ROY CONSULTANTS

ENGINEERING SERVICES D'INGÉNIERIE

Environmental Impact Assessment

Wastewater Lagoon Replacement

Mactaquac Provincial Park
Mactaquac, NB

Our File No.: 093-23-C
December 7, 2023

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M. MacMullin:

Subject: Environmental Impact Assessment
Wastewater Lagoon Replacement, Mactaquac Provincial Park
Mactaquac, New Brunswick

We are pleased to present you with this report for the aforementioned subject studied.

We appreciate the opportunity to assist you in this project and we trust this report is to your entire satisfaction. However, should you have any questions or comments, or should you require further assistance, please do not hesitate to contact the undersigned.

Yours truly,

Jon Burtt, EP
Environmental Specialist

MJG/JB/mh

Cc- Guillaume Arseneau, P.Eng., CIVIL Engineer – Roy Consultants

[1] Ref.: Y:\2023\093-23\C\EIA Report\093-23 EIA DRAFT Report (Dec. 6, 2023) JB

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EXECUTIVE SUMMARY

The New Brunswick Department of Tourism, Heritage and Culture is proposing to replace the existing Mactaquac Provincial Park wastewater treatment lagoon, located near Mactaquac, New Brunswick. The project would span over two years, starting in spring 2024. The first year would include the construction of a new lagoon adjacent to the current one. The water treatment system would include a combination of aeration and UV disinfection. In the second year, the new lagoon would be connected to the collection system and the existing lagoon (Photo No. 1) would be decommissioned.

Photo No. 1: Existing Lagoon

Roy Consultants initiated an Environmental Impact Assessment for the proposed project, as per Item (n) of Schedule A of the *New Brunswick Environmental Impact Assessment Regulation – Clean Environment Act* for "all sewage disposal or sewage treatment facilities, other than domestic, on-site facilities". Significance of impacts was determined based on the criteria of likelihood, scale, duration and proposed mitigation. Based on this assessment, no significant adverse environmental impacts are anticipated.

1 PROPONENT

1.1 Name of the Proponent

The project proponent is Tourism, Heritage and Culture

1.2 Address of the Proponent

Marysville Place
PO Box 6000
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1.3 Principal Contact: Proponent

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1.5 Property Ownership

The subject site consists of a property owned by the New Brunswick Department of Tourism, Heritage and Culture.

2 PROJECT DESCRIPTION

2.1 Project Name

The proposed project name is “Mactaquac Park Wastewater Treatment Lagoon Replacement”.

2.2 Project Overview

The Mactaquac Provincial Park is an approximately 1,300-acre park providing serviced and unserviced tent and RV campsites, an 18-hole golf course, an extensive network of hiking trails, a treetop adventure activity (“TreeGo”), a public and camper’s beach, as well as winter activities.

The existing lagoon was built in 1967 (Photo No. 2). It has a footprint of 0.46 ha. It consists of a single cell without separation equipped with two aerators, one of which is non-functioning. The proposed project is to decommission this lagoon and to replace it. The new lagoon would combine aerators with an ultraviolet (UV) disinfection system. The proposed project would improve the treatment efficiency, reduce odours to nearby receptors and reduce nitrogen and phosphorus released in the headpond.

Photo No. 2: 1972 Aerial Photo of Mactaquac Provincial Park (lagoon circled in red), (Source: NRCAN)

2.3 Purpose, Rationale and/or Need for the Undertaking

The existing wastewater treatment lagoon is inadequate to treat the volume of domestic waste produced by the Mactaquac Provincial Park operation. It does not have sufficient treatment for anticipated volumes of waste if the park expands in the future. The new wastewater treatment system would consist of an aerated lagoon that could accommodate future loads, provide flexibility to the operators and meet limiting criteria for biochemical oxygen demand (BOD), total suspended solids (TSS) and ammonia removal. Additionally, an ultraviolet (UV) system for disinfection is included to address microbes, since recreational activities are practised in the receiving body of water.

The "do-nothing" alternative was assessed. From an environmental perspective, this is not desirable as the current lagoon is not adequate to effectively treat current waste volumes. If no action is taken, the operation of the treatment lagoon could become non-compliant with the Approval to Operate discharge limits, could cause the release of harmful ammonia, pH, and Dissolved Oxygen levels, as well as E. Coli, into the riverine environment. Mactaquac Provincial Park may also increase the number of campsites in the future, which would also likely overload the lagoon's capacity to treat waste, resulting in negative impacts on the environment.

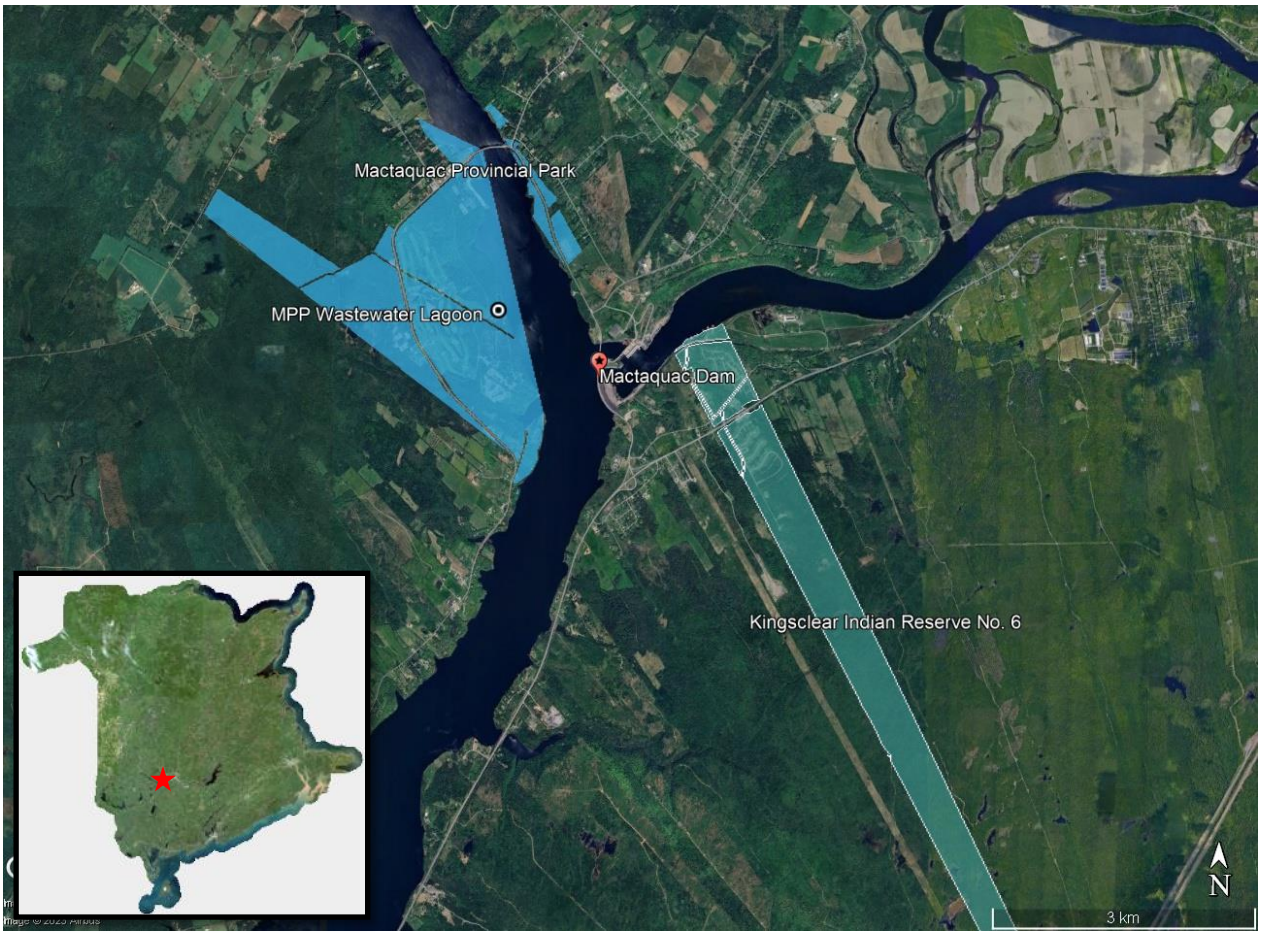
2.4 Project Location

The subject site is located in the Bright Local Service District, New Brunswick (Figure A). The civic address is listed as 1256 Highway No. 105. The centre of the proposed project is geo-referenced at Latitude 45.958798, Longitude -66.886118. Per the Service New Brunswick (SNB) online Planet database, the subject site contains the following Parcels (Table 1):

Table 1: Subject Site Parcel Information

PARCEL ID	OWNER	DESCRIPTION	AREA (ha)
75132449	Tourism and Parks	Provincial park and golf course (Recreation and conservation areas)	435.07
75132662	Tourism and Parks	Watercourse buffer zone and service areas	85

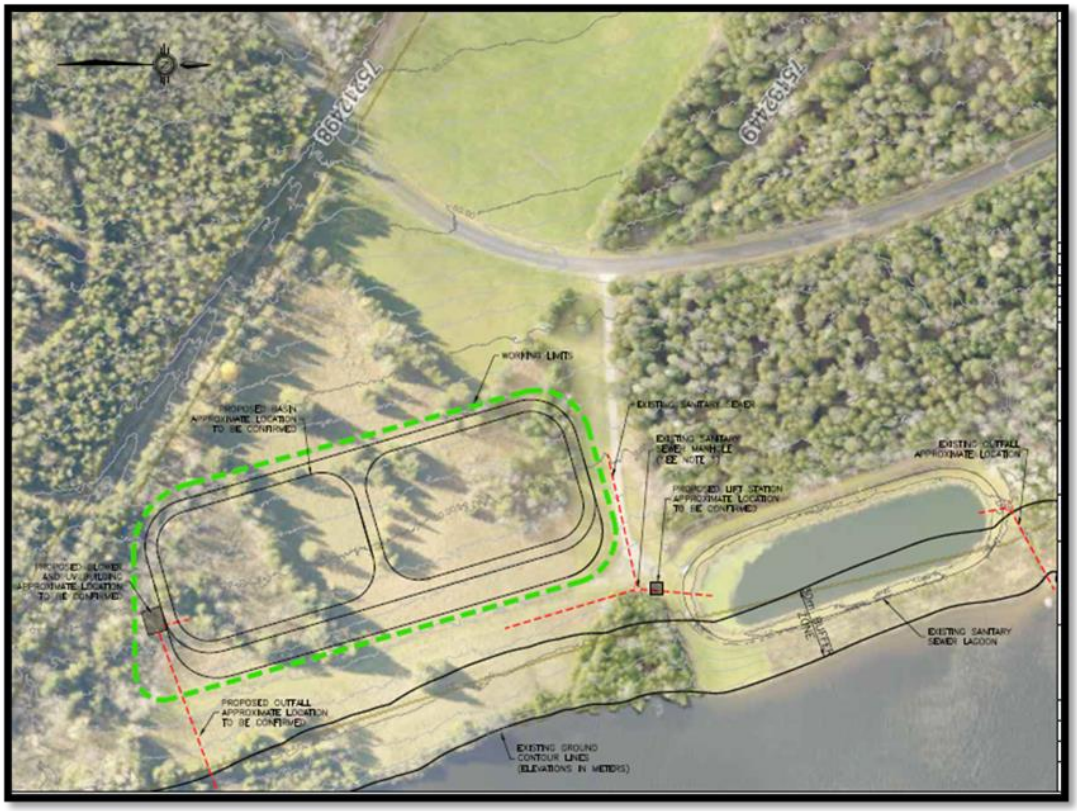
Figure A: Location of the Mactaquac Provincial Park Wastewater Treatment Lagoon



2.5 Siting Considerations

The new site was chosen because of its convenient location adjacent to the existing lagoon, the fact that it is land already owned by the proponent, that it can accommodate the lagoon at a distance greater than 30 m from the water, that it is an existing field requiring less mature vegetation removal and that it can easily be used to treat waste from the decommissioning of the existing lagoon (Figure B).

Figure B: Conceptual Future Site of the Mactaquac Wastewater Lagoon



2.6 Physical Components and Dimensions of the Project

Refer to the Design Brief in Appendix A for additional project details.

2.6.1 Existing Lagoon

The existing wastewater treatment plant (WWTP) was built around 1967. It is composed of a single cell without separation. The lagoon has an approximate area of 0.46 ha. It is equipped with two mechanical surface aerators, of which one is out of service. The treatment process can be described as a facultative treatment with an aerobic layer at the top and near the surface aerators, and an anaerobic layer at the bottom near the sludge blanket. It offers a primary treatment by the settling of solids and a secondary treatment by the action of microorganisms.

The presence of duckweed covering most of the lagoon could create an anaerobic environment and limit the penetration of sunrays essential in the disinfection process. As mentioned by Gerardi 2015, duckweed is found in quiescent and nutrient-rich lagoons. It is an indicator of an older lagoon that received excess nutrients and that contains a buildup of bottom sediments composed mostly of organic materials. The excess nutrients promote the rapid growth of duckweed, thus creating an anaerobic layer. This results in the discharge of an anaerobic effluent into a receiving waterbody, which can be harmful to the aquatic life and can create strong odours.

The lagoon is located less than 30 m from the Mactaquac Headpond (Saint John River/Wolastoq). The only element separating the river from the lagoon is the liner and dyke made of clay material. The lagoon receives wastewater through a gravitational sanitary sewer system collecting wastewater from the campground, golf course lounge and sanitary facilities. The lagoon discharges into the Mactaquac Headpond located northwest of the Mactaquac dam via a submerged discharge pipe.

The mechanical system is composed of two mechanical surface aerators. These are original to the construction, i.e. 55 years old, and parts are difficult to obtain in a reasonable timeframe. The existing aeration system has reached the end of its service life. Therefore, an upgrade to the mechanical system is required.

The electrical system is also original. The electrical panel and wiring servicing the aerators do not meet the requirements of the most recent edition of the Canadian Standards Association (CSA) Canadian Electrical (CE) Code. The electrical components at the lagoon have reached the end of their service life. An upgrade to the electrical supply panel and wiring system is therefore required.

Based on recent sampling results, the existing lagoon seems to adequately treat the actual organic loads in terms of CBOD5; however, these are results of sampling performed at a time when some campsites were closed. In addition to CBOD5, it is recommended that the nitrification process be performed. The purpose of nitrification is to reduce the effluent's ammonia concentration since it is harmful to the aquatic life and it favours eutrophication. This would require more dissolved oxygen (DO), thus requiring more aeration.

2.6.2 Proposed Lagoon

The proposed lagoon's detailed design has not been completed. A design brief containing conceptual details can be found in the enclosed Appendix A. Based on the design brief and the CBCL Environmental Risk Assessment (ERA) in Appendix B, the following is recommended:

- Relocation of the existing lagoon further away from the head pond;
- Installation of a new lift station to move the sanitary sewerage to the new WWTP which would be located at a higher elevation;
- Installation of a UV system for disinfection since recreational activities are practised in the receiving body of water;
- The new wastewater treatment system would consist of an aerated lagoon that could accommodate future loads, provide flexibility to the operators and meet limiting criteria for BOD, TSS and ammonia removal. The aeration diffusers should be a fine bubble system to provide adequate mixing and oxygen to microorganisms;
- The proposed wastewater treatment system would be comprised of two basins built in series. The second basin would be further divided into two sections using a floating baffle;
- The preferred location for the new wastewater treatment facility is adjacent to the existing lagoon (Figure B).

A preliminary geotechnical investigation would be required to identify whether it is possible to build the new lagoon in the proposed area.

Table 2: Summary of the Proposed Modifications to the Existing WWTP

Items	Existing Lagoon	Proposed Lagoon
Lagoon Footprint	4,600 m^2	To be confirmed in the detailed design phase
Lagoon Approximate Depth	1.8 m	To be confirmed in the detailed design phase
Lagoon Approximate Volume	7,100	To be confirmed in the detailed design phase
Aeration System	Two Floating Aerators	Air diffusers and blower building
Aeration System (HP)	HP unknown	To be confirmed in the detailed design phase
UV System	no	A UV system is proposed at this stage of the study.
Lagoon Type	One Cell	Two cells (in series) are proposed at this stage of the study.
Liner Type	Clay Liner	HDPE Liner (80 mil)
Theoretical Average Daily Design Flow	305 m^3/day	340 m^3/day
Theoretical Minimum Daily Flow	235 m^3/day	260 m^3/day
Theoretical Maximum Daily Flow	710 m^3/day	785 m^3/day
Theoretical Organic Load	75 kg/day	80 kg/day

2.7 Construction Details

The proposed lagoon upgrades must be completed in a manner that allows the uninterrupted treatment of waste during the construction period. The steps and timeline would be presented in the detailed construction design. The construction sequence in Figures C and D is recommended for a seamless transition from the existing to the proposed lagoon.

