management	C
Total	1,397,470 m^2 (139.747 ha)	434,383 m^2 (43.438 ha)	No proposed alteration	4
			Total complete wetland alterations	7
			Total partial wetland alterations	11

Note: TMF = tailings management facility
* Blue felt lichen occurrences in wetland area beyond PA
[1] Wetland area within the PA.
[2] P – Partial wetland alteration, C – Complete wetland alteration

5.7.6.1.2 Direct Impacts to Wetland Types and Functions

The expected Project-related direct wetland impacts were further assessed at the wetland habitat and functional level, using the P-ELC model and WESP-AC results. While the WESP-AC results are considered through the assessment of functional losses, in order to compare losses to the LAA the wetland class and associated habitat type are used as a proxy of function (e.g., peatlands (open wetlands) provide carbon sequestration functions, whereas alder swamps provide nitrogen fixing functions) for the determination of the predicated magnitude of effects. Specifically, impacts to the P-ELC modeled wetland habitat types in comparison to the LAA are presented in Table 5.7-7. The magnitude of direct impacts to wetland habitat types range from low to moderate (negligible impacts to Alder Swamps due to absence). Based on the defined magnitudes of effects in Section 5.7.5.3, direct impacts to cutover and open (i.e., peatlands, marshes) wetland types are low, whereas direct impacts to forested swamp habitats (including hardwood, softwood and mixedwood) are moderate. This elevated effect to forested swamps is expected as they are the dominate wetland type on the local (LAA) and provincial landscape. No alder swamp habitat types (i.e., no tree canopy) were modelled within the wetland LAA or PA and therefore no impacts are expected (negligible).

Table 5.7-7 Impacts to Wetland Habitat Types within the LAA and Magnitude of Effects

Wetland Habitat Type[1]	Estimated Direct Impact Area (ha)[2]	Habitat Area within the LAA (ha) (% of LAA)	% of LAA Habitat Area Directly Impacted (ha)	Magnitude of Effect[3]
Open Wetlands (bogs, fens, marshes)	13.5	651.4 (15%)	2.1%	Low
Alder Swamps	0.0	0.0 (0%)	0%	Negligible
Forested Swamps (hardwood, softwood and mixedwood)	75.4	817.6 (19%)	9.4%	Moderate
Cutover/Regenerative Wetlands	2.3	90.2 (2%)	2.6%	Low
Total LAA Modeled Wetland Area[2]		**1559.2**		

[1] P-ELC habitat types presented in Section 5.7.5.2 and further defined in Section 5.9 (Terrestrial Environment)
[2] Habitat impacts were calculated using the wetland-specific direct impact area shown in Figure 5.7-3A-C, which differs from Terrestrial Environment impact extent, and the P-ELC classification of wetland habitat. As habitat areas are derived from a raster model to permit an appropriate comparison to the broader LAA, they may not directly correspond or equate to the impact area of the field delineated wetlands presented in Section 5.7.6.1. As a result, impacts by habitat type are only assessed relative to the LAA and an impact area total is not shown here (see Table 5.7-5 for total wetland impacts). See Section 5.9 (Terrestrial Environment) for discussion of the P-ELC methods and limitations.
[3] Based on magnitude of a predicted change defined in Section 5.7.5.3.

A summary of WESP-AC results and functional scores, specific to wetlands directly impacted by the Project, are provided in Appendix G.2 (see the Wetlands Baseline Report in Appendix G.1 for WESP-AC results for all wetlands within the PA). Similar to wetland functional trends within the larger PA, the average grouped function and benefit scores for the Project impacted wetlands range from Lower to Moderate, with the exception of the Water Quality, Aquatic Support and Transitional Habitat groups which score higher. The descriptions of each group are provided in the Wetland Baseline Report (Appendix G.1). No functional WSS were identified through the WESP-AC assessments.

5.7.6.2 Potential Indirect Impacts

Indirect impacts are described as changes to wetland condition where wetland habitat is not directly lost but may be changed as the result of Project activities. Project-related indirect impacts to wetlands may occur as a result of:

- Changes to local hydrology resulting in wetting or drying of wetlands, such as inadvertent drainage or impoundment, groundwater drawdown associated with the open pits, loss of surface water flow within local catchment areas (LCA) or impacts to headwater contributing areas.
- The spread or introduction of invasive species into wetlands through construction equipment, vehicles, or runoff from adjacent. Increased traffic during the construction and operations phases can elevate this risk.
- Potential sedimentation within wetlands as a result of up-gradient activities (e.g., earth moving, removal of vegetation, soil stockpiling). Depending on the degree, a sedimentation event may suffocate wetland vegetation and increase nutrient levels.
- Dust deposition, which can, similarly to sediment, also introduce minerals and nutrients into wetlands and stress wetland vegetation (particularly non-vascular species).
- Changes to wetland microclimate and habitat functions as a result of proximity to Project infrastructure and edge effects.

Potential indirect impacts to wetland flora and fauna (e.g., edge effects, dust) are further discussed in Section 5.9 (Terrestrial Environment). Changes to water quality are not expected to indirectly impact wetland habitat integrity. Surface water, including groundwater seepage contributions, will be tested and treated to meet regulatory water quality discharge criteria for the aquatic environment prior to release. Active water treatment is required during operations and for the first two years of the closure phase. Project effects to water quality and sampling locations are further discussed in Sections 5.5 (Groundwater Resources) and 5.6 (Surface Water Resources).

Impacts of infrastructure proximity to wetlands (e.g., clearing, edge effects) have not been assessed at this stage. Infrastructure specific buffers will be reviewed at the detailed design and permitting stage and appropriate wetland mitigations, monitoring and/or compensation will be applied as deemed necessary in consultation with NSECC.

Changes to wetland hydrology are a common driver for further change to wetland function and habitat integrity. Potential indirect impacts to wetland hydrology through changes in contributing LCAs, surface water flow reductions, and groundwater drawdown can be assessed through modeled impacts to surface water and groundwater. These hydrological effects are discussed and estimated in the following sections. As a result of the models used, the indirect wetland impact estimates provided herein represent a “worse-case”, conservative impact extent and are primarily used to inform recommendations for monitoring. Actual indirect impacts of the Project will be determined at the permitting stage and through monitoring programs (presented in Section 5.7.8).

