8.8 WETLAND ENVIRONMENT

The Wetland Environment is the sum of water, soil, and biota that occur in areas that are saturated with water for sufficient periods to promote aquatic processes as indicated by hydric soils, hydrophytic vegetation, and biological activities adapted to the wet environment. The Wetland Environment was selected as a valued environmental component (VEC) because of the potential for interactions between the Project and the Wetland Environment in consideration of the value of wetlands on a local and landscape scale as recognized by regulatory agencies, the public, and other stakeholders, and in recognition of both federal and provincial wetland conservation policy objectives of no net loss of wetland function.

Various information sources were used to create a wetland model for the Local Assessment Area (LAA, defined later), which was subsequently verified and corrected through extensive field surveys, during which descriptions of wetlands and observations on wetland function were noted. In this section, potential Project-VEC interactions are evaluated, including Construction activities such as site preparation, which will lead to the direct loss of GeoNB-mapped wetlands and unmapped wetlands within the Project Development Area (PDA; Figure 1.2.1), and Operation activities which may lead to the indirect loss of wetland in the LAA (outside of the PDA) due to changes in drainage and local hydrology. Mitigation measures are outlined, including compensation for wetland loss and/or functional changes. Potential cumulative environmental effects of the Project in combination with other projects or activities that have been or will be carried out are also evaluated, including particularly future forestry and agricultural land use, which was determined to be most likely to potentially interact cumulatively with the Project on the Wetland Environment in the future.

Though the Project will result in the direct and indirect loss of area and function of some wetlands, the direct loss of GeoNB-mapped wetlands will be compensated. For the remaining unmapped wetland, this residual loss represents less than 0.1% of all wetland in the Regional Assessment Area (RAA). The extent of indirect loss of GeoNB-mapped and unmapped wetland in areas outside of the PDA will be evaluated through a follow-up program, the results of which will be used to determine the requirements for adaptive management. Overall, it is not expected that these losses will be substantive. Consequently the environmental effects of the Project on the Wetland Environment are rated not significant.

8.8.1 Scope of Assessment

This section defines the scope of the environmental assessment of the Wetland Environment in consideration of the regulatory setting, issues identified during public and First Nations engagement activities, potential Project-VEC interactions, and existing knowledge.

8.8.1.1 Rationale for Selection of Valued Environmental Component, Regulatory Context, and Issues Raised During Engagement

The Wetland Environment was selected as a VEC because of the potential for interactions between the Project and the Wetland Environment and the value of wetlands on a local and landscape scale as recognized by regulatory agencies (particularly through the New Brunswick Wetlands Conservation Policy (NBDNRE 2002)), naturalists, the public, other stakeholders. The policy lists various types of function that can be fulfilled by wetlands in New Brunswick as the impetus for wetland conservation, including: storm surge protection; shoreline stabilization; human health protection; biodiversity; and cultural and scientific opportunities. Many of these are not applicable to the wetlands affected by the Project. These lists of functions tend to commingle actual wetland function with the values placed on them. The true importance of wetlands for humans lies in the fulfillment of ecological, hydrological, biological, and chemical functions that have particular value to humans and it should be recognized that both individual wetlands and wetland types perform these to widely varying degrees.

Wetland is managed in New Brunswick by the Department of Environment and Local Government (NBDELG), through the New Brunswick Wetlands Conservation Policy (NBDNRE 2002). The objectives of this policy are to maintain wetland function, and to protect wetland through securement, stewardship, education, and awareness. Specifically, the policy does not support most activities that pose a risk to Provincially Significant Wetlands (PSWs)[1], none of which will be affected by the Project. The New Brunswick Wetlands Conservation Policy also states that activities in all other (*i.e.*, non-PSW) wetlands over one hectare will be subject to a review process that will assess the functions of the wetland and the potential for negative results to wetlands from anthropogenic activities.

Legislation supporting the New Brunswick Wetlands Conservation Policy includes the New Brunswick *Clean Water Act* and the associated *Watercourse and Wetland Alteration Regulation* (WAWA Regulation), as well as the New Brunswick *Clean Environment Act* and the associated *Environmental Impact Assessment Regulation* (EIA Regulation). The *WAWA Regulation* applies to all wetlands of 1 hectare (ha) or greater in size, or any wetland contiguous to a watercourse. A permit under the *WAWA Regulation* is required for all activities within 30 m of a regulated wetland (*i.e.,* 1 ha or greater in size, or contiguous to a watercourse). The EIA Regulation states that any undertaking affecting two or more hectares of wetland requires registration with the Minister of Environment to determine if an EIA is required. Consequently, the environmental effects assessment of this VEC is mandated provincially, and the wetland affected by the Project is also subject to permitting under the WAWA Regulation. Federal policy applies to federal land and waters, or federally designated wetlands such as Ramsar sites, of which there are none affected by the Project.

On February 13, 2012, the New Brunswick Minister of Environment released a document entitled “Long-Term Wetland Management Strategy” (NBDELG 2012e). Although this document only outlines protection of PSWs (none of which are found in the LAA) and does not describe protection of all other wetlands, this document was preceded by the Short and Long Term Strategies document released on March 18, 2011, which stated that only wetlands currently mapped on the GeoNB website (GeoNB n.d.) (representing approximately 6% of New Brunswick) are managed by NBDELG and require permitting for alterations and associated compensation (referred to herein as “GeoNB-mapped wetlands” or “regulated wetlands”). The existing provincial policy, acts, and regulations currently in place remain unchanged.

[1] Provincially Significant Wetlands (PSWs) are defined as wetlands having provincial, national, or international importance, namely: coastal marshes; wetlands designated under other conservation-based agencies; wetlands that contain species listed under the New Brunswick *Species at Risk Act*); and wetlands with significant ecological, hydrological function, or social values or functions.

In order for development to proceed in a wetland in consideration of the regulatory and policy framework in New Brunswick, a hierarchy of protective measures must be followed. First, wetlands must be avoided if possible. If this is not possible, then some type of mitigation must be attempted to minimize adverse environmental effects to the Wetland Environment. If mitigation is not possible and wetlands must be destroyed or displaced, then permitting and associated compensation are required. Provincially, compensation is required, on an interim basis, only for GeoNB-mapped wetlands as defined by the GeoNB-mapped, regulated wetland layer. Alterations to PSWs are not generally permitted. Regardless of the complexities and limitations of the regulatory and policy framework, the approach to the consideration of wetlands in this EIA is to evaluate the environmental effects of the Project on all wetlands. While avoidance or mitigation will be applied to all affected wetlands, compensation at the 2:1 ratio as applicable will apply only to GeoNB-mapped wetlands, in accordance with the current provincial approach to wetland policy implementation, unless superseded by a provincial long-term strategy for wetlands protection if it occurs prior to Project permitting.

Finally, wetland conservation is promoted federally through the Federal Policy on Wetland Conservation (Government of Canada 1991). The FPWC applies to all federally managed lands and protected areas, of which there are none in the LAA. The federal policy does apply to any wetland when the federal government has decision-making authority in respect of a development that may potentially affect wetlands (*e.g.,* in an assessment under the *Canadian Environmental Assessment Act* (*CEAA*) as per this assessment), although there are no supporting legislative measures specific to wetlands which fall under provincial jurisdiction on non-federal lands and waters.

As required by the Final Guidelines (NBENV 2009) and the Terms of Reference (Stantec 2012a), the assessment of the Wetland Environment includes a description of the existing environment and the assessment of potential environmental effects of the Project during all phases. The description of the existing conditions will also assist with developing mitigation strategies and the assessment of cumulative environmental effects of the Project in combination with other past, present, or reasonably foreseeable future projects or activities that have been or will be carried out.

Although no issues specific to the Wetland Environment were raised during public, stakeholder, and Aboriginal engagement activities conducted in support of the Project, the following issues raised in terms of Water Resources (Section 8.4) and the Aquatic Environment (Section 8.5), respectively, are also relevant to the Wetland Environment.

- How will groundwater be affected by the Project?
- Will waterways be re-routed?

These concerns influenced baseline data collection and modelling, and were addressed through an analysis of surface and groundwater, and modelling of associated potential changes to wetland. The environmental effects of changes to groundwater and surface water for human consumption are assessed in Section 8.4 (Water Resources), and changes to aquatic life and aquatic habitat are assessed in Section 8.5 (Aquatic Environment). The changes to wildlife and wildlife habitat, including birds, are assessed in Section 8.6 (Terrestrial Environment).

8.8.1.2 Selection of Environmental Effect and Measurable Parameters

The environmental assessment of the Wetland Environment is focused on the following environmental effect:

- Change in Wetland Environment.

The Project has the potential to affect the Wetland Environment through loss of wetland area and/or change in wetland function resulting from such factors as disturbance, interception and retention of surface water and groundwater flow, deposition of contaminants from the air (dust), change in drainage and flow patterns, change in water quality and/or quantity, and other alterations of hydrological conditions such as evapotranspiration, interception and infiltration.

The measurable parameters used for the assessment of the environmental effect presented above and the rationale for their selection is provided in Table 8.8.1.

Table 8.8.1 Measurable Parameters for Wetland Environment

Environmental Effect	Measurable Parameter	Rationale for Selection of the Measurable Parameter
Change in Wetland Environment	Loss of Wetland Area (ha)	• The area of various wetland types that will be lost is a measurable parameter that is related to many wetland functions. The proportion of wetland lost within the Regional Assessment Area (RAA, defined later) can also be estimated to determine the extent of change within the greater landscape.
	Change in Wetland Function (various units of measurement where possible)	• The New Brunswick Wetlands Conservation Policy indicates that wetlands provide functions that are important in New Brunswick from hydrological, ecological, and socioeconomic standpoints.

Although many functions are ascribed to wetlands by the New Brunswick Wetland Conservation Policy, no specific measurements or indicators of wetland function are prescribed. The typical approach to measuring wetland function in Atlantic Canada and many other jurisdictions has been largely qualitative due to the difficulties and lack of precedents in the development of objective, readily measurable indicators of valued wetland functions. For example, the Study Team relied upon a conceptual understanding of hydrologic function deduced from a number of factors observed in the field and in mapping related to geology, topography, drainage, water table, soils, and vegetation type. Ecological function is considered particularly by focusing on unique or valued functions such as the habitat for species at risk (SAR), species of conservation concern (SOCC), and uncommon vegetation communities. In such instances, measurable parameters in Table 8.8.1 can include number of individuals or communities or area of habitat (ha).

8.8.1.3 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on the Wetland Environment include the three phases of Construction, Operation, and Decommissioning, Reclamation and Closure, as defined in Chapter 3.

The temporal boundaries for the characterization of existing (baseline) conditions for the Wetland Environment include the years 2011 and 2012, when wetland mapping, walkover, field delineation and evaluation of wetland function of wetlands in the PDA and LAA were carried out by Stantec.

8.8.1.4 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of the Wetland Environment are defined below. Refer to Figure 1.1.1 for the site location.

Project Development Area (PDA): The PDA (Figure 8.8.1) is the most basic and immediate area of the Project, and consists of the area of physical disturbance associated with the Construction and Operation of the Project. Specifically, the PDA consists of an area of approximately 1,253 hectares that includes: the open pit; ore processing plant; storage areas; TSF; quarry; the relocated Fire Road and new Project site access road; and new and relocated power transmission lines. The PDA is the area represented by the physical Project footprint as detailed in Chapter 3.

Local Assessment Area (LAA): The LAA is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence. The LAA includes the PDA and any adjacent areas where Project-related environmental effects may reasonably be expected to occur. For the Wetland Environment, the LAA encompasses the entire PDA, and for the area of the PDA encompassing the mine and associated facilities also includes contiguous wetlands downstream of the PDA to the point where they converge with a larger receiving watercourse/wetland system (encompassing the likely zone of influence for the Wetland Environment), and also includes a minimum buffer area of 45 m (*i.e.*, 1.5 times the standard 30 m wetland buffer as prescribed in the WAWA Regulation) from the perimeter of the PDA. This affords an added precaution to allow for the identification and assessment of indirect environmental effects on wetlands. Additional areas around Trouser and Christmas Lakes to the south of the PDA were included as part of the LAA due to the potential hydrological changes resulting from expected groundwater drawdown arising from the dewatering of the open pit, based on considerations in relation to Water Resources in Section 8.4. The Nashwaak Ridge to the east, and higher elevations and surface water inputs external to the PDA to the west of the open pit limit the potential zone of effects in those areas. The LAA for the transmission line portion of the PDA includes standard 30 m wetland buffers on either side of the transmission line corridor. The LAA comprises an area of approximately 2,404 ha.

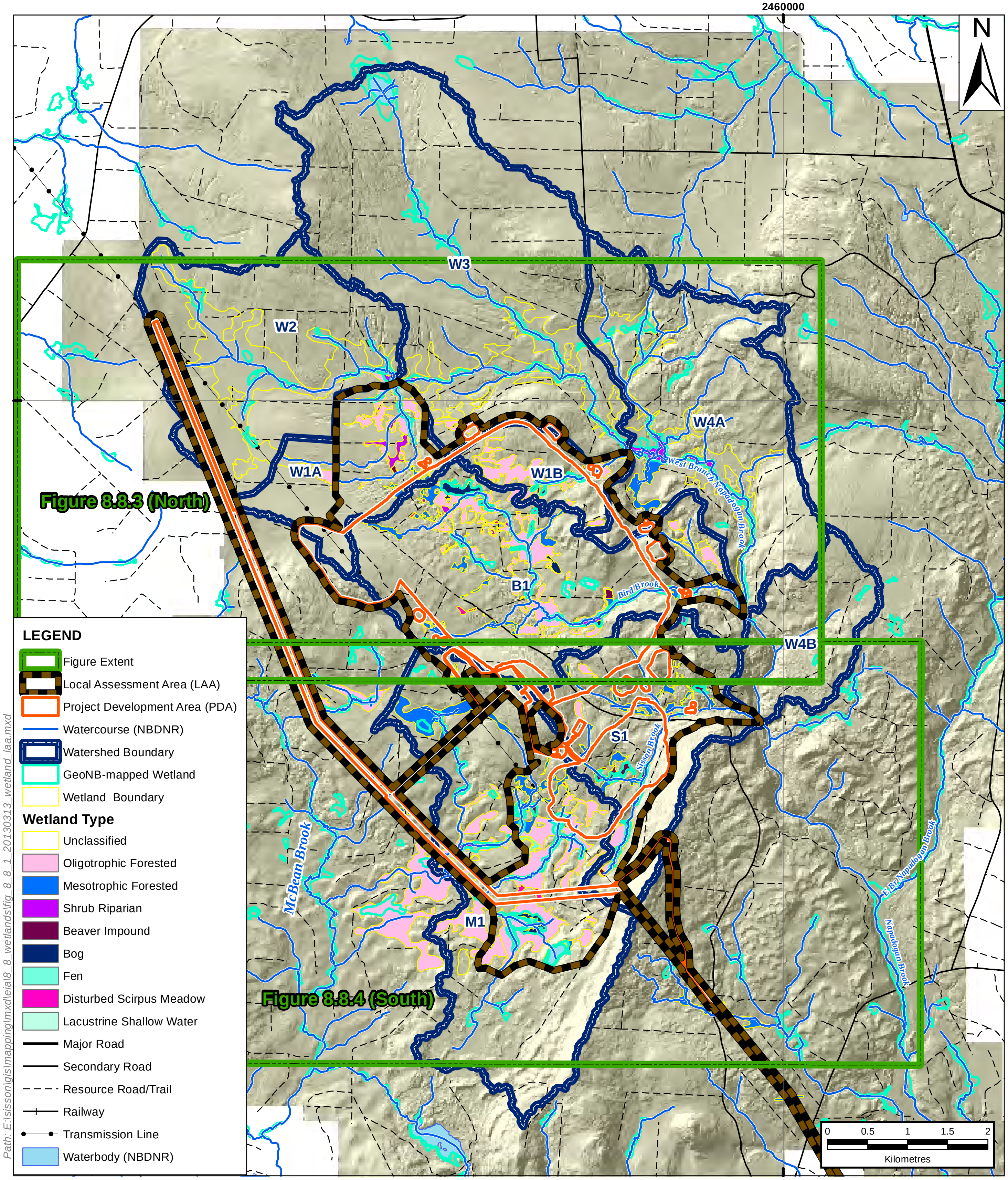
Regional Assessment Area (RAA): The RAA is the area within which the environmental effects of the Project may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out. The extent to which cumulative environmental effects for the Wetland Environment may occur depend on physical and biological conditions and the type and location of other past, present, or reasonably foreseeable future projects or activities that have been or will be carried out, as defined within the RAA. The RAA for the Wetland Environment conservatively includes the Central Uplands Ecoregion (excluding the Caledonia Uplands) and the Valley Lowlands Ecoregion and is shown on Figure 8.8.2.

While the PDA does intersect a small portion of the Grand Lake Lowlands Ecoregion, the RAA for the Wetland Environment does not include this area, consistent with the approach for the Vegetated Environment (Section 8.7). The PDA contains species assemblages that include many southern species not seen in other areas of the province. The area surrounding the transmission line portion of the PDA within the Grand Lake Lowlands Ecoregion does not differ greatly from the Valley Lowlands Ecoregion or the Central Uplands Ecoregion in terms of forest cover data (most notably, fewer spruce-dominated stands). Because such a small portion of the overall Project is within the most northern section of the Grand Lake Lowlands Ecoregion, which differs so greatly from other areas in the province, it is believed that this small section is not representative of the ecoregion as a whole. In addition, increasing the area of the RAA to include the Grand Lake Lowlands would result in less conservative predictions of environmental effects on the Wetland Environment.