Figure C: Construction Sequence – Proposed Lagoon

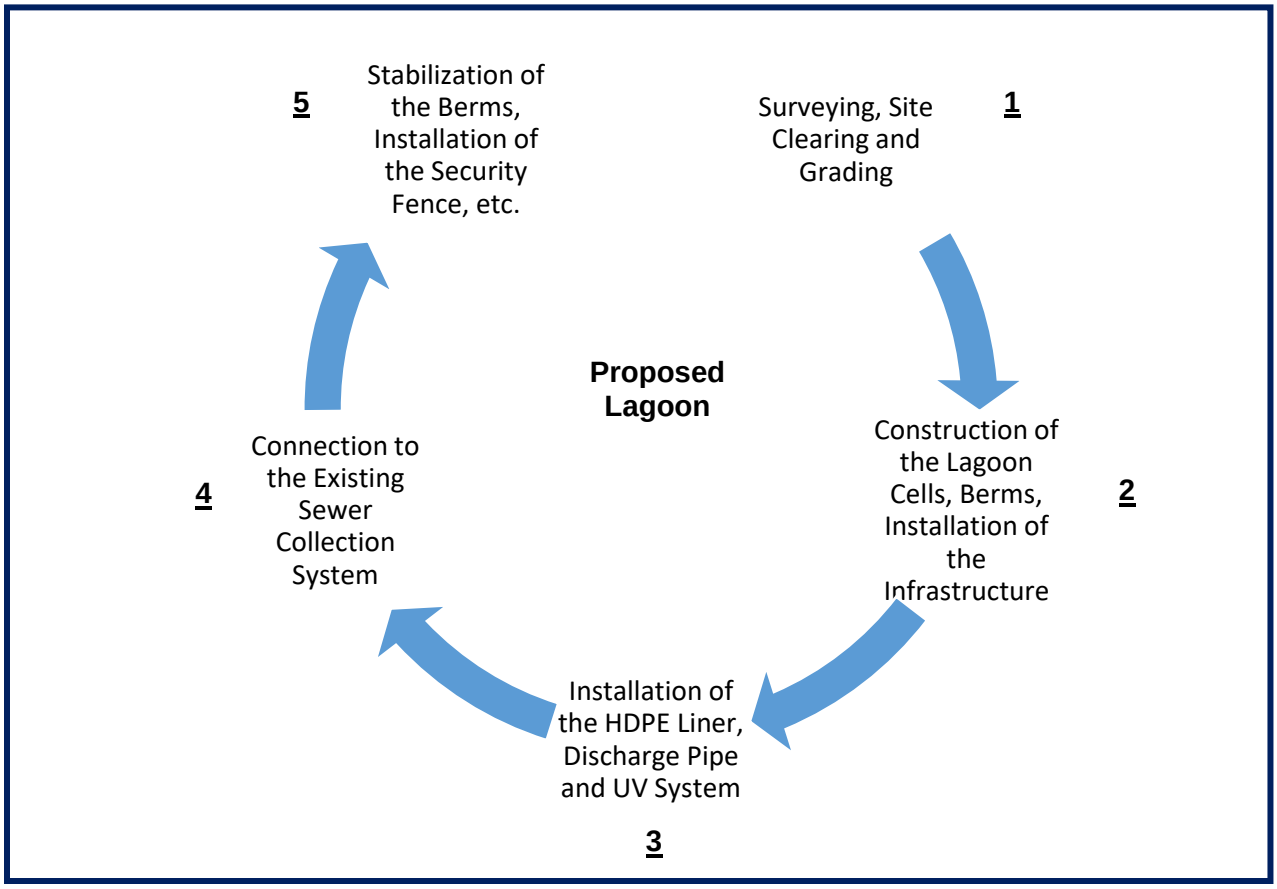


Table 3: Effluent Criteria and Point of Discharge

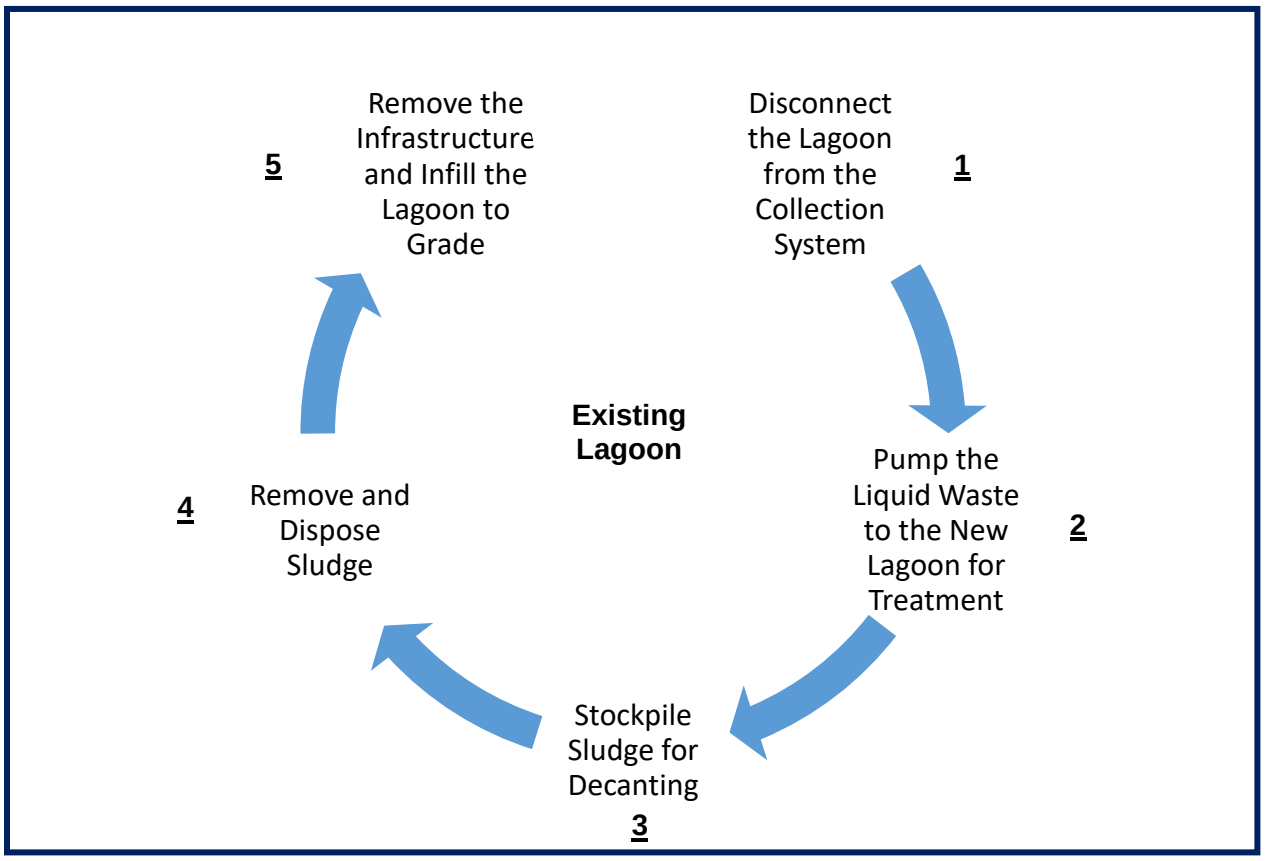
Criteria	Concentration Limit
CBOD5 (mg/l)	25
Total Suspended Solid (mg/l)	25

The exact location of the discharge pipe has not been determined; it should be completed during the detailed design and/or approval to construct application process. However, it would be submerged and buried with concrete collars to ensure it does not pose a navigation hazard. The end of pipe shall contain a diffuser to ensure sufficient mixing in the receiving water.

2.8 Operation and Maintenance Details

The lagoon would be operated by a certified operator and would comply with the requirements of the Approval to Operate issued by the New Brunswick Department of Environment and Local Government (NBDELG). The performance standards at the point of discharge are presented in the above Table 3.

Figure D: Construction Sequence – Existing Lagoon



The proposed construction activities listed herein would be subject to the requirements of a certificate of Approval from NBDELG.

2.9 Decommissioning

Decommissioning of the existing lagoon is described in Figure D.

As of the drafting of this report, the existing discharge pipe would be left in place, given the fact that it is fully submerged, would not pose a navigation hazard, would not adversely impact water quality or fish habitat by remaining in place, and would be more likely to adversely affect water quality by removing the pipe rather than leaving it in situ.

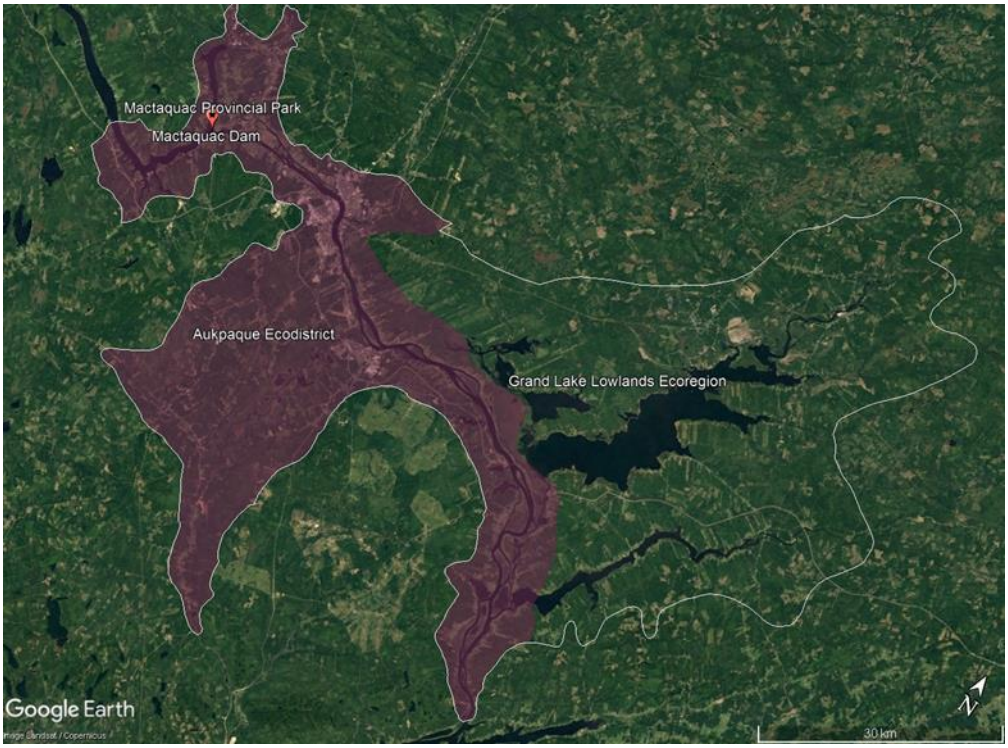
No plans for decommissioning the proposed new lagoon are considered at this time.

3 EXISTING ENVIRONMENT

3.1 Physical and Natural Features

The Mactaquac Provincial Park is in the Aukpaque Ecodistrict which is part of the Grand Lake Lowlands Ecoregion (Figure E). The Grand Lake Lowlands Ecoregion encompasses the Grand Lake watershed, the Oromocto River watershed and the floodplains surrounding Grand Lake. The region is characterized by its extensive alluvial floodplains. Most of the alluvial lowlands upstream of the dam and in proximity of the lagoon were flooded following the construction of the Mactaquac dam in 1967. The Grand Lake Lowlands climate is the warmest in New Brunswick with the longest growing season.

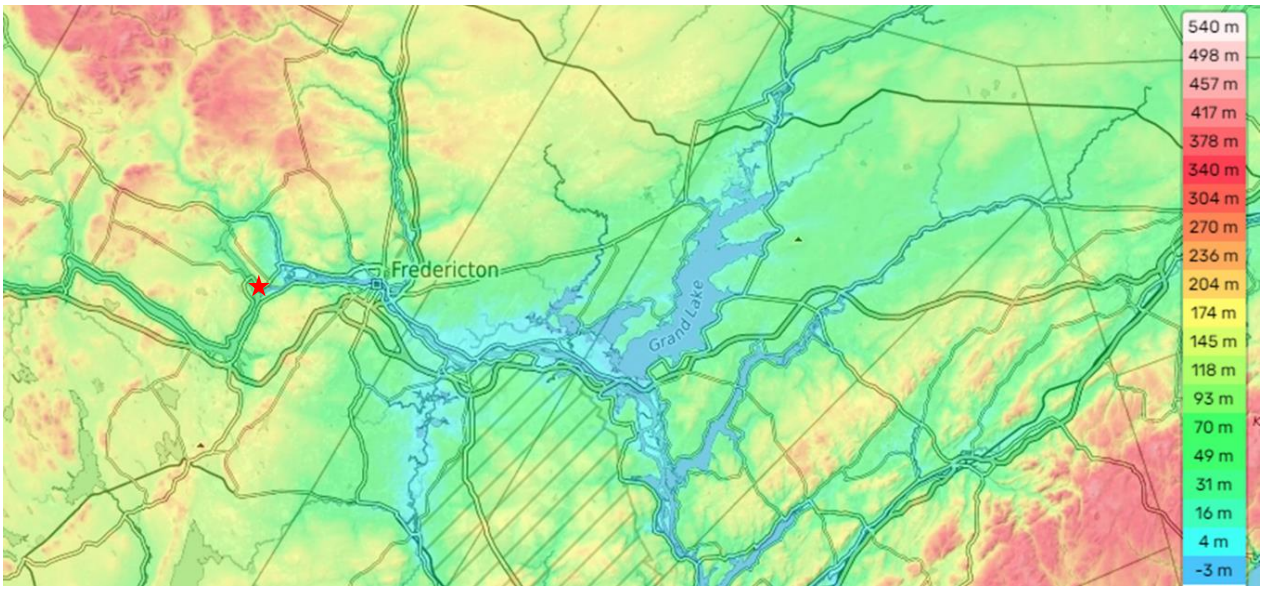
Figure E: Ecodistrict and Ecoregion of the Site



3.1.1 Topography and Drainage

The general topography of the Ecodistrict forms a low-lying trough centered on Grand Lake (Figure F). The altitude varies from around 150 m west of Fredericton to the sea level along the Lower Saint John River/Wolastoq floodplains. The wastewater treatment lagoon is at the bottom of a hill facing east with a 9% slope; therefore, surface- and groundwater are anticipated to drain east to the Mactaquac Arm.

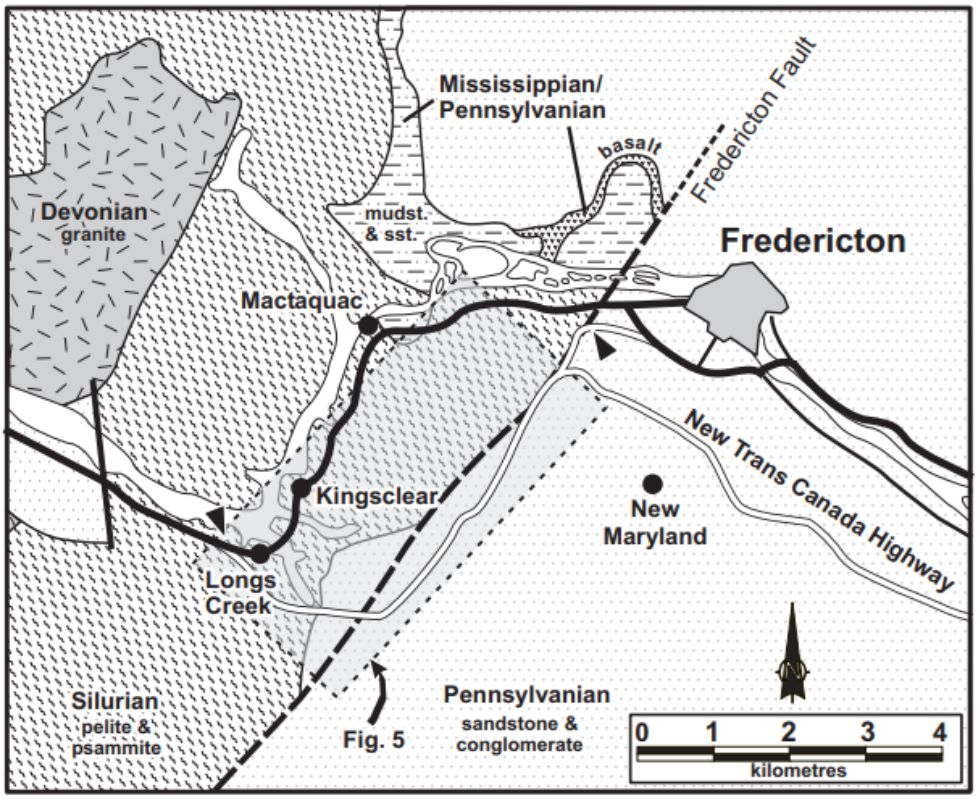
Figure F: Topography of the Aukpaque Ecodistrict



3.1.2 Geology

The underlying bedrock at the site is the Burtts Corner Formation (Figure G) which belongs to the Kingsclear Group. The beds of turbidites are formed from sedimentary rocks, medium to fine grained, dating from the Silurian. It includes gray lithic wacke interlayered with dark gray siltstone and shale. Turbidite systems have complex behaviours, sometimes acting as aquitards and, at other times, as aquifers depending on their lithology and their hydraulic features.

Figure G: Bedrock Geology of the Mactaquac Provincial Park (Source: Park and Whitehead, 2003)



The surface deposit is a ground moraine formed from a till irregularly deposited during the late Wisconsinian. Its thickness varies between 0.5 to 3 m thick. The soils formed on the first meter of the till belong to the Carleton (Cr) association (Rees *et al.*, 2005). It is dominated by Podzolic Gray Luvisols with good to imperfect drainage with a saturated hydraulic conductivity varying between 0.1 and 10 cm/hr. The texture varies from fine (sandy clay loam) to medium (loam). There is less than 20% of coarse fragments (> 2 mm). As it is the case at Mactaquac Provincial Park, the Carleton Association is often associated with the Thibault (TH) soils, another soil that has developed on parent materials derived from calcareous to weakly calcareous rock types.

The soil has a relatively deep - 50 cm or more – rooting zone with excellent nutrient and water retention capacities. The change of bulk density from 1.20 to 1.75 g/cm^3 indicates the presence of a compacted layer at a depth of 50 cm. The available water holding capacity (AWHC) varies between 15 and 25%. These soils can support a wide range of plant species due to a good fertility.

3.1.3 Surface Water

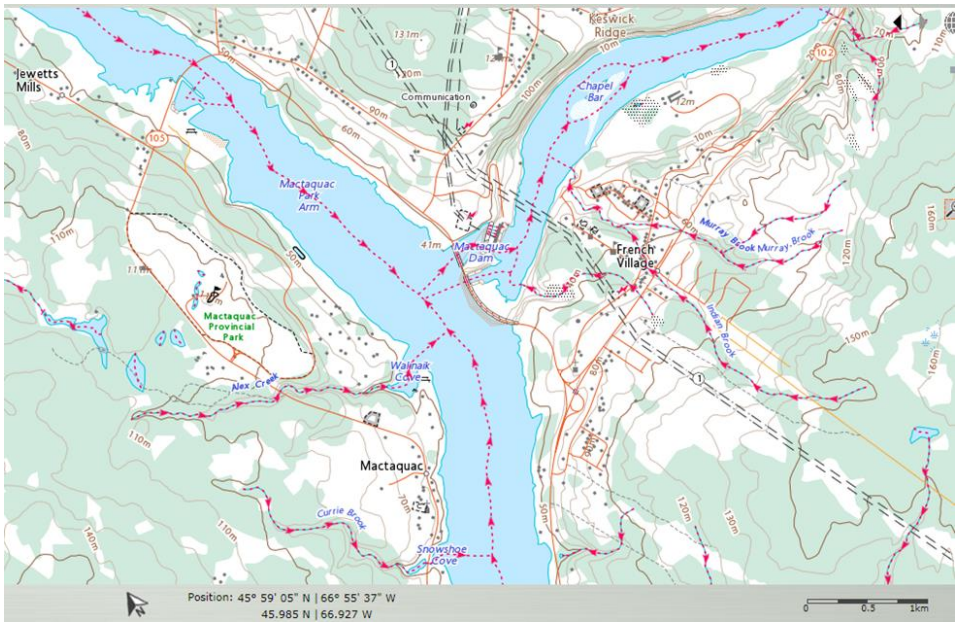
The outfall of the lagoon discharges the effluent in the Mactaquac Arm of the headpond, which is the nearest major waterbody to the project (Figure H). A small unnamed tributary is located immediately northwest of the existing lagoon. There is a small ditch located immediately to its southeast. There are no designated surface water supply watersheds within proximity of the proposed project.