Mitigations and monitoring to address potential indirect impacts from other sources (e.g., dust, sedimentation, invasive species) are presented in Section 5.7.7 and 5.7.8 respectively. Mechanisms to reduce the potential for wetland impacts from accidents and malfunctions are discussed in Section 5.14.

5.7.6.2.1 Indirect Hydrological Impacts

Potential hydrological effects to wetlands were assessed in consideration of wetland type, WESP-AC functional assessment results, direct Project impacts and associated hydrological function (e.g., recharge vs. discharge, landscape position, associated surface water features). To identify potential effects of the Project on local wetland hydrology, the following indirect impact pathways were assessed for each wetland within the PA:

- Modelled flow reductions within each LCA in which infrastructure is proposed
- Modelled open pit groundwater drawdown ROI, for the West Pit, East Pit and TMF
- Changes in headwater contributing area within each LCA

Potential for down-gradient, indirect wetland impacts can be expected as a result of up-gradient hydrological alteration and reduction of contributing headwater area. Project infrastructure and associated collection ditches divert contact water and runoff from infrastructure to designated treatment locations through the Project’s surface water management system (Section 2.4.2.15). Collector ditches divert water away from local surface water features within each relevant catchment and may divert water from one catchment to another.

As a result, it is expected that the alteration of hydrological flow paths may result in indirect impacts to wetlands through surface water and groundwater flow reduction. The effects of these hydrological changes to wetlands were assessed at the LCA scale through modelled flow reductions at a series of down-gradient assessment points (described in Section 5.6.5.2), as well as a qualitative assessment of headwater infrastructure impacts within each LCA. Where applicable, the average annual percent changes in monthly flows were reviewed at each assessment point (see Figure 5.6-5 for assessment points locations) at East Pit EOM (Year 8) and West Pit EOM (Year 11). For the purposes of this assessment, the most conservative (greatest) EOM flow reduction was used (e.g., Year 8 or Year 11). Due to the timeline between the Project’s construction phase and pit filling (Year 35), it is expected that potential effects to wetlands as a result of LCA flow reduction will occur prior the completion of pit filling.

Wetlands within LCAs with a >10% modelled change in flow and/or notable headwater impacts were evaluated on a case-by-case basis, excluding those expected to be completely directly impacted (Table 5.7-5). LCAs where down-gradient assessment points show a <10% reduction in flow were not expected to impact wetland hydrology and therefore wetlands within these LCAs were not included in this indirect flow reduction assessment. Reduction in flow will affect each wetland differently, depending on wetland type, water source, watercourse/waterbody association, magnitude of predicted flow change, and position both in the LCA and relative position to proposed infrastructure. These factors were conservatively considered by subject experts when determining the potential for indirect effects of flow reduction to Project wetlands. Wetlands expected to be indirectly impacted by reductions to LCA flow and contributing area are presented in Table 5.7-8.

Indirect impacts to wetlands through groundwater drawdown adjacent to the open pits is also expected. The modeled groundwater drawdown ROI is further detailed in Section 5.5 and Figures 5.5-9 through 5.5-11. Similar to the LCA flow reduction assessment, when assessing indirect effects from groundwater drawdown, the East Pit EOM and West Pit EOM ROI simulations were reviewed and the largest ROI extent was used as a conservative approach (e.g., Year 8 for the East Pit and Year 11 for the West Pit). The predicted groundwater drawdown at EOM ranges from ~0-20 m directly adjacent to the pits to 0.5 m between 600 and 700 m south of the East Pit (at Year 8). Groundwater levels are also expected to decrease by 0.5 m within 150 m from the TMF at EOM. However, many of the wetlands within the ROI are already determined to be directly impacted by Project infrastructure. Table 5.7-8 presents wetlands expected to be impacted by the ROI, excluding those expected to be completely directly impacted. Intact or partially intact wetlands within the ROI are expected to experience drawdown (conservative estimate) on the order of, at minimum, 0.5 m, increasing with proximity to the pits. At the post-closure stage, the predicted groundwater ROI decreases in size around the pits as they fill. The maximum extent of a 0.5 m drawdown post-closure is approximately 225 m (north of the West Pit). There is no modeled change to the TMF ROI post-closure. All wetland areas within the 0.5 m post-closure groundwater ROI are proposed for direct hydrological impact (predicted alteration), as water levels are not expected to recover to baseline conditions within these wetland areas. The modelled groundwater ROI is not expected to extend into wetland habitat beyond the PA.

Wetlands regularly undergo seasonal Relative Groundwater Depth (RGWD) fluctuations in response to annual precipitation and seasonal variability. Geographically isolated wetlands have been reported to have seasonal fluctuations ranging as high as ± 20 cm (Keddy, 2010). Keddy (2010) also found that wetlands associated with lakes and watercourses were found to have seasonal variability as high as ± 1.5 m. The US Army Corp of Engineers (2012) stipulates that wetland hydrology is defined as saturation of soils 20 cm below the surface or groundwater levels within 30 cm of the surface for a period of two consecutive weeks in the growing season (typically June through September).

The stability, size and function of wetlands is primarily controlled by hydrological processes (Carter, 1996; Price, 2005, Tiner 2005). Drawdown caused by mining can affect all wetlands that have direct groundwater connectivity (discharge and recharge wetlands), which generally includes most wetlands with the exception of those systems disconnected from local groundwater flow systems (e.g., perched wetlands, some raised bogs). Drawdown can change the hydroperiod of a wetland and reduce water levels which can cause an adverse effect on wetland function (Mortellaro et al., 1995). Effects include dryer conditions, change in dominant flow direction (lateral and vertical), changes to vegetation, and changes to wildlife habitat.