8.8.1.5 Administrative and Technical Boundaries

The administrative boundaries for the Wetland Environment were summarized in Section 8.8.1.1 above, in terms of the legislative, regulatory and policy instruments at the provincial and federal level. Wetlands are addressed provincially by the New Brunswick Wetlands Conservation Policy (NBDNRE 2002). The primary objective of this policy is to prevent the loss of provincially significant wetlands (PSW) and achieve no net loss of wetland function for other wetlands. Implementation of this policy is the responsibility of NBDELG, through existing legislation. Wetlands are also protected provincially under the *Clean Water Act* and the *Clean Environment Act*. Under *the Clean Water Act*, the *Watercourse and Wetland Alteration Regulation* requires a wetland and watercourse alteration permit for a wetland alteration. These acts are administered by the NBDELG.

Technical boundaries for the Wetland Environment include spatial limitations in existing data sources used to characterize the wetlands in the LAA. Existing information used for the assessment includes NBDNR forest inventory data, aerial imagery, LiDAR (Light Detecting and Ranging) data, GeoNB wetland mapping data, Atlantic Canada Data Conservation Centre (AC CDC) elemental occurrence, and expert opinion range map data (a predictive model maintained by AC CDC for potential occurrence of rare species). Northcliff also commissioned the assessment of wetlands in the LAA in accordance with that proposed in Section 4.7 of the Terms of Reference (Stantec 2012a). These data are sufficient to accurately describe existing conditions and assess potential Project-related environmental effects, but some of the data sources do not cover the entire RAA so the cumulative environmental effects assessment was designed to rely on only the data that were available for the RAA.

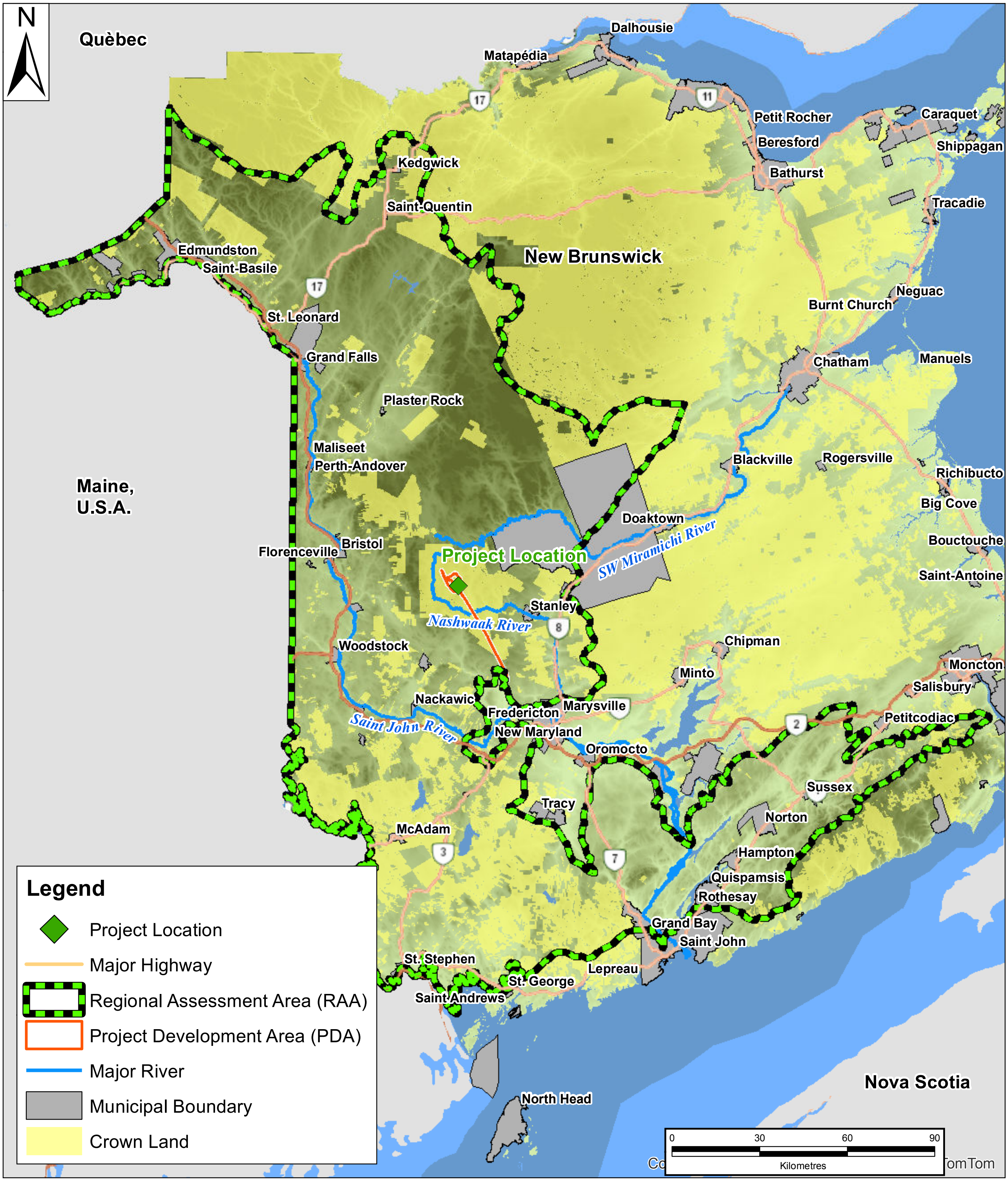


NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

Project Development Area (PDA), and Local Assessment Area (LAA) for the Wetland Environment Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:65,000	Project No.: 121810356		Data Sources: NBDNR	Fig. No.: 8.8.1
	Date: (dd/mm/yyyy) 14/03/2013	Dwn. By: JAB	Appd. By: DLM		
Client: Northcliff Resources Ltd.					

Stantec

Map: NAD83 CSRS NB Double Stereographic



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

Regional Assessment Area (RAA) for the Wetland Environment Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:1,800,000	Project No.: 121810356		Data Sources: NBDNR ESRI Online	Fig. No.: 8.8.2	Stantec
Client: Northcliff Resources Ltd.	Date: (dd/mm/yyyy) 13/03/2013	Dwn. By: JAB	Appd. By: DLM			

Map: NAD83 CSRS NB Double Stereographic

The most substantive technical boundary is the lack of region-specific scientific research supporting the analysis of wetland function as articulated in the New Brunswick Wetlands Conservation Policy. There is little or no relevant technical or scientific literature specific to wetland function in New Brunswick or the surrounding region. Consequently, the attribution of wetland functional value in New Brunswick is based on a general acceptance of the notion that wetland performs certain functions. In the absence of peer reviewed literature, function is therefore deduced on the basis of certain assumptions derived from a range of scientific evidence and through the extrapolation of literature from other regions of North America. Therefore, in fulfilling the requirement to consider wetland function in this EIA, there is an effort to apply deductive reasoning and available information to evaluate wetland function within a broad analytical framework, with a view to providing at least some reasonable basis for qualitatively assessing changes in wetland function. For some wetland functions like the provision of habitat for plants and animals, this is straightforward, whereas less tangible or less obvious aspects like hydrological function are more problematic. This assessment applies a conceptual model, particularly for hydrologic function, to understand the potential importance of wetland function in the LAA. Further limiting to the consideration of wetland function is the lack of balanced consideration of hydrologic and other functions in non-wetland environments. Frequently, the application of protective wetland policy is in the absence of balanced consideration of the various ecological land types. As a consequence, wetland function (which is regulated) is often favoured at the expense of other upland land types that may in some cases be of greater importance for ecological and other valued functions.

8.8.1.6 Residual Environmental Effects Significance Criteria

A significant adverse residual environmental effect on the Wetland Environment is defined as one that results in:

- an unauthorized net loss of wetland function (as represented by area affected) in a wetland for which alteration would otherwise require authorization under the current wetland conservation strategy in New Brunswick (*i.e.*, currently focused on GeoNB-mapped wetland);
- the unauthorized loss of wetland function (as represented by area affected) in a PSW after consideration of planned mitigation or provincially required compensation for unavoidable wetland losses; or
- the loss of valued function identified to be of particular importance as provided by non-GeoNB-mapped wetland that cannot be avoided, mitigated or compensated.

An understanding of function is the basis for application of wetland mitigation hierarchy; therefore significance is based on the nature and magnitude of an environmental effect after the mitigation hierarchy has been applied. The first two significance criteria are based in part on the NBDELG's current approach to wetland policy implementation, discussed previously. The third criterion offers consideration for environmental effects on valued functions of unmapped wetlands which may constitute a large proportion of wetlands on the landscape. Its consideration is necessarily qualitative and evidence-based, and informed by professional judgment.

For all wetlands that are not PSW or do not appear on the GeoNB-mapping layer, the key wetland functions of concern are the potential changes in stream flow in the watershed or sub-watershed, or potential changes to biodiversity as a result of wetland function loss. An important consideration is whether the loss of drainage area is the principal cause in hydrology-related environmental effects due to the Project, so as not to over-emphasize the importance of the loss of drainage area because it is wetland.

8.8.2 Existing Conditions

8.8.2.1 Overview

As shown in Figure 6.3.8, New Brunswick is divided into seven ecoregions which differ in physical characteristics such as climate, geology and soils, forest cover and vegetation, and wetlands. The portion of the PDA covered by the mine site is entirely within the Beadle Ecodistrict in the southern portion of the Central Uplands Ecoregion, but relatively close (approximately 3 km) to the Valley Lowlands Ecoregion. The transmission line portion of the PDA extends from the mine site in the Central Uplands Ecoregion through the Valley Lowlands Ecoregion and ending at an existing NB Power terminal near Burtts Corner. The final 1.5 km of the new transmission line is within the Grand Lake Lowlands Ecoregion, which is the smallest ecoregion in the province and differs markedly from other ecoregions in its warm climate and abundance of floodplain wetlands.

The Central Uplands Ecoregion includes two geographically separate but ecologically similar areas, the Madawaska Uplands in northwestern New Brunswick and the Caledonia Uplands in the southeast part of the province near the Bay of Fundy. The portions of the PDA and LAA associated with the mine site are located in the southern portion of the Madawaska Uplands, which is characterized by plateaus and warmer, south-facing slopes that support tree species such as balsam fir (*Abies balsamea)*; red, white, and black spruce (*Picea rubens*, *P. glauca*, and *P. mariana*); and tolerant hardwoods such as sugar maple (*Acer saccarum*), yellow birch (*Betula alleghaniensis*), and beech (*Fagus grandifolia*) (NBDNR 2007). Common understory shrub species include mountain maple (*Acer spicatum*), striped maple (*A. pensylvanicum*), and hobblebush (*Viburnum lantanoides*).

Generally, watercourses in the northern part of this region flow into the St. John River whereas those in the southern part of the region primarily flow east and eventually into the Miramichi River. Rivers in the extreme south of the Madawaska Uplands are an exception; these flow into the Nashwaak River, which drain into the St. John River. The Central Uplands Ecoregion contains many different wetland types, particularly in southern areas where the landscape is less constrained by steep slopes. Bedrock within the Beadle Ecodistrict (where the mine site is located) is primarily granitic, with relatively few fractures and low porosity causing poor surface drainage (Colpitts *et al.* 1995). This poor drainage has resulted in more lakes, ponds, and wetlands in the ecodistrict. Common wetland types include shrub riparian wetlands dominated by alder (*Alnus* spp.), open water wetlands, and peatlands (NBDNR 2007).

The Valley Lowlands Ecoregion, through which the majority of the transmission line corridor passes, is the largest ecoregion in the province. It is associated with several large river systems, including St. John River and Kennebecasis River (NBDNR 2007). Because this ecoregion is associated with large river systems that are removed from the moderating climactic influence of the ocean, winters are colder and summers are warmer compared to most of the province. The Valley Lowlands Ecoregion has such a large area and wide provincial coverage that it is divided into 12 ecodistricts, with variable geology and diverse types of forest and wetland (NBDNR 2007).

8.8.2.2 Wetland Evaluation Methods

8.8.2.2.1 Information Sources

Various sources of information were obtained from a variety of sources to characterize the LAA and identify information to be collected during field surveys. These information sources include the New Brunswick Department of Natural Resources (NBDNR) forest stand data (2008), watercourses, and waterbodies; aerial imagery (2008); LiDAR data collected for the Project; and wetlands information documented by NBDELG.

NBDNR forest cover data for the areas covered by the Project are based on air photos taken in 2008. LiDAR data were collected for the Project in December 2010, and were used to update changes in the forest layer that have occurred since 2008, interpret watercourse locations and extents to develop a hydrograph "layer", develop a wetland model guide, assist the planning of field surveys, and assist in the interpretation of wetland boundaries. GeoNB-mapped wetland data were used to determine the locations of wetlands regulated by NBDELG.

8.8.2.2.2 Remote Sensing, Modelling, and Field Surveys

Existing conditions for the Wetland Environment were determined using a combination of remote sensing, modelling, and field surveys. Prior to conducting field surveys, remote sensing and modelling were used to predict the locations and extents of wetlands.

The locations of wetlands within the mine site portion of the LAA were initially determined through modelling. LiDAR data were used to create a bare earth digital elevation model (DEM) at 2 m resolution for the LAA and surrounding area. An initial "hydrograph" layer (not to be confused with the term hydrograph in hydrology) was created based on NBDNR mapped water bodies, watercourses, GeoNB-mapped wetlands, and interpreted streams based on flow accumulation and direction grids created from the DEM. Elevation differences were assigned to the nearest water feature for each 2 m cell in the LAA, creating a wetland model showing areas that likely had water table within 25 cm of the ground surface. The model was updated using initial field delineations of wetlands, and a predicted water table depth of 50 cm below the ground surface was used to predict the extent of wetland, as this was shown to result in modelled wetland boundaries that most closely aligned with field observations and delineations.

From early June to mid-September 2011, following initial wetland modelling, field surveys were completed within the portion of the LAA associated with the mine site during which wetland boundaries were adjusted, and observations were made on wetland types, dominant vegetation (and SAR/SOCC, if present), and wetland function. Wetland delineation was conducted in accordance with the "Corps of Engineers Wetland Delineation Manual" (Environmental Laboratory 1987) and the "Draft Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region" (US Army Corps of Engineers 2008). Wetland boundaries were also interpreted in some areas (*e.g.*, contiguous wetlands outside of the LAA) using the wetland model, DEM, and aerial imagery. Representative, or "control", wetlands of each wetland type were surveyed to illustrate typical conditions for each wetland type within the LAA. In each control wetland, vegetation, hydrology, and soils data were recorded at both wetland and upland data points on either side of the wetland boundary, in accordance with the "Corps of Engineers Wetland Delineation Manual" (Environmental Laboratory 1987).

The portion of the LAA associated with the new 138 kV transmission line was field surveyed from June to early September 2012. As LiDAR data were not available for the 42 km-long transmission line portion of the LAA, the wetland modelling methods described above were not used for this area. The entire transmission line portion of the LAA was surveyed in the field, and all wetlands encountered were delineated.

Further details on methodology are available in the Baseline Vegetation and Wetland Environments Technical Report (Stantec 2012g).

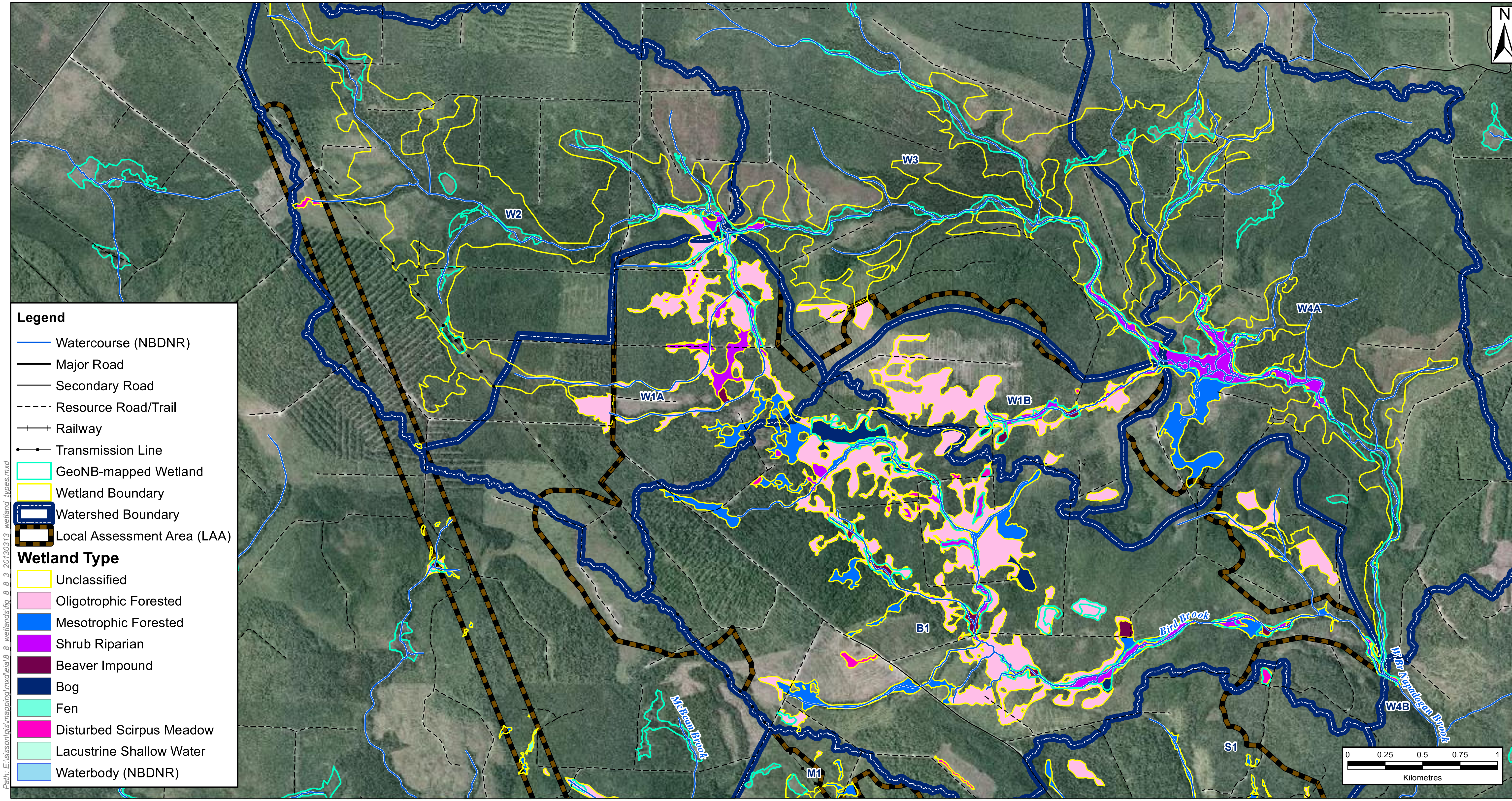
8.8.2.3 Wetlands in the LAA

The wetland classification system used by Stantec was developed to characterize the wetlands within the LAA from both a functional and physical perspective. The basis for wetland classification system is the conventional New Brunswick naming system used by NBDNR and NBDELG, with additional descriptive qualifiers based on the Canadian Wetland Classification System (Warner and Rubec 1997). A total of 58 GeoNB-mapped wetlands (none of which are PSW) are located within, or partially within, the LAA.