The Saint John River/Wolastoq watershed covers an area of 55,110 km^2. Its overall elevation range is 820 m from its highest point to the sea level. The average elevation of the Mactaquac Headpond stands at 40 m. The average discharge of the Saint John River/Wolastoq is 1,110 m^3/s. The flow is at its minimum in autumn and at its highest during the spring snowmelt at 6,800 m^3/s. The average precipitation in the watershed is 1,218 mm per year, 30% as snow and the remaining 70% as rain.

The Mactaquac hydroelectric dam, approximately 1.2 km east of the subject site, is 18 km upstream of Fredericton, New Brunswick. The reservoir created by the dam – Mactaquac Lake or headpond – is 97 km long with a maximum usable storage of 455,000,000 m^3.

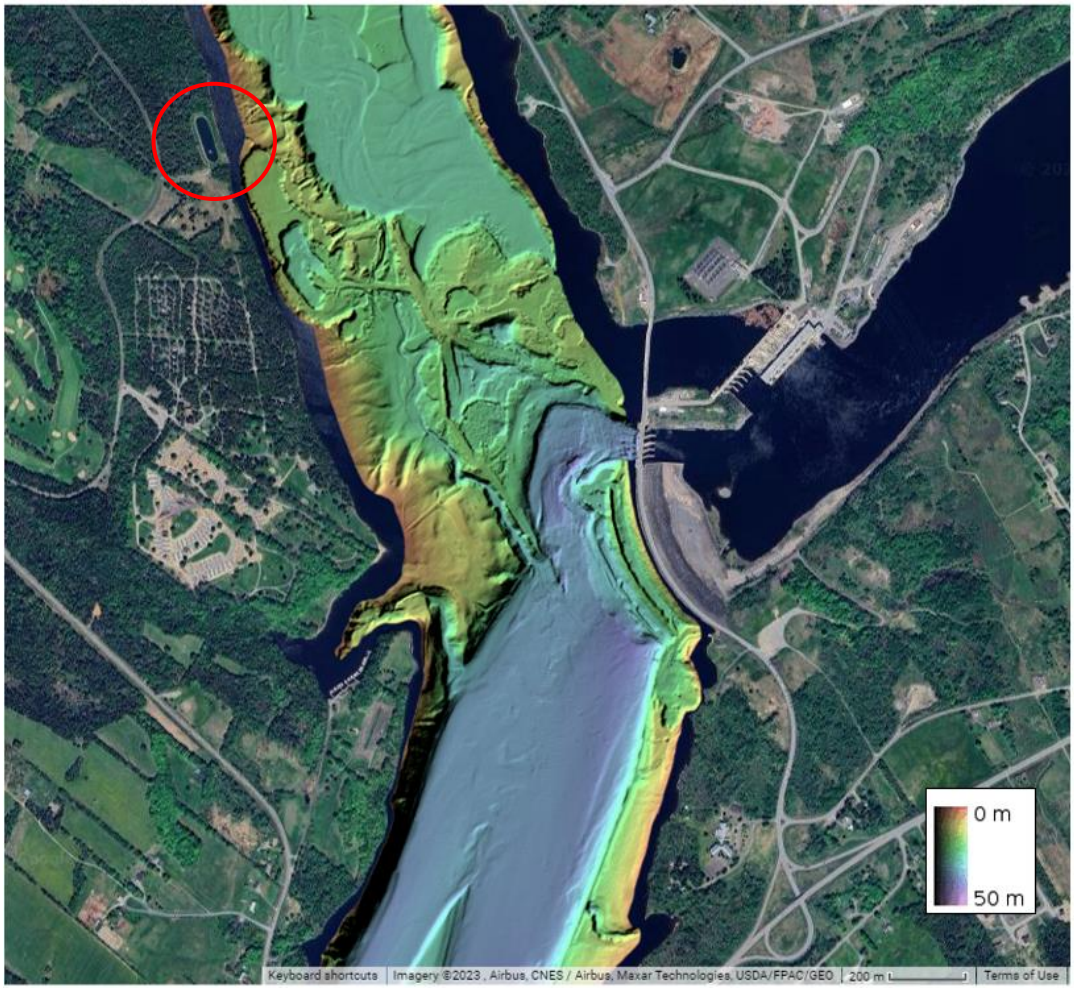
The discharge flow at the dam varies from its lowest in late summer of about 400 m^3/s to a maximum of 2,500 m^3/s in April. It has a dimictic regime since it has a summer and winter stratification under the ice, the mixing of the layers happening only during spring and fall. An NB Power press release dated July 18, 2023, confirms that the NB Power Corporation is planning to refurbish the Mactaquac Dam; as such, no significant alteration of water levels or flows in the headpond is anticipated in the foreseeable future as a result of NB Power's operation of the dam.

Figure H: Drainage in the Hydrographic Network in the Vicinity of the Mactaquac Dam (Source: Toporama)



The depth of the reservoir is shallower in the Mactaquac Arm than the rest of the reservoir (Figure I). At its deepest, the Mactaquac Arm is approximately 20 m while the reservoir on the Saint John River/Wolastoq is 35 m.

Figure I: Bathymetry of the Mactaquac Dam Impoundment



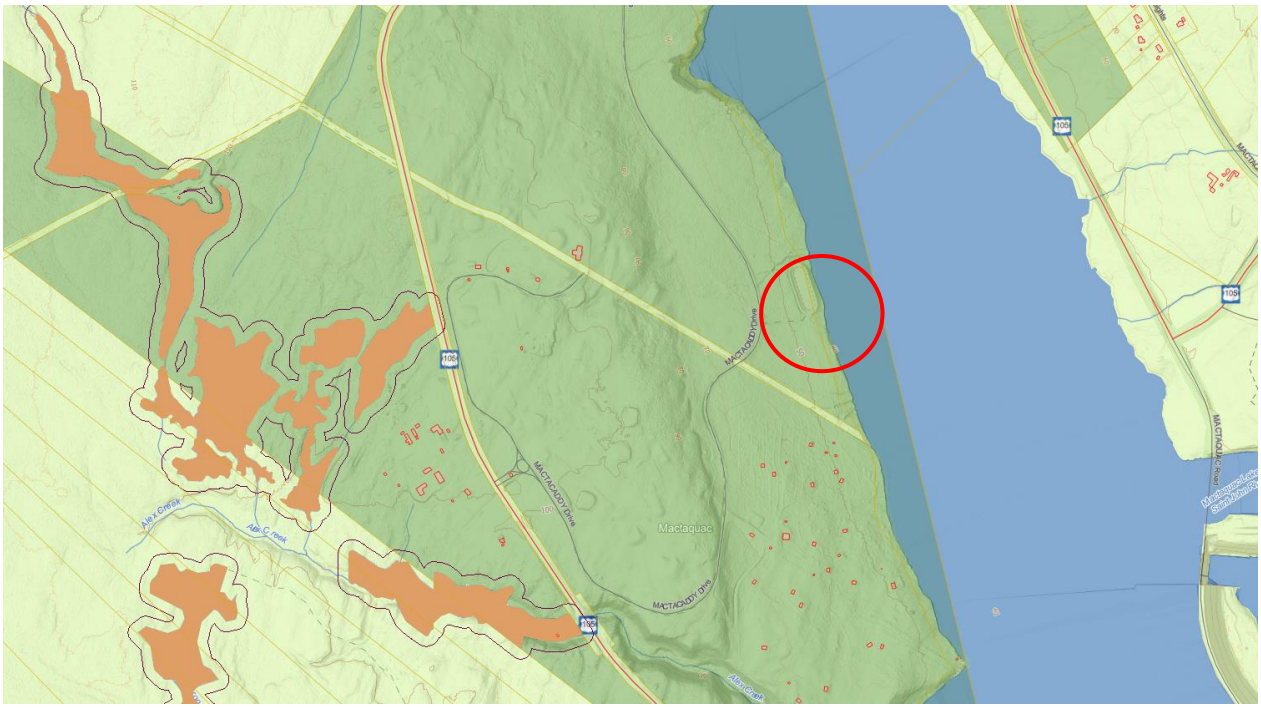
3.1.4 Groundwater

There are no designated wellfield protected areas nor habitation in the vicinity of the lagoon. The nearest domestic potable well is over 1 km away to the west. At the subject site, the saturated hydraulic conductivity of the soil, which varies between 0.1 and 10 cm/hr, means that transfer of contaminants to the receiving water, i.e. the headpond, may occur if the existing lagoon is leaking, although this has not been assessed to date.

3.1.5 Wetlands

There are no mapped or unmapped wetlands in proximity of the wastewater treatment lagoon (Figure J). The closest wetlands are located approximately 1 km to the west of the subject site.

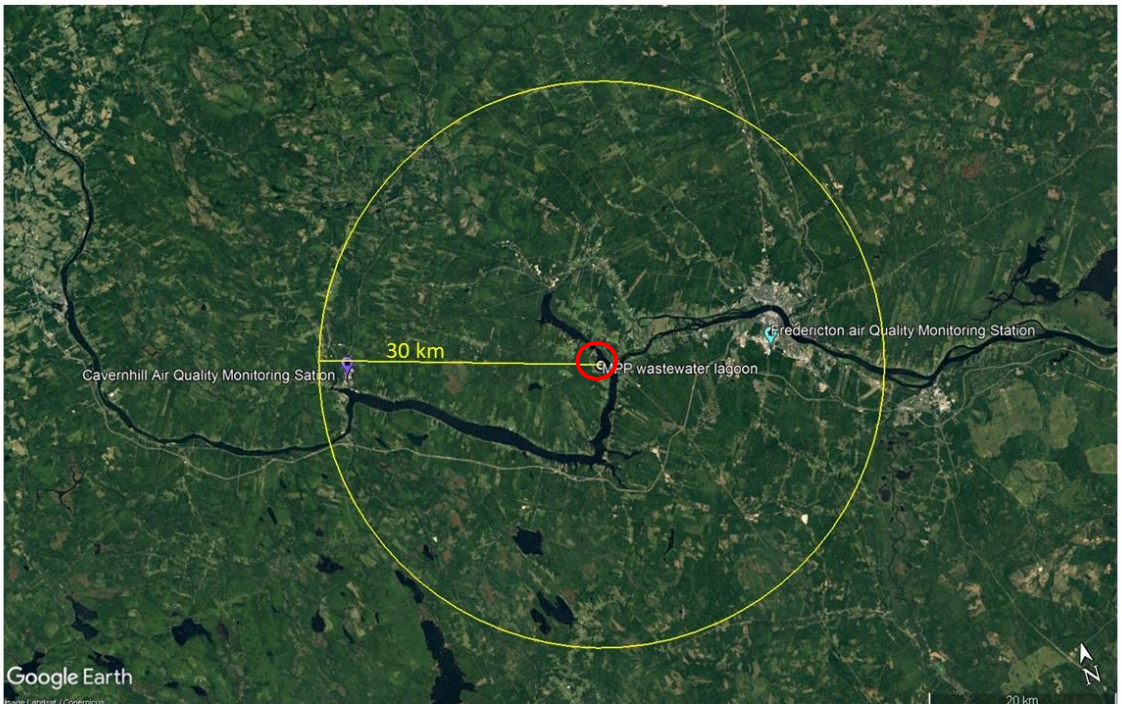
Figure J: GeoNB's Wetland Layer for the Mactaquac Provincial Park



3.1.6 Atmospheric

Atmospheric conditions, or air quality, refer to the existing ambient air conditions in proximity to the proposed project. This includes common air pollution, greenhouse gas (GHG) emissions, odours and noise. The subject site is located within the central air zone of New Brunswick which includes the two largest population centres, i.e. Fredericton and. It also contains industrial emitters, the closest one being the AV Group pulp mill in Nackawic, New Brunswick. The site is 19 km from the air quality monitoring station in Fredericton and 27 km from the AV Nackawic pulp mill and Caverhill Road air quality monitoring station (Figure K).

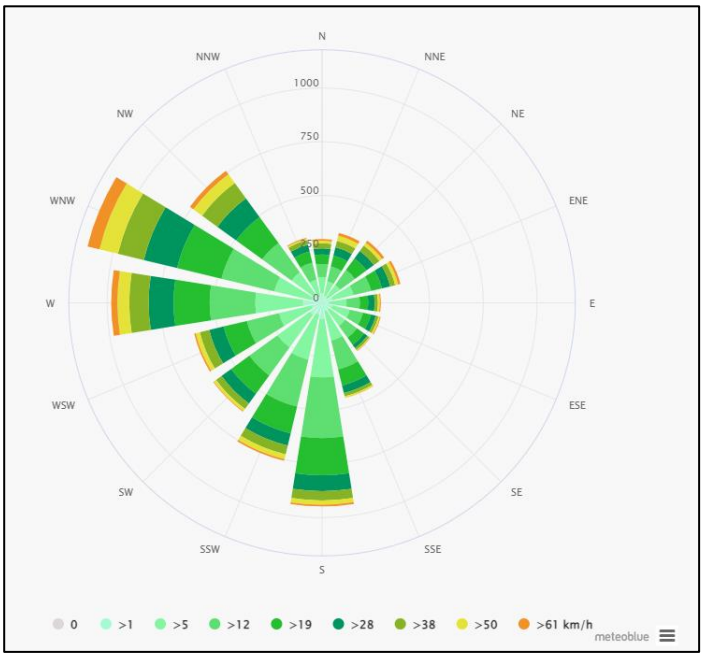
Figure K: Air Quality Monitoring Stations Closest to the Wastewater Lagoon



The dominant winds at the site are from the West (Figure L). Therefore, the air quality of the Mactaquac Provincial Park is more likely to be affected by the pulp mill. According to the latest air monitoring quality report, the concentration of fine particulate matter at the Nackawic station has an annual average concentration of 5.3 ug/m^3. Other parameters measured are at concentrations presenting no air quality issues.

Wastewater treatment lagoons may be a source of odour nuisance associated mostly with hydrogen sulphide (H_2S), ammonia (NH_3) and volatile organic compounds. Even considering the dominant winds, air impacts from the proposed project are not anticipated as the closest residential receptors are at a distance of more than 1 km from the subject site.

Figure L: Wind Rose for Mactaquac Provincial Park Based on 30 Years of Data (Units are hours/year from the indicated direction.)



3.1.7 Climate Change

According to the business-as-usual scenario RCP 8.5 (high level of GHG emissions), the region of Fredericton should experience higher precipitations, higher average temperature and longer frost-free seasons (Table 4). A recent model (Budhathoki *et al.* 2021) predicts that from 2041 to 2100, higher winter discharge would occur while summer flows should decrease compared to the baseline (1991-2020).

By 2071, following the Koppen Geiger climate classification, New Brunswick would have transitioned from *Warm-summer humid continental climate* to a *Hot-summer humid continental climate* (Beck *et al*. 2018). This means that at least one month per year would experience an average above 22 °C. Recent projections of the impacts of the climate change on key species of the Saint John River/Wolastoq forecast that the conditions would become increasingly too warm for the Atlantic salmon (*Salmo salar*) while favourizing the Striped Bass (*Morone saxatilis*) (Dugdale *et al.* 2018). Climate change has already significantly increased the acidification, temperature and deoxygenation of freshwater and marine ecosystems. In eutrophic waters, this might increase the occurrences of toxic algal blooms as the conditions would be more favourable to primary production.

Table 4: RCP 8.5 High Carbon Climate Future for the Region of Fredericton (Climate Atlas of Canada, 2019)

RCP 8.5: High Carbon climate future

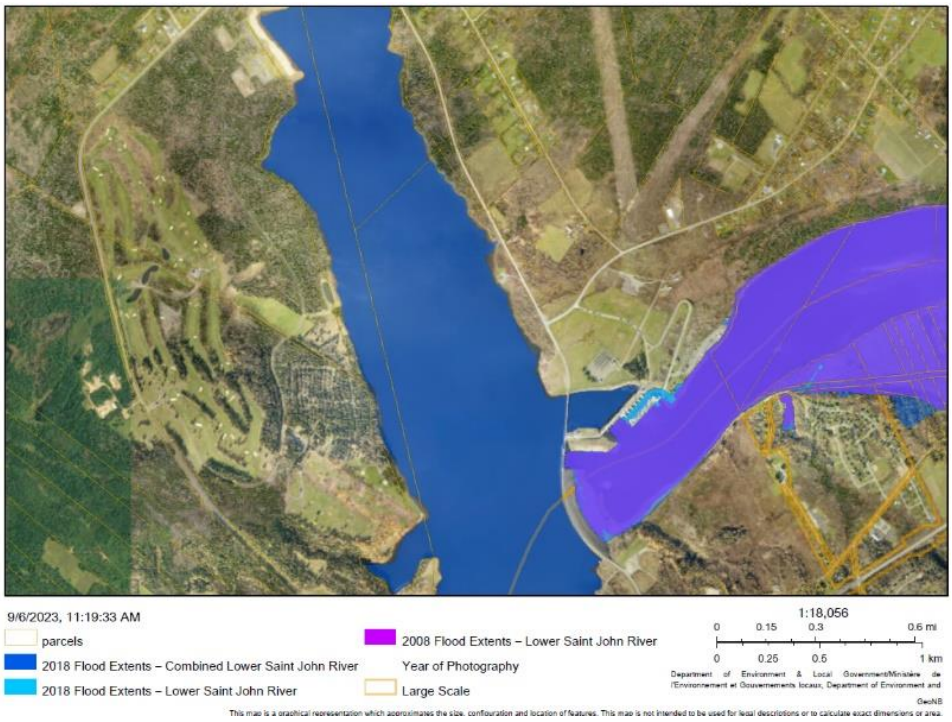
GHG emissions continue to increase at current rates

Variable	Period	1976-2005	2021-2050			2051-2080		
		Mean	Low	Mean	High	Low	Mean	High
Precipitation (mm)	annual	1160	1042	1231	1430	1083	1286	1516
Precipitation (mm)	spring	280	212	301	403	221	320	427
Precipitation (mm)	summer	261	189	275	369	183	279	390
Precipitation (mm)	fall	314	218	323	440	225	332	453
Precipitation (mm)	winter	305	235	332	431	250	354	476
Mean Temperature (°C)	annual	5.7	6.6	7.7	8.9	8.5	9.8	11.3
Mean Temperature (°C)	spring	4.2	4.2	6	8	5.9	7.9	10.1
Mean Temperature (°C)	summer	17.2	17.9	19.2	20.5	19.5	21.3	23.1
Mean Temperature (°C)	fall	7.8	8.4	9.9	11.4	10.2	11.9	13.5
Mean Temperature (°C)	winter	-6.9	-6.9	-4.6	-2.2	-4.5	-2.1	0.1
Tropical Nights	annual	0	0	2	4	2	9	21
Very hot days (+30°C)	annual	4	4	12	21	12	28	47
Very cold days (-30°C)	annual	1	0	0	1	0	0	0
Date of Last Spring Frost	annual	May 7	April 14	April 28	May 10	April 1	April 17	May 2
Date of First Fall Frost	annual	Oct. 4	Oct. 3	Oct. 18	Nov. 1	Oct. 15	Oct. 29	Nov. 14
Frost-Free Season (days)	annual	147	149	170	194	169	192	218

Because the height of the water in the impoundment is regulated by the dam, the risk of the lagoon site being flooded is virtually non-existent (Figure M).