Large wetland systems within the groundwater drawdown area around the open pits that have large area of standing water (e.g., riparian wetlands along Gold Brook Lake and Gold Brook) and defined surface water inputs are less likely to be affected by drawdown. Conversely, the impacts to isolated wetlands predominantly fed by groundwater without defined surface water inputs are likely to be more severe. If wetlands dry beyond their natural thresholds, organic soils can begin to decompose and subside, and vegetation may become stressed. Many wetland plants, however, can survive periodic dry conditions and reproduce under altered hydrologic conditions. Loss of groundwater can also convert discharge wetlands into recharge wetlands which in turn can reduce surface water supplies and levels down-gradient (Siegel & Glaser, 1987; Tiner, 2005). Resultant changes in surface water quantity can affect downstream wetlands, watercourses and waterbodies that relay on surface water inputs, as discussed above, as well as in Section 5.8 (Fish and Fish Habitat).

Table 5.7-8 details the indirect hydrologic impacts to intact and partial intact wetlands within the PA. Wetlands not presented in Table 5.7-8 are either proposed to be completed altered or are not expected to be hydrologically impacted by the Project. Wetlands not expected to be hydrologically impacted by the Project may still demonstrate shifts in hydrological conditions, however it’s expected that these shifts will be within the wetland’s natural variability and will not alter the wetland’s baseline characteristics or hydrological function. For example, while there are notable changes within the headwater catchment area of Wetland 150, this wetland is classified as a bog. Bogs are fundamentally driven by atmospheric hydrological inputs and are therefore less reliant on surface water and groundwater contributions from up-gradient water sources. Bogs are also naturally more resistant to hydrological stressors as a result of soil and plant physiology. Therefore, it is not predicted that this wetland will be hydrologically altered by up-gradient Project development.

While the modeled LCA flow reductions through Watercourses 14, 16 and 50 associated with Wetland 27 are expected to substantially decrease during Project operations (from ~17 to 90%), Wetland 27 is a complex with large peatland components and varying hydrological connectivity. As a result, potential indirect hydrologic impacts and extent from LCA flow reduction is undefined at this time. It is recommended that Wetland 27 be considered for monitoring, but indirect impact areas have not been estimated in Table 5.7-8.

Based on the indirect effects assessment, Table 5.7-8 identifies and provides rationale for cases where there is a) potential for indirect hydrological impacts and b) where hydrological changes are likely to result in wetland alteration (e.g., significant/complete loss of contributing area and/or associated watercourse, wetland area with groundwater drawdown of >0.5 m post-Closure). Instances where wetland alteration is predicted are conservatively considered and presented as predicted (confirmed) indirect impacts. All wetlands with predicted or potential indirect hydrological impacts will be carried forward into the monitoring program, presented in Section 5.7.8. Indirect hydrological impacts to wetlands are presented in Figure 5.7-3A-C and summarized in Table 5.7-8.

For the purposes of indirect impacts to wetlands, the effects of groundwater drawdown are assessed and shown in conjunction with the LCA assessment, as groundwater drawdown is incorporated in the modeled baseflow reduction in the LCAs.

Table 5.7-8 Expected Indirect Hydrological Impacts to Wetlands within the PA

Wetland ID	Wetland Type	Wetland Area (m^2)[1]	Estimated Direct Impact Area (m^2)[2]	Predicted Indirect Impact Area (m^2)[3]	Potential Indirect Impact Area (m^2)[4]	% Direct Impact Area[2]	% Indirect Impact Area[5]	Hydrological Impacts
1	**Complex**	**724700**	**224924**	**15721**	**38488**	**31.0%**	**7.4%**	Large complex which lies within the 0.5 m groundwater drawdown ROI, during EOM and at post-closure. Portions down-gradient of infrastructure are disconnected from the remaining wetland and collector ditches will divert water away from these wetland areas. Predicted LCA flow reduction >10%.
4	Swamp	10330	2050	276	8008	19.8%	80.2%	Remaining intact wetland area is impacted by the 0.5 m groundwater drawdown ROI, at EOM and at post-closure. Notable impacts to immediate up-gradient catchment area.
5	Swamp	13460	5375	0	8085	39.9%	60.1%	Remaining intact wetland area is impacted by the 0.5 m groundwater drawdown ROI at EOM. Notable impacts to immediate up-gradient catchment area. Collector ditches will divert water away from the wetland.
6	Bog	840	12	828	0	1.4%	98.6%	Small isolated swamp. Remaining intact wetland area lies entirely within the 0.5 m groundwater drawdown ROI at EOM and post-closure.
11	Swamp	1240	853	386	0	68.8%	31.1%	Small isolated swamp. Remaining intact wetland area lies entirely within the 0.5 m groundwater drawdown ROI at EOM and post-closure.
12	**Complex**	**58050**	**7432**	**0**	**9025**	**12.8%**	**15.5%**	Portions of the intact wetland are disconnected from the remaining up-gradient wetland and collector ditches will divert water away from these wetland areas. Notable catchment area impacts immediately up-gradient of headwater portions of the wetland. Predicted LCA flow reduction >10% and indirect impacts to associated Watercourse 9.
16	Swamp	4500	2591	1909	0	57.6%	42.4%	Remaining intact wetland area lies entirely within the 0.5 m groundwater drawdown ROI at EOM and post-Closure. Direct impacts to associated Watercourse 4.
17	**Complex**	**119300**	**99446**	**0**	**2113**	**83.4%**	**1.8%**	Portions of the intact wetland lie within the 0.5 m groundwater drawdown ROI at EOM. Bog and headwater areas are not expected to be hydrologically impacted.