There are a total of 449 ha of wetland within the LAA (representing 18.7% of the total area of the LAA for the Wetland Environment) distributed among eight types of wetland:

- oligotrophic forested wetland (OFW);
- mesotrophic forested wetland (MFW);
- shrub riparian wetland (SRW);
- beaver impoundment wetland (BIW);
- bog;
- fen;
- disturbed scirpus meadow (DSM); and
- lucustrine shallow water wetland (LSW).

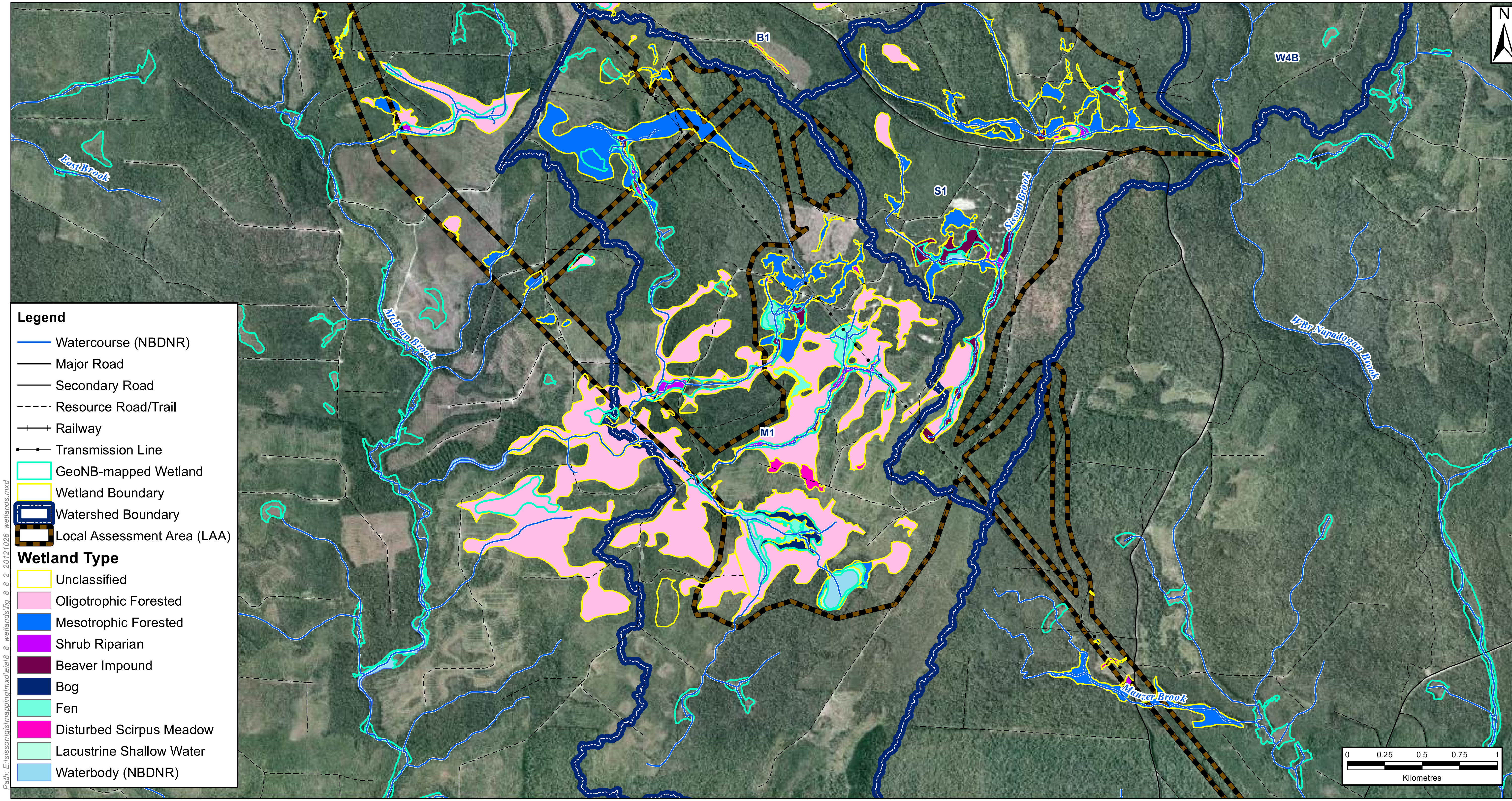
The location and distribution of wetlands (and their types) within the PDA and LAA are shown on Figures 8.8.3 and 8.8.4.



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

Wetland Types (North) Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:25,000	Project No.: 121810356	Data Sources: NBDNR	Fig. No.: 8.8.3
	Date: (dd/mm/yyyy): 13/03/2013	Fig. By: JAB	Appd. By: DLM	Stantec
Client: Northcliff Resources Ltd.				

Coordinate System: NAD 1983 CSRS New Brunswick Stereographic



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

Wetland Types (South) Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:25,000	Project No.: 121810356	Data Sources: NBDNR	Fig. No.: 8.8.4	Stantec
	Date: (dd/mm/yyyy): 13/03/2013	Fig. By: JAB	Appd. By: DLM		
Client: Northcliff Resources Ltd.					

Coordinate System: NAD 1983 CSRS New Brunswick Stereographic

Approximately 19% of the LAA is wetland, and more than three quarters of that wetland is forested wetland, which is typical of the Central Uplands Ecoregion. There is a conspicuous absence of more eutrophic wetlands such as cedar swamps compared to other ecodistricts in the Central Uplands Ecoregion, reflecting the lack of calcareous soils and predominance of soils locally derived from granitic bedrock formations in the LAA. The forested wetlands are generally poor in nutrients, low in plant diversity, and largely dominated by black spruce and balsam fir with ericaceous shrub understory.

There is some peat formation in these wetlands, and while their hydrologic status maintains wetness with some consistency, drainage is not sufficiently impeded to allow paludification to progress at a rate that is conducive to peat production and the transition to fen and bog-forming conditions. The scarcity of bogs and limited area of fen in the LAA is typical of the Central Uplands Ecoregion. In the LAA, the bogs are small and occur at the upper limits of the Bird Brook watershed. Fens are more widely occurring; however, it would appear that the factors contributing to paludification are limited within the watershed by a number of topographical and hydrological factors. The overburden in the valley bottoms tends to be relatively coarse-grained with less than typical silt and clay content for glaciated New Brunswick landscape. The character of the overburden is supported by measurements of groundwater movement through the overburden of 0.2 m/day in the valley bottom where wetlands are predominantly located (Knight Piésold 2013a). This relatively fast shallow groundwater flow may be a factor in limiting wetness and lessening the conditions for paludification.

Figures 8.8.5 and 8.8.6 provide a three-dimensional, oblique angle view of the landscape around Bird Brook and the proposed open pit area, illustrating the relative positions of each wetland type on the landscape. Note that these figures are not to scale and are shown with five-times vertical exaggeration, for ease in presentation and interpretation. Most of the valley floor is occupied by OFW where mineral inputs are minimal due to groundwater input that is abundant and consistent, but low in mineral content (Figure 8.8.5). Somewhat richer forested wetlands (MFW) are found where the input of throughflow (shallow groundwater flow) and surface water run-off contribute more nutrients from the immediately surrounding upland than experienced in OFW which are typically more distant from the surrounding contributions of run-off and shallow groundwater (Figure 8.8.5). These are typically found at the base of steeper slopes on the upland margin of OFW. Some MFW can be found along watercourses, particularly in ravines where seepage and flood waters supply nutrients and beaver activity is absent.

Beavers are active along much of the length of watercourses within the LAA where the typical wetland type is BIW, as shown on Figures 8.8.5 and 8.8.6. Major flooding in December 2010 caused washouts of many long-established beaver dams along watercourses so many of the older BIWs in the mid to lower watershed positions had lower water levels during field surveys, and several new dams were established along lower order streams. BIW wetland is highly dynamic in its relative proportion of open water to surrounding meadow, depending on beaver activity and extreme weather events that affect the water management workings of beaver. Shrub wetlands are also prevalent along watercourses and are often transitional between BIW and MFW as many of them likely originated from MFW wetlands that were temporarily flooded by beaver activity in the past and have again begun to regenerate tall woody plants in the drier conditions.

Fens are more common in the southern portion of the LAA than in the Bird Brook watershed, probably due to the apparently higher degree of deep groundwater discharge in that area which supplies these wetlands with abundant, relatively rich water (Figure 8.8.5). Deep groundwater contributions are more consistent and less varying through the year than run-off and shallow water contributions in the higher positions of the watershed. These typically occur in the valley bottoms but their location depends on localized aquifer discharge more than topography.

DSM wetlands are found at random locations in the upper watershed position wherever poorly drained man-made excavations have been created.

In the LAA, the GeoNB-mapped wetlands summarized in Table 8.8.2 were nested within large complexes derived from the wetland types described above. Many of these wetlands are hydraulically contiguous.

Table 8.8.2 Wetland Area, Vegetation and Hydrologic Characteristics

Wetland Type	Total Area of Wetland Type in the PDA (ha)	Total Area of Wetland Type in the LAA (ha)	Area of Wetland Type in the LAA (% of total area of LAA)	Dominant Vegetation	Hydrologic Characteristics
Oligotrophic Forested Wetland (OFW)	114.96	238.25	9.91	black spruce over ericaceous shrub and three-seeded sedge	Upper to mid-watershed position. Fed by precipitation predominantly, with throughflow and shallow groundwater contributions, with some surface run-off. Shallow groundwater flow in mineral subsoil is relatively fast.
Mesotrophic Forested Wetland (MFW)	52.92	111.68	4.64	balsam fir, black spruce, red maple, and blue birch over mixed ferns and bluejoint reed grass	Upper to mid watershed position. Fed by rainfall, but dominated by seepage and run-off at toe of slope or watercourse flood waters.
Shrub Riparian Wetland (SRW)	19.15	40.2	1.66	speckled alder, with understory of tall meadow rue, spotted touch-me-not, sensitive fern, and blue-joint reed grass	Mid- to lower watershed position. Fed primarily by surface return from adjacent wetland and watercourses, rainfall input is relatively minor.
Beaver Impoundment Wetland (BIW)	14.71	30.58	1.27	blue-joint reed grass, black-girdled bulrush; and sometimes leatherleaf and sweet gale	Mid- to lower watershed position. Fed by watercourses and surface return. Highly variable water table related to beaver activity and response to extreme events that affect beaver workings.
Bog	7.94	11.99	0.50	boreal bog sedge, tussock cottongrass, three-leaved false Solomon's seal, northern pitcher plant, black spruce and larch	Upper watershed position. Fed by precipitation only.
Fen	1.55	10.15	0.42	few-flowered sedge, few-seeded sedge, northern arrowhead, Michaux's sedge, and three-leaved Solomon's seal	Any watershed position. Fed by deeper groundwater and watercourses, with other inputs relatively less important.
Disturbed Scirpus Meadow (DSM)	3.11	5.41	0.23	wooly bulrush	Upper watershed position, isolated. Fed by stormwater from roadside ditches and other surface run-off, contained by man-made disturbance.

Table 8.8.2 Wetland Area, Vegetation and Hydrologic Characteristics

Wetland Type	Total Area of Wetland Type in the PDA (ha)	Total Area of Wetland Type in the LAA (ha)	Area of Wetland Type in the LAA (% of total area of LAA)	Dominant Vegetation	Hydrologic Characteristics
Lacustrine Shallow Water Wetland (LSW)		0.86	0.04	white buttons	Upper watershed position. This wetland is primarily fed by groundwater input. It outflows to Trouser Lake.
Total	**214.34**	**448.94**	**18.67**	**-**	**-**

Further details on each of these wetland types are provided in the following text.

Oligotrophic forested wetland (OFW) is the most abundant wetland type with the LAA, occupying approximately 238 ha (9.91% of the total area of the LAA). This wetland type does not have great peat accumulation, typically less than 30 cm. OFW is prone to partially drying out during droughty periods and to forest fires under such conditions, although fire suppression and forest management in recent decades have arrested that cycle in the LAA.

OFW typically has a forest cover dominated by black spruce with lesser components of balsam fir. The understory is dominated by ericaceous shrubs including northern wild raisin (*Viburnum nudum*), sheep laurel (*Kalmia angustifolia*), velvet-leaved blueberry and mountain holly, with an herbaceous layer of three-seeded sedge (*Carex trisperma*), two-seeded sedge (*C. disperma*), bunchberry, and sphagnum mosses (*Sphagnum* spp.). Large areas of this wetland type have historically been affected by forestry activity in the LAA, and most areas have been cutover within the last 25 years and have since been pre-commercially thinned (PCT). This has led to a well-developed herbaceous and shrub understory in the openings, and the age class of the forest structure is young and contains more spruce that would be present in the absence of pre-commercial thinning.

These wetlands form the greater part of large complexes associated with the upper reaches of catchments and associated with headwater streams. These wetlands are wet most of the time but they are dryer than other wetlands types, lacking wetland characteristics near upland transitions particularly during droughty periods. Within the larger wetland complexes, the OFW is occasionally adjacent to upland while the slightly richer MFW and BIW fringe the watercourses where they receive periodic mineral and organic material input during flooding. In other circumstances, OFW can be proximal to MFW that is at the toe of slope, with OFW more distant from the toe of slope.

The soils underlying these wetlands are relatively well-drained, derived from coarse-textured granitic, locally derived overburden. A layer of peat up to 30 cm thick covers the mineral soil with stones and small boulders emerging through it along the wide fringing transitions to upland.

Mesotrophic forested wetland (MFW) is the second most abundant wetland type within the LAA, covering approximately 111.68 ha (4.64% of the total area of the LAA). These wetlands are distributed throughout the LAA and are associated with watercourses and areas of groundwater discharge and seepage. They tend to be situated between OFW and watercourses or in deeply incised gorges. These wetlands tend to be more consistently wet, and as they tend to occupy areas closer to streams, they are more influenced by flooding. They are less prone to dryness and forest fire, but proximity to OFW makes them susceptible to fire.

MFW is characterized by a forest cover that ranges from coniferous (balsam fir and black spruce), to mixedwood (balsam fir, red maple, black spruce, and occasional eastern white cedar). The forest cover of this wetland type is in some cases similar to OFW, although in contrast, the understory is not dominated by ericaceous shrubs. The MFW is characterized by ground cover that is usually dominated by mixed fern species interspersed with three-seeded sedge. Associations with watercourses and seepages supply these wetlands with slightly more mineral-laden water supply than available to OFW, which when combined with more stable hydrology create conditions that can support uncommon plant species. While no SOCC were identified within any of the wetlands in the LAA, a white fringed orchid was found in a MFW outside of the LAA. Other uncommon plants found in MFW in the LAA included checkered rattlesnake-plantain (*Goodyera tesselata*; ranked as S4 (Secure) by AC CDC), and dwarf rattlesnake-plantain (*G. repens,* ranked as S4 (Secure) by AC CDC). Most of the area of this wetland type within the LAA is managed for forestry and has been harvested within the last 25 years. Only 15 of the 81 ha of MFW within the LAA are classed as mature-overmature forest.