Based on the available information and the project design, the environmental effects of climate change are not anticipated to adversely impact the proposed project.

Figure M: GeoNB Flood Mapping for Subject Site



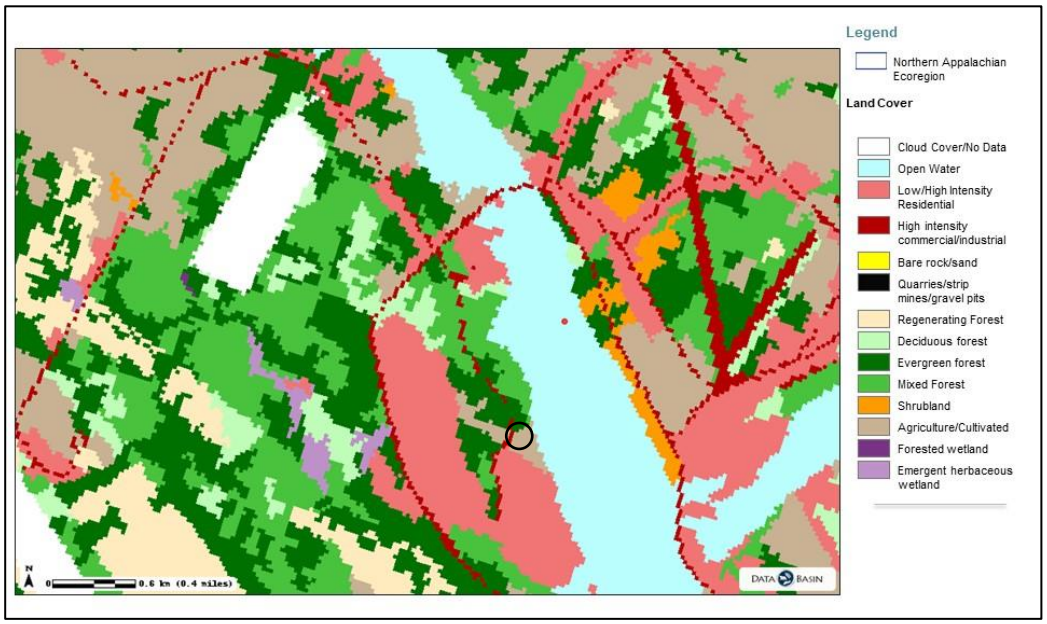
3.1.8 Flora

The site is located in the Acadian Temperate Forest zone. The most prevalent tree species in this zone are Balsam fir (*Abies balsamea*), red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), yellow birch (*Betula alleghaniensis*), red spruce (*Picea rubens*), sugar maple (*Acer saccharum*) and white spruce (*Picea glauca).* Eastern white pine (*Pinus strobus*), Eastern hemlock (*Tsuga canadensis*) and American beech (*Fagus grandifolia*) are common canopy associates or dominants in the southern part of the range and at low elevations in the north.

Three types of land cover (Figure N) surround the lagoon: mixed forest, evergreen forest and agriculture (abandoned pastures) with 85 species of plants identified. Tree species observed on site included red maple, Eastern white cedar, trembling aspen, white spruce, black spruce, Eastern hemlock, Balsam fir and yellow birch. Common shrub species, including speckled alder (*Alnus incana*), common serviceberry (*Amalanchier arborea*) and chokecherry (*Prunus virginiana*) were dominant on site; herbs included common species such as fireweed (*Chamerion angustifolium*), common buttercup (*Ranunculus acris*), Solidago spp., field horsetail (*Equisetum arvense*) and red raspberry (*Rubus idaeus*). No black ash was observed on site during the survey.

The complete vegetation survey report is provided in Appendix D.

Figure N: Land Cover in the Vicinity of the Mactaquac Wastewater Treatment Lagoon (Black Circle)

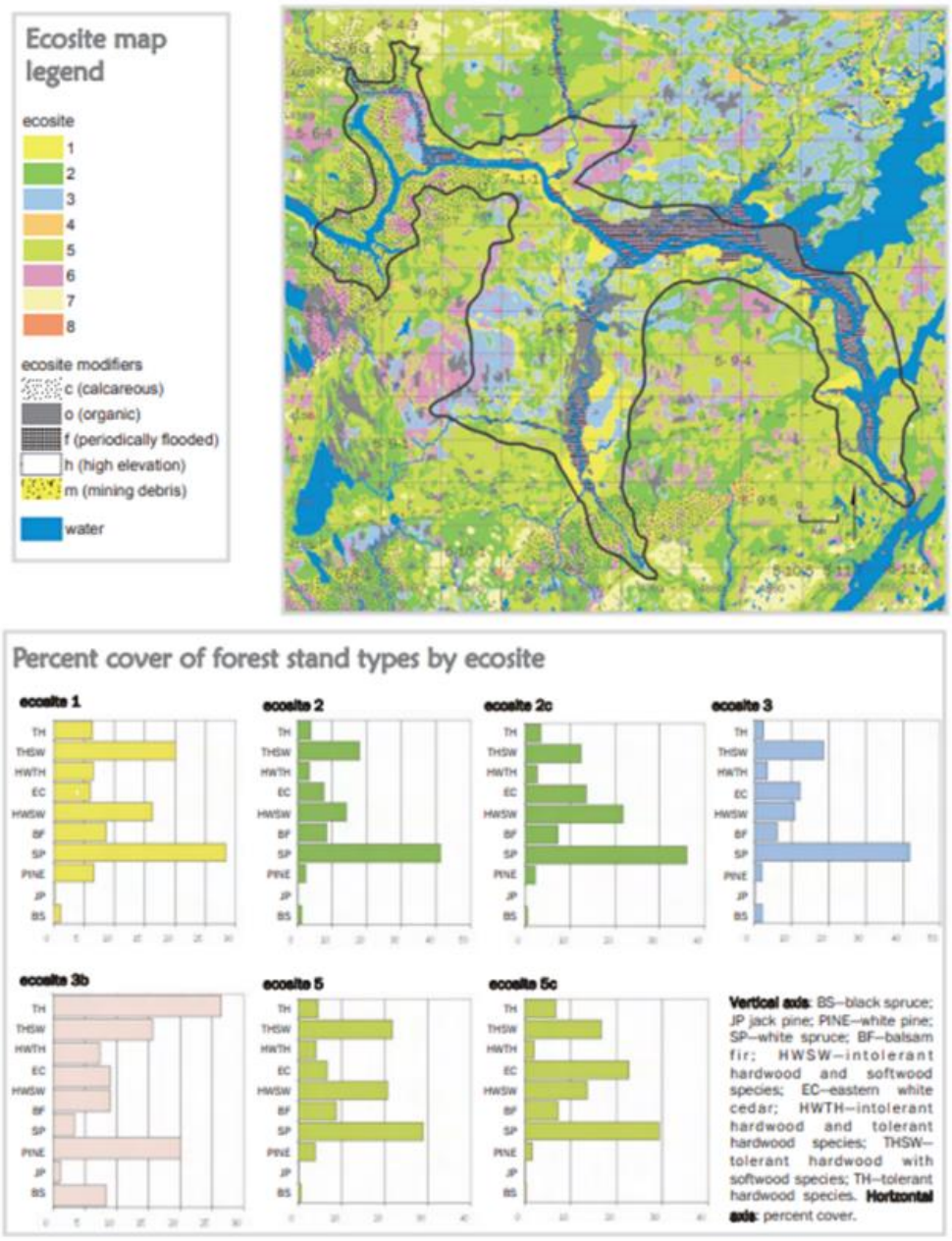


3.1.9 Terrestrial Wildlife

According to Forbes *et al*. (2010), 38 species of mammals are commonly found in the Saint John River/Wolastoq Valley. The mammals inhabiting the area, like the beaver (*Castor canadensis*), otter (*Lontra canadensis*) and moose (*Alces alces*) are common throughout eastern Canada.

No terrestrial wildlife nor evidence of wildlife was observed within the subject area during site visits.

Figure O: Forest Stand Types by Ecosite (Zelazny, 2007)



3.1.10 Migratory Birds

At present, the Avibase checklist for the Mactaquac Provincial Park contains 136 species in total, i.e. 132 natives, one introduced and three accidentals.

Migratory birds are an important consideration in any project. Environment and Climate Change Canada (ECCC) regulates the protection of migratory birds through the *Migratory Birds*

Convention Act (MBCA) which protects migratory birds, their eggs, nests and young through the *Migratory Birds Regulations* (MBR).

Under Section 5 of the Migratory Birds Regulations (MBR), no person shall disturb, destroy or take a nest or egg of a migratory bird; or to be in possession of a live migratory bird, or its carcass, skin, nest or egg, except under authority of a permit. It is important to note that under the current MBR, no permits can be issued for the incidental take of migratory birds caused by development projects or other economic activities. Furthermore, Section 5.1 of the MBCA describes prohibitions related to deposit of substances harmful to migratory birds.

> *"5.1 (1) No person or vessel shall deposit a substance that is harmful to migratory birds, or permit such a substance to be deposited, in waters or an area frequented by migratory birds or in a place from which the substance may enter such waters or such an area.*
>
> *(2) No person or vessel shall deposit a substance or permit a substance to be deposited in any place if the substance, in combination with one or more substances, results in a substance — in waters or an area frequented by migratory birds or in a place from which it may enter such waters or such an area — that is harmful to migratory birds."*

Migratory birds protected by the MBCA include all seabirds except cormorants and pelicans, all waterfowl, all shorebirds and most land birds, i.e. birds with principally terrestrial life cycles. Most of these birds are specifically named in the Environment Canada publication titled *Birds Protected in Canada under the Migratory Birds Convention Act*, Canadian Wildlife Service's Occasional Paper No. 1.

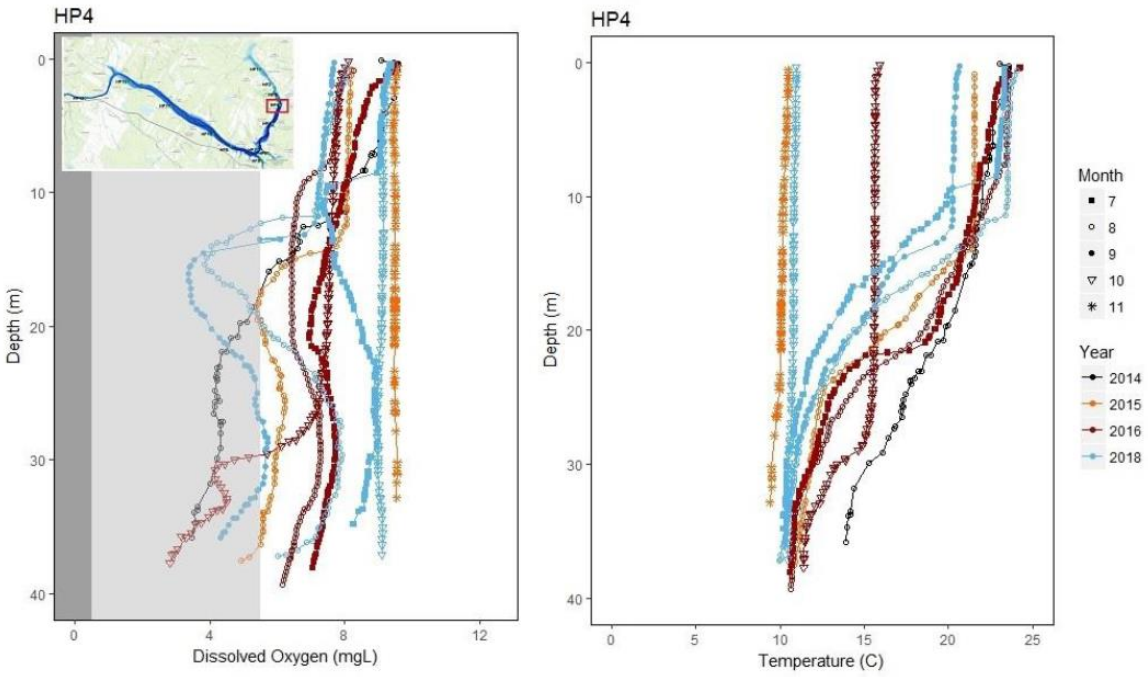
The subject site contains suitable foraging, nesting and migration staging habitat for waterfowl species, songbirds and other migratory birds protected under the MBR. Species observed on site, per Avibase, include Osprey (*Pandion haliaetus*), American crow (*Corvus brachyrhynchos*), Mallard (*Anas platyrhynchos*), Canada goose (*Branta canadensis*) and various songbird species. Notable migrators include wood duck (*Aix sponsa*), green-winged teal (*Anas carolinensis*) and cedar waxwing (*Bombycilla cedrorum*).

According to the Birds Canada Nesting Calendar Query Tool, most bird species in the region of the proposed project nest between April 15th and September 1st.

3.1.11 Aquatic Wildlife and Habitat

The Saint John River/Wolastoq Watershed water quality has been impacted by human activities that slow the flow of water, augment nutrients causing eutrophication and increase the concentration of toxic chemicals in water and sediments. Water impoundment reduces the level of oxygen below the threshold necessary for sensitive species of Salmonidae; the dissolved oxygen measured in the headpond between 2014 and 2019 (Dolson-Edge *et al*. 2019) and presented on the Figure P is comparable to the concentration of 7 mg/L^{-1} reported for 1969 by Ruggles and Watt.

Figure P: Dissolved Oxygen (DO) and Temperature Collected in the Mactaquac Headpond in Proximity of the Wastewater Lagoon Treatment
In the DO Profile, the Dark Grey Shading Stands for the Anoxic Zone (<1 mg/L) and the Light Grey Shading Represents the Hypoxic Zone (<5.5 mg/L which is the Critical Threshold for Aquatic Life, CCME 2007) (Source: Ruggles *et al.* 2019)



Phosphorus is the main cause of eutrophication in freshwater bodies as it controls primary production. The criteria proposed by the Canadian River Institute (CRI) (2011) to avoid algal blooms in the Saint John River/Wolastoq is a maximum concentration of total phosphorus of 8 mg/m^3.

Fish community sampling was undertaken for the Mactaquac Aquatic Ecosystem Study (MAES) in 2016 and 2017. The objective was to describe the fish community structure in the headpond. The species of fish reported are those which can thrive with low levels of oxygenation (Table 5). A fish habitat survey of the receiving water was undertaken in August 2023. The results are in the enclosed Appendix E.

Table 5: Fish Species Observed in the Mactaquac Reservoir in 2016 and 2017

Common Names	Scientific Names	2016	2017
American Eel	*Anguilla rostrata*		X
Banded Killifish	*Fundulus diaphanus*	X	X
Blacknose Dace	*Rhinichthys atratulus*		X
Brown Bullhead	*Ameiurus nebulosus*	X	X
Chain Pickerel	*Esox niger*	X	X
Common Shiner	*Luxilus cornutus*	X	X
Fallfish	*Semotilus corporalis*	X	X
Golden Shiner	*Notemigonus crysoleucas*	X	X
Largemouth Bass	*Micropterus salmoides*		X
Pumpkinseed Sunfish	*Lepomis gibbosus*	X	X
Smallmouth Bass	*Micropterus dolomieui*	X	X
White Perch	*Morone americana*	X	X
White Sucker	*Catostomus commersoni*	X	X
Yellow Perch	*Perca flavescens*	X	X

Roy Consultants completed a fish and fish habitat survey of the downstream receiving water (theoretical mixing zone) in 2023. The enclosed Appendix E provides more information.

3.1.12 Managed and Environmentally Significant Areas

According to the Nature NB Environmentally Significant Areas (ESA) database, two managed areas and two ESAs are within a 5 km radius of the subject site.

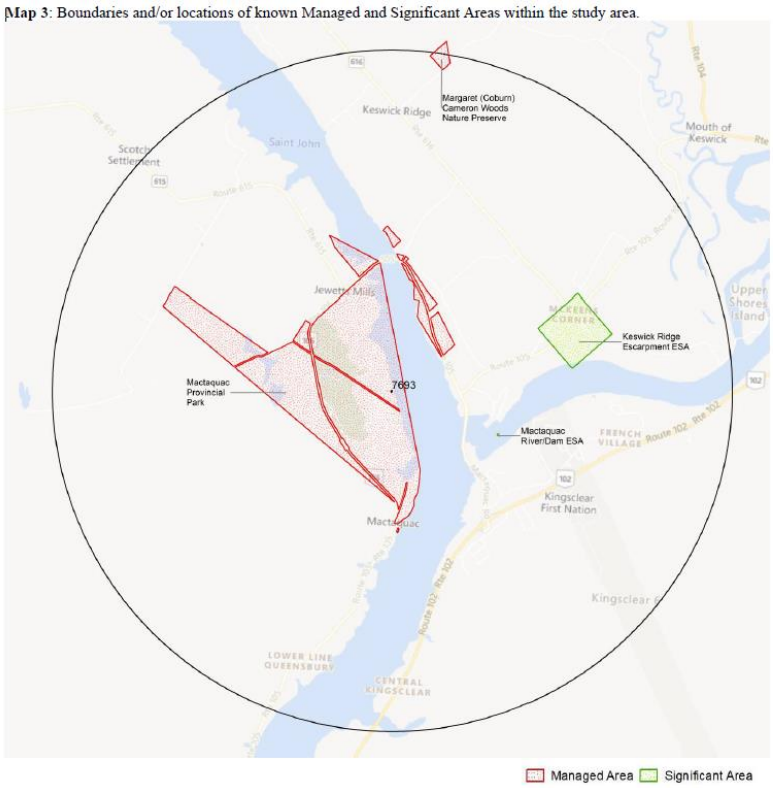
- **"ESA No. 582 – Keswick Ridge Escarpment**: It is a river valley ecosystem on the north shore of the Saint John River just west of Fredericton, including a beach, an exposed ledge and mature mixed-wood slope up to the crest of the valley. The western beach contains a diversity of micro-habitats due to flooding, erosion and ice scour disturbance. The steep slope above the western beach is stable containing mostly mature softwood forest, including an impressive stand of hemlock. The exposed ledge on the eastern shore is slightly calcareous and it contains numerous cracks and small ledges that encourage plant colonization. This area supports one of the richest concentration in the province of rare and uncommon plant species. Some of these are typical of calcareous ledges and escarpments, while others are restricted in their distribution to this part of the Saint John River Valley.
- **ESA No. 583 – Mactaquac River/Dam**: This area consists of the water and shore of the Saint John River extending approximately 1 km below the dam. This location provides winter habitat and excellent bird watching opportunities for numerous waterfowl species; in addition, osprey and bald eagle congregate here in significant numbers, especially during late fall. One pair of bald eagle nests on the islands below the dam. All birds are attracted to the area to feed on the abundance of stunned and injured fish which pass through the gates of the dam.
- **Margaret Coburn Cameron Wood Nature Preserve**: This preserve is one of the few remaining areas in Keswick Ridge supporting Appalachian hardwood forests. The mixed forest is dominated by sugar maple, yellow birch, white ash, ironwood, American basswood, American beech, Eastern hemlock, balsam fir and Eastern white cedars. Several

endangered butternut trees (*Juglans cinerea*) are present. The preserve also provides habitats to understory plants like the American lopseed (*Phryma leptostachya*) and the round-lobed hepatica (*Hepatica americana*).