Table 5.7-8 Expected Indirect Hydrological Impacts to Wetlands within the PA

Wetland ID	Wetland Type	Wetland Area (m^2)[1]	Estimated Direct Impact Area (m^2)[2]	Predicted Indirect Impact Area (m^2)[3]	Potential Indirect Impact Area (m^2)[4]	% Direct Impact Area[2]	% Indirect Impact Area[5]	Hydrological Impacts
18	**Fen**	**30960**	**22078**	**8896**	**0**	**71.3%**	**28.7%**	Remaining intact wetland area lies within the 0.5 m groundwater drawdown ROI at EOM and post-closure. Direct impacts to associated Watercourses 5 and 7.
19	Swamp	1030	0	0	1030	0%	100.0%	Small isolated swamp. Remaining intact wetland area interacts with the 0.5 m groundwater drawdown ROI at EOM. Notable catchment area impacts and collector ditches immediately up-gradient likely to impact contributing area and groundwater inputs.
20	**Swamp**	**16740**	**6789**	**1990**	**7964**	**40.6%**	**59.5%**	Remaining intact wetland area interacts with the 0.5 m groundwater drawdown ROI at EOM and post-closure. Impacts may be reduced in the lentic riparian portion adjacent to Gold Brook Lake.
22	Swamp	2000	123	1876	0	6.1%	93.8%	Small isolated swamp. Remaining intact wetland area interacts with the 0.5 m groundwater drawdown ROI at EOM and post-closure.
23	Swamp	7090	735	1849	4504	10.4%	89.6%	Remaining intact wetland area interacts with the 0.5 m groundwater drawdown ROI at EOM and post-closure.
24	Swamp	19900	10394	0	9684	52.2%	48.7%	Remaining intact wetland area lies within the 0.5 m groundwater drawdown ROI, at EOM and at post-closure.
25	Complex	61960	47900	14094	0	77.3%	29.4%	Up-gradient catchment area and surrounding wetland area directly impacted. Collector ditches will divert water away from remaining wetland areas. Predicted LCA flow reduction >10% and indirect impacts to associated Watercourse 9.
35	Complex	21680	0	0	391	0%	1.8%	Small portion of wetland within the 0.5 m groundwater drawdown ROI at EOM
47	Swamp	480	35	0	442	7.3%	92.1%	Partially impacted isolated swamp. Notable catchment area impacts and collector ditches immediately up-gradient likely to impact contributing area and groundwater inputs.
49	Swamp	1270	0	0	1270	0%	100.0%	Small isolated swamp (no immediate hydrological connection to adjacent wetlands or surface water features). Notable catchment area impacts and collector ditches immediately up-gradient likely to impact

Table 5.7-8 Expected Indirect Hydrological Impacts to Wetlands within the PA

Wetland ID	Wetland Type	Wetland Area (m²)[1]	Estimated Direct Impact Area (m²)[2]	Predicted Indirect Impact Area (m²)[3]	Potential Indirect Impact Area (m²)[4]	% Direct Impact Area[2]	% Indirect Impact Area[5]	Hydrological Impacts
								contributing area and groundwater inputs. Predicted LCA flow reduction >10%.
50	Swamp	830	0	0	830	0%	100.0%	Small isolated swamp (no immediate hydrological connection to adjacent wetlands or surface water features). Notable catchment area impacts and collector ditches immediately up-gradient likely to impact contributing area and groundwater inputs. Predicted LCA flow reduction >10%.
73	Swamp	1200	0	0	1200	0%	100.0%	Small isolated swamp (no immediate hydrological connection to adjacent wetlands or surface water features). Notable catchment area impacts and collector ditches immediately up-gradient likely to impact contributing area and groundwater inputs.
139	Swamp	18160	0	0	18165	0%	100.0%	Hydrological contributions to wetland likely impacted by up-gradient catchment area impacts (TMF), collector ditches, and direct impacts to contributing Watercourse 45.
166	Complex	21700	0	0	14778	0%	68.1%	Hydrological contributions to headwater wetland areas likely impacted by up-gradient catchment area impacts (TMF), collector ditches, and direct impacts to contributing Watercourse 49.
187	**Swamp**	**8330**	**3978**	**4355**	**0**	**47.8%**	**52.3%**	Partially impacted swamp. Hydrological contributions will be impacted by notable immediate up-gradient catchment area impacts (TMF), collector ditches, and direct impacts to contributing Watercourse 57.
203	Swamp	6550	4987	1568	0	76.1%	23.9%	Partially impacted isolated swamp. Notable catchment area impacts (TMF) and collector ditches immediately up-gradient likely to impact contributing area and groundwater inputs.
207	Swamp	4140	2322	0	1818	56.1%	43.9%	Partially impacted isolated swamp. Notable catchment area impacts (TMF) and collector ditches immediately up-gradient likely to impact contributing area and groundwater inputs.

Table 5.7-8 Expected Indirect Hydrological Impacts to Wetlands within the PA

Wetland ID	Wetland Type	Wetland Area (m^2)[1]	Estimated Direct Impact Area (m^2)[2]	Predicted Indirect Impact Area (m^2)[3]	Potential Indirect Impact Area (m^2)[4]	% Direct Impact Area[2]	% Indirect Impact Area[5]	Hydrological Impacts
247	Complex	7960	5856	0	2100	73.6%	26.4%	Catchment area impacts (TMF) and collector ditches immediately up-gradient of remaining intact wetland area.
Total				5**3,748 m^2** (5.375 ha)	129,892 m^2 (12.989 ha)			

Notes: Predicted WSS are in **bold**, as defined in the Wetland Baseline Report (Appendix G.1).
[1] Wetland area within the PA.
[2] As presented in Table 5.7-5.
[3] Indirect hydrological impacts predicted to result in wetland alteration. Treated as direct impact area for the purposes of the wetland effects assessment.
[4] Indirect hydrological impacts have the potential to effect wetlands, but alteration are unconfirmed at this time.
[5] Includes both ‘predicted and ‘potential’ indirect impacts.

Conservatively, it is estimated that 25 wetlands or 18.364 ha may be indirectly impacted by Project-related changes to local hydrology. Of the total area, predicted hydrological changes to certain wetlands were assessed to likely result in wetland alterations, totalling 5.375 ha of predicted indirect effects. Whereas 12.989 ha of wetland area may potentially be hydrologically impacted, rather than a confirmed alteration area, and will be assessed through the wetland monitoring program presented in Section 5.7.7. Monitoring for indirect impacts will be conducted to verify the accuracy of the predicted environmental effects and the effectiveness of mitigation measures Further consultation with NSECC regarding indirect effects and monitoring will occur through the wetland permitting process.

The effects of the Project on surface water quality and quantity are described in detail in Section 5.6. Hydraulic modelling was completed to estimate the effects of the Project on the hydraulic regime of Gold Brook between Gold Brook Lake (upstream) and Seal Harbour Lake (downstream) (see Appendix F.6). The maximum modelled change is an increase of 15 cm within portions of the brook, under low flow conditions. The magnitude and temporal period of this change is within the natural variability of the riparian wetlands found along Gold Brook, and therefore is not expected to result in impacts to wetlands down-gradient of the PA.