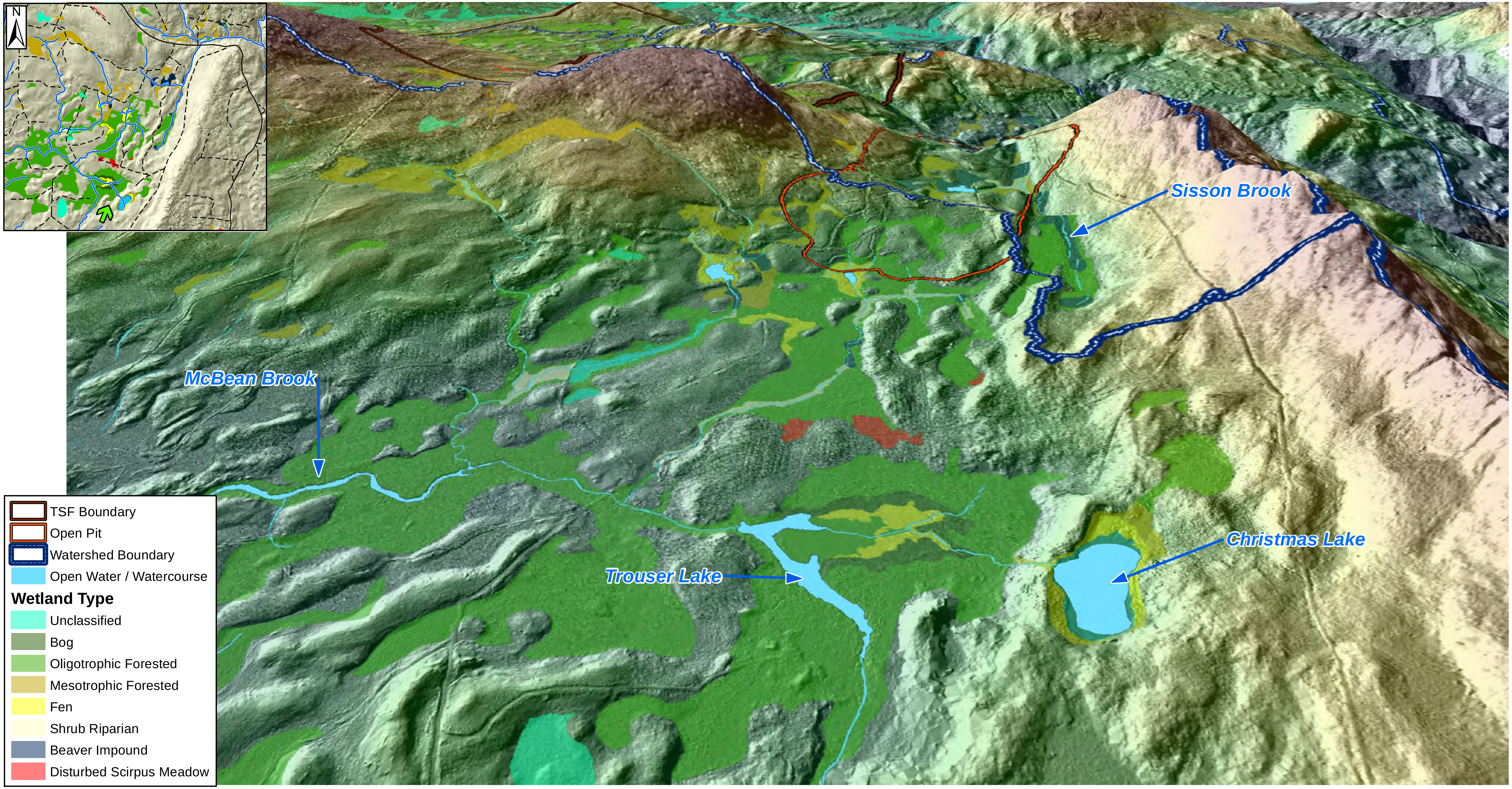
MFW tends to be closely associated with watercourses or groundwater discharge points (or run-off at the break in slope), which are their primary sources of water. Along watercourses, this wetland type usually begins just beyond the typical high water mark with shrub riparian habitat within the flood zone, so that wetness is somewhat stable within the MFW, and more so where they are fed by groundwater discharge.

The soils in these wetlands have varying depths of peat (0-25 cm) over silty loam and sometimes mixed organic silty muck that occurs in areas that have had beaver activity in the distant past.

There are approximately 40 ha of **shrub riparian wetland (SRW)** along watercourses throughout the LAA (1.66% of the total area of the LAA). This wetland type occurs along watercourses where the water level fluctuates widely either because of beaver activity or “flashy” flow in the associated watercourse, which inhibits the development of a forest cover by drowning trees during high water periods. Beaver activity of varying ages is evident at many locations along most watercourses in the LAA. These wetlands differ from beaver meadows in that they have developed full shrub layers and have typically not been flooded for extended periods within the last five years.

SRW are strongly dominated by speckled alder (*Alnus incana*), with scattered hybrid birch (*Betula x caerulea*), black spruce, and willow near the margins. The understory is not usually well developed but is dominated by tall meadow-rue (*Thalictrum pubescens*), blue-joint reed grass, spotted touch-me-not (*Impatiens capensis*), and sensitive fern (*Onoclea sensibilis*).

SRW are closely associated with watercourses by definition, and their hydrology is subject to the water level in these. As a result they are subject to inundation during flood periods and over longer cycles through beaver impoundment. SRW are often fringed by a much wider band of forested wetland (*i.e.,* either OFW or MFW). There is some transitional gradient between the two types, but the normal flood level does not usually extend beyond the shrub vegetation into the forested wetland beyond. Where these wetlands occur along watercourses in gullies, they are also fed by shallow groundwater seepage from the toe of the adjacent slopes.



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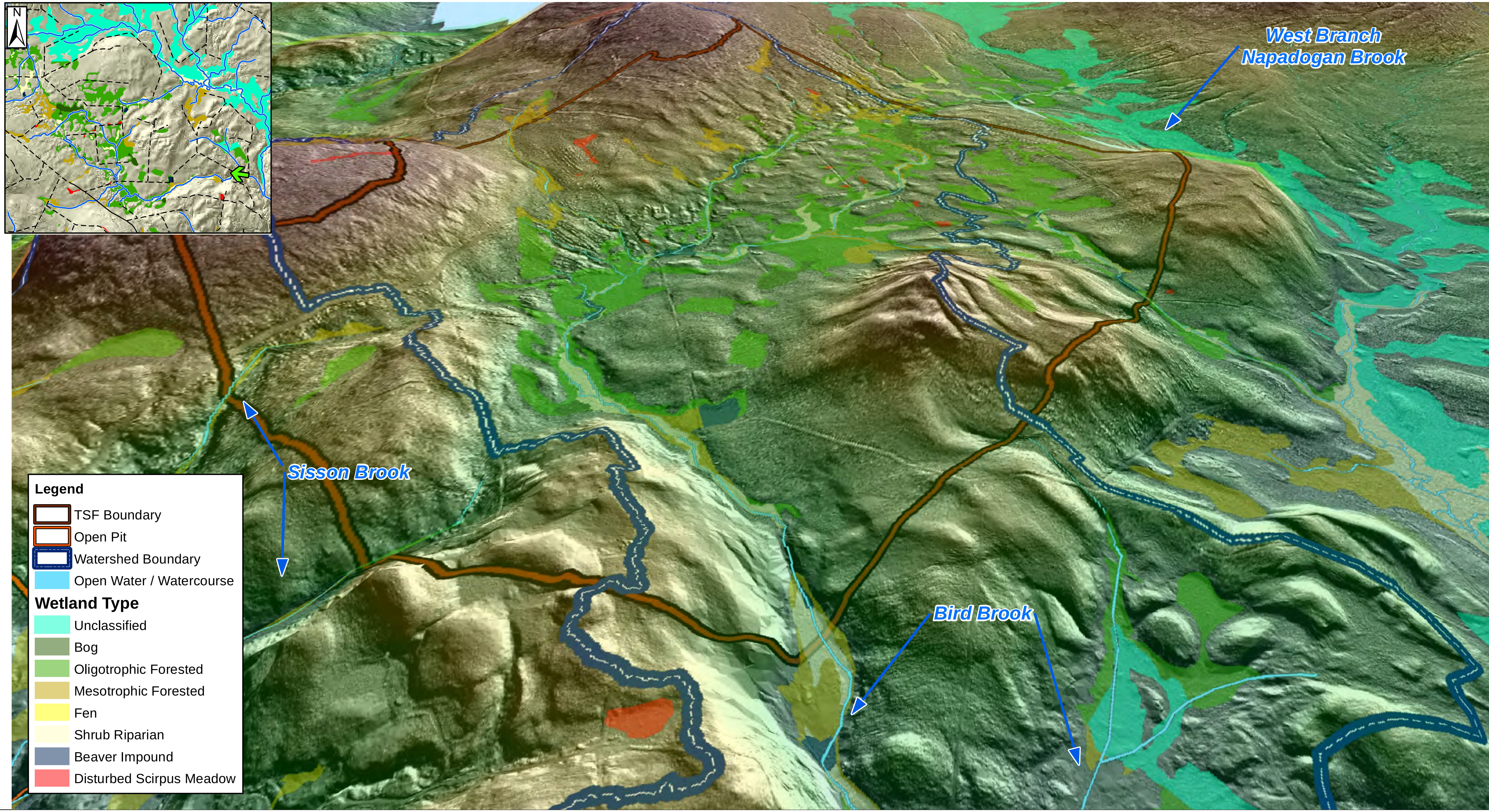
NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

Landscape Position of Wetlands - Sisson Brook Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: Not to Scale 5x Vertical Exaggeration	Project No.: 121810356		Data Sources: NBDNR	Fig. No.: 8.8.5
Client: Northcliff Resources Ltd.	Date: (dd/mm/yyyy): 05/04/2013	Fig. By: JAB	Appd. By: DLM		

Stantec

Coordinate System: NAD 1983 CSRS New Brunswick Stereographic



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

Landscape Position of Wetlands - Bird Brook Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: Not to Scale 5x Vertical Exaggeration	Project No.: 121810356		Data Sources: NBDNR	Fig. No.: 8.8.6
	Date: (dd/mm/yyyy): 05/04/2013	Fig. By: JAB	Appd. By: DLM		
Client: Northcliff Resources Ltd.					

Stantec

Coordinate System: NAD 1983 CSRS New Brunswick Stereographic

The soils found in SRW vary from mineral soil with very little organic material, to having 40 cm or more of organic muck. The latter condition can be found in areas that were subject to extended periods of beaver impoundment which allowed the accumulation of a deep layer of organic material with some mineral component, before the water level dropped. Where SRW occur along watercourses that are subject to annual freshets there is less accumulation of organic material.

There are approximately 30.58 ha of **beaver impoundment wetlands (BIW)** within the LAA (1.27% of the total area of the LAA). This includes active or recently active beaver-made impoundments and the adjacent fringing meadow and are scattered throughout the LAA with a slight concentration in the southern portion of the LAA. Most of these wetlands are located at the site of long-term beaver activity where the water level fluctuates from year to year depending on the condition and location of dams. There is commonly a wide fringing meadow surrounding these wetlands. The absence of shrub cover or recent snags of drowned trees as present in typical SRW indicates regular and recent inundation. Within the LAA, the fringing meadow is typically larger by area than the open water portion of BIW.

Plant diversity is low in BIW, which are dominated by blue joint reed grass and black girdle wool grass (*Scirpus atrocinctus*), and have a sparse shrub cover of willow, speckled alder, and young black spruce and balsam fir near the margins. Some wetlands of this type have scattered dense patches of leatherleaf (*Chamaedaphne calyculata*) and sweet gale (*Myrica gale*) growing near the open water. The fluctuation of the water table creates a vegetation community that is dominated by species adapted to a broad range of hydrological conditions and/or pioneer species, and they do not represent high potential areas for rare plants, which are typically adapted to specific and stable conditions. However, two uncommon species (ranked S3 or S4, Secure) were found near the margin of a BIW (mosquito bulrush (*Scirpus hattorianus*) and blunt-leaved orchid (*Platanthera obtusata*)).

BIW wetlands usually have some open water component and are associated with a watercourse. The proportion of meadow to open water varies greatly depending on the condition of the beaver dam creating the impoundment. Most of these areas undergo regular cycles of rising and dropping water levels as dams are breached and repaired over the years. Over longer periods, these wetlands have very similar functions. Often the wetland boundary will shift if a dam is breached or altered for a sustained period, but they are typically located in flat plains and where wetland conditions are retained in the meadow that forms in the flooded area after a dam breaches. They are also often fed by seepages of shallow groundwater along the surrounding upland embankments.

The soils in BIW wetland are highly variable depending on the position and the age of the impoundment. If an area has been used for many years, deep layers of organic muck can accumulate. This muck becomes thinner near the edges and in areas where there is flowing water. In the LAA, this organic muck overlays soil that can be gravelly or stony/bouldery closer to the channel, or comprised of coarse-grained sandy loam derived from weathered granite.

There are 12 ha of **bog** within the LAA (0.5% of the total area of the LAA), of which more than 8 ha is divided between two bogs located at opposite ends of the PDA. One is a typical bog located within the footprint of the proposed tailings storage facility (TSF), and the other is located in the southern portion of the LAA near Trouser Lake. The latter is less typical in that it transitions to fen and is not distinctly raised, reflecting it is perhaps transitioning to bog from fen. These areas exhibit signs of heavy moose usage and moose were observed in the area during field work.

The bogs within the LAA have typical vegetation for the region, with stunted tamarack (*Larix laricina*) and black spruce around the margins with various sphagnum mosses and ericaceous shrub species dominating the centre. Dominant shrub species in bogs in the LAA were Labrador tea (*Ledum groenlandicum*) and leatherleaf, and the herbaceous layer is dominated by *Sphagnum* spp., boreal bog sedge (*Carex magellanica*), tussock cottongrass (*Eriophorum vaginatum*), three-leaved false Solomon's seal (*Maianthemum trifolium*), and northern pitcher plant (*Sarracenia purpurea*).

These bogs are fed by rainwater though they are not fully ombrotrophic, as they appear to be receiving water from adjacent OFW, and indirectly from nearby watercourses. The hydrology of these bogs will be predominantly influenced by precipitation and weather, but occasionally by watercourse flooding and influx from adjacent OFW. This would suggest that they are still transitional to bog from fen, and conditions are marginally conducive to the development of true bog.

The soil in the bogs in the LAA is comprised of sphagnum-based peat. While the depth was not measured, the peat layer is not well developed as bogs are uncommon and small within the LAA compared to more typical bogs found in New Brunswick. The scarcity of bogs may be attributable to the highly conductive (0.2 m/day) (Knight Piésold 2013a), somewhat ubiquitous blanket of overburden (up to 5 m thick) (Knight Piésold 2013a), that does not confine water to an extent favorable for paludification. This reinforces the notion that the two bogs are likely only transitional from fen.

There are approximately 10 ha of **fen wetlands** within the LAA (0.42% of the total area), concentrated in the southern portion where deeper groundwater input is likely (Figure 8.8.6). These wetlands are usually associated with areas of open water and have clearly some degree of groundwater input in addition to other inputs from run-off, throughflow and watercourse flooding.

The fens in the LAA are typically dominated by few-flowered sedge (*Carex oligosperma*), few seeded sedge (*C. pauciflora*), northern arrowhead (*Sagittaria cuneata*), Michaux's sedge, and three leaved false Solomon's seal. The species richness is high within these wetlands relative to others within the LAA due to higher mineral availability than other wetland types, the wide gradient of hydrologic conditions from the open water to the upland side, and the absence of dense tree cover. While no plant SAR or SOCC were found, some uncommon species were found in fens in the LAA including brown beakrush, Michaux's sedge, and white fringed orchid.

Fens are concentrated in the southern portion of the LAA and all share a degree of connectivity within a large, sprawling wetland complex dominated by OFW. These fens all have a high degree of groundwater input as evidenced by the number of springs found during field work. Groundwater input is particularly pronounced in the Trouser and Christmas Lakes area where there are major springs that feed these two bodies of water, likely from the very high ridge to the southeast (Naskwaak Ridge) visible on Figure 8.8.3. The latter water body is essentially a large spring. The outflow of this lake at the time of field work was approximately 2 m wide while the inflow was less than 50 cm wide (and was also spring fed). Because of the location of these wetlands within large wetland complexes and the high input from groundwater, the hydrology tends to be very stable.

Soils in fens consist of deep, sedge-based peat typical of fen. The depth was not measured, but the edge was observed in the clear open water, and was estimated to be at least 2 m deep at the deepest point.

Disturbed scirpus meadow (DSM) is relatively uncommon, occupying 5.4 ha (0.23%) of the total area of the LAA. These wetlands tend to form in borrow pits where road building materials were excavated for the construction of forestry roads. While the present wetland conditions would likely change given enough time for more organic material to accumulate, the conditions are stable enough that pits as old as 20 years remain in this condition.

DSM is strongly dominated by common woolly bulrush (*Scirpus cyperinus*) with no forest cover and only scattered willows (*Salix* spp.), grey birch (*Betula populifolia*), and red raspberry around the margins.

DSM accumulates water from surface run-off and from ditches along the adjacent logging roads. Water is usually perched on bedrock and there is some standing water throughout much of the growing season. In spring and following heavy precipitation events, these will often fill, draining and evaporating gradually afterward over days or weeks.

DSM typically contains soil consisting of a layer of peat (approximately 10 cm) over a thin layer of disturbed sandy loam. The native soil is largely removed for road building and the remaining soil rests on bedrock and is of mixed texture. Over a time period spanning decades, peat would accumulate further in these wetlands and they would likely assume a fen-like character.

One **lacustrine shallow water (LSW)** wetland (Christmas Lake, less than 1 ha) is present within the LAA, accounting for just 0.04% of the total area of the LAA (Figure 8.8.4.). It is located at the southern end of the LAA. Christmas Lake is less than 2 m deep and is vegetated throughout with aquatic vegetation so is therefore classified as a wetland (Environmental Laboratory 1987). This wetland is fringed by a band of lacustrine fen and drains into Trouser Lake. It is heavily groundwater fed and contributes to maintaining base flow in McBean Brook.

The vegetation in the LSW is sparse within the wetland, but is evenly distributed throughout with some concentration near the edges. The dominant plant species in this wetland was white buttons (*Eriocaulon aquaticum*), with lesser amounts of slender water milfoil (*Myriophyllum tenellum*), northern arrowhead, ribbon-leaved pondweed (*Potamageton epihydrus*), and variegated pond-lily (*Nuphar variegata*) also present. No plant SAR or SOCC were found, but slender water milfoil, and eastern purple bladderwort (*Utricularia purpurea*), which were found there, are uncommon.

This LSW is fed by a large amount of groundwater diffusely seeping in from the bottom of the open water. There is a small inflow on the northeastern side of Christmas Lake that flows from a spring-fed forested wetland, but the watercourse flowing out of Christmas Lake towards Trouser Lake was several times larger than the surface inflow. The wetland is located in an unusual position at the top of a high embankment approximately 5 m higher than Trouser Lake which is nearby to the northwest so that the water cascades down over the embankment toward the Trouser Lake wetland complex. Despite the spring-fed nature of this lake, there is some evidence of minor fluctuations in water level reflecting some influence of other inputs and losses (*e.g.,* evapotranspiration). The soils in this wetland type consist of a uniform silty organic muck that is up to 60 cm deep with boulders and stones scattered throughout.