- **Mactaquac Provincial Park**: This park of 525 ha is mostly recognized for hosting 130 species of birds. All nine species of flycatchers in Atlantic Canada use the park as breeding ground. Also, the headpond is a halt for migrating waterfowl species on their way to northern breeding areas" (Nature NB, 2016).

Due to the scale and location of the proposed project in relation to the above-noted ESAs, no adverse interaction with this valued environmental component (VEC) is anticipated as a result of the project.

Figure Q: Environmentally Significant and Managed Areas



3.1.13 Species at Risk

The proponent is aware that the *Species at Risk Act* (SARA) General Prohibitions apply to this project. In applying the general prohibitions, the proponent, staff and contractors are aware that no person shall:

- kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species;

- possess, collect, buy, sell or trade an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species, or any part or derivative;
- damage or destroy the residence of one or more individuals that is listed as an endangered species or a threatened species, or that is listed as an extirpated species.

In the case of the proposed project, the general prohibitions apply automatically to migratory birds protected under the MBCA anywhere they occur. The proponent is also aware that Section 33 of SARA prohibits damaging or destroying the residence of a listed threatened, endangered, or extirpated species. For migratory bird species at risk (SAR), this prohibition immediately applies on all lands or waters (federal, provincial, territorial, and private) in which the species occurs.

A review of available Species at Risk (SAR) data was conducted for the subject site, including data obtained from the Atlantic Canada Conservation Data Centre (ACCDC). These species' habitat requirements were compared with the subject site and adjoining properties' characteristics.

ACCDC identified 10 SAR birds, one SAR mammal, two fishes, three invertebrates and five plants reported within 5 km of the proposed project (Table 6). The status of the species protected by the provincial SARA is also indicated.

Table 6: ACCDC Report: Species at Risk Occurrences Within 5 km of the Subject Site

Scientific Names	Common Names	COSEWIC*	SARA	Provincial Legal Protection	Provincial Rarity Rank
Birds					
Sturnella magna	Eastern Meadowlark	Threatened	Threatened	Critically imperiled	S1B
Hirundo rustica	Barn Swallow	Special Concern	Threatened	Threatened	S2B
Hylocychla mustelina	Wood Thrush	Threatened	Threatened	Threatened	S1S2B
Riparia riparia	Bank Swallow	Threatened	Threatened		S2B
Bucephala islandica	Barrow's Goldeneye	Special Concern	Special Concern	Special Concern	S2S3N, S3M
Contopus virens	Eastern Wood Pewee	Special Concern	Special Concern	Special Concern	S3B
Chordeiles minor	Common Nighthawk	Special Concern	Special Concern	Special Concern	S3B, S4M
Chaetura pelagica	Chimney Swift	Threatened	Threatened	Threatened	S2S3B, S2M
Dolichonyx oryzivorus	Bobolink	Special Concern	Threatened	Threatened	S3B
Cardellina canadensis	Canada Warbler	Special Concern	Threatened	Threatened	S3S4B

Fishes					
Salmo salar pop. 7	Atlantic Salmon - Outer Bay of Fundy population	Endangered		Endangered	SNR
Acipenser brevirostrum	Shortnose Sturgeon	Special Concern	Special Concern	Special Concern	S3
Invertebrates					
Danaus plexippus	Monarch Butterfly	Endangered	Special Concern	Special Concern	S2S3?B
Lampsilis cariosa	Yellow Lampmussel	Special Concern	Special Concern	Special Concern	S3
Mammals					
Puma concolor pop. 1	Cougar - Eastern population	Data Deficient		Endangered	SU
Plants					
Juglans cinerea	Butternut	Endangered	Endangered	Endangered	S1
Fraxinus nigra	Black Ash	Threatened			S3S4
Symphyotrichum anticostense	Anticosti Aster	Special Concern	Special Concern	Endangered	S3
Pterospora andromedea	Woodland Pinedrops			Endangered	S1
Anzia colpodes	Black-Foam Lichen	Threatened	Threatened		S1S2

*COSEWIC: Committee on the Status of Wildlife in Canada

Eastern Meadowlark (*Sturnella magna*): It has a COSEWIC and SARA status as a threatened species. At the provincial level, it is designated as critically imperiled. This small omnivorous bird is a ground-nesting grassland specialist. The last of its nesting habitat is the main factor behind its decline. The Maritime provinces are the farthest north of its distribution. The New Brunswick population is migratory and it returns to its nesting area in early April. The males arrive about two weeks prior to females.

Barn Swallow (*Hirundo rustica*): It has a COSEWIC status of special concern, as well as a SARA and provincial legal status of threatened. It is a medium-sized aerial insectivore with a deeply forked tail with long outer feathers. It breeds in every province and territory. The Barn Swallow's preferred nesting habitat is in man-made structures including barns, houses, sheds and bridges. It prefers to hunt over open spaces such as wetlands, grasslands, agricultural fields, shorelines, woodland clearings and roads. Based on this species' habitat requirements and the spatial and temporal extent of the proposed project, no adverse interaction between the project and this species is anticipated.

Wood Thrush (*Hylocichla mustelina*): It has a COSEWIC, SARA and provincial legal protection status of threatened. In Canada, the wood thrush nests mainly in second growth and mature deciduous and mixed forests, with saplings and well-developed understory layers. This species prefers large forest mosaics, but it may also nest in small forest fragments. Wintering habitat is characterized primarily by undisturbed to moderately disturbed wet primary lowland forests.

Based on this species' habitat requirements and the spatial and temporal extent of the proposed project, no adverse interaction between the project and this species is anticipated.

Bank Swallow (*Riparia riparia*): It has a COSEWIC and SARA status of threatened. The bank swallow is a small insectivorous songbird that nests by excavating burrows in eroding vertical banks in a wide variety of natural and artificial sites including riverbanks, lake and ocean bluffs, gravel pits, road cuts and stockpiles. Breeding sites are often situated near open terrestrial habitat used for aerial foraging. Large wetlands are used as communal nocturnal roost sites post-breeding, during migration and wintering. Based on this species' habitat requirements and the spatial and temporal extent of the proposed project, no adverse interaction between the project and this species is anticipated.

Chimney Swift (*Chaetura pelagica*) has COSEWIC, SARA and Provincial status of Threatened. This small aerial insectivore breeds in central and eastern Canada and the eastern United States, and winters in South America. It is assumed that Chimney Swift mainly used large hollow trees for nesting and roosting, before the arrival of Europeans in North America. Since then, with the impacts of logging, they are now mainly associated with urban and rural areas where chimneys and similar structures are available, and where aerial insects are abundant for foraging. Based on this species' habitat requirements and the spatial and temporal extent of the proposed project, no adverse interaction between the project and this species is anticipated.

Barrow's Goldeneye (*Bucephala islandica*): It has a special concern designation by COSEWIC. Under federal and provincial laws, it has a conservation status of special concern. The Barrow's goldeneye is a sea duck with three distinct populations in North America and Iceland. It breeds in Northern Quebec, and winters in the estuary and the Gulf of St. Lawrence.

Eastern Wood Pewee (*Contopus virens*): It has a COSEWIC, SARA and Provincial Legal status of special concern. It is a small forest bird which can be distinguished from similar-appearing species by its distinctive three-phased whistled song. The wood pewee breeds from southeastern Saskatchewan to the Maritime provinces, mostly associated with mid-canopy layers of forest clearings and edges of deciduous and mixed forests.

Common Nighthawk (*Chordeiles minor*): This species has a COSEWIC, SARA and provincial designation of special concern. The common nighthawk is a medium-sized grey-brown bird usually seen or heard overhead at dusk and dawn. The species has undergone significant long- and short-term declines across the portion of its range. Loss of nesting habitat is thought to be one among many causes of its decline. It nests on the ground in open land or forest clearings. A nighthawk survey was completed as part of the migratory bird survey for the proposed project because the park offers suitable habitats for nesting. The results are in Appendix C.

Bobolink (*Dolichonyx oryzivorus*): It has a COSEWIC status of special concern and a SARA and provincial status of threatened. It is a medium-sized passerine which breeds in the southern part of all Canadian provinces. Originally, it nested in the tall-grass prairie, but since the conversion of prairie to cropland, it has nested in forage crops as well as various grassland habitats including wet prairie, graminoid peatlands and abandoned fields dominated by tall grass.

Canada Warbler (*Cardellina canadensis*): It has a COSEWIC status of special concern and a SARA and provincial status of threatened. Canada warblers favour forested habitats such as conifer and deciduous forests. They nest on or near ground within areas of dense shrubs, ferns or rhododendrons. Based on this species' habitat requirements and the spatial and temporal

extent of the proposed project, no adverse interaction between the project and this species is anticipated.

Atlantic Salmon – Outer Bay of Fundy *(Salmo salar pop. 7):* Wild anadromous Atlantic salmon populations have been in decline throughout their native range over the past three decades. The Outer Bay of Fundy population is distinctive for its local migration and genotypically discrete from other regional groups of Atlantic salmon in Canada. The species needs rivers or streams that are generally clear, cool and well-oxygenated for reproduction before it migrates in the North Atlantic Ocean. The population has historically suffered from dams that have impeded spawning migrations and flooded spawning and rearing habitats, and other factors like pollution and logging.

Shortnose Sturgeon *(Acipenser brevirostrum*): The shortnose sturgeon is listed as special concern under the federal and provincial SARA. This is a large-bodied, slow-growing and late-maturing fish. In Canada, it is only found in the Saint John River/Wolastoq and estuaries. Because of its limited distribution, it is vulnerable to change in the Saint John River/Wolastoq. In the Saint John River/Wolastoq, the shortnose sturgeon is suspected to spawn within a 10 km stretch below the Mactaquac Dam. Because it is a bottom-dwelling fish consuming prey living in the sediments, it is at risk of being exposed to contaminants in both sediments and its food. Based on this species' habitat requirements and the location and nature of the proposed project, no adverse interaction between the project and this species is anticipated.

Monarch Butterfly (*Danaus plexippus*): The monarch butterfly is a migratory butterfly with a COSEWIC status of endangered and a species of special concern and provincial and federal SARA. Loss of breeding habitat due to reduced milkweed abundance associated with herbicide use is considered one of the main causes of the monarch's decline. Loss of wintering sites and climate change also contribute to the butterfly's decline. Based on this species' habitat requirements and the spatial and temporal extent of the proposed project, no adverse interaction between the project and this species is anticipated.

Yellow Lampmussel (*Lampsilis cariosa*): This freshwater mussel is predominantly a species living in medium to large rivers. The damming may have reduced the historic area of its habitat as it has not been encountered in surveys of the headpond, but more work is necessary to eliminate the possibility of populations in and upstream of the Mactaquac Headpond. According to COSEWIC, above the Mactaquac dam, the yellow lampmussel (YLM) host fish species is present, as is the mussel species used to indicate possible or likely YLM presence. There is also suitable and available YLM habitat. Nonetheless, there is no direct evidence that the yellow lampmussel was present historically in this section of the Saint John River/Wolastoq (Sabine et al. 2004). Per COSEWIC, a 2001-02 survey of the Mactaquac Headpond yielded no individuals of L. cariosa. Based on this information and the results of the fish habitat survey, no interaction between the project and this species is anticipated.

Cougar – Eastern Population (*Puma concolor ssp. cougar*): The cougar was considered endangered until 1978. After a re-examination in 1998, it was designated a Data Deficient (DD) COSEWIC status. It still has an endangered status in the Province of New Brunswick. Eastern cougars need a large undisturbed territory to survive. Their main diet is the white-tailed deer. Based on this species' habitat requirements and the spatial and temporal extent of the proposed project, no adverse interaction between the project and this species is anticipated.

Butternut (*Juglans cinerea*): According to the latest assessment by the COSEWIC, it has been listed as endangered since 2003. It is protected under the Canada and New Brunswick SARA. It

is a deciduous tree with light grey bark that can reach 25 m in height. The butternut prefers rich, moist, well-drained soils, often bordering streams. It is a light species. It grows rapidly, but it has a relatively short life expectancy, rarely exceeding 80 years. The butternut is seriously threatened by a canker caused by the fungus *Ophiognomonia clavigignenti-juglandacearum*. In some areas, 90% of butternut trees have been exterminated. Based on the results of the vegetation survey, no interaction between the project and this species is anticipated.

Black Ash (*Fraxinus nigra*): The black ash is protected under both provincial and federal SARA. The species, once abundant in the forests and towns of the American Northeast, is now considered to be critically endangered worldwide by the International Union for Conservation of Nature (IUCN). The reason for this decline is the arrival of an exotic beetle species known as the emerald ash borer, whose invasion has killed several million ash trees, devastating populations in Canada and United States. This small tree with a narrow crown is predominantly a wetland species found in swamps, floodplains and fens. No black ash trees were observed on site. Based on the results of the vegetation survey, no interaction between the project and this species is anticipated.

Anticosti Aster (*Symphyotrichum anticostense*): The herbaceous species is protected under the New Brunswick *Endangered Species Act.* It has been on Canada's *List of Wildlife Species at Risk* since as a species of concerns. Approximately 95% of the world population is found in Canada. It grows on high-flow river flats and limestone soils. Despite its ability to reproduce sexually, it favours vegetative reproduction which limits its genetic diversity and makes it more vulnerable. Based on this species' habitat requirements and the spatial and temporal extent of the proposed project, no adverse interaction between the project and this species is anticipated.

Woodland Pinedrops *(Pterospora andromedea)*: This species is protected under the New Brunswick SARA. It grows as a mycoheterotroph – dependent on fungi rather than photosynthesis for nutrients – in coniferous or mixed forests. It is a form of carbon acquisition that is parasitic on fungal organisms and epiparasitic on photosynthetic plants that are symbionts of the fungal host. Like all other Monotropoideae species, pinedrops are host specific to a certain fungus which in turn makes them specific to the photosynthetic organism associated with their fungal host. In this case, *Pterospora andromedea* requires the fungus *Rhizopogon kretzerae*. Rhizopogon species are also highly host specific and mainly associated with pines. This level of host specificity makes disruption of its mycorrhizal association a threat. Based on this species' habitat requirements and the spatial and temporal extent of the proposed project, and the results of the vegetation survey, no adverse interaction between the project and this species is anticipated.

Black-Foam Lichen (*Anzia colpodes*): This lichen has a threatened status in the federal SARA. It is believed that it is endemic to North America. It grows on mature deciduous trees growing where high humidity is supplied by nearby wetlands, lakes or streams. Based on this species' habitat requirements and the spatial and temporal extent of the proposed project, no adverse interaction between the project and this species is anticipated.

Redbreast Sunfish (*Lepomis auratus*): It is listed as Data Deficient (DD) by COSEWIC and as special concern by the federal SARA. The redbreast sunfish is a relatively small fish distinguished from other sunfish by the long, narrow, entirely black opercular flap. Its Canadian distribution is limited entirely to lakes within the southwestern Saint John River/Wolastoq drainage. It prefers slower sections of rivers and vegetated margins of lakes on a variety of substrates with abundant cover. It typically breeds during the early-mid summer months when the water temperature is between 16.7 and 27.4 ^{o}C. During the fish habitat survey, a suspected redbreast sunfish was

observed; however, it cannot be conclusively identified as the fish only appeared on video and due to the possibility of hybridization with the pumpkinseed sunfish which is prevalent in the Saint John River/Wolastoq. Per the COSEWIC Assessment and Update Status Report:

> *As noted by Houston (1989), the redbreast sunfish has occasionally been mistaken for the pumpkinseed, a source of confusion which underlines the need to be cautious in interpreting historical reports, but which also points to the possibility of redbreast sunfish as having been overlooked in some fish surveys. The occurrence of natural hybrids with pumpkinseed, a more common species in southern New Brunswick, is an additional source of difficulty in identification (COSEWIC, 2008).*

Based on its habitat requirements and the results of the fish habitat survey, no adverse interactions between the project and this species is anticipated.

3.2 Cultural Features

3.2.1 Archaeological Resources

Stone tools have been found at Marysville, New Brunswick, establishing the presence of Aboriginal people in New Brunswick for at least 11,000 years. By the time Wolastoqiyik first appeared on the Champlain map of 1604 (Figure R), they already had occupied their territory for generations and developed a lifestyle combining hunting and gathering with agriculture on the interval soils of the Saint John River/Wolastoq.

Figure R: Map of Samuel de Champlain 1612

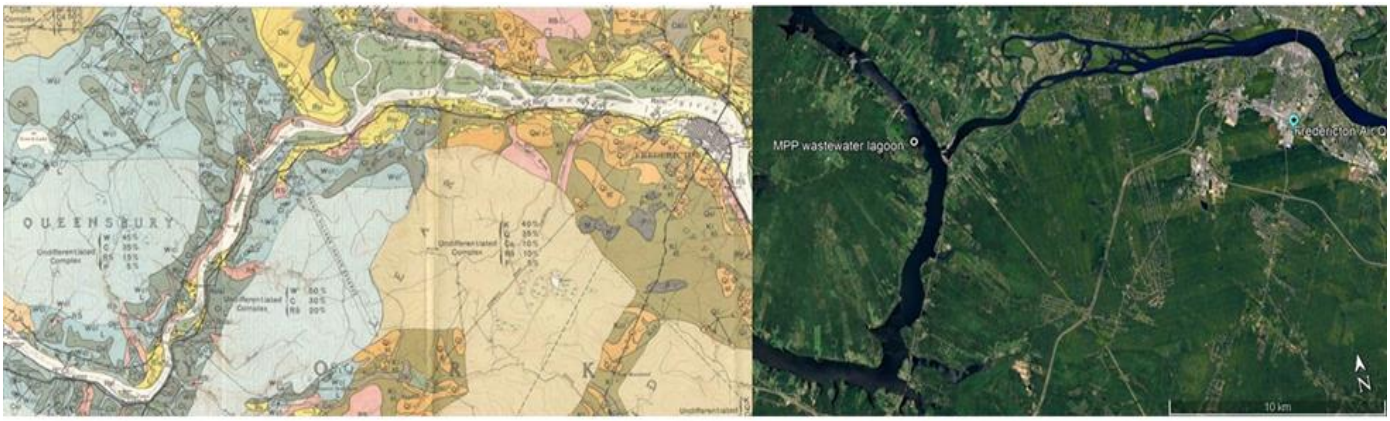
Wolastoq is known today as the Saint John River. Wolastoqiyik and Maliseet are used interchangeably among the sources reviewed. The sources show the entire Saint John River watershed as the Wolastoqiyik Traditional Territory which covered an area of 400 km from the Bay of Fundy northeast to the St. Lawrence River and approximately 300 km at its widest in the upper Saint John River. Wolastoqiyik Traditional Territory is bordered to the west by Passamaquoddy Traditional Territory along the Bay of Fundy and Gulf of Maine coast and Penobscot Traditional Territory.