5.7.6.3 Direct and Potential Indirect Impacts Summary

Direct and potentially indirect impacts to wetlands will occur as a result of Project development. Project infrastructure footprints will result in the direct alteration of wetland area. All altered wetlands require compensation under the NS Wetland Conservation Policy, which is outlined in the Project's preliminary Wetland Compensation Plan (Appendix G.3).

Generally, changes in hydrology (i.e., reduced flow and contributing area, groundwater drawdown) due to the placement of Project infrastructure have the greatest potential to indirectly affect wetland function. On-going detailed infrastructure design and additional micro-siting will be completed to minimize these impacts where practical. Targeted monitoring for wetlands will also be conducted where hydrological impacts are likely to result in indirect effects (Section 5.7.6.2).

The protection and viability of connected, unaltered wetland area is considered as part of the provincial wetland alteration process. Design of suitable hydrological connectivity structures (e.g., culverts), implementation of a Project EMP and planned mitigation measures outlined in Section 5.7.7, will be employed to protect upstream or downstream wetland areas against avoidable indirect impacts as a result of Project activities. In addition, post-construction wetland monitoring, including invasive species monitoring, will be completed as discussed in Section 5.7.8.

To support the effects assessment, conservative impact scenarios were employed in determining total direct and potential indirect impacts to wetlands, as described in the previous sections. Hydrological impacts were considered as the primary pathway for indirect effects to wetlands (i.e., reduced flow and contributing area, groundwater drawdown). Direct and indirect impacts have been brought forward and summarized in Table 5.7-5 and 5.7-8, respectively.

In summary, the Project's proposed direct alteration area to wetlands is 90.599 ha, representing 27.5% of the delineated wetland area in the PA and 5.8% of the total (modeled) wetland area in the LAA. It is conservatively estimated that an additional 5.375 ha of wetland area will be altered as a result of predicted hydrological impacts, representing 1.6% of the PA wetland and 0.3% of wetland area in the LAA. It is estimated that another 12.898 ha of wetland area may be indirectly impacted by Project-related changes to hydrology, however, this area is only considered potentially impacted at this point, rather than a confirmed alteration area and will be assessed through the wetland monitoring program. In total, approximately 95.974 ha of wetland area is expected to be altered by the Project through direct and predicted indirect impacts.

In consideration of the impacts to WSS, specific wetland habitat types and wetland compensation, the magnitude of direct impacts to wetland habitat is assessed as moderate. Predicted wetland alterations as a result of indirect hydrological effects (5.375 ha) results in impacts of <5% to each wetland habitat type within the LAA, resulting in a low indirect impact assessment. It is anticipated that the actual indirect impacts to wetlands will be lower, given the conservative assessment approach and suite of mitigation measures proposed.

Impacts to wetland habitat accessible to fish are accounted for in the drafted Fisheries Offsetting Plan (Appendix H.3) and discussed in Section 5.8 (Fish and Fish Habitat). The effects of direct and indirect impacts to wetland habitat on terrestrial flora and fauna, including SAR and SOCI, are discussed in Section 5.9 (Terrestrial Environment).

5.7.7 Mitigation

The following sections detail the avoidance and mitigation measures taken to limit Project effects to wetlands. Species-specific mitigations for wetland associated flora and fauna, and their habitats, are detailed in their respective chapters (i.e., Terrestrial Environment (Section 5.9) and Fish and Fish Habitat (Section 5.8).

5.7.7.1 Wetland Avoidance

Signal Gold has considered environmental features observed during the biophysical surveys in the design of the Project. Of the total wetland area in the PA, direct impacts will be avoided for 72.5% of the wetland area. Through the Alternatives Assessment and Multiple Accounts Analysis processes (detailed in Section 2.8), the Project design and infrastructure layout has been revised to reduce impacts to wetlands, while considering other valued components, engineering constraints, regulatory requirements, and other factors. Specifically, additional consideration and all reasonable attempts to avoid SAR occurrences and associated wetlands were made and are described below. While blue felt lichen has been found in relative abundance in the local area (i.e., beyond the PA, Section 5.9), the Project team has, nonetheless, worked to avoid the blue felt lichen wherever practical. However, due to the location in which some proposed Project activities can be performed (the locations of the East and West Pits are fixed by geology) the extent to which the Project can be manipulated to avoid impacts to wetland habitat is constrained.

The TMF is the largest single infrastructure impact to wetlands. Many factors were 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, noise, dust and light considerations, proximity to residences and cottages, 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. As a result, siting of the TMF to further avoid wetlands was not feasible (see Section 2.8.1.8).

Infrastructure with greater ability to be micro-sited (i.e., till and organic material stockpiles and WRSAs) were adjusted to reduce impacts to wetlands, specifically potential WSS (e.g., avoidance of SAR lichen occurrences) where practical. Specifically, the below infrastructure layouts considered wetland impacts in their placement and design (shown in Figure 5.7-2):

- The northeast WRSA was redesigned several times to reduce impact to wetlands, associated blue felt lichen, and as a result, potential WSS. The engineering team was able to re-distribute and increase the height of the stockpile to minimize its footprint and direct impacts. As a result, direct impacts were avoided to Wetland 27 and the impact area to Wetland 12 (WSS) was reduced to avoid blue felt lichen occurrence and associated setbacks.
- The northeast organics stockpile was designed in consideration of Wetlands 117 (WSS) and 255 and shaped to avoid additional direct impacts to these wetlands.
- The northeast till stockpile and Northeast WRSA were spilt to avoid direct impacts to Watercourse 9 and therefore the associated riparian area of Wetland 25, this portion of Wetland 25 was assessed to be directly impacted by a change in hydrology.
- The northwest WRSA was redesigned to reduce overall impact to wetlands, associated blue felt lichen, and as a result, potential WSS. Similar to the Northeast stockpile, the northwest WRSA was able to re-distribute in order to reduce its footprint and direct impacts. The wetland habitat directly north of this stockpile was originally impacted by waste rock storage. Direct impacts to many of these wetlands were avoided or at a minimum notably reduced, including impacts to potential WSS Wetland 51 and 52. Furthermore, the southern extent of this WRSA was also adjusted to avoid another occurrence of blue felt lichen and the associated area of Wetland 17 (WSS).
- The southwest till stockpile, particularly the northern portion, was re-designed and moved south to avoid fish and fish habitat, multiple occurrences of blue felt lichen and as a result, associated wetland habitat of Wetland 1 (WSS).