8.8.2.3.1 Wetland Function

The objectives of the New Brunswick Wetlands Conservation Policy are no net loss of wetland function and no loss of function for Provincially Significant Wetlands. The impetus for the protection of wetland is the value we place on certain ecological, hydrological, biological, and chemical functions that can provide benefits to the health of the human community, culture, the economy, and the greater ecosystem. For this EIA, valued function for wetland can include any function that is integral to the following:

- the contribution to the quality and quantity of groundwater and surface water so that humans, regional fish populations and human health are not put at risk;
- the accommodation of SAR and the provision of habitat to SAR that is essential to the sustainability of regional populations;
- the support of a rare or protected vegetation community type;
- the provision of resources that fulfil important cultural roles that are exclusive to rare wetland types or are tied to a particular area for cultural reasons; or
- the provision of an economic resource that in central to a local or regional economy.

For simplicity, the approach of the Province of New Brunswick to conserving valued wetland function in New Brunswick is to require compensation for alteration to wetland that is part of the provincial inventory of mapped wetlands depicted on the GeoNB website. This inventory was reportedly created through a variety of means, but primarily through aerial imagery interpretation and tends to exclude more marginal and/or forested wetlands. In 2010, the New Brunswick Department of Environment (NBENV) developed a wetland predictive layer on GeoNB that showed approximately 18% of the province as wetland. This mapping has been since removed, but the 18% figure is consistent with previous wetland studies conducted by Stantec in New Brunswick, including large linear corridors Stantec has evaluated in other parts of the province. As a general habitat type, wetlands are not rare. Most of the wetlands in the province are, as is the case in the LAA, forested wetlands dominated by wet-tolerant coniferous tree species such as black spruce and balsam fir forest cover, although the exact ratio and extent of wetland types in New Brunswick has not been precisely measured.

The valued functions for wetland within the LAA are described in detail at multiple scales in the Baseline Vegetated and Wetland Environments Technical Report (Stantec 2012g) and are summarized for each wetland type below in Table 8.8.3. Within the LAA, nearly 80% of the wetland is forested. The most abundant wetland type is OFW (nearly 60% of all wetland by area) which typically hosts a simple, coniferous/ericaceous vegetation community with hydrologic characteristics considered marginal for wetland, being more typical of forest with interception and evapotranspiration being more important wetland functions during the growing season. The water table is usually below the surface of the soil, and lateral flow is expected to be diffuse and slow, largely due to the flat topography in the valley floors of the PDA where OFW tends to occur. The soil and parent material beneath OFW (below any peat layer) is relatively, hydraulically conductive due to coarse mineral soil allowing water to move laterally beneath the surface towards drainage features (watercourses and proximal wetland). The porous overburden and apparent lack of continuous confining layers above the bedrock allow for some aeration and steady throughflow of water, despite relatively flat topography in the valley bottoms where OFW occurs. The steady drainage through the granular soil and coarse parent material are also thought to contribute to the apparently wide fluctuations in water table within OFW wetlands which, under drier conditions, may have large storage capacity. These conditions hinder the paludification process in most OFW areas, and create favourable growing conditions for hydrophytic tree species such as black spruce, which despite relatively low nutrient conditions reach heights of up to approximately 18 m. The conductive mineral soil and overburden do not prevent flashy run-off in outflowing watercourses but may contribute to slowing hydrologic response to rainfall. This granular conductive soil is also thought to limit the presence of bogs in the LAA and consequently occur rather in bedrock depressions surrounded by thin layers of overburden.

OFW is often more toward the headwaters for watercourses and although groundwater fed primarily, are not heavily enriched by it due presumably to the granitic character of the bedrock and overburden. Within the LAA, there were no plant SOCC associated with OFW and they do not provide important habitat to the avian SOCC found within the LAA, with the possible exception of Olive-sided Flycatcher, which tend to inhabit the coniferous forested edge of shrub wetlands. Most of the forested wetland area is managed for forestry, although it is not as productive as surrounding upland and has a longer harvest rotation cycle due to slower growth and productivity. Hydrologically, this type of wetland generally processes a small volume of water by unit-area relative to other wetland types within the PDA (except the bog) as they do not typically have direct interaction with watercourses as most are flanked by other wetland types such as MFW, BIW and SRW, and they lack large inputs from deeper groundwater.

A further 20% of wetland area is occupied by MFW, which is similar to OFW but slightly more minerotrophic, usually resulting from greater inputs from watercourse floodwater, throughflow (shallow groundwater flow that re-emerges as surface water) and less occasionally, deeper groundwater sources, which tend to lead to relatively higher mineral availability and a slightly richer plant community. These wetlands are often more closely associated with watercourses and the bottom of slopes and embankments, and sometimes fall within 30 m buffer zones along watercourses, and are therefore not subjected to harvest, but rather persist as riparian zone protection in management plans.

Relative to the surrounding upland, the dominant forested wetland types are estimated to have comparable plant diversity, comparable potential for occurrence of SOCC, less timber value, and greater, albeit more limited interaction with watercourses. However, they do help to support and moderate water levels within the watercourses flowing from the LAA as do all forms of vegetated landscape. These watercourses are productive salmonid habitat; Bird Brook was determined to provide habitat for Atlantic salmon, though only one parr was captured during aquatic field surveys in the lowest reach of the brook. Importantly, OFW and MFW do not perform hydrologic function that is differentially more important than upland forest. In fact, it is logical based on the considerations herein, that they perform a less important hydrologic function than upland forest where stem density, canopy type, and other factors may have relatively higher rates of interception and evapotransportation.

Table 8.8.3 provides a summary of functions for each wetland type within the PDA.

Table 8.8.3 Summary of Wetland Functions for Each Wetland Type by Function Category

Wetland Type	Watershed Position	Estimated Regional Abundance	Valued Function Category			
			Hydrological	Water Quality	Ecological	Socioeconomic, Recreational, or Scientific Values
OFW	Upper to Mid	Common	Effective at sublimating snowfall directly from coniferous foliage in winter and by mitigating spring thaws so that peak run-off periods are spread out over wider timeframes. They are areas of throughflow discharge and but their lack of deeper groundwater inputs limits their ability to improve baseflow in down-flow wetlands. They may mitigate peak flows during flood events and may lessen run-off except perhaps in dry warm periods where evapotranspiration, interception and storage may lessen consequent run-off.	Typically large and flat, and allow rainwater to percolate slowly toward watercourses, reducing peak flow events and associated erosion events.	Low in diversity but are abundant and have minor habitat value for a variety of species.	Heavily managed for forest products within the LAA and are used for moose hunting. Relatively low productivity due to nutrient status.
MFW	Upper to Mid	Common	Often fed by groundwater and throughflow discharge from the base of steeper slopes and by watercourses in flood plains where they may help mitigate peak flows. These wetlands perform similar hydrologic function to OFW.	Prevent erosion along watercourse by stabilizing areas within the high water mark. They also help mitigate road washout events by retaining sediments during high flow. When positioned along watercourses they can serve as small floodplains, although they typically follow streams through gorges where topography does not allow much storage.	Some of these wetlands serve as vestiges of mature forest in a heavily cutover landscape and provide habitat for moose, bear, and avian SAR such as Canada Warbler and Olive-sided Flycatcher. Due to a slightly more mineral laden water inputs than OFW, these wetlands offer greater plant diversity than OFW.	Some of these wetlands are managed for timber production in the LAA and are used for moose hunting.

Table 8.8.3 Summary of Wetland Functions for Each Wetland Type by Function Category

Wetland Type	Watershed Position	Estimated Regional Abundance	Valued Function Category			
			Hydrological	Water Quality	Ecological	Socioeconomic, Recreational, or Scientific Values
SRW	Mid to Lower	Common	Typically located along watercourses and prevent erosion and reduce flow energy during flood periods. They are typically at the interface of throughflow discharge and watercourses.	These wetlands establish quickly in disturbed areas, stabilizing watercourse banks to reduce erosion. They also provide shade that helps maintain cool water temperature.	Maintain quality for fish habitat and provide nesting and/or foraging areas for birds including Canada Warbler.	These wetlands show little or no evidence of use by humans.
BIW	Mid to Lower	Common	Hold rainfall and run-off on the landscape and release it slowly through porous outflows. Flow energy of watercourses is reduced in the impoundments.	They retain large quantities of sediment from watercourses, but periodically create large sedimentation events at wash-outs on roadways. They have a slight increasing effect on water temperature.	Create and provide habitat that is enriched by sediment deposit and creates structural diversity in the landscape. Rusty Blackbirds (SOCC) were seen using these habitats in the LAA.	These wetlands exhibit little evidence of use by humans, although the open nature of the vegetation cover may facilitate moose hunting opportunities.
Bog	Upper	Common	The small bogs in the LAA do not cumulatively fulfill strong hydrological function. They are largely isolated from groundwater, and are too small to have any substantive influence on baseflow in streams.	Bogs are isolated from groundwater input and tend to release nutrient poor, tannin-rich water with low pH water into the downstream environment.	In the LAA, these may provide calving areas for moose and potential nesting areas for common nighthawks (one was seen foraging over the largest bog in the LAA). They also provide carbon storage.	These wetlands exhibit little evidence of use by humans, although the open nature of the vegetation cover may facilitate moose hunting opportunities.
Fen	Upper to Mid	Common	Fens in the LAA are heavily groundwater fed and are concentrated near the headwaters of McBean Brook. These wetlands contribute to base-flow maintenance. These fens process groundwater to watercourses but may play only a minor role in retention and slowing discharge to watercourses due to lesser evapotranspiration and extended periods of positive water balance.	Heavily fed by groundwater and supply a steady and substantial flow of clean water to receiving watercourses.	Contain plant species that are not found in other habitats (no SOCC found) and show evidence of heavy use by moose. The combination of open water, herbaceous and shrub communities provide diverse habitat to a variety of species.	These wetlands exhibit little evidence of use by humans, although the open nature of the vegetation cover may facilitate moose hunting opportunities.

Table 8.8.3 Summary of Wetland Functions for Each Wetland Type by Function Category

Wetland Type	Watershed Position	Estimated Regional Abundance	Valued Function Category			
			Hydrological	Water Quality	Ecological	Socioeconomic, Recreational, or Scientific Values
LSW	Upper to Mid	Moderate	Trouser Lake is the only LSW within the LAA and is heavily groundwater fed; this wetland by virtue of its spring provides a conduit for base flow to McBean Brook. This one wetland has a positive effect on quantity and flow quality of water in that stream and is locally important in this regard.	This wetland does little to improve the quality of the groundwater passing through and may increase the temperature somewhat, but the wetland serves as a conduit for cool clean water to the downstream environment.	One of the largest bodies of open water within the LAA providing habitat for various forms of aquatic life including fish and herpetiles. Wading birds and moose were seen at the site, and evidence of use suggests that it is an important moose foraging site.	ATV access and a tree stand were seen near this wetland. Moose were also observed within the wetland.

Legend:
OFW oligotrophic forested wetland; MFW mesotrophic forested wetland; SRW shrub riparian wetland
BIW beaver impoundment wetland; DSM disturbed scirpus meadow; LSW lacustrine shallow water wetland

8.8.3 Potential Project-VEC Interactions

Table 8.8.4 below lists each Project activity and physical work for the Project, and ranks each interaction as 0, 1, or 2 based on the level of interaction each activity or physical work will have with the Wetland Environment.

Table 8.8.4 Potential Project Environmental Effects to the Wetland Environment

Project Activities and Physical Works	Potential Environmental Effects
	Change in Wetland Environment
Construction	
Site Preparation of Open Pit, TSF, and Buildings and Ancillary Facilities	2
Physical Construction and Installation of Project Facilities	2
Physical Construction of Transmission Lines and Associated Infrastructure	1
Physical Construction of Realigned Fire Road, New Site Access Road, and Internal Site Roads	2
Implementation of Fish Habitat Compensation Initiatives	0
Emissions and Wastes	1
Transportation	0
Employment and Expenditure	0
Operation	
Mining	1
Ore Processing	0
Mine Waste and Water Management	2
Linear Facilities Presence, Operation, and Maintenance	1
Emissions and Wastes	1
Transportation	0
Employment and Expenditure	0
Decommissioning, Reclamation, and Closure	
Decommissioning	0
Reclamation	1
Closure	1
Post-Closure	0
Emissions and Wastes	1
Transportation	0
Employment and Expenditure	0

Project-Related Environmental Effects
Notes:
Project-Related Environmental Effects were ranked as follows:
0 No substantive interaction. The environmental effects are rated not significant and are not considered further in this report.
1 Interaction will occur. However, based on past experience and professional judgment, the interaction would not result in a significant environmental effect, even without mitigation, or the interaction would clearly not be significant due to application of codified practices and/or permit conditions. The environmental effects are rated not significant and are not considered further in this report.
2 Interaction may, even with codified mitigation and/or permit conditions, result in a potentially significant environmental effect and/or is important to regulatory and/or public interest. Potential environmental effects are considered further and in more detail in the EA.

Some of the Project Activities listed in Table 8.8.4 are not expected to have any substantive interaction with the Wetland Environment and were thus ranked as 0 in the table. These activities include: Transportation (in all phases) of goods, materials, and personnel, which is currently occurring in the LAA; Implementation of Fish Habitat Compensation Initiatives (no known wetland near the Lower Lake Dam or in access points to it); Employment and Expenditure (in all phases); Ore Processing (conducted in an enclosed environment); Decommissioning (removing buildings and equipment), and Post-Closure (the presence of the water-filled former open pit and TSF). These activities, some of which are not physical works or activities, should not affect wetlands in any substantive way, and as such, their interaction with the Wetland Environment is ranked as 0 in Table 8.8.4, their environmental effects are rated not significant, and they are not discussed further.

The following Project Activities may interact with the Wetland Environment, and are thus ranked as 1 in Table 8.8.4:

- Physical Construction of Transmission Lines and Associated Infrastructure;
- Emissions and Wastes (all phases);
- Mining;
- Linear Facilities Presence, Operation, and Maintenance;
- Reclamation; and
- Closure.

The interaction between the Wetland Environment and these activities, mitigated by the use of standard construction and best management practices (BMPs), would be low enough in magnitude so as to not result in a significant adverse residual environmental effect on Wetland Environment, or have a potential positive environmental effect on the VEC.

Physical Construction of Transmission Lines and Associated Infrastructure was ranked as 1 in Table 8.8.4 and will be conducted so as to avoid wetlands and wetland buffers when planning pole placement whenever feasible, thus avoiding substantive direct disturbance. If, during transmission line planning, it is determined that transmission line pole placement in a wetland or wetland buffer is necessary, wetland compensation values and planning will be adjusted as required as a part of the overall program. Any forested wetlands falling within the 25 m wide corridor will be deforested but will remain vegetated for Operation and changes to wetland function will likely be minimal or at least neutral in that they will remain wetland and continue to fulfill functions. The 138 kV transmission line will be constructed immediately adjacent to an existing cleared transmission corridor for most of its length. The distribution of material and construction equipment will maximize the use of the existing trail along the 345 kV transmission line and this BMP will be incorporated into the Environmental Protection Plan (EPP). In addition, vegetation clearing in wetlands will be minimal and completed by hand, when necessary, and NB Power will follow an established EPP for construction activities along electrical transmission lines that includes a range of BMPs developed by the utility to manage its construction and operational activities on its transmission system. Thus, the interaction with wetlands is expected to be minimal.

Emissions and Wastes arising from Construction, Operation, and Decommissioning, Reclamation and Closure activities was ranked as 1 in Table 8.8.4 and may include: air contaminants; sound emissions; vibration; water storage, treatment, and release; mining waste disposal; and solid waste (*i.e.*, non-mining) disposal. Mining waste disposal, including tailings and waste rock, is addressed under the Project Activity Mine Waste and Water Management. Air contaminant emissions (*e.g.*, dust), sound emissions, and vibration are not expected to have interaction with the Wetland Environment that would lead to a significant environmental effect as no significant environmental effects are predicted on Atmospheric Environment (Section 8.2) or Acoustic Environment (Section 8.3). Mine contact water on-site will be stored in the TSF and treated as necessary prior to release, limiting adverse interactions with wetlands. Treated surplus water release may change the hydrology and quality of water in downstream wetlands. The environmental effects on Water Resources are not significant (Section 8.4) overall and this aspect of those changes is a minor contribution to overall environmental effects on Water Resources, and not significant. The change in hydrology and water quality downstream of the mine related to the overall loss of drainage are discussed later in relation to the overall environmental effect of the emplacement and operation of the TSF and other operations and is not considered further here. The potential environmental effects of these releases on the Wetland Environment are predicted to be of low consequence. Non-mining solid waste will be disposed of off-site in an appropriate manner outlined in the EPP.

Mining was ranked as 1 in Table 8.8.4 and includes operation of explosives magazine, blasting, extraction of ore and waste rock, on-site transportation of ore to crusher, ore crushing and conveyance to processing plant, and rock quarrying, trucking, crushing and, until the last mining phase (when waste rock will be stored in the open pit), on-site transportation of waste rock to the TSF. The direct loss of wetland due to mining is accounted for later in relation to Construction of the facilities. Mining activities such as the transportation of ore and other materials, blasting, crushing and trucking could have limited interaction with the Wetland Environment immediately around the area where these activities occur, but are accounted for in relation to Atmospheric Environment and Water Resources, and are not significant.

On-site vehicle operation (Transportation) during Mining has the potential for increased generation of air and waterborne particulates and could facilitate in the introduction and dispersal of non-native and invasive species which have the potential to alter native plant communities and outcompete native species for resources (light, nutrients), potentially altering the function of wetlands (*e.g.,* for wildlife habitat and nutrient cycling). Dust generated from vehicles and blasting may alter the mineralogy of some nearby oligotrophic wetlands leading to a longer term shift in nutrient cycling which may affect paludification (the process of peat formation) and vegetation community composition through increased mineralization of wetlands. There is also potential for wetland vegetation near transport routes maybe also become covered with particulate which could lead to a shift in plant species composition on wetlands. Mitigation of these potential environmental effects is described in Section 8.2 in relation to Atmospheric Environment and will not be significant. Mitigation includes the installation of appropriate erosion control systems prior to ground disturbance including silt fencing, vegetation cover, erosion control blankets, straw bales, check dams, siltation ponds, and rock riprap around transportation routes. Water will be applied to road surfaces on-site to control dust during drier periods.