While the lagoon site is within 80 m of the Mactaquac Lake, it is outside of the zone of high potential for archaeological resources due to the creation of the headpond by man-made interventions, the construction of the dam, (Figure S); the original watercourse in this area was well beyond 80 m from the subject site.

Figure S: Before and After Aerial Photos of the Subject Site (ESRI© – Before the Mactaquac Headpond)

A side-by-side comparison of a historical soil map from 1940 and a present-day aerial photograph also illustrates the extent of the flooding in the area. The Mactaquac stream enlarged to become the present-day Mactaquac Arm and many of the islands upstream of the dam are currently underwater (Figure T).

Figure T: Soil Map of 1940 (left) and Aerial Photo of 2023



In the event of a discovery of a potential archaeological resource during excavation, work in the area would be stopped immediately and an archaeological curator at the New Brunswick Department of Tourism, Heritage and Culture – Heritage and Archaeological Services (Branch) would be contacted at 506-453-3115.

3.2.1 Heritage Resources

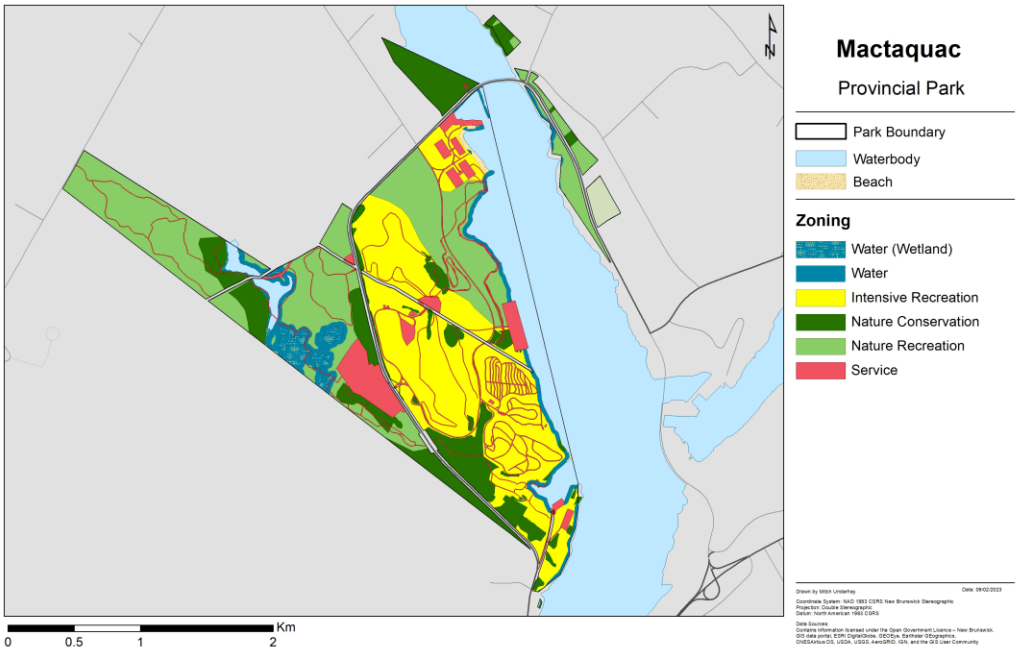
According to a search of the Canadian and New Brunswick Registers of Historic Places, there are no historically nor culturally significant resources in the vicinity of the subject site.

3.2.1 Land Use

The Park is in the Regional Service Commission 11. The lagoon site, on the Western shore of the Mactaquac Arm, is in the Bright LSD. The East shore of the park is in the Keswick Ridge LSD. In each district, the MMP is zoned as “park”. Most of the area surrounding the park is zoned as “rural”. The zoning maps enclosed in Appendix G provides more details.

The Mactaquac Provincial Park has its own zoning plan (Figure U). The subject site is in an area zoned as “service”.

Figure U: Zoning of the Mactaquac Provincial Park



4 IDENTIFICATION OF ENVIRONMENTAL IMPACTS

The environmental impact assessment methodology used herein focuses on those VECs present on site that are most likely to be impacted by the project before mitigation is implemented. VECs are selected based on a review of site information and potential project-VEC interactions. Determination of significance of these potential impacts on VECs is based on an evaluation of magnitude, reversibility, geographic extent, duration and frequency.

Based on the review of the project description and the biophysical characteristics of the environment, the following potential VECs were identified and assessed for the proposed project:

- Aquatic Wildlife and Habitat;
- Atmospheric Quality;
- Migratory Birds and SAR Birds;
- Surface Water Quality;
- Terrestrial Wildlife.

Where there is potential for a project-VEC interaction, further discussion is provided in the following sections. For issues where there is limited or no anticipated interaction, a rationale was provided in Section 3, and the issue is not discussed further in the present report. Potential project-environment interactions are presented in Table 7.

Table 7: Potential Project-Environment Interaction Matrix

Activities → / VECs ↓	Construction/ Installation of Physical Work	Operation/ Maintenance of Physical Work	Decommissioning/ Abandonment of the Physical Work	Accidents and Unplanned Events
Aquatic Wildlife and Habitat	X	X		X
Atmospheric Quality	X	X		X
Migratory/SAR Birds	X			X
Surface Water Quality	X	X		X
Terrestrial Wildlife	X			X
Invasive Species	X			
Accidents/Unplanned Events	X			X

Potential impacts and recommended mitigation are presented in Table 8.

5 INVASIVE SPECIES

5.1 Invasive Species

The construction of the proposed project would require the use of motorized light and heavy equipment, including excavators, mini-excavators, bulldozers and dump trucks. Invasive species, including terrestrial and aquatic flora species, may be transported to and from the project location by sticking to equipment. Once established, invasive species can out-compete native vegetation for resources and adversely impact an ecosystem.

The proposed project would be awarded through a tender bid process. Contractors would be required to adhere to a technical specifications package which would include mitigation measures to address the unwanted transportation of invasive flora species. The aquatic plant Eurasian Watermilfoil (*Myriphyllum spicatum*) and terrestrial plants such as Glossy Buckthorn (*Frangula alnus*) and Japanese Knotweed (*Fallopia japonica*) are already known to occur within the Mactaquac region.

Refer to Table 8 for recommended mitigation measures.

6 ACCIDENTS AND UNPLANNED EVENTS

The construction project will require the use of motorized equipment, both on land and over the water (either on the ice or a barge). Use of motorized equipment on a construction site can pose hazards to workers through workplace accidents, or to the environment through leaks and spills.

The proposed project would be awarded through a tender bid process. Contractors would be required to adhere to a technical specifications package which would include mitigation measures to address accidents and unplanned events.

Refer to Table 8 for recommended mitigation measures.

7 POTENTIAL IMPACTS, MITIGATION AND SIGNIFICANCE

The following table outlines potential impacts, recommended mitigation measures, and Significance criteria for each VEC.

Table 8: Potential Impacts, Recommended Mitigation and Significance

VALUED ENVIRONMENTAL COMPONENT	EXISTING CONDITIONS	POTENTIAL IMPACTS	RECOMMENDED MITIGATION	SIGNIFICANCE
Aquatic Wildlife and Habitat	The subject site is adjacent to the Mactaquac Headpond, a dimictic impoundment reservoir upstream of the Mactaquac hydroelectric dam.	Treated wastewater from the lagoon would continue to be discharged to the Mactaquac branch of the dam impoundment as per the present situation, which may create localized impacts to aquatic life and habitat.	1: The updates to the lagoon would enhance the treatment efficiency resulting in an improved water quality in the mixing zone and the reduction in nutrients compared to the current lagoon. 2: The proponent commissioned an ERA to establish design effluent criteria for the new treatment lagoon, to minimize impacts on water quality, aquatic habitat and wildlife. 3: The Mactaquac Provincial Park would operate the lagoon per the NBDELG approval to operate which includes requirements for regular monitoring and reporting. 4: The installation of the discharge pipe would be conducted by excavating a narrow trench in the bed of the headpond, via a barge. Small-scale equipment shall be used to minimize the size of the trench. 5: Installation of the discharge pipe would take place outside of the spawning season, namely mid-May to late August, to minimize impacts on aquatic wildlife lifecycles – particularly for the Redbreast Sunfish. 6: The discharge pipe would be fitted with a diffuser to ensure proper diffusion of waste within the receiving water and to minimize accumulation of waste within	Small magnitude, reversible, immediate, moderate-term and ongoing.

			the sediments near the end-of-pipe. 7: Vehicles and equipment would be checked for lubricant or fuel leaks and maintained in good working order. Equipment would be immediately repaired upon discovery of a leak. 8: All equipment and machinery would be operated within the manufacturer's recommended parameters. 9: Fuelling or lubrication of the equipment would not occur within 30 m of any water body or storm drains, and it must take place on a designated impervious level surface. 10: On site, crews must have on site an emergency spill clean-up equipment adequate for the activity involved. Spill equipment would include, as a minimum, at least one 250 L (i.e., 55 gal) overpack spill kit containing items to prevent a spill from spreading, i.e. absorbent booms, pillows, mats, rubber gloves and plastic disposal bags. 11: All spills or leaks must be promptly contained, cleaned up and reported to the NBDELG Fredericton Regional Office at 506-453-2690 or the 24-Hour Environmental Emergencies Report System at 1-800-565-1633.	
Atmospheric Quality	There is no residential receptor located within a distance of 1 km from the lagoon.	1: The construction of the project includes dredging and temporarily storing the lagoon sludge in situ – within the unused lagoon cell – for decanting. This would temporarily create odours which may impact nearby receptors.	1: Sludge drying on site would be seeded or covered to mitigate odours. This would be a temporary impact for the duration of construction. 2: Sludge would be removed as soon as possible to be disposed off-site at an approved disposal facility. 3: Work hours would adhere to local noise bylaws.	Small magnitude, reversible, immediate, short-term and once.

		2: Operation of motorized equipment would create localized emissions (odours, particulate and greenhouse gas emissions from internal combustion engines). 3: Operation of motorized equipment would create noise which may impact nearby receptors.	4: All equipment to be used is to be in proper working order and properly muffled. 5: Equipment shall be used for its intended use only. 6: Equipment shall not idle excessively.	
Migratory Birds	The subject site contains suitable breeding, foraging and staging habitat for migratory birds. The majority of bird species breed in this zone between April 15th and September 1st.	The construction of the project could displace or temporarily disturb migratory birds.	1: Vegetation clearing is scheduled to take place outside of the breeding bird season. 2: Removal of mature vegetation would be limited to the least amount possible to maintain nesting habitat. 3: Low herbaceous vegetation would be re-established upon completion of the project, using only native vegetation, typical of the region. 4: No materials would be stockpiled on site to prevent bank swallows from nesting in temporary stockpiles. 5: Construction activities during migration: It is anticipated that migrating waterfowl would avoid an active construction site. The presence of machinery operating would displace birds from the lagoon into the nearby headpond which contains a large area of suitable staging habitat, immediately adjacent to the subject site. 6: Contractors would be advised not to approach or disturb migratory birds or their nests.	Small magnitude, reversible, immediate, short-term and once.
Surface Water Quality	The subject site is adjacent to the Mactaquac Arm, a section of the Mactaquac Dam impoundment of the Saint John River/Wolastoq.	1: Treated wastewater from the lagoon would be discharged the Mactaquac Headpond, which may adversely impact the water quality near the end-of-pipe and mixing zone. This may result in	1: The updates to the lagoon would enhance the treatment efficacy resulting in improved water quality in the receiving water at the end-of-pipe and mixing zone. 2: The proponent would obtain and adhere to a NBDELG approval to operate for the proposed project. Effluent quality would meet the requirements of the	Small magnitude, reversible, immediate, long-term and ongoing.

		elevated nutrients, temperature, CBOD5 and TSS in this area.	NBDELG approval to operate. 3: The proponent would operate the lagoon per the NBDELG approval to operate which includes requirements for regular monitoring at the end-of-pipe and for reporting of results.
		2: Demolition of the existing lagoon and construction of the new lagoon, including installation of the submerged discharge pipe, may cause adverse water quality through sediment migration or disturbance.	4: The contractor would be required to have suitable operational and engineering controls to prevent and to contain erosion and sedimentation within the work area. All sedimentation and erosion mitigation measures must be designed and constructed, and in sufficient quantity to prevent surface runoff from the project from having a negative impact on surface water quality. Such mitigation measures must be installed prior to exposure of erosion-susceptible soils and maintained regularly to ensure they are functioning properly. Additional mitigation measures must be added, as applicable. All such mitigation measures must be maintained until such time as vegetation is re-established. 5: The new lagoon berms shall be stabilized, as soon as practical, by re-seeding them with native vegetation species common in the region. All exposed soil susceptible to erosion created by the project must be permanently revegetated with plant species that are native to the region and non-invasive, and covered with straw. If the work is completed outside of the growing season, all slopes must be temporarily stabilized in such a manner to withstand winter conditions until such time as permanent revegetation can be completed. 6: In-water mitigation measures, such as a silt boom, would be employed for the installation of the discharge pipe. 7: If erosion of soil or sedimentation of wetlands occurs, all work must cease

			until the cause is identified and corrected. 8: Weather conditions are to be assessed daily to determine the risk of extreme weather in the project areas. Avoid work during periods with rainfall or heavy wind warnings for the work area. 9: Turbidity would be monitored in accordance with applicable acts, regulations and permit requirements. 10: Any construction-related materials used must be clean and non-toxic, i.e. free of fuel, oil, grease and/or any contaminants. 11: No refuelling or fuel storage shall be permitted within 30 m of a watercourse.	
Terrestrial Wildlife	The new lagoon would be built primarily within a former agricultural field inside a service zone of the park. With a similar footprint to the old lagoon, the loss of terrestrial wildlife habitat would be offset by the decommissioning and restoration of the old lagoon site.	Construction of the project, primarily removing low vegetation and re-instating the berms, could disrupt or kill small terrestrial wildlife species and temporarily disturb approximately 10,000 m2 of terrestrial – field, edge and forested – habitat.	1: Construction contractors shall be required to have a wildlife response plan in the event that terrestrial wildlife and nesting birds are discovered during construction. This requirement would be stated in the technical specification document and shall be required to adhere to the 2021 ECCC Guidelines for Wildlife Response Plans.	Small magnitude, reversible, immediate, short-term and once.
Invasive Species	The construction of the proposed project would require the use of motorized (light and heavy) equipment, including excavators, bulldozers and dump trucks. Invasive species, including terrestrial and aquatic flora species, may be transported to and from the project location by sticking to equipment.	1: Invasive flora species could be transported on site. Once established, invasive species can out-compete native vegetation for resources and adversely impact an ecosystem. 2: In-water work for the installation of the discharge pipe could introduce, or carry off-site, aquatic invasive species.	1: Equipment shall be thoroughly inspected and cleaned before entering and leaving the site using a pressure washer. 2: When construction is completed, all care shall be taken to ensure any plant fragments captured in environmental mitigation measures (silt fencing, etc.) are removed and properly disposed of to avoid spreading plant fragments. This includes removing silt fencing onto land, allowing it to dry completely, placing in plastic bags and sealing tightly, and disposing of the bags at an approved facility. Silt fencing shall not be re-used. 3: Excavated soils shall not be taken off-site for use. 4: Contractors shall maintain a written log of this activity	Moderate magnitude, reversible, immediate, long-term, and once.

			and present it to inspectors upon request.	
Accidents and Unplanned Events	The construction of the proposed project would require the use of motorized light and heavy equipment, including excavators, mini-excavators, bulldozers and dump trucks.	Leaks, spills or other unplanned events can result in adverse impacts on the terrestrial and aquatic environment.	1: If a suspected archaeological resource is uncovered during excavation, work in the area would be stopped immediately and an archaeological curator at the New Brunswick Department of Tourism, Heritage and Culture – Heritage and Archaeological Services (Branch) would be contacted at 506-453-3115. 2: Procedures and training aimed at safe construction practices would be implemented during the construction to prevent or avoid potential situations that might lead to accidents, malfunctions or unplanned events. 3: The contractor would be required to have an emergency response plan to control any accidental spills or unplanned events, which would include having appropriate on-site spill response equipment readily available for immediate deployment. 4: All equipment to be used is to be free from leaks or coating of hydrocarbon-based fluids and/or lubricants harmful to the environment. Hoses and tanks are to be inspected on a regular basis to prevent fractures and breaks. 5: On site, crews must have an emergency spill clean-up equipment adequate for the activity involved. Spill equipment would include, as a minimum, at least one 250 L (i.e., 55 gal) overpack spill kit containing items to prevent a spill from spreading, i.e. absorbent booms, pillows, mats, rubber gloves and plastic disposal bags. 6: All spills or leaks must be promptly contained, cleaned up and reported to the NBDELG Fredericton Regional Office at 506-453-2690 or the 24-Hour Environmental Emergencies Report System at 1-800-565-1633. 7: All equipment and materials must be operated and stored in such a manner to prevent deleterious	Small magnitude, reversible, immediate, short-term and once.

			substances from entering wetlands or watercourses. 8: All materials stored within 30 m of a wetland or watercourse must be free of contaminants. 9: Contractors shall implement measures to ensure no invasive plant species are imported to the project site. 10: Contractors would be required to have a wildlife response plan for the project using the 2021 ECCC Guidelines for Wildlife Response Plans as a guide. 11: Storage of fuel or refuelling of equipment shall not be permitted within 30 m of a wetland or watercourse.

Based on the project's improvement to wastewater quality, the assessment of potential adverse impacts, the proposed mitigation measures and the significance criteria presented herein, impacts from the proposed project are considered not significant.

8 CUMULATIVE EFFECTS ANALYSIS

Cumulative effects are “changes to the environment that are caused by an action in combination with other past, present and future human actions” (CEAA, 1999). In order to properly review cumulative effects from a project, the study area must be large enough to assess the chosen Valued Environmental Component(s) (VEC), and must identify additional actions that have occurred, or may reasonably be assumed to occur in the foreseeable future. In the context of the proposed project, water quality was the only VEC assessed for cumulative impacts. Specifically, what cumulative impacts could the proposed wastewater discharge, in addition to other water quality impacts, have on overall water quality of the Saint John River/Wolastoq downstream of the subject site.

The scope of the cumulative assessment was limited to downstream water quality in the Mactaquac Headpond within a 5km vicinity of the proposed project.

The proposed project represents an improvement in the treatment of wastewater from the park, resulting in a reduction in the levels of nutrients and microbes discharged into the Mactaquac Headpond.