Four identified potential WSS (WL44, 48, 101 and 131) will be avoided by Project infrastructure and are not expected to be indirectly impacted by Project activities. As discussed above, impacts to the other 18 potential WSS have been minimized where practical, specifically in consideration of impacts to the SAR lichen (i.e., blue felt lichen and frosted glass-whiskers lichen) occurrences within them, as shown in Figures 5.9-3A through 5.9-3E in Section 5.9 (Terrestrial Environment). As shown in Figure 5.7-3A-C, proposed impacts to four of the potential WSS (WL51, 52, 117, and 196) are from road and water management infrastructure and represented <5% of their total respective wetland areas. Further micro-siting of roads, ditching and ponds may be possible and this will be reassessed at the detailed design, engineering, and permitting stage. Fourteen (14) of the potential WSS are proposed to be altered by infrastructure with limited ability to be micro-sited, such as the East and West Pits and the TMF. See above for detail on stockpile avoidance of WSS.

5.7.7.2 Wetland Mitigation

Table 5.7-9 provides the proposed wetland mitigation measures and common best practices that will be implemented where direct and potential indirect impacts to wetlands are expected. Mitigation measures are detailed for all phases of Project development: construction, operations, and closure. Signal Gold will apply for approval to alter wetlands through NSECC prior to the commencement of Project construction and will abide by all site-specific approval conditions. Mitigation measures will be verified through wetland monitoring requirements, as introduced in the Section 5.7.8. The Project's wetland monitoring plan will be refined in consultation with NSECC and submitted for approval during the permitting stage once detailed engineering and design activities are complete.

Complementary mitigations for wetland associated species and activities are provided in respective VC chapters (e.g., Terrestrial Environment, Fish and Fish Habitat, Surface Water). Supporting management and monitoring plans have also been prepared, including a Lichen Management and Monitoring Plan, Wildlife Management Plan, and Water Monitoring Plan.

In addition to mitigations, and where wetlands impacts could not be avoided, Signal Gold is committed to engaging in wetland compensation activities for the wetland loss associated with the Project as required by the provincial wetland alteration process. The preliminary Wetland Compensation Plan is further discussed in Section 5.7.8 and has been provided in Appendix G.3.

Table 5.7-9 Wetland Mitigation Measures

Project Phase	Mitigations
Construction	Ensure all wetlands in the PA are visually delineated prior to construction (e.g., flagged)
	Complete pre-construction site meetings for all relevant staff/contractors related to working around wetlands and watercourses to minimize unauthorized disturbance, such as the introduction of invasive species.
	Acquire and adhere to wetland alteration approvals prior to alteration of any wetland habitat.
	Complete detailed design of road alignments and micro-siting of infrastructure to avoid or minimize impacts to wetlands wherever practical.
	Complete detailed culvert design to maintain current hydrology and necessary fish passage, including where upgrades to existing culverts are required.
	Implement construction methods that reduce the potential to drain or flood surrounding wetlands (e.g., appropriately sized/spaced culverts, no unpermitted pilling of soil/grubbings, no unnecessary ditching/artificial channelization)
Construction, Operations	Implementation of the Erosion and Sediment Control Plan (Appendix F.10) to ensure site runoff is not directed towards wetlands to maintain habitat integrity and existing drainage patterns.
	Minimize erosion of wetland soils by limiting flow velocities by means of hydraulic dissipation techniques and directing runoff through natural upland vegetation, wherever practical.
	Minimize the rutting of wetland habitat by limiting the use of machinery within wetland habitat and use of swamp mats/corduroy bridges as required

Table 5.7-9 Wetland Mitigation Measures

Project Phase	Mitigations
	Follow NSECC watercourse crossing guidelines, for temporary and permanent crossings.
	Maintain pre-construction hydrological flows through wetland habitats and partially altered wetlands wherever practical, particularly through wetlands bisected by roads.
	Organic topsoil will be salvaged and stored for use in site reclamation where practical.
	Re-vegetate slopes adjacent to wetlands, using native seed mixes, to limit erosion and sediment release.
	Review and consider alternatives to traditional hydroseeding methods to advance vegetation re-establishment and reclamation methods Consideration will be given to native species with Indigenous significance.
	Conduct vegetation management (cutting and clearing) in or near wetlands and watercourses in accordance with applicable guidelines and in consideration of breeding bird windows and wetland associated SAR. Maintain wetland vegetation wherever practical.
	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.
	Avoidance of SAR lichen occurrences where practical and maintain 100 m setback as per *At-risk Lichens Special Management Plan (see* Lichen Management and Monitoring Plan).
	Prepare and implement a site-specific Wetland Monitoring Plan through the wetland permitting process, subject to NSECC approval, including baseline and post-construction monitoring, as introduced in Section 5.7.8.
	The Wetland Monitoring and Compensation Plans will be updated as necessary to meet evolving Project and NSECC requirements.
	Implement Emergency Response and Contingency Plans and appropriately store/manage hazardous and non-hazardous materials/waste to protect wetland habitat from accidental spills.
Closure	Review and consider alternatives to traditional hydroseeding methods to advance vegetation re-establishment and reclamation methods. Consideration will be given to native species with Indigenous significance.
	Compensate for permanent loss of wetland function through implementation of the Wetland Compensation Plan (preliminary plan in Appendix G.3 to be refined).
	Follow monitoring as required in wetland alteration permits and approved Wetland Monitoring Plan (to be completed at permitting stage).
	Potential on-site wetland and riparian area reclamation approaches are presented in the Conceptual Reclamation and Closure Plan (Appendix B.1) and will be further considered and detailed throughout the iterative reclamation planning process. Potential on-site reclamation may include riparian area stabilization and revegetation with wetland species, including consideration of species with Indigenous significance.