Mining activities such as blasting and trucking also have the potential to affect the behaviour of wildlife that may be using wetlands near the site. This interaction is addressed in the Terrestrial Environment VEC in Section 8.6 and the environmental effects of the Project on the Terrestrial Environment were rated not significant.

Linear Facilities Presence, Operation, and Maintenance was ranked as 1 in Table 8.8.4 and is expected to result in minimal environmental effects on wetlands, as vegetation clearing in wetlands will be completed by hand, when necessary, and NB Power will follow and established EPP for maintenance activities along electrical transmission lines. Maintenance activities involving terrestrial vehicles will primarily be restricted to the adjacent and 345 kV transmission line right-of-way travel routes, and will avoid wetlands where possible.

Reclamation activities were ranked as 1 in Table 8.8.4 and will stabilize the landscape for closure by returning the site to near pre-Project conditions where possible, and re-vegetating the terrestrial surface of the remainder of the site where growth can be encouraged. Two lakes will be present: the former TSF pond and former open pit. The cessation of collection and diversion of water on site may lead to an increase in wetland area within the PDA and surrounding LAA, particularly with respect to the losses incurred during Construction and Operation. Thus, Reclamation is expected to have a minor but potentially positive interaction with the Wetland Environment and will be not significant.

Closure was ranked as 1 in Table 8.8.4 and represents the period following decommissioning and reclamation activities, during which the overflow from the TSF will be directed to the open pit to allow it to be filled with water. Redirecting this water will remove this potential input to areas downstream of the TSF (*i.e*., Bird and Sisson Brooks, and ultimately, Napadogan Brook), but as this diversion will have been occurring for the life of the mine to support mineral processing, the continued potential interaction with the Wetland Environment is expected to be low and not significant. When the open pit is filled (*i.e.,* Post-Closure), flow can resume in the longer term to the downstream wetland and watercourses.

Thus, in consideration of the nature of the interactions and the planned implementation of known and proven mitigation, the potential environmental effects of all Project activities and physical works that were ranked as 0 or 1 in Table 8.8.4, including cumulative environmental effects, on the Wetland Environment during any phase of the Project are rated not significant, and are not considered further in the assessment.

8.8.4 Assessment of Project-Related Environmental Effects

A summary of the environmental effects assessment and prediction of residual environmental effects resulting from interactions ranked as 2 on the Wetland Environment is provided in Table 8.8.5.

Table 8.8.5 Summary of Residual Project-Related Environmental Effects on the Wetland Environment

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Mitigation / Compensation Measures	Residual Environmental Effects Characteristics						Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring
			Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/ Socioeconomic Context					
Change in Wetland Environment • Change in wetland area (ha); • Change in wetland function.	Construction: • Site Preparation of Open Pit, TSF, and Buildings and Ancillary Facilities. • Physical Construction and Installation of Project Facilities. • Physical Construction of Realigned Fire Road, New Site Access Road, and Internal Site Roads.	Mitigation to be implemented during Construction is as follows. • Clearing activities will be restricted to necessary portions of the PDA, and not beyond, to minimize the amount of habitat lost or altered through direct disturbance, or adjacent edge effects. • Standard erosion and sedimentation control measures will be employed, including: ○ erosion control fencing; ○ check dams; ○ sedimentation control ponds where appropriate; ○ construction sequencing to minimize soil exposure; ○ retaining existing vegetation as long as possible; ○ re-vegetation and mulching of denuded areas; ○ diverting run-off away from denuded areas; ○ optimizing length and steepness of slope; ○ keeping surface water run-off velocities low; ○ proper sizing and protecting of drainage ways and outlets; ○ intercepting of sediments on site; and ○ inspecting and maintaining the	A	L	S	LT/ OC	R	D	N	H	--	Y	None recommended.

Table 8.8.5 Summary of Residual Project-Related Environmental Effects on the Wetland Environment

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Mitigation / Compensation Measures	Residual Environmental Effects Characteristics						Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring
			Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/ Socioeconomic Context					
		above-mentioned control measures. • Any loss of GeoNB-mapped wetlands will be compensated. • Standard dust control measures will be implemented. • Quarried, crushed material will be used for road building in and near wetlands, to minimize the risk of introducing or spreading exotic and/or invasive vascular plant species. • Road construction activities will be minimized in wetland areas to reduce the potential environmental effects of disturbance, such as erosion and sedimentation, and the introduction or spread of exotic and/or invasive vascular plant species.											
	Operation • Mine Waste and Water Management.	Mitigation to be implemented during Operation is as follows. • Water will be treated as necessary prior to release to the environment. • Invasive species will be managed, as described above for Construction activities. • Standard erosion and sedimentation control measures will be employed, as described above for Construction activities. • Standard dust control measures will be implemented.	A/ P	L	L	LT/ OC	R	D	N	M	--	Y	Follow-up is recommended to verify the outcome of compensation measures aimed at enhancing, maintaining and developing new wetland for direct losses. Follow-up will occur as a part of adaptive management downgradient of mine infrastructure. This would determine the nature, magnitude and extent of

Table 8.8.5 Summary of Residual Project-Related Environmental Effects on the Wetland Environment

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Mitigation / Compensation Measures	Residual Environmental Effects Characteristics						Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring
			Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/ Socioeconomic Context					
													environmental effects, and the need for additional mitigation or compensation. Water quality will be monitored under the Aquatic Environment monitoring program.
	Decommissioning, Reclamation and Closure												
	Residual Environmental Effects for all Phases								N	M	--	Y	

Table 8.8.5 Summary of Residual Project-Related Environmental Effects on the Wetland Environment

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Mitigation / Compensation Measures	Residual Environmental Effects Characteristics						Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring
			Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/ Socioeconomic Context					

KEY

Direction
P Positive.
A Adverse.

Magnitude
L Low: <5% loss of existing wetland by area within the RAA.
M Medium: 5-25% loss of existing wetland by area within the RAA.
H High: >25% loss of existing wetland by area within the RAA.

Geographic Extent
S Site-specific: Within the PDA.
L Local: Within the LAA.
R Regional: Within the RAA.

Duration
ST Short-term: Occurs and lasts for short periods (*e.g.,* days/weeks).
MT Medium-term: Occurs and lasts for extended periods of time (*e.g.,* years).
LT Long-term: Occurs during Construction and/or Operation and lasts for the life of Project.
P Permanent: Occurs during Construction and Operation and beyond.

Frequency
O Occurs once.
S Occurs sporadically at irregular intervals.
R Occurs on a regular basis and at regular intervals.
C Continuous.

Reversibility
R Reversible.
I Irreversible.

Ecological/Socioeconomic Context
U Undisturbed: Area relatively or not adversely affected by human activity.
D Developed: Area has been substantially previously disturbed by human development or human development is still present.
N/A Not Applicable.

Significance
S Significant.
N Not Significant.

Prediction Confidence
Confidence in the significance prediction, based on scientific information and statistical analysis, professional judgment and known effectiveness of mitigation:
L Low level of confidence.
M Moderate level of confidence.
H High level of confidence.

Likelihood
If a significant environmental effect is predicted, the likelihood of that significant environmental effect occurring, based on professional judgment:
L Low probability of occurrence.
M Medium probability of occurrence.
H High probability of occurrence.

Cumulative Environmental Effects?
Y Potential for environmental effect to interact with the environmental effects of other past, present or foreseeable projects or activities in RAA.
N Environmental effect will not or is not likely to interact with the environmental effects of other past, present or foreseeable projects or activities in RAA.

8.8.4.1 Potential Project Environmental Effects Mechanisms

The following Project Activities associated with the Construction or Operation phase that were ranked as 2 have potential to result in significant adverse residual environmental effects, and will thus be considered in more detail in this EIA:

Construction:

- Site Preparation of Open Pit, TSF, Buildings and Ancillary Facilities;
- Physical Construction and Installation of Project Facilities;
- Physical Construction of Realigned Fire Road, New Site Access Road, and Internal Site Roads; and

Operation:

- Mine Waste and Water Management.

The interaction between these Project Activities and the Wetland Environment will be discussed below in the context of measurable parameters.

The three Construction activities of: Site Preparation of Open Pit, TSF, Buildings and Ancillary Facilities; Physical Construction and Installation of Project Facilities; and Physical Construction of Realigned Fire Road, New Site Access Road, and Internal Site Roads are all considered together, since all include vegetation removal, ground disturbance, grading and physical construction activities that will affect the Wetland Environment through a loss of wetland area and function. These activities (such as clearing, grubbing, removal of topsoil and overburden, grading, construction of the TSF starter embankments, and ditching) will result in the direct disturbance and loss of wetlands through the removal of vegetation, the removal of wetland soils and overburden material, and the infilling of wetlands. Progressive construction of the TSF embankments during Operation will encroach on wetlands in the form of the toe of the embankments as the TSF expands to its ultimate extent. In addition to the direct disturbance of wetlands as these facilities are constructed, these activities will also likely have indirect environmental effects on some down-gradient wetlands; particularly in wetlands down-gradient of the TSF where surface water will be later retained in the TSF and consequently flow toward wetlands is reduced. This latter potential environmental effect is addressed under Mine Waste and Water Management.

Mine Waste and Water Management activities include the dewatering of the open pit and the retention, and to a lesser extent redirection, of surface run-off. These activities will have indirect environmental effects on wetlands around the open pit (due to groundwater drawdown into the pit) and down-gradient of the TSF and other facilities (as mine contact water on the Project site is collected and sequestered in the TSF, affecting downstream flow and possibly riparian wetlands). These environmental effects are difficult to predict and are subject to numerous variables at multiple scales that make modelling or prediction of such an environmental effect difficult, but the potential extent and nature of the environmental effects are discussed in Section 8.8.4.3. The range of changes to wetlands resulting from lower water table could include any or all of the following: reduction in standing water; reduced or altered flow in associated watercourses; reduced shallow groundwater flow and input; transition from hydrophytic vegetation communities to upland communities; change in the accumulation of organic material; shifts in wetland community type; or changes in wildlife use of wetlands.

8.8.4.2 Mitigation of Project Environmental Effects

The following mitigation measures, through careful design and planning, will be employed to avoid or reduce the environmental effects of the Project on the Wetland Environment potentially resulting from the environmental effects mechanisms described above.

- Clearing activities will be restricted to necessary portions of the PDA, and not beyond, to minimize the amount of habitat lost or altered through direct disturbance, or adjacent edge effects.
- Standard erosion and sedimentation control measures will be employed, including:
  - erosion control fencing;
  - check dams;
  - sedimentation control ponds where appropriate;
  - construction sequencing to minimize soil exposure;
  - retaining existing vegetation as long as possible;
  - re-vegetation and mulching of denuded areas;
  - diverting run-off away from denuded areas;
  - optimizing length and steepness of slope;
  - keeping surface water run-off velocities low;
  - proper sizing and protecting of drainage ways and outlets;
  - intercepting of sediments on site; and
  - inspecting and maintaining the above-mentioned control measures.
- Any loss of GeoNB-mapped wetlands will be compensated.
- Standard dust control measures will be implemented.
- Quarried, crushed material will be used for road building in and near wetlands, to minimize the risk of introducing or spreading exotic and/or invasive vascular plant species.

- Road construction activities will be minimized in wetland areas to reduce the potential environmental effects of disturbance, such as erosion and sedimentation, and the introduction or spread of exotic and/or invasive vascular plant species.

- Water will be treated as necessary prior to release to the environment.

The loss of provincially regulated (*i.e.,* GeoNB-mapped) wetland and wetland function will be compensated for according to a plan that will be developed in coordination with, and approved by NBDELG. The wetland compensation system in New Brunswick as currently understood is described below.

8.8.4.2.1 Wetland Mitigation in New Brunswick

The most recent guidance on wetland mitigation from the Province was provided in the 2003 "Proposed Wetland Mitigation Guidelines for New Brunswick" (NBDNR 2003). NBDELG is currently working on a new "Long-Term Wetland Management Strategy" (NBDELG 2012e) that will include guidance for wetland compensation, designed to help the Province achieve the goals of the New Brunswick Wetlands Conservation Policy: no net loss of wetland function and no loss of provincially significant wetland. Currently NBDELG does not permit alteration to wetlands designated as PSW and requires that any loss of other GeoNB-mapped wetlands is compensated. PSWs include wetlands that fulfill highly valued functions such as floodwater storage or providing habitat for SOCC. This approach is designed to protect the most valued functions of important individual wetlands and rare wetland types in the province, such as coastal marshes that have undergone significant loss to development since European settlement.

Before NBDELG grants permission for alteration to non-PSW, GeoNB-mapped wetland, the Proponent must first demonstrate that the Project has been designed as much as feasible to avoid, and minimize alterations to wetlands, before requesting permission to alter it. For simplicity and consistency in the determination of compensation requirements, wetland function in New Brunswick is often, for simplicity, equated with wetland area. Compensation for GeoNB-mapped wetlands is typically required at a higher area-rate than is actually lost (typically 2:1) as a result of a project to accommodate for any lag in wetland function that constructed or restored wetlands might exhibit relative to the natural wetlands lost.

Anticipating the eventual requirement to develop a wetland compensation plan under the WAWA Regulation, Northcliff has been developing a conceptual wetland compensation approach to explore options for mitigating the loss of wetland function resulting from the Project. While the implementation of wetland compensation has a short history in New Brunswick, Northcliff has identified several potential approaches to compensating for lost wetland function that have the potential to create positive environmental effects on the Wetland Environment in the RAA and province-wide. These options include:

- considering various initiatives that could be led directly by Northcliff for restoring wetlands that have been adversely affected in the RAA;

- working with Ducks Unlimited Canada to identify suitable wetland compensation projects that they could implement, supported by Northcliff; and/or

- providing funding and/or other in-kind opportunities designed to further wetland conservation in the province.

These initiatives aim to compensate for the anticipated loss of valued wetland functions within the affected watershed as and where possible. The availability and feasibility of various options will be explored further in consultation with regulatory authorities and other stakeholders, as required during permitting. These options will be pursued by Northcliff in consultation with NBDELG as part of WAWA permitting for the Project, and the final wetland compensation approach and plan as agreed to with regulatory agencies will be consistent with the objectives of the New Brunswick Wetlands Conservation Policy.

8.8.4.3 Characterization of Residual Project Environmental Effects

Based on extensive field studies used to characterize the existing environment (described in Section 8.8.3) and the extent of the PDA, the activities to be conducted during the Construction phase of the Project are expected to result in the direct loss of 200 ha of wetland area in the PDA (Table 8.8.6). The area of GeoNB-mapped and field-identified unmapped wetland that will be directly affected by the Project within the PDA and LAA (*i.e.*, not including the 138 kV transmission line) is summarized in Table 8.8.6. Wetland loss in the 138 kV transmission line corridor is avoided as transmission poles will span wetlands and their 30 m buffers. Where possible, wetlands will be avoided and indirect environmental effects on wetlands will be limited using standard mitigation procedures to the extent possible; however, the ability to avoid wetland area is limited based on the location of the ore resource and the size of the infrastructure required (*e.g.,* TSF), and as such some loss is unavoidable. This loss will be incurred during clearing, grubbing, grading, and construction of Project facilities, roads, and the open pit. Of this lost area, 26.7 ha represents GeoNB-mapped wetlands, which will be compensated for in a Wetland Compensation Plan developed in consultation with NBDELG as part of WAWA permitting and as described in the ESMS (Chapter 2 and Appendix D). With compensation, these losses are expected to be adequately offset.

Mine Waste and Water Management will result in retention of some site precipitation within the TSF and redirection of run-off adjacent to facilities that will indirectly affect wetlands, as well as an unknown extent of indirect loss of wetland through changes in water table hydrology adjacent to the open pit due to groundwater drawdown into the open pit. The Mine Waste and Water Management activity of the Operation Phase (and to a lesser extent, the Site Preparation and Physical Construction activities within the Construction Phase) are anticipated to result in some indirect loss of GeoNB-mapped wetlands, the extent of which will be determined through long-term follow-up and mitigated or compensated as required. This approach to adaptive management is necessary due to the difficulty of predicting the extent of such environmental effects.

The important valued functions associated with the wetlands anticipated to be affected within the LAA are the support of watercourses that support fish habitat (particularly Bird Brook which was found to support Atlantic salmon habitat in its lowest reach), and the provision of habitat for avian SOCC. These functions are most closely associated with riparian wetland types such as BIW, SRW, fens, and LSW which are typically mapped on GeoNB and for which compensation will be provided. The losses of these valued functions are addressed in Section 8.5 (Aquatic Environment) and Section 8.6 (Terrestrial Environment), respectively, and were determined to constitute no significant environmental effect on these VECs.

There are no PSWs or rare wetland types within the PDA and approximately three quarters of lost wetland is forested wetland which, relative to other wetland types recorded, has less potential for SOCC presence, more marginal wetland hydrology, lower volume of water processed per area (except for the bog), and was not found to fulfill any important wetland functions.

8.8.4.3.1 Direct Loss of GeoNB-mapped Wetlands

A total of 26.7 ha of GeoNB-mapped wetlands will be directly affected within the PDA as a result of the Project activities carried out in the Construction phase (Table 8.8.6). The nature of the direct environmental effect will be the removal of vegetation and topsoil and the redirection of surface flow and/or the secondment of surface flow within the TSF. Access roads will displace wetlands directly within their footprint, but will be designed to avoid indirect environmental effects on adjacent wetland by use of standard erosion and sediment controls, and proper culvert placement and installation.

The GeoNB-mapped wetlands that will be directly affected include one bog (7.9 ha), a number of beaver impoundment wetlands that are categorized as freshwater marsh by the Province (8.5 ha), and a number of shrub wetlands that were field-identified as largely alder-dominated riparian wetlands (18.8 ha). There were avian SOCC identified in and near many of these wetlands (*e.g.,* Olive-sided Flycatcher, Canada Warbler, and Rusty Blackbird), which are addressed in Section 8.6 (Terrestrial Environment). Some of these wetlands may play a role in the support of habitat for Atlantic salmon (only one parr was identified in lower Bird Brook) and are addressed in Section 8.5 (Aquatic Environment). The GeoNB-mapped wetlands within the PDA are not managed for forestry.