At present, there are no municipal or industrial wastewater treatment plants (lagoons, etc.) within 5kms upstream of the subject site. Upstream land uses within this area, which may contribute nutrients and microbiological parameters to the Headpond include non-point sources such as agricultural and residential application of fertilizers, malfunctioning domestic septic systems, illegal dumping of waste from pleasure craft, and natural sources.

The nearest upstream nutrient point sources that could contribute to the cumulative impacts on water quality are at Woolastook Park (13km), King’s Landing Historical Park (14km), the Town of Nackawic wastewater treatment plant (38km), and AV Nackawic Pulp and Paper Mill) (38 km).

Downstream nutrient point sources that could contribute include the Bilijk (Kingsclear) First Nation community wastewater treatment lagoon (3km downstream), the Mactaquac Fish Culture Station (4.4 km downstream), and further downstream the City of Fredericton wastewater treatment system discharges (16 and 22km downstream).

Given the distances of the subject site from similar up- and downstream nutrient point sources, the dilution factor provided by the Mactaquac Headpond and the Saint John River/Wolastoq, and the fact that the proposed project will significantly improve the wastewater quality discharged, cumulative effects are not considered significant.

9 PUBLIC AND FIRST NATIONS INVOLVEMENT

9.1 Public Involvement Program

The proposed project is on Crown Land, and adjacent to a public waterway used for recreational purposes by a variety of groups. Given its location and proponent, the following minimum required public involvement program is recommended per the requirements of Appendix C of the 2018 NBDELG *A Guide to Environmental Impact Assessment in New Brunswick*. It would involve the following based on a program to be submitted and approved by NBDELG:

> *The proponent must communicate directly with elected officials (i.e., MLA and mayor), local service districts, community groups, environmental groups, and other key stakeholder groups (companies, agencies, interest groups, etc.) and First Nations as appropriate, enabling them to become familiar with the proposal and ask questions and/or raise concerns...*
>
> *The proponent must provide direct, written notification (letter, information flyer, etc.) about the project and its location to potentially affected First Nations, area residents, and landowners and individuals (to be determined in consultation with EIA Branch). The notification must include the following:*
>
> - *A brief description of the proposed undertaking;*
> - *Information on how to view the Registration Document;*
> - *A description of proposed location (map is desirable).*
> - *The status of the Provincial approval process (i.e., "The undertaking is currently registered for review with the Department of Environment and Local Government under the Environmental Impact Assessment Regulation, Clean Environment Act");*
> - *A statement indicating that people can ask questions or raise concerns with the proponent regarding the environmental impacts;*
> - *Proponent and/or consultant contact information (name, address, phone number, E-mail); and*
> - *The date by which comments must be received (See Section 6.0 of the Registration Guide).*

1) When the EIA report is completed, it would be submitted to the NBDELG and placed on its website. The registration document – and any subsequent submissions in response to issues raised by the Technical Review Committee – shall be made available for the public review at 20 McGloin Street, 2nd Floor, Fredericton, New Brunswick.

2) The proponent shall make copies of the project's registration document – and any subsequent submissions in response to issues raised by the Technical Review Committee – available to any interested members of the public, stakeholders or First Nations.

3) Within 60 days of the project registration, the proponent shall prepare and submit to NBDELG a report documenting the above public involvement activities and make this report available for the public review.

In addition to the above minimum requirements, the project description would be posted on the Mactaquac Provincial Park website and/or Facebook page to allow members of the community to view and to provide comments.

9.2 Indigenous Peoples Engagement

The Government of New Brunswick recognizes the importance of the Saint John River /Wolastoq to the Wolastoqiyik Indigenous People.

Given that the project is on Crown Land and the Government of New Brunswick is the proponent, the proponent will work with the Department of Indigenous Affairs (DIA) for advice and support on the assessment of the Crown's Duty to Consult obligations.

Upon the initial review by DIA, an introductory letter and project description, as well as copies of the Draft EIA registration document will be provided to all Wolastoqey First Nations, the Wolastoqey Nation in New Brunswick (WNNB) directly by email.

10 APPROVAL OF THE PROJECT

The following authorizations are anticipated for the proposed project.

- Environmental Impact Assessment Certificate of Determination (NBDELG);
- Certificate of Approval to Construct (NBDELG);
- Certificate of Approval to Operate (NBDELG).

Any additional permits would be obtained by the Mactaquac Provincial Park prior to initiating construction on an as-needed basis.

11 FUNDING

The proposed project would be publicly funded by the Province of New Brunswick.

12 FUTURE PHASE

The current outfall location is in the Mactaquac Arm section of the headpond. The Saint John River/Wolastoq already has eutrophication issues causing toxic algal blooms due to previous impacts of human activities. Improvement of the wastewater treatment is anticipated to reduce the cumulative effects of nutrients in the river.

The next phase would consist of developing detailed plans of the new wastewater treatment lagoon taking into consideration the fish and fish habitat survey, the rare plant survey and the ecological risk assessment (ERA). This phase would begin after EIA determination through the Approval to Construct application process, subject to available funding.

13 CLOSURE

This report was completed for the New Brunswick Department of Tourism, Heritage and Culture for the replacement of the Mactaquac Provincial Park wastewater treatment lagoon. Where avoidance is not feasible, generally accepted, and effective mitigation measures are proposed. Significance of impacts was then determined based on the criteria of likelihood, scale, duration and proposed mitigation.

Potential VECs were identified and assessed as either not potentially impacted by the project or potential impacts were considered not significant based on the above criteria.

This report was prepared by Roy Consultants for the exclusive use of the proponent. The information contained herein may not be republished or relied upon for any other purpose or by any other third party without the express written notice of the author.

14 REFERENCES

Atlantic Canada Conservation Data Centre. Data report 7693: Mactaquac Provincial Park, NB. Prepared by J. Pender, Data Analyst, 29 May 2023.

Beck, H. E., Zimmermann, N. E., McVicar, T. R., Vergopolan, N., Berg, A., & Wood, E. F. (2018). Present and future Köppen-Geiger climate classification maps at 1-km resolution. Scientific data, 5(1), 1-12.

Budhathoki, S., Rokaya, P., & Lindenschmidt, K. E. (2022). Impacts of future climate on the hydrology of a transboundary river basin in northeastern North America. Journal of Hydrology, 605, 127317.

BirdLife International, Birds Canada and Nature Canada. Website Accessed February 2023.

Canadian Rivers Institute, Kidd, S. D., Curry, R. A., & Munkittrick, K. R. (2011). The Saint John River: A State of the Environment Report; a Publication of the Canadian Rivers Institute Celebrating 10 Years of Science. Canadian Rivers Institute, UNB.

Committee on the Status of Wildlife in Canada (COSEWIC). Assessment and Status Report on the Bank Swallow in Canada. 2013.

Committee on the Status of Wildlife in Canada (COSEWIC). Assessment and Status Report on the Barn Swallow in Canada. 2021.

Committee on the Status of Wildlife in Canada (COSEWIC). Assessment and Status Report on the Bobolink in Canada. 2010.

Committee on the Status of Wildlife in Canada (COSEWIC). Assessment and Status Report on the Canada Warbler in Canada, 2020.

Committee on the Status of Wildlife in Canada (COSEWIC). Assessment and Status Report on the Chimney Swift in Canada. 2018.

Committee on the Status of Wildlife in Canada (COSEWIC). Assessment and Status Report on the Eastern Wood-pewee in Canada. 2012.

Committee on the Status of Wildlife in Canada (COSEWIC). Assessment and Status Report on the Wood Thrush in Canada. 2012.

Cornell Lab of Ornithology. Allaboutbirds.com. Website accessed February 2023.

COSEWIC. 2015. COSEWIC assessment and status report on the Black-foam Lichen Anzia colpodes in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 47 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

COSEWIC. 2008. COSEWIC Assessment and Update Status Report on the Redbreast Sunfish in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 33 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

Dokken, R. J., Waldron, J. W., & Dufrane, S. A. (2018). Detrital zircon geochronology of the Fredericton trough, New Brunswick, Canada: Constraints on the Silurian closure of remnant Iapetus Ocean. American Journal of Science, 318(6), 684-725.

Dolson-Edge, R., Tarr, C., Hirtle, S, and Curry, R., A. 2019. Temperature and Dissolved Oxygen Conditions in the Mactaquac Headpond. Mactaquac Aquatic Ecosystem Study Report Series 2019-068. Canadian Rivers Institute, University of New Brunswick, 27 p

Dugdale, S. J., Allen Curry, R., St-Hilaire, A., & Andrews, S. N. (2018). Impact of future climate change on water temperature and thermal habitat for keystone fishes in the lower Saint John River, Canada. Water Resources Management, 32, 4853-4878.forbes

Environment Canada. 2011. Management Plan for the Barrow's Goldeneye (*Bucephala islandica*), Eastern Population, in Canada [Proposed]. Species at Risk Act Management Plan Series. Environment Canada, Ottawa. iv + 15 pages.

Environment Canada. 2016. Recovery Strategy for the Common Nighthawk (Chordeiles minor) in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. vii + 49 pp

Gerardi, Micheal H. and Lytle, Brittany. The Biology and Troubleshooting of Facultative Lagoons. Hoboken, New Jersey. 2015.

Gibson, A.J.F., Jones, R.A. and MacAskill, G.J. 2016. Recovery Potential Assessment for Outer Bay of Fundy Atlantic Salmon (Salmo Salar): Population Dynamics and Viability. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/032. v + 87 p.

Forbes, G.J., McAlpine, D.F., and Scott F.W. (2010). Mammals of the Atlantic Maritime Ecozone. Assessment of the Species Diversity in the Atlantic Maritime Ecozone, 693-714.

NatureNB Environmentally Significant Areas Database. 2016.

New Brunswick Department of Environment and Local Government. A Guide to Environmental Impact Assessment in New Brunswick. January 2018.

New Brunswick Department of Environment and Local Government. Additional Information Requirements for Wastewater Treatment Projects. Version 04-11-25.

New Brunswick Department of Environment and Local Government. 2021 Air Quality Monitoring Results. Environmental Reporting Series. 2022.

New Brunswick Department of Environment and Local Government. New Brunswick Air Quality Data Portal. https://www.elgegl.gnb.ca/AirNB. Site accessed January 2023.

New Brunswick Department of Natural Resources, 2008. Bedrock Geology of New Brunswick. Minerals, Policy and Planning Division. Map NR-1 (2008 Edition). Scale 1:500000 (revised December 2008).

New Brunswick Invasive Species Council. www.nbinvasives.ca Website accessed October, 2023.

O'Sullivan, A., Curry, R.A., and Yamazaki, G. 2016. Assessment of the Mactaquac Headpond geomorphology and estimated sediment distribution. Mactaquac Aquatic Ecosystem Study Report Series 2016-29. Canadian Rivers Institute, University of New Brunswick, 10p.

Park, A. F., & Whitehead, J. (2003). Structural transect through Silurian turbidites of the Fredericton Belt southwest of Fredericton, New Brunswick: the role of the Fredericton Fault in late Iapetus convergence. Atlantic Geology, 39(3), 227-237.

Pawling, M. A. (2017). Wəlastəkwey (Maliseet) Homeland: Waterscapes and Continuity within the Lower St. John River Valley, 1784-1900. Acadiensis, 46(2),5–34.

Rees, H. W., Fahmy, S. H., Wang, C. and Wells, R. E. 2005. Soils of Central and Northern New Brunswick. Potato Research Centre, Research Branch, Agriculture and Agri-Food Canada, Fredericton, N. B. 137 pp with map.

Rizzo, P., Severini, E., Bucci, A., Bocchia, F., Palladino, G., Riboni, N., ... & Celico, F. (2022). How do turbidite systems behave from the hydrogeological point of view? New insights and open questions coming from an interdisciplinary work in southern Italy. Plos one, 17(5), e0268252.

Smith, E.A. 2005. Bedrock geology of southwestern New Brunswick (NTS 21 G, part of 21 B). New Brunswick Department of Natural Resources, Minerals, Policy and Planning Division. NR-5 (Second Edition).

Zelazny, V. F., Martin, G. L., Toner, M., Gorman, M., Colpitts, M., Veen, H., ... & Roberts, M. (2007). Our landscape heritage: the story of ecological land classification in New Brunswick. New Brunswick Department of Natural Resources, Hugh John Fleming Forestry Centre, Fredericton, NB E3C 2G6, Canada.

15 APPENDICES

- Appendix A : Project Design Brief (Roy Consultants)
- Appendix B : Environmental Risk Assessment (CBCL)
- Appendix C : Migratory Bird Survey (Aster Environmental, Roy Consultants)
- Appendix D : Vegetation Survey (Roy Consultants)
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- Appendix F : ACCDC Report 7693
- Appendix G : Zoning Map
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APPENDICES

APPENDIX A

Appendix A – Project Design Brief

ROY CONSULTANTS

ENGINEERING SERVICES D'INGÉNIERIE

Assessment, Rev. 2

Mactaquac Provincial Park Wastewater Treatment Plant

Tourism, Heritage and Culture
Fredericton, NB

Our File No.: 279-22-C
December 11, 2023

Prepared for:

New Nouveau Brunswick

Prepared by:

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December 11, 2023

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Our File No.: 279-22-C[1]

MacMullin:

Subject: Design Brief, Rev. 2, Wastewater Treatment Plant Assessment Mactaquac Provincial Park, Fredericton, NB

Following our review of the Tourism, Heritage and Culture Department's comments, we are pleased to present the enclosed revised design brief for the Mactaquac Provincial Park Wastewater Treatment Plant (WWTP) assessment.

Yours truly,

Guillaume Arseneau, P.Eng.
Civil Engineer

GA/

Cc- Michel Poirier, P.Eng., CIVIL Engineer – Roy Consultants

Enc.

[1] Ref.: Y:\2023\093-23_Mactaquac Wastewater Lagoon EIA - JB\C\EIA Report\279-22 - Design Brief Rev.2 (Dec. 11, 2023) GA

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1 INTRODUCTION

1.1 Scope of Work

The purpose of this design brief is to provide Tourism, Heritage and Culture with the information required to make an informed decision on either the selection of an upgrade or the replacement of the Mactaquac Provincial Park's wastewater treatment plant.

An assessment of the existing treatment system was completed to assess its adequacy as well as to identify if any improvements could be made. As results were gathered, it became evident the existing system was not adequate for the treatment of the Park's current and future influent loads.

Upon review of regulatory requirements, sampling results, future influent loads and an assessment of the lagoon's current state and projected life expectancy, a new system is proposed and a Class C budget cost estimate is presented for budgetary purposes.

A review of environmental constraints pertaining to the proposed upgrades has been completed as part of a preliminary step.

2 EXISTING SYSTEMS

2.1 Description of Existing Systems

2.1.1 Mactaquac Provincial Park's Site Operations

In the summer, the existing treatment system receives water from the camping sites, the golf course, the lounge and the marina. During winter, only the lounge is used to serve snowmobilers.

2.1.2 Existing Wastewater Treatment Plant

The existing wastewater treatment plant (WWTP) was built around 1967 and is composed of a single cell without separation. The lagoon has an approximate area of 0.46 ha. It is equipped with two (2) mechanical surface aerators, of which one was out of service during our August 2022 site visit. The process can be described as a facultative treatment with an aerobic layer at the top and near the surface aerators, and an anaerobic layer at the bottom near the sludge blanket. It offers a primary treatment by the settling of solids and a secondary treatment by the action of microorganisms. However, the presence of duckweed covering most of the lagoon could create an anaerobic environment and limit the penetration of sunrays essential in the disinfection process. As mentioned by Gerardi[2], duckweed is found in quiescent and nutrient-rich lagoons. It is an indicator of an older lagoon that received excess nutrients and that contains a buildup of bottom sediment composed mostly of organic material. The excess nutrients promote the rapid growth of duckweed, thus creating an anaerobic layer. The discharge of an anaerobic effluent into a receiving waterbody can be harmful to aquatic life and can create strong odours. See Photos Nos. 1 and 2 taken August 24, 2022 (Figure No. 1 faces north, while Figure No. 2 faces south).

Photos Nos. 1 and 2: Existing Lagoon

The lagoon is located relatively far from houses, less than 30 metres from the Mactaquac head pond (Saint John River). The only element separating the river from the lagoon is the dyke made of clay material. Refer to the enclosed original drawings in Appendix B.

[2] Gerardi, Michael H. & Lytle, Brittany (2015). *The Biology and Troubleshooting of Facultative Lagoons*. Hoboken, New Jersey.

The lagoon receives wastewater through a gravitational sanitary sewer system collecting wastewater from the campground, the lounge and sanitary facilities. The sewer system was not assessed through this study. Drawing 279-22-P1 shows the lagoon's location in relation to the surrounding land; see Appendix A.

Considering the dyke was built approximately 55 years ago, steps must be taken to identify possible breaches. Should this be the case, the sealing layer would have to be repaired or replaced, either by one composed of clay or a high-density polyethylene (HDPE) liner.

2.1.3 Mechanical System

The mechanical system is composed of two (2) mechanical surface aerators. At the time of our visit, one was out of service. The site representative mentioned the aerators are original to the construction (i.e., 55 years old) and parts are difficult to obtain in a reasonable timeframe. The existing aeration system has reached the end of its service life and an upgrade to the mechanical system is recommended.

2.1.4 Electrical System

The electrical system is also original to the construction. The electrical panel and wiring servicing the aerators do not meet the requirements of the most recent edition of the CSA Canadian Electrical Code. The electrical components at the lagoon have reached the end of their service life. An upgrade to the electrical supply panel and wiring system is recommended.

2.1.5 Receiving Water Body

The lagoon empties into the Mactaquac head pond located northwest of the Mactaquac Dam. The Mactauquac Provincial Park recreational beach is 1 km from the lagoon's discharge point. Recreational fishing and swimming take place in proximity to the lagoon's discharge point. Ineffective wastewater treatment would negatively impact the head pond's water quality and could restrict recreational opportunities currently being practised near the lagoon.

2.1.6 Operating Permit

The Mactaquac Provincial Park must comply with the conditions of the "*Approval to Operate"* for its WWTP. The performance standards at the point of discharge are summarized in Table No. 1 hereafter.

Table No. 1: Limiting Criteria

CRITERION	LIMIT CONCENTRATION (mg/L)
$CBOD_5$	25
Suspended Solids	25

A study is recommended to evaluate Environmental Quality Objectives (EQO) and Effluent Discharge Objectives (EDO). EQO are used to determine safe contaminant concentration limits in the environment for the safety of humans and ecosystems. EDO are used to determine the

WWTP effluent's maximum acceptable concentrations to meet the EQO after dilution in the receiving water body. The effluent study must also include an assessment of the mixing zone of the receiving water body.