5.7.8 Monitoring and Follow-up

Wetlands are protected under the provincial *Environment Act* and Wetland Conservation Policy and an approval is required for alteration. Wetland alteration applications will be submitted and permitting will be obtained prior to any Project alterations to wetlands. Wetlands altered by the Project will be compensated at the ratio determined through consultation with NSECC and the Wetland Compensation Plan, in keeping with the prevention no net loss of wetland habitat and function. The Proponent will continue to work with NSECC to develop the required mitigation measures, including wetland compensation, to mitigate loss of habitat based on function and relative value.

A preliminary Wetland Compensation Plan is provided in Appendix G.3 and will be refined through the life cycle of the permitting process. Signal Gold will target local compensation opportunities whenever practical. The plan outlines the preliminary identification of primary and secondary compensation projects, which is already underway with the goal of identifying viable opportunities prior to Project construction. Three sites have been reviewed for primary compensation opportunities, two of which are bogs located locally in Port Bickerton (approximately 8 km southwest of the PA). It is expected that 40-60 ha of each of the Port Bickerton sites have been anthropologically disturbed and presently exist in an unnatural state through historic peat harvesting and heavy ATV use. Three additional secondary compensation opportunities have also been identified to support provincial wetland research and assessment advancement (e.g., wetland studies and continued WESP-AC calibration).

Wetland monitoring will be completed to verify the accuracy of the predicted environmental effects, the effectiveness of the mitigation measures outlined in Section 5.7.7, and signal a need to implement environmental control measures if monitoring indicates adverse environmental effects are or may be occurring due to activities of the Project. A detailed Wetland Monitoring Plan will be established through the life cycle of the permitting process, in consultation with NSECC, and will commit to monitoring during baseline/pre-construction to establish baseline conditions, and through the construction and operational phases. The focus of the plan will be to ensure the long-term protection of remaining wetland habitat post-development. Wetland monitoring may be completed at the closure phase if determined to be required.

Wetland monitoring will be completed for the Project on all wetlands that have been predicted to have direct or potential indirect effects from Project development. Based on predictions presented in the above wetland effects assessment, the below wetlands are recommended for monitoring. Additional wetlands may be added (or removed) through the development of the detailed Wetland Monitoring Plan, informed by on-going Project design, detailed permitting, and regulatory consultation.

- All partially altered wetlands (see Section 5.7.6.1.)
- Wetlands with predicted or potential indirect hydrological impacts due to changes in groundwater and surface water contributions (e.g., LCA flow reduction, groundwater drawdown, reduction in headwater contributing area; see Section 5.7.6.2.), including Wetland 27 (extent of potential hydrologic impact undefined)
- Additional avoided wetlands may be monitored if up or down gradient impacts to contiguous hydrological features may result in indirect impacts (e.g., potential drying through up-gradient impacts to a connected watercourse/wetland)

Potential Project-related effects to wetlands are identified in this EARD. The Project infrastructure layout has been adjusted to minimize impacts to wetlands and watercourses in the PA as is practical. Of the total 222 freshwater wetlands in the PA, 112 are expected to be completely (56) or partially (56) altered to support Project development. 18 of the wetlands proposed for alteration are identified as potential WSS due to the presence of blue felt lichen. It is estimated that 5.375 ha of wetland area will be altered as a result of predicted hydrological impacts, whereas 12.989 ha may be potential impacted by Project-related changes to local hydrology. Wetlands with predicted and/or potential indirect impacts will be incorporated into the detailed Wetland Monitoring Plan to determine whether alteration is occurring and to identify any additional compensation requirements.

The Wetland Monitoring Plan will outline the methods used to evaluate partially altered or potentially impacted wetlands, as listed above. The typical methods employed to evaluate wetland health include hydrological and vegetative studies to determine potential shifts in wetland characteristics over time. Visual observations of wetland conditions are also used to supplement this information. A hierarchy of monitoring approaches will be applied in consideration of the magnitude and type of individual wetland impacts. More intensive techniques may be employed for wetlands and wetland systems that meet specific alteration criteria (i.e., type of wetland, contiguity with other off-site wetlands and watercourses and size of wetland).

Baseline monitoring (pre-construction) will take place before construction commences. Post-construction monitoring of these variables will also be completed during operations at the established locations. Conditions recorded during baseline monitoring will be compared to post-construction monitoring to determine whether areas of unaltered wetland habitat remain viable, and healthy wetland characteristics are present. Comparison methods and indicators of change will be detailed in the Wetland Monitoring Plan and subsequent reporting.

Generally, the wetland monitoring program will include the following assessments:

- **Wetland hydrology**: Hydrological conditions, and possible shifts in hydrology, will be evaluated in each monitored wetland. Techniques will range from standardized visual qualitative observations of hydrological conditions to the installation of shallow monitoring wells equipped with automated water level loggers. Water level loggers will be used to record the detailed hydroperiod within the wetland or wetland system. Additionally, small soil test pits will be hand dug to a depth of ~30 cm to determine if positive indicators of wetland hydrology are present (i.e. saturation within 20 cm, groundwater within 30cm, hydrogen sulfide odour, etc.). Presence of hydric soil indicators will also be recorded.
- **Wetland vegetation**: Vegetative conditions, health, and possible shifts, will be evaluated in each monitored wetland. Techniques will range from standardized visual qualitative observations of vegetation conditions to the completion of specified, repeatable vegetation transects and/or plots. Data collected will include general vegetive health, presence of invasive species and relative species abundance.
- **Observations of direct and indirect impacts**: Standardized general observations will be completed at all monitored wetlands to determine whether the wetland was subject to additional direct or indirect impacts, beyond permitted extents. Impacts could include ground disturbances (e.g., rutting, excavation), sedimentation and erosion issues, and unplanned changes in hydrological inflow and outflow (e.g., damming, de-watering, disturbance to natural swales and drainage corridors).

Implementation of the strategies discussed above will support the mitigation process associated with wetland protection. The final Wetland Monitoring Plan will be refined in order to meet the specific activities and timing of activities within the Project. Annual monitoring results, as well as any changes to the program, will be provided to NSECC, as per wetland alteration permit conditions.