The other valued functions attributed to the GeoNB-mapped wetlands in the PDA were related to their contribution to the maintenance of water quality and flow in the out-flowing watercourses from the PDA, which include Sisson Brook, McBean Brook, Bird Brook, and an NBDNR-mapped tributary to West Branch Napadogan Brook. Parts of these watercourses will be lost within the Project footprint, and the flows within the residual watercourses will be reduced as precipitation is captured for Project use during Operation, though some Project discharge to Sisson Brook is expected starting about Year 9 of Operation. The loss of these watercourses is addressed in Section 8.5 (Aquatic Environment), and in consideration of planned mitigation including HADD compensation, is determined to result in no significant environmental effect. The loss of wetland function in support of flow and water quality of these watercourses is therefore not a significant environmental effect. There will likely be some reduction in baseflow to the residual lengths of these watercourses and the higher order streams that they feed (*i.e.*, Napadogan Brook), which will be determined through monitoring and is addressed in Section 8.4 (Water Resources).

The GeoNB-mapped wetlands that will be directly affected will be compensated according to a Wetland Compensation Plan to be developed with, and approved by, NBDELG in support of WAWA permitting for the Project.

Residual environmental effects related to surface water and wildlife SOCC will fall under the mitigation and follow-up measures of the Water Resources, Aquatic Environment, and Terrestrial Environment VECs.

8.8.4.3.2 Direct Loss of Unmapped Wetlands

Direct loss of wetlands not mapped on the GeoNB mapping layer (*i.e.*, "unmapped wetlands") will occur during the Construction phase, and will result in a residual environmental effect. Of the total 200 ha of wetlands field-identified within the PDA (excluding the 138 kV transmission line), 173 ha are not nested within GeoNB-mapped wetland polygons, which is a typical proportion for the province. Of this 173 ha of unmapped wetland, 158 ha, or 91%, was field-identified as forested wetlands (115 ha of OFW, and 43 ha of MFW).

The GeoNB-mapped wetlands, such as marshes, bogs, fens, beaver ponds, and cedar swamps, are typically more obvious on aerial imagery. More marginal forested wetlands such as black spruce dominated forested wetlands tend to be more prevalent in the PDA and LAA, but are typically not included in the GeoNB layer and compensation for loss of these wetlands is not required by NBDELG. Within the LAA, only 1.7 ha of the total 318 ha of field-identified forested wetland is included within the GeoNB-mapped wetlands. The majority of wetlands in the PDA and LAA (and New Brunswick as a whole), are forested and are unmapped under the GeoNB layer. Wetlands are valued for their ability to retain water, improve water quality, provide habitat to unique or rare assemblages of species, and provide a source of cultural or economic benefit. Wetlands that retain or process more water have more rare species or communities, and harbour greater biodiversity, have higher cultural or economic value and would therefore be considered of higher value. The black spruce-dominated forested wetlands described as OFW within the PDA and LAA were assessed to have comparatively little ecological value relative to other wetland types (such as fens and bogs) and surrounding upland. Likewise, their cultural and economic value is limited. They are productive forest land and are managed for timber, but are typically not as productive as adjacent uplands with better drained soils, having lower growth rates and longer harvest rotation periods. Moose hunting does occur within this habitat type in the PDA and LAA, but more open wetlands with greater visibility are frequently used hunting locations. Likewise, they are not a rare habitat type in New Brunswick, and while they can provide habitat for species of conservation concern such as Canada lynx (*Lynx canadensis*) and southern twayblade (*Listera australis*), they are typically considered to have lower potential for rare plant species relative to some other wetland types such as cedar swamps, coastal marshes or floodplain wetlands, and have lower diversity in general. OFWs also have more but similarly marginal hydrological value, typically retaining and processing less water by area than other types of wetlands previously mentioned. The prevalence of this type of wetland across the province, and the lack of associated rare species indicates they do not have a high ecological value. The important ecological functions observed during the field assessment were the support of avian SOCC such as Olive-sided Flycatcher which inhabited the edges of OFWs where they met with other more open habitats such as SRW.

Table 8.8.6 Wetlands Within the PDA, LAA, and RAA (Crown Land Only and Estimated Total RAA), and Percent of RAA that May Be Directly or Indirectly Lost as a Result of the Project

Project Wetland Type	NBDELG Wetland Type	PDA – Actual Loss of Wetland (GeoNB-mapped and unmapped) (ha)[a]	LAA – Actual Loss of Wetland (GeoNB-mapped and unmapped) (ha)[a]	PDA – Loss of GeoNB Mapped Wetland (ha)[a]	LAA – Loss of GeoNB Mapped Wetland (ha)[a]	Actual to GeoNB Mapped Factor (LAA)	RAA (Crown Land Only) – Total Area of GeoNB Mapped Wetlands (ha)	RAA (Crown Land Only) – Estimated Actual Total Area of Wetland Available (ha)[b]	RAA (Total) – Estimated Total Actual Area of Wetland Available (ha) [c]	% RAA Directly Lost Within PDA	% RAA Potentially Indirectly Lost Within LAA
LSW	Aquatic Bed	0.0	0.9	0.0	3.1	0.28	2,788	788	1210	0.0	0.07
Bog	Bog	7.9	12.0	7.9	7.9	1.52	8,574	13,051	20,040	0.4	0.02
-	Coastal Marsh	0.0	0.0	0.0	0.00	na	27	na	na	0.0	na
Fen	Fen	1.2	9.3	0.0	0.00	na	11,183	na	na	na	na
BIW	Freshwater Marsh	11.9	21.4	8.5	31.4	0.85	11,495	9,819	15,076.4	0.1	0.08
DSM		3.1	5.4								
OFW	Forested	114.6	237.0	0.0	1.7	191.3	1,707	272,532[d] – 326,513	418,462 – 501,347	0.03 – 0.04	0.03 – 0.04
MFW		43.4	80.9								
SRW	Shrub	17.4	33.9	18.8	26.3	1.29	41,635	53,604	82,306	0.02	0.02
-	PSW (unclassified)	-	0.00	0.00	0.00	0.00	3,113	na	na	0.0	0.00
-	Wetland (unclassified)	-	0.00	0.00	0.00	0.00	5	na	na	0.0	0.00
	Total	**199.6**	**400.7**	**26.7**	**70.2**	**5.7**	**80,527**	**4,593,689[e]**	**705,342[e]**	**0.03[e]**	**0.01[e]**

Notes:

[a] PDA and LAA values do not include the 138 kV transmission line portion of the Project, as there is no anticipated loss of wetland associated with this portion of the Project.

[b] Values in this column are calculated by multiplying the Crown Land Only values for GeoNB-mapped wetlands (previous column) by the corresponding "Actual to Mapped Factor."

[c] Values in this column are calculated by increasing the Crown Land Only values (previous column) by a factor of 1.69, the difference in area between the entire RAA and the Crown Land Only portion of the RAA.

[d] Value is calculated based on DWT area in the RAA (Crown Land Only), minus any GeoNB-mapped wetlands, and increased by a factor of 1.69 (calculated based on applying the same DWT method to the LAA, and comparing with the actual amount of forested wetland observed).

[e] Values are not column sums, but are calculated in the same manner as the other values in that column.

The value of the hydrological function of the wetlands within the PDA would be realized both inside and outside the LAA through the water quality and flow characteristics of the watercourses that flow from the PDA and through any contribution to local aquifers that these wetlands might play a role in. However, the Project will involve the removal of the watercourses that flow from the site, and groundwater recharge function is not highly valued for these wetlands as consumption of groundwater by humans in this area is limited. Any local change in groundwater that results from the removal of wetlands will be minor relative to the dewatering of the open pit. The environmental effects of this are assessed in Section 8.4 (Water Resources) and are rated not significant.

Important ecological benefits from wetlands within the PDA that may have implications within the greater LAA are the support of salmon habitat in Bird Brook and further downstream, and the provision of habitat for avian SOCC such as Rusty Blackbird, Canada Warbler, and Olive-sided Flycatcher. The environmental effects on these values have been assessed respectively in Section 8.6 (Terrestrial Environment) and Section 8.5 (Aquatic Environment) and were determined to be not significant in both cases.

The unmapped wetlands within the PDA were estimated to play some role in the slow release of water and maintenance of base flow through surface return. However, within the PDA, the watercourses that are fed by these wetlands will be replaced by the TSF. There will be no increase in flashiness given the planned retention of surface water within the TSF, and the use of diversion channels for any redirected surface run-off from the mine site. The loss of these watercourses and their ecological, social, hydrological, and cultural values has been assessed as having no significant environmental effect in Section 8.5 (Aquatic Environment) and Section 8.4 (Water Resources), where interactions related to the alteration to these watercourses are discussed in detail, and mitigation is proposed. Other hydrological functions such as groundwater recharge and groundwater discharge will be altered but these functions are not highly valued in this area due to low demand on surface and groundwater for consumption.

8.8.4.3.3 Percent Loss within the RAA

Provincial wetland mapping on the GeoNB website was used to estimate the proportion of each wetland type (for both GeoNB-mapped and unmapped wetlands) that would be lost in the entire RAA as a result of Construction Activities of the Project (Table 8.8.6). The field-identified wetland types were equated with their corresponding NBDNR wetland type and the relative proportions of each mapped type within the LAA *vs.* the RAA were used to estimate the total amount of each unmapped wetland type in the RAA, and the percent of each type that will be affected by the Project. There were no GeoNB-mapped fens inside the LAA despite the presence of field-identified fens, so no estimate of the environmental effect on fens across the RAA was developed. However, it is likely that as in the LAA, fens are underrepresented across the RAA and are likely to be more common than as mapped on GeoNB. It is also likely that the percentage of these affected is very low (<0.01%).

Because forested wetlands are not typically identified on GeoNB wetland mapping layer (none of the forested wetlands within the PDA appear on the GeoNB wetland layer), the approach described above would likely overestimate the amount of unmapped forested wetland within the RAA. NBDNR depth-to-water table-mapping (<25 cm from surface) was used to estimate the amount of forested wetland within the RAA and the proportion that would be lost as a result of the project. Both values are given as a range of possible forested wetland area within the RAA (Table 8.8.6).

The total percent of each wetland type that will be directly affected within the PDA during the Construction and Operation phases, as a proportion of the estimated availability of that type within the RAA, is less than 0.1% for each of the wetland types. None of the affected types are rare within the RAA and none were found to perform important valued functions.

8.8.4.3.4 Indirect Loss of Wetlands

The indirect loss of wetlands from Mine Waste and Water Management during the Operation phase as a result of open pit dewatering will occur gradually, and is anticipated to advance further from the pit as the pit becomes deeper. This environmental effect is expected to be realized primarily in wetlands to the south of the pit, in the McBean Brook watershed. To the east (Nashwaak Ridge) and northwest of the open pit are pronounced topographical features with little or no wetland that are anticipated to limit the environmental effects of the Project on wetlands beyond them. To the north, wetlands will be directly affected by other Project components (*e.g.,* TSF). This drawdown will reverse following Closure when the open pit is filled with water and the water table returns to approximate pre-Construction level, and most of the area that has been dewatered to the south of the pit is anticipated to eventually transition back to wetland conditions.

The indirect loss of wetlands is difficult to predict given the variety of localized and generalized water inputs and outputs from wetlands from groundwater, precipitation, and evapotranspiration, and combined with complex substrates that may include various types of confining layers and bedrock, over glacial till that varies in thickness and texture. Knight Piésold (2012c) has modelled a maximum area of potential environmental effect around the open pit based on predicted groundwater drawdown from pit dewatering, where there is greater likelihood of environmental effect close to the pit, but increasing unlikelihood of environmental effect on wetlands for up to 2 km from the centre of the open pit when it reaches its maximum depth. A similar environmental effect is not expected in the area of the rock quarry to the northwest of the TSF, as there is little wetland present in this area and the quarry will not be deep like the open pit. This radius from the open pit will primarily affect wetlands to the south in the direction of Trouser and Christmas Lakes, where it reaches the northern edge of the fringing wetland of these open water features. There are fewer wetlands to the east and west, and the wetlands to the north will largely be already affected from the onset of Construction. The quantification of actual loss of wetlands resulting from this drawdown effect will rely on follow-up of wetlands across the gradient of the 2 km radius and beyond to include Trouser and Christmas Lakes. Figure 8.8.7 shows the approximate extent and nature of both direct and indirect environmental effects on wetlands.

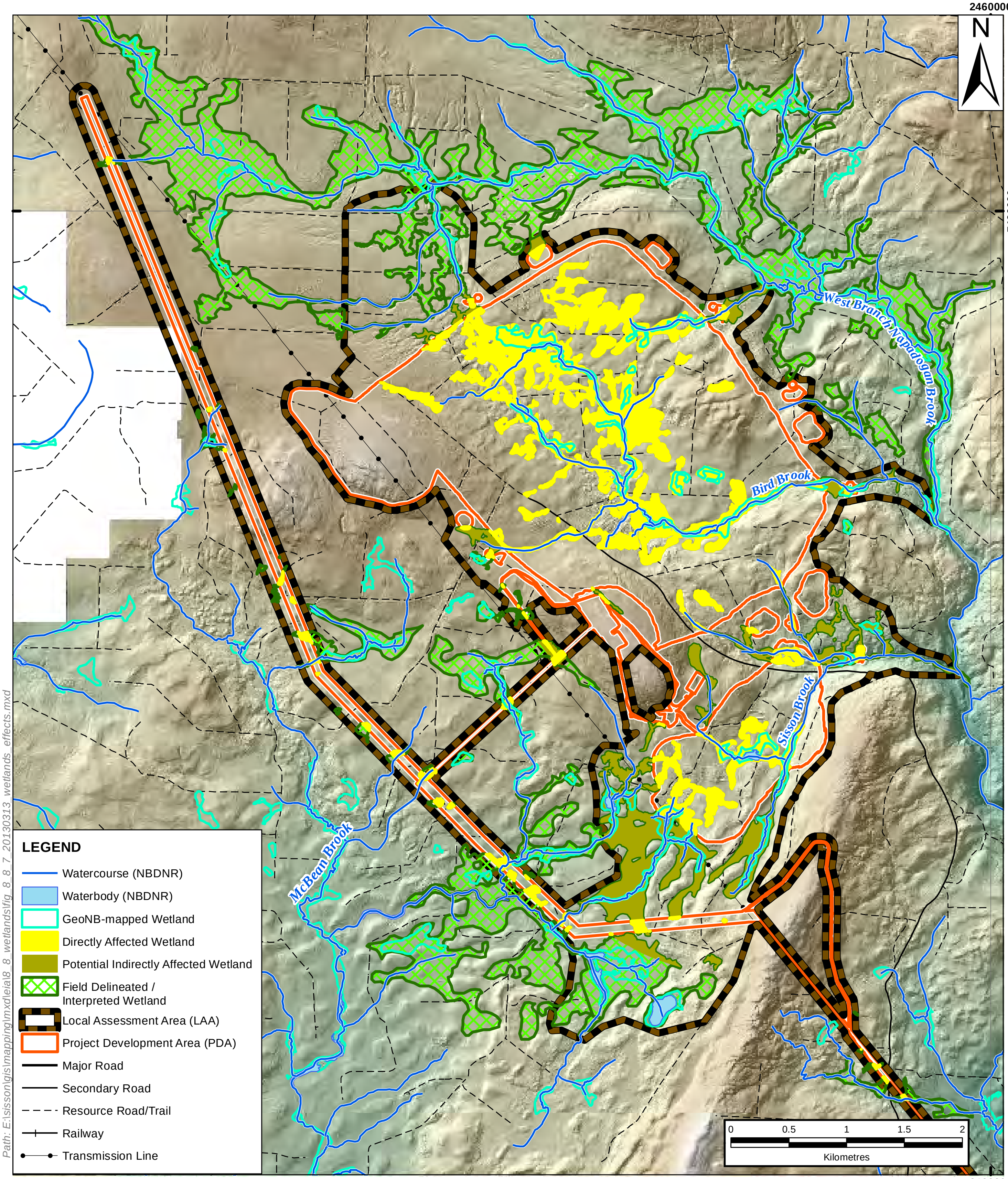
Loss of function is not anticipated for the wetlands in and around Trouser and Christmas Lakes, which appear to be important contributors to flow in McBean Brook. The productive groundwater inputs to these wetlands that supply baseflow to McBean Brook are estimated to be the most valued function of these wetlands and are not anticipated to be lost. Although 3.6% (156 ha of 4,335 ha) of McBean Brook watershed will be directly affected by Project components, the relative ratio of groundwater to surface water inputs to the headwaters of McBean Brook cannot be accurately determined. A modelling exercise to predict the change in flow within McBean Brook predicted a net change in total annual flow of approximately 1% (Knight Piésold 2012f), which is not anticipated to result in a change to the wetland environment outside the LAA in that watershed. The modelling considered the diversion of the upper reaches of Sisson Brook, located immediately east of the open pit, toward McBean Brook watershed, which will partially mitigate annual flow reduction resulting from loss of watershed area within the PDA and groundwater drawdown into the open pit.