A wetland awareness program will be implemented to clearly identify boundaries of approved alteration areas and communicate these and all Approval requirements to relevant site personnel. Should post construction wetland monitoring and/or ongoing construction monitoring indicate a potential issue above natural variation, the Proponent will consult with NSECC to identify whether corrective actions or compensation will be required. Operations staff will be notified, and an investigation of the possible contributing factors will take place to identify and attempt to rectify the cause. Specific action levels and response procedures will be based on the Project related activity responsible for the variation in wetland conditions being observed. NSECC will be contacted and consulted in the instance of direct and/or indirect wetland response as a result of such activities, and a determination to what degree further action is required will be determined by all parties.

Proposed follow up and monitoring programs have been reviewed with local communities, organizations, and the Mi’kmaq of Nova Scotia during engagement efforts, including open houses and meetings. Local wetland compensation effort was heard as a priority for the municipality. On-going engagement with the Mi’kmaq will continue through the EARD process and associated permitting relating to follow-up programs and monitoring.

5.7.9 Company Commitments

During the permitting and detailed design stage, additional micro-siting of infrastructure will be considered to further avoid wetland impacts, and infrastructure-specific buffers will be added to wetland impact areas where necessary.

5.7.10 Residual Effects and Significance

A significant adverse effect on the Wetlands VC was defined in Section 5.7.6 as:

- A Project-related effect that results in an unmitigated or uncompensated net loss of wetland habitat, including WSS, as defined under the NSECC Wetland Conservation Policy (NSE, 2019), and its associated no-net loss policy. An adverse effect that does not cause a permanent loss of wetland habitat, in consideration of wetland functions, WSS and proposed mitigation/compensation, is not considered a significant adverse effect.

The predicted residual environmental effects of Project construction, operations and closure on wetlands are assessed to be adverse, but not significant (as defined in Section 5.7.5.3). The overall residual effect of the Project on wetlands is assessed as not significant in consideration of direct and indirect impacts to wetland habitats within the LAA and after the above discussed mitigation measures have been implemented, especially wetland compensation efforts. Direct impacts to wetlands as a result of Project construction were assessed to be moderate (Section 5.7.6.1), based on impacts to 5.8% of wetland area within the LAA, equating to a <10% loss of each wetland habitat type, and direct impacts to potential WSS. Indirect hydrological impacts anticipated to result in wetland alteration, as presented in Section 5.7.6.2, represent a maximum of 0.3% of wetland area within the LAA or <5% loss of each wetland habitat type, resulting in a low indirect impact assessment.

Anticipating that the proposed on-site mitigation measures and wetland compensation requirements are applied (see Appendix G.3: Wetland Compensation Plan) the Project is not likely to result in a significant adverse effects to wetlands, as defined (i.e., an unmitigated or uncompensated net loss of wetland habitat). Residual effects to wetlands are summarized in Table 5.7-10.

A significant adverse environmental effect for wetlands 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:

- During construction:
  - Direct impacts to wetlands will occur. However, these losses are <6% of the total available wetland habitat within the LAA. The majority of wetlands proposed for alteration are locally abundant and relatively isolated systems (isolated swamps). The largest impacts by area are to wetland complexes, the largest being Wetland 1. However, due to the size and abundance of wetlands within the LAA, and more broadly, the combined direct effects results in a moderate magnitude.
  - Direct impacts are anticipated within potential WSS to support Project design, which are identified due to the presence of a sessile SAR lichen. A Lichen Management and Monitoring Plan has been prepared to assess indirect impacts to SAR lichen. Four identified potential WSS (WL44, 48, 101 and 131) will be avoided by Project infrastructure and are not expected to be indirectly impacted by Project activities.
- During operations:
  - Indirect hydrological impacts are anticipated to result in wetland alteration to 0.3% of the total available wetland habitat within the LAA. Wetland monitoring will be implemented to evaluate additional potential indirect impacts. Indirect impacts will be limited through the implementation of described mitigation measures.
  - Based on the headwater potion of the PA within the Gold Brook Lake watershed and results of hydrological modeling down-gradient of the PA (Appendix F.6), hydrologic impacts to wetlands are not expected within the LAA.
- During closure:
  - Limited additional impacts to wetlands are predicted based on the implementation of mitigation measures (e.g., sediment and erosion control) during closure. The reclamation process will endeavor to maintain hydrological pathways and flows.
  - Off-site wetland compensation will be completed to off-set Project-related wetland alterations (Appendix G.3: Wetland Compensation Plan). Local compensation projects will be prioritized wherever practical.
  - On-site wetland reclamation opportunities within the PA will be considered where practical and are introduced in the Conceptual Reclamation and Closure Plan (Appendix B.1).

Table 5.7-10 Residual Effects on Wetlands

Project Phase	Mitigation and Compensation Measures	Nature of Effect	Residual Effects Characteristics						Residual Effect	Significance
			Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility		
Construction – Direct wetland alteration, clearing/grubbing	Limit impacts through detailed Project design, on-site wetland training, wetland permitting process	A	M Project results in up to 10% loss of a specific wetland habitat in the LAA. Direct impacts to potential WSS.	PA Potential adverse effects to wetlands within the PA	A Seasonal aspects may affect VC	P VC unlikely to recover to baseline conditions	O Effects occur once during construction	IR VC will be permanently altered from baseline conditions	Habitat loss, disturbance	Not significant
Construction and Operations – Indirect impacts to wetlands: hydrological, dust, sediment and erosion, invasive species, accidents/malfunctions)	Sediment and erosion control, maintain hydrological flow paths, water management, wetland heath and invasive species monitoring, spill preparedness	A	L Project results in up to 5% loss of a specific wetland habitat in the LAA. Predicted indirect impacts to potential WSS.	PA Potential adverse effects to wetlands within the PA	A Seasonal aspects may affect VC	LT Effects extend beyond 3 years	R Effects occur at regular intervals throughout the Project	PR Mitigations can not guarantee a return to baseline conditions	Disturbance	Not significant
Closure – Reclamation activities	Sediment and erosion control, best practices, spill preparedness, wetland compensation	P	L On-site wetland reclamation opportunities	PA Potential effects to wetlands within the PA	A Seasonal aspects may affect VC	LT Effects extend beyond 3 years	O Effects occur once during reclamation	PR Mitigations and reclamation can not guarantee a return to baseline conditions	Habitat reclamation	Not significant

Legend (refer to Table 5.7-1 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