Additional indirect loss of wetland will occur down-gradient of Project components (*e.g.*, the TSF), in areas where surface flow was an important input to wetland hydrology. Although this indirect loss will undoubtedly begin during the Construction phase, it is being considered in the Operation phase, as loss will continue through Mine Waste and Water Management. The areas that are anticipated to be affected are riparian wetlands associated with watercourses flowing from the TSF area including Sisson Brook, Bird Brook, and an unnamed tributary to West Branch Napadogan Brook that flows from the PDA to the northeast. These watercourses are associated with wetland complexes that contain both GeoNB-mapped wetlands and unmapped forested wetlands. It is anticipated that the removal of these watercourses within the PDA will lead to a reduction in size of these wetlands, although there are additional and varied inputs to these wetlands including surface flow input from outside the PDA and throughflow that feeds them laterally. While a complete loss of these wetlands outside the PDA but within the LAA is unlikely, the character and function may change as a result of the change in surface water input from the watercourses. This environmental effect will result in a change in wetland conditions, most obviously along the watercourses, causing beaver impoundments to draw down and some shrub wetland to gradually have increased tree cover, potentially transitioning to upland communities. Some more marginal forested wetland will transition to upland, but lateral surface run-off and throughflow return will continue to feed these wetlands water to an unknown degree. Because of the variable inputs and outputs of water to these wetlands, follow-up will be required to determine the actual extent of indirect changes to these wetlands and fulfill the need, through adaptive management, to provided further mitigation and/or compensation as appropriate.

At some time during Operation (starting at approximately Year 8), treated surplus water will be released from the Project to the former Sisson Brook channel, and may represent an opportunity for positive environmental effects on wetlands that were affected during Construction. Monitoring will also be employed to assess this opportunity and any benefits to wetland function that may be realized from strategic use of this discharge for wetland mitigation.

8.8.4.3.5 Provincially Significant Wetlands

As much as 18% of New Brunswick is covered with wetland by area, and wetland as a general habitat type is not rare in this Province. However, there are certain types of wetlands that are either rare, perform highly valued functions, or have experienced significant post-European settlement decline. Such communities include coastal marshes, cedar swamps, and St. John River flood plain wetlands. Wetland types known to be rare or to perform highly valued functions are identified on GeoNB mapping as PSWs and cannot be altered as per the New Brunswick Wetlands Conservation Policy which stipulates “no loss” of wetlands categorized as PSW. There are no PSWs within the LAA, and thus no irreplaceable loss of significant valued function.



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

Potential Environmental Effects on Wetlands Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:45,000	Project No.: 121810356	Data Sources: NBDNR, Leading Edge Geomatics Ltd.	Fig. No.: 8.8.7
Client: Northcliff Resources Ltd.	Date: (dd/mm/yyyy) 13/03/2013	Dwn. By: JAB	Appd. By: DLM	

Stantec

Map: NAD83 CSRS NB Double Stereographic

8.8.5 Assessment of Cumulative Environmental Effects

In addition to the Project environmental effects discussed above, an assessment of the potential cumulative environmental effects was conducted for other projects or activities that have potential to cause environmental effects that overlap with those of the Project, as identified in Table 8.8.4. Table 8.8.7 below presents the potential cumulative environmental effects to the Wetland Environment, and ranks each interaction with those other projects or activities as 0, 1, or 2 with respect to the nature and degree to which important Project-related environmental effects overlap with those of other projects or activities that have been or will be carried out.

Table 8.8.7 Potential Cumulative Environmental Effects to the Wetland Environment

Other Projects or Activities With Potential for Cumulative Environmental Effects	Potential Cumulative Environmental Effects
	Change in Wetland Environment
Past or Present Projects or Activities That Have Been Carried Out	
Industrial Land Use (Past or Present)	1
Forestry and Agricultural Land Use (Past or Present)	1
Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons (Past or Present)	1
Recreational Land Use (Past or Present)	1
Residential Land Use (Past or Present)	0
Potential Future Projects or Activities That Will Be Carried Out	
Industrial Land Use (Future)	0
Forestry and Agricultural Land Use (Future)	2
Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons (Future)	1
Recreational Land Use (Future)	1
Planned Residential Development (Future)	0

Cumulative Environmental Effects
Notes:
Cumulative environmental effects were ranked as follows:
0 Project environmental effects do not act cumulatively with those of other projects or activities that have been or will be carried out.
1 Project environmental effects act cumulatively with those of other projects or activities that have been or will be carried out, but are unlikely to result in significant cumulative environmental effects; or Project environmental effects act cumulatively with existing significant levels of cumulative environmental effects but will not measurably change the state of the VEC.
2 Project environmental effects act cumulatively with those of other projects or activities that have been or will be carried out, and may result in significant cumulative environmental effects; or Project environmental effects act cumulatively with existing significant levels of cumulative environmental effects and may measurably change the state of the VEC.

Past, present and future industrial land use (non-forestry and agricultural) within the RAA is limited, and not predicted to act cumulatively with the Project on the Wetland Environment. The RAA and Project location is shown in Figure 8.8.2. Past, present, and future residential land use, both ranked as 0 in Table 8.8.7, although extensive in some areas of the RAA, is most prevalent in urban areas that are not near the LAA, thus the resulting cumulative environmental effect is low and concentrated in urban portions of the RAA. There are no known large-scale residential developments planned for the vicinity of the LAA. In addition, residential developments are typically planned to avoid wetland areas to comply with provincial regulations and to minimize potential flooding issues. The interaction between these activities and Project activities should not affect wetlands, and as such, their interaction with the Wetland Environment is ranked as 0 in Table 8.8.7; their cumulative environmental effects are not significant, and they are not discussed further.

Forestry and agricultural land use has occurred and continues to occur in the RAA. Within the LAA, active forest management is more widespread in the northern portion and surrounding region, including on Crown land adjacent to the mine site portion of the PDA. Agricultural activities are currently fairly restricted to southern regions of the RAA which contain more private land. Prior to the implementation of provincial wetland regulations these activities have affected wetlands within the province; however, these activities and their interactions with wetlands are currently regulated by the province. Though both past and present forestry and agricultural land use have and will affect wetlands within the RAA, because they are regulated activities with restrictions in wetlands, and managed by regulation and within forest management plans and activities on both private and Crown land, these activities and the Project are not expected to have any significant adverse residual cumulative environmental effect on the Wetland Environment.

Land and resources within the RAA have been, and will continue to be used for traditional purposes by Aboriginal persons. With respect to the Wetland Environment, this includes activities such as hunting, fishing, trapping, gathering, and timber harvesting. These activities are currently occurring at low, relatively sustainable levels within the RAA. In particular, timber harvesting by the 15 First Nations communities in New Brunswick is conducted under agreements with NBDNR. The interaction of past, present and future current use of land and resources for traditional purposes by Aboriginal persons and Project activities is not likely to have any significant adverse residual cumulative environmental effects on the Wetland Environment.

Recreational land use, including hunting, fishing, trail development, and all-terrain vehicle use, has been and will continue to occur within the RAA. These activities may affect wetlands in a minimal way through the removal of wildlife and fish, disturbance or removal of vegetation, soil compaction and rutting, and resulting hydrological changes. However, these activities occur on such small spatial and temporal scales, the interaction between past and present or future recreational land use and the Project is not expected to have any significant adverse residual cumulative environmental effects on the Wetland Environment.

Thus, in consideration of the nature of the interactions and the planned implementation of known and proven mitigation, the cumulative environmental effects of all Project activities in combination with those of other projects or activities that have been or will be carried out that were ranked as 0 or 1 in Table 8.8.7, on the Wetland Environment during any phase of the Project are rated not significant, and are not considered further in the assessment.

The environmental effects of projects and activities that will potentially overlap with the environmental effects of the Project ranked as 2 (and thus have the potential to result in significant residual cumulative environmental effects with the Project) are limited to future forestry and agricultural land use.

To address the potential cumulative interactions listed above and ranked as 2, a cumulative environmental effects assessment for Change in Wetland Environment was conducted in relation to the Project. The cumulative environmental effect mechanisms, mitigation measures, and characterization of residual cumulative environmental effects are presented in Table 8.8.8 below.

Table 8.8.8 Summary of Residual Cumulative Environmental Effects on the Wetland Environment

Cumulative Environmental Effects	Case	Other Projects, Activities or Actions	Mitigation / Compensation Measures	Residual Cumulative Environmental Effects Characteristics						Significance	Prediction Confidence	Likelihood	Recommended Follow-up or Monitoring
				Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/ Socioeconomic Context				
Change in Wetland Environment • Loss of wetland area (ha); • Change in wetland function	Cumulative Environmental Effects with Project	• Future Forestry and Agricultural Land Use.	• Forested crown land that will be removed from the Project Development Area (including forested wetlands) will be accounted for by NBDNR and the appropriate forest licensee in the management plans of the subsequent forest cycle, to maintain the appropriate overall annual allowable cut (AAC) for the licensee. • Any merchantable timber within the PDA would be allotted to the current licensee during site preparation, so there should be little or no requirement for additional allotments to compensate for loss in AAC.	A	L	R	P/C	R	D	N	H	--	None recommended.
	Project Contribution to Cumulative Environmental Effects			A	L	L	MT/O	R	D	N	H	--	

Table 8.8.8 Summary of Residual Cumulative Environmental Effects on the Wetland Environment

Cumulative Environmental Effects	Case	Other Projects, Activities or Actions	Mitigation / Compensation Measures	Residual Cumulative Environmental Effects Characteristics						Significance	Prediction Confidence	Likelihood	Recommended Follow-up or Monitoring
				Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/ Socioeconomic Context				

KEY

Direction
P Positive.
A Adverse.

Magnitude
L Low: <5% loss of existing wetland by area within the RAA.
M Medium: 5-25% loss of existing wetland by area within the RAA.
H High: >25% loss of existing wetland by area within the RAA.

Geographic Extent
S Site-specific: Within the PDA.
L Local: Within the LAA.
R Regional: Within the RAA.

Duration
ST Short-term: Occurs and lasts for short periods (*e.g.,* days/weeks).
MT Medium-term: Occurs and lasts for extended periods of time (*e.g.,* years).
LT Long-term: Occurs during Construction and/or Operation and lasts for the life of Project.
P Permanent: Occurs during Construction and Operation and beyond.

Frequency
O Occurs once.
S Occurs sporadically at irregular intervals.
R Occurs on a regular basis and at regular intervals.
C Continuous.

Reversibility
R Reversible.
I Irreversible.

Ecological/Socioeconomic Context
U Undisturbed: Area relatively or not adversely affected by human activity.
D Developed: Area has been substantially previously disturbed by human development or human development is still present.
N/A Not Applicable.

Significance
S Significant.
N Not Significant.

Prediction Confidence
Confidence in the significance prediction, based on scientific information and statistical analysis, professional judgment and known effectiveness of mitigation:
L Low level of confidence.
M Moderate level of confidence.
H High level of confidence.

Likelihood
If a significant cumulative environmental effect is predicted, the likelihood of that significant cumulative environmental effect occurring (if applicable), based on professional judgment:
L Low probability of occurrence.
M Medium probability of occurrence.
H High probability of occurrence.

Other Projects, Activities, and Actions
List of specific projects and activities that would contribute to the cumulative environmental effects.

8.8.5.1 Cumulative Environmental Effects Mechanisms

The cumulative environmental effects mechanisms for a Change in Wetland Environment are described below. Projects or activities with the potential to overlap with the environmental effects of the Project include future forestry and agricultural land use. Future agricultural land use is not expected to act cumulatively with the Project on the Wetland Environment; the PDA currently overlaps with 0.89 ha of agricultural land, and there are no known planned agricultural developments within the LAA. Thus, the following discussion focusses on future forestry land use.

Forest harvesting and management on New Brunswick's Crown land is an industry that is tightly controlled by NBDNR. The Crown lands are divided into 10 licenses that are leased to licensees. NBDNR and forest licensees work together to achieve specific objectives relative to economics, wood supply, and social and environmental goals. These goals are achieved through 25-year management plans (updated every five years) that are produced by the licensee to demonstrate how they will meet NBDNR's sustainability goals and objectives. In addition, licensees must submit more detailed annual operating plans that specify where harvesting and other silvicultural operations will be carried out. The annual maximum volume per tree species that can be harvested sustainably within a particular forest licence is known as the annual allowable harvest or cut (AAC).

The majority of the forested wetlands within the PDA/LAA are managed under annual operating plans and their timber can be used towards the AAC for that license, unless they are currently being managed for non-timber objectives, *e.g.,* as a conservation forest stand such as part of a watercourse buffer. Harvesting activities can result in changes to wetlands, such as soil compaction and rutting, and resulting changes in hydrology, and changes in vegetation community composition. Changes in vegetation community composition, particularly resulting from the removal of trees, can result in changes in use by wildlife, *e.g.*, if removed trees are used as a source of food or for shelter or nesting by wildlife species.

If wetlands within the PDA were slated for harvest within the operating plan of a licensee, the timber volume lost within those areas might be reallocated and harvested from another area, potentially another wetland. Therefore, the Project, in combination with forest harvesting planned for the area, could result in a greater overall area of wetland that is lost or changed relative to forest harvesting alone.

The amount of forested wetland within the entire PDA (as identified by Stantec (2012g)) is 167.9 ha. However, of this, 47.8 ha is currently managed for non-timber conservation values, such as Conservation Vegetation Communities or watercourse buffers, and would not be scheduled for harvest within the current management or operational plans of the licensees. Of the remaining 120.1 ha, only 30.7%, or 36.8 ha is currently classified as mature or overmature, representing the maximum potential amount of wetland that may be harvested in the near future (younger stands would be unlikely to be scheduled for harvest within the current five-year management plan). Based on the estimated total amount of forested wetland within the RAA of 418,462 to 501,347 ha (described in Section 8.8.4.3.3), the maximum potential amount of wetland that may be harvested in the near future represents approximately 0.007 to 0.009% of the forested wetland in the RAA.

8.8.5.2 Mitigation of Cumulative Environmental Effects

Mitigation measures for the Project were discussed previously for Project-related environmental effects (Section 8.8.4.2). The mitigation measures proposed for the Project-related environmental effects are also anticipated to be effective in mitigating any cumulative environmental effects, as would the mitigation associated with other past and future projects or activities. Beyond these previously described mitigation measures, the following additional mitigation measures will be employed to avoid or reduce the cumulative environmental effects of the Project on the Wetland Environment potentially resulting from the cumulative environmental effects mechanisms described above.

- Forested Crown land that will be removed from the PDA (including forested wetlands) will be accounted for by NBDNR and the appropriate forest licensee in the management plans of the subsequent forest cycle, to maintain the appropriate overall AAC for the licensee.
- Any merchantable timber within the PDA would be allotted to the current licensee during site preparation, so there should be little or no requirement for additional allotments to compensate for loss in AAC.

8.8.5.3 Characterization of Residual Cumulative Environmental Effects

Cumulative environmental effects are likely to result from the Project in combination with future forestry activities, as both will result in the loss or alteration of wetlands, particularly forested wetlands. With mitigation, and given the very small magnitude of the loss compared to that available in the RAA, these cumulative environmental effects will be limited to a minor, temporary change in the planned alteration of forested wetlands within the RAA related to forest harvesting and the removal of timber.

8.8.6 Determination of Significance

8.8.6.1 Residual Project Environmental Effects

Though the Project will result in the direct and indirect loss of area and function of some wetlands, the direct loss of GeoNB-mapped wetlands will be compensated. For the remaining unmapped wetland, this residual loss represents less than 0.1% of all wetland in the Regional Assessment Area (RAA). The extent of indirect loss of GeoNB-mapped and unmapped wetland in areas outside of the PDA will be evaluated through a follow-up program, the results of which will be used to determine the requirements for adaptive management. Overall, it is not expected that these losses will be substantive.

With the proposed mitigation and environmental protection measures, the residual environmental effect of a Change in Wetland Environment during all phases of the Project is rated not significant. This conclusion has been determined with a moderate level of confidence because of the lack of certainty of the extent of indirect loss of wetlands outside of the PDA.

8.8.6.2 Residual Cumulative Environmental Effects

Though cumulative environmental effects arising from the loss of wetlands are likely to result from the Project in combination with future forestry activities, given the very small magnitude of the loss compared to that available in the RAA, these cumulative environmental effects will be limited to a minor, temporary change in the planned alteration of forested wetlands within the RAA related to forest harvesting and the removal of timber.

The characterization of the potential cumulative environmental effects and associated mechanisms, combined with the proposed mitigation measures proposed in Section 8.8.4.2 demonstrate that the residual cumulative environmental effect of a Change in Wetland Environment is rated not significant. This determination has been made with a high level of confidence, given the limited temporal and spatial nature of the potential residual cumulative effects, the professional knowledge and experience of the Study Team, as well as the associated mitigation.

8.8.7 Follow-up or Monitoring

Follow-up or monitoring programs will be implemented for the Wetland Environment as summarized in Table 8.8.5.

A follow-up program will be designed to assess the indirect change to the Wetland Environment (both GeoNB-mapped and unmapped) within the LAA, targeting areas of likely, but unknown environmental effect, *e.g.,* within the groundwater drawdown zone of the open pit, and down-gradient of the TSF area where surface flow to wetlands outside the PDA will be reduced. The objective of the program will be to assess the extent and nature of the any changes in area and function of wetlands outside of the PDA through indirect interaction with the Project, and to determine the level of need for adaptive management.

Given the extensive and interconnected nature of the wetland complexes in the LAA, the assessment will include both GeoNB-mapped and unmapped wetlands as well as small adjacent upland conditions. The program will consist of the establishment and subsequent monitoring of plots arranged in transects extending from within the boundary of GeoNB-mapped wetlands through unmapped wetlands (if present), to the upland area beyond the wetland edge. Transects will be established along a gradient of potential environmental effect with increasing distance from the pit area, and also at wetlands downstream of watercourses formerly originating within the TSF area. Similar transects will also be established and monitored in wetlands within the same watersheds, but outside of the LAA, to be used as controls to interpret any natural variability in water levels in the general area. These plots will be used to evaluate vegetation (including the relative amount of hydrophytic vegetation) and hydrology as indicators of wetland function. Water quality and flow characteristics in downstream watercourses will also be tracked as an indication of potential changes in the wetlands that feed them occurring during operation.

Monitoring programs will occur as a part of the wetland compensation program for GeoNB-mapped wetlands directly affected by the PDA, and described in the Wetland Compensation Plan to be developed for this Project in consultation with NBDELG and as a part of the ESMS. In addition, compliance monitoring, as will be identified in the EPP for the Project, will be conducted to confirm the proper implementation of other mitigation measures.