2.1.7 Sampling Results

Based on recent sampling results, the existing lagoon seems to adequately treat the actual organic loads in terms of $CBOD_5$. However, these are results of sampling performed at a time when some campsites were closed. Furthermore, the Department of Tourism, Heritage and Culture plans to add 50 more campsites to the Provincial Park. Should all current campsites and the additional planned 50 sites be in use, this would most likely cause the lagoon to be overloaded. A loading rate between 22 and 67 kg BOD_5/ha/d is recommended by the United States Environmental Protection Agency (USEPA) in the case of a facultative lagoon. Considering the planned campground expansion, the loading rate would be approximately 190 kg BOD_5/ha/d. A more extensive treatment system would be required to treat this organic load.

In addition to $CBOD_5$, it is recommended the nitrification process be performed. The purpose of nitrification is to reduce the effluent's ammonia concentration since it is harmful to aquatic life and favours eutrophication. This would require more dissolved oxygen, thus requiring more aeration

2.2 Hydraulic and Organic Loading

2.2.1 Existing Hydraulic and Organic Loading

No flowmeters are available in situ to measure actual flow running through the pond. However, the minimal flow, average flow and maximum flow can be calculated through theoretical hydraulic and organic loads based on the number of campgrounds, golf club, marina and lounge users during the summer months. During the winter months, the golf club and the campground are closed, but the lounge is still open as a restaurant.

Table No. 2: Existing Hydraulic and Organic Loading

ITEM	DURING SUMMER	DURING WINTER
Minimum Flow (m^3/d)	235	10
Average Flow (m^3/d)	305	15
Maximum Flow (m^3/d)	710	30
Organic Loading (kg/d)	75	5

2.2.2 Future Hydraulic and Organic Loading

An increase in the number of campsites is planned, which would entail an additional 10% occupation in the summer.

Table No. 3: Future Hydraulic and Organic Loading

ITEM	DURING SUMMER	DURING WINTER
Minimum Flow (m^3/d)	260	10
Average Flow (m^3/d)	340	15
Maximum Flow (m^3/d)	785	30
Organic Loading (kg/d)	80	5

3 DEVELOPMENT OF TREATMENT PROCESSES

3.1 Treatment Processes

Aerated lagoons provide wastewater treatment at the primary and secondary levels; they are therefore very effective in reducing $CBOD_5$ and TSS, and provide partial ammonia removal. On the other hand, nutrient reduction and disinfection require additional processes for total phosphorus reduction, denitrification, complete nitrogen removal and disinfection.

3.1.1 Ammonia Reduction

The ammonia reduction process includes nitrification and denitrification. Nitrification converts ammonia (NH_3) into nitrate (NO_3); denitrification converts nitrate (NO_3) into nitrogen. The following can be considered when dealing with nitrogen products:

- Ammonia is a contaminant toxic to aquatic life;
- Nitrate is a nutrient that contributes to the eutrophication of rivers;
- Nitrogen is a gas that occurs naturally in the air.

Since the WWTP is close to a recreational body of water, the Canadian Council of Ministers of the Environment (CCME) recommends the effluent has a 1.25 mg/L concentration limit.

The normal requirements for the nitrification process are:

- $5^{\circ}C < T^{\circ} < 30^{\circ}C$, starts at a minimum of $10^{\circ}C$;
- $7.0 < pH < 8.5$, minimum 6.5;
- $1.0\ mg/L > DO$;
- $30\ mg/L < CBOD_5$.

The normal requirements for the denitrification process are:

- $5^{\circ}C < T^{\circ} < 30^{\circ}C$;
- $7.0 < pH < 8.5$;
- $DO < 0.2\ mg/L$;
- A carbon source is required.

3.1.2 Phosphorus Reduction

Phosphorus reduction can be achieved through precipitation, biological treatment and plant uptake or soil treatment. The precipitation method using a physical-chemical treatment is more effective. The process involves the use of alum, ferric chlorine or ferrous sulfate to precipitate phosphates. A recirculating filter is more often used in the separation of the precipitate.

3.1.3 Disinfection

Disinfection, which consists of reducing the number of microorganisms released, is a safe practice for shellfish consumption and recreational activities in contact with water (e.g., swimming). Disinfection can be achieved using chlorination; however, nowadays it is most often done using a UV system, since chlorine can create toxic byproducts when in contact with ammonia.

3.1.4 Effluent Quality and E. coli Results

At present, no E. coli or total coliforms limiting criteria are mentioned in the operating permit. However, it is good practice to have a disinfection process at the end of every wastewater treatment plant. For facilities in very close proximity to recreational waters, an effluent with a maximum concentration of 1000 MPN/100 ml of E. coli is required. An effluent sample was collected August 18, 2022; results indicated its concentration was 1553.1 MPN/100 ml of E. coli.

We recommend adding a disinfection system to the existing or future wastewater treatment plant.

3.1.5 Sludge Removal

The existing sludge blanket depth is unknown. We recommend having the sludge surveyed to evaluate its depth and impact on the existing treatment and hydraulic retention time. A high sludge blanket would reduce the treatment duration and efficiency. Furthermore, if the sludge blanket is deep enough, benthic feedback can occur. This feedback can cause a non-compliant effluent.

3.2 Summary of Assessment Findings

Hereafter is a summary of our assessment findings for the Mactaquac Provincial Park lagoon.

- The lagoon and the Mactaquac head pond are separated only by a dyke. The lagoon is located in the 30-metre buffer zone from the river. Relocation of the lagoon to mitigate the risk and consequences related to potential leakage or disruption of the dyke due to a storm event is recommended;
- The pond's surface was covered in duckweed during the site visit. This cover could create an anaerobic zone, which would in turn most likely create the emission of unpleasant gas odours. The addition of aeration would potentially reduce the formation of algae/duckweed by disturbing quiescent zones and keep the production of odorous compounds at bay;
- The mechanical and electrical systems are approximately 55 years old. During the site visit, we observed an aerator was out of service due to failure. Based on our observation of its components, the electrical panel would also be obsolete in the near future. An upgrade of both the mechanical and electrical systems is recommended;
- The addition of a disinfection process is recommended. This would help prevent the spread of infectious diseases as recreational activities are practised in the head pond. A UV treatment system would be a potential upgrade to the existing treatment;
- Additional dissolved oxygen would most likely be required to reduce the amount of ammonia released in the environment. The constant release of ammonia in the environment could result in chronic and acute toxicity. The need for the addition of nitrification equipment would be confirmed with an ERA study to determine the impact of the effluent on the Mactaquac head pond;
- The sludge accumulation in the existing lagoon since it was built in the 1960s would most likely cause a non-complying effluent harmful to aquatic life and have a negative impact on the pond's performance through the reduction of the retention time and the feedback coming from the benthic zone. A benthic study is recommended to evaluate the sludge's impact on the treatment;
- With future expansion, the existing pond will most likely become overloaded. An upgrade will be needed to accommodate future loads.

The following list identifies possible consequences should no actions be undertaken to upgrade the existing wastewater treatment plan.

- Non-compliant effluent due to anaerobic conditions, benthic feedback from sludge accumulation and release of unsafe concentrations of ammonia which would be harmful to aquatic life;
- Chronic and acute toxicity caused by various conditions:
  - Elevated release of ammonia;
  - Harmful levels of pH caused by benthic feedback;
  - Low dissolved oxygen levels;
- Discharge of effluent with unsafe concentrations of E.coli which could be harmful to recreational activities;

- The release of strong and offensive odours that could result in public complaints should the treatment process lack aeration.

Based on the points mentioned here, we recommend the existing wastewater treatment be replaced within two or three years.

Additional information such as an Environmental Risk Assessment (ERA) and project registration at the Environmental Impact Assessment (EIA) office would be completed in the early stages of the new wastewater treatment system's detail design.

4 IDENTIFICATION OF AVAILABLE TREATMENT PROCESSES

4.1 Typical Effluent Quality Produced by Various Treatment Processes

The following figure taken from the 2006 *Atlantic Canada Wastewater Guidelines Manual* presents different processes and their typical performances.

Figure No. 1: Sewage Treatment Process's Typical Effluent Quality

TABLE 4.1 TABLEAU 4.1	SEWAGE TREATMENT PROCESS TYPICAL EFFLUENT QUALITY QUALITÉ TYPE DES EFFLUENTS PRODUITS PAR DIVERS PROCÉDÉS DE TRAITEMENT			
PROCESS PROCÉDÉ	BOD_5 DBO_5 mg/ℓ	TSS MES mg/ℓ	Total P Phosphore total mg/ℓ	Total N Azote total mg/ℓ
Primary | Primaire				
including anaerobic lagoons | y compris les bassins anaérobies	75 -150	50 -110	5 – 7	25 – 45
With P Removal | Avec élimination du phosphore	45 - 85	25 – 50	1 – 2	20 – 40
Chemically enhanced primary | Traitement primaire amélioré par des moyens chimiques	70-125[f]	105 – 160[f]	8 - 10[f]	Not Available Non disponible
Secondary | Secondaire				
Activated Sludge | Boues activées	10 - 25	10 – 25	3.5 – 6.5	15 – 35
Aerated Lagoons | Étangs aérés	15 - 30	20 – 35	4 – 7	20 – 40
Facultative Lagoons | Lagunes facultatives - Winter to Late Spring | de l'hiver à la fin du printemps - Summer to Late Fall | de l'été à la fin de l'automne	 25 - 70 10 - 30	 20 – 60 10 – 40	 3.5 – 7 2 – 5	 20 – 35 5 – 10
Advanced | Avancé				
Secondary with chemical treatment (P control) | Traitement secondaire avec conditionnement chimique (élimination du phosphore)	5 - 15	10 - 30	0.5 – 1.5	15 - 35
Other Biological Systems | Autres traitements biologiques				
Biological Aerated Filters | Lits bactériens aérés	10 - 20	10 - 20	Not Available Non disponible	Not Available Non disponible
Moving Bed Biofilm Reactors | Réacteurs à biofilm à lit mobile	10 - 25	10 – 25	3.5 – 6.5	15 – 35
Membrane Bioreactors | Bioréacteurs à membrane	< 5	< 1	< 0.2[a] < 0.5[b]	< 10[c] < 3[d]
Recirculating Sand Filters | Filtres à sable à recirculation	< 15	< 15	10 - 30	12 – 30[e]

a – With chemical addition
b – With Bio-P removal
c – With preanoxic zone
d – With preanoxic and postanoxic zones
e – Based on septic tank effluent with 50% nitrogen removal
f – Based on percent removal and the following average raw effluent values from MOP 11 – Operation of Municipal Treatment Plants.
BOD_5: 175 mg/ℓ (40-70% removal)
TSS: 175 mg/ℓ (60-90% removal)
Total P: 11 mg/ℓ (70-90% removal)

a – Avec apports chimiques
b – Avec élimination biologique du phosphore
c – Avec zone pré-anoxique
d – Avec zones pré-anoxique et post-anoxique
e – Fondé sur des effluents de fosse septique dont l'azote a été éliminé à 50 %
f – Fondé sur le pourcentage d'élimination et les valeurs moyennes suivantes pour les effluents non traités [tirés du MOP 11 – Operation of Municipal Treatment Plants]
DBO_5: 175 mg/ℓ (élimination de 40 à 70 %)
MES: 175 mg/ℓ (élimination de 60 à 90 %)
Phosphore total:11 mg/ℓ (élimination de 70 à 90 %)

4.2 Identification of Potential Treatment Solutions

We performed a literary review of several systems and processes that can be applied to the Mactaquac Provincial Park lagoon. According to the literature, hereafter are some recommended treatments. Their level of treatment is also shown.

Table No. 4: Literary Review of Treatment Systems

SYSTEMS	LEVEL OF TREATMENT					
	DBO	TSS	Total P	Nitrification	Denitrification	Total N
Aerated Lagoon	X	X		X[5]		
Facultative Lagoon	X	X		X[5]	X[5]	
Activated Sludge	X	X		X[5]		
Submerged Attached Growth Reactor (SAGR)	X	X		X		
Anoxic Submerged Attached Growth Reactor (ANSAGR)	X	X			X	X
Continuous Backwash Sand Filter	X	X	X[1]			
Membrane Bioreactor (MBR) with Ultrafiltration	X	X	X[1]	X	X	X
Integrated Fixed-film Activated Sludge (IFAS)	X[2]	X[2]		X[2]	X[2]	X[2]
Flotable Aerated Bio-filters[4]	X	X	X[1]	X		
Anaerobic Ammonium Oxidation (Anammox)	X[3]	X[3]				X[3]
Sequencing Batch Reactor (SBR)	X	X	X[1]	X	X	X
Moving Bed Bioreactor (MBBR)	X	X		X	X	X

Notes:
1 Can require a chemical agent.
2 Can require a filter or a clarifier to separate the solids.
3 For concentrate effluent coming from sludge digesters.
4 Can only be used in conjunction with primary and secondary treatments.
5 Partial reduction of nitrogen.

One of the advantages of using an aerobic process is the attenuation of odours, which can be produced by the biological process of reducing BOD, TSS and ammonia. Anaerobic or anoxic processes can create gaseous compounds associated with strong odours.

4.3 Process Description

Upon review of various treatment options and discussions with suppliers of wastewater treatment plants or equipment, hereafter is a list of treatment system options that could be a good fit with the Mactaquac Provincial Park site. The options are listed in no specific order.

- Activated Sludge Process;
- Aerated Lagoon with a partially mix system;
- MBBR Process;
- Sequencing Batch Reactor;
- Aerated Lagoon with SAGR.
- Facultative lagoon without an aeration system;
- Septic tank and septic field.

The treatments listed above are described in the following sections. All the above processes would require a new mechanical equipment building, UV system – electrical and mechanical appurtenances only – and lift station. The UV system – UV lamps and UV set up equipment – is presented separately since two (2) types of systems are available, i.e. open and closed channels.

4.3.1 Activated Sludge Process

The activated sludge process proposed is composed of a first basin with aeration diffusers followed by a clarifier. The system is designed to reduce BOD, TSS and ammonia. The process bases its efficiency on its hydraulic retention time (HRT) and its solid retention time (SRT), and is considered a complete-mix model.

This system would require the installation of a grit removal system and equipment to store waste sludge on site before being taken to a sanitary landfill. This operation would require an operator to frequently be on site to check the process.

4.3.2 Aerated Lagoon with a Partially Mix System

An aerated lagoon is considered a partial mix process when a portion of suspended solids can decant at the bottom of the lagoon. It uses aeration from diffusers to mix the solids and provide oxygen to microorganisms. The technology of aerated lagoons is simple to operate and provides flexibility to the operators. The process degrades BOD, TSS and ammonia below admissible limiting criteria. The surface of an aerated lagoon would be smaller than that of a facultative one, since the aeration system provides enough oxygen to microorganisms. A fine bubble aeration system would be recommended at this stage of the study to supply adequate mixing and oxygen to microorganisms. The proposed lagoon would be divided into two (2) basins built in series. The second basin would be divided into two (2) sections using a floating baffle.

A constructed wetland could be added to the process but wouldn’t necessarily add a major treatment impact to the effluent, since the reduction of phosphorus is not targeted in the operating permit. At this stage, this aspect was not included in our study. It can, however, be once the EIA

and effluent study are completed and should the results indicate that a treatment such a constructed wetland is required.

4.3.3 MBBR Process

The moving bed bioreactor (MBBR) filtration system is a moving biomass process comparable to the activated sludge process. It reduces organic loads and performs nitrification. The process has some advantages such as the small area required and the simplicity of operation without any need for sludge bulking verification, sludge testing for SRT control and sludge recycling. However, it does present some disadvantages such as a higher energy demand and the need to use proprietary media. This system also requires the use of a clarifier and coagulants to separate solids. For this study, the MBBR process was proposed conjunctly with an aerated lagoon.

4.3.4 Sequencing Batch Reactor

Parkson's sequencing batch reactor (SBR) is comparable to an activated sludge process, which is operated in a continuous fill sequence. All SBR unit process steps are included within the reactor. There is no need for anaerobic or anoxic zones, return activating sludge (RAS) systems or secondary clarifiers. The treatment is achieved through the following steps:

- Fill;
- React;
- Settle;
- Decant.

This operation of this treatment process is much more complex since an operator is required on site on a daily basis to verify all the treatment steps mentioned above. The short retention time can also cause problems during peak storm runoff events should wastewater accumulation be required before treatment. The SBR can also require the addition of chemical compounds throughout the treatment process. Based on this information, we do not recommend replacing the existing wastewater treatment plant with a process such as a sequencing batch reactor as it requires daily extensive operational work.

4.3.5 Aerated Lagoon with SAGR

The proposed process uses an aerated lagoon to provide oxygen, residence and contact time for natural microorganisms to reduce organic matter (BOD), TSS and ammonia. The proposed aeration system by suppliers consists of floating laterals and submerged aeration units. Aeration is provided by a fine bubble system for oxygen supply.

The submerged attached growth reactor (SAGR) process is designed to ensure the nitrification of effluents from lagoons operating in cold climates. This treatment method involves directing effluents from aerated lagoons to clean aggregate beds covered with peat moss or mulch to prevent frost. Large bubble aeration systems provide the oxygen needed for effluent nitrification processes. Aeration systems also ensure uniform distribution of effluents, maximize contact with aggregates and improve digestion of sludge.

4.3.6 Facultative Lagoon Without Aeration System

Facultative lagoons consist of an earthen basin lined with a synthetic membrane. They use action from wind and algae to provide aeration to microorganisms. Facultative lagoons reduce BOD, TSS and ammonia. They can also denitrify wastewater to some extent. Since the facultative process relies on ambient temperature, treatment process efficiency can vary greatly throughout seasonal changes. One of the advantages of using a facultative lagoon is the flexible operating range. However, the susceptibility to temperature variance can sometimes create a non-compliant effluent.

A facultative lagoon would require a large land area to provide enough treatment for the Mactaquac Provincial Park influent. This process is not recommended and would not be a valuable option for the Park.

4.3.7 Septic Tanks and Fields

Septic tanks and fields are used for smaller systems such as residential ones. This type of system is not recommended to treat the wastewater coming from all park activities.

4.3.8 UV System – Closed Channel

A closed channel UV system is designed so that the water flows through transparent tubes. UV lamps are installed outside the tubes, surrounding them. Disinfection occurs when microorganisms meet UV rays for a given contact time. This system permits pressurize flow.

4.3.9 UV System – Open Channel

An open channel system consists of submersible UV lamps inserted in a channel to be directly in contact with the effluent. Disinfection occurs when microorganisms meet UV rays with a given contact time. This system does not permit pressurize flow.

5 RECOMMENDATIONS

The main goals of this study were to assess the Mactaquac Provincial Park's existing wastewater treatment plant and provide upgrade or replacement options. Future development had to be considered and planned for to allow for possible improvements should standards become more stringent. We evaluated various options to determine which process would best suit the Park. The following steps were conducted to assess the existing lagoon.

- Review of regulatory requirements;
- Review of effluent quality sampling results;
- Preliminary estimate of current and future influent loads;
- Assessment of the lagoon's current condition and remaining life expectancy;
- Site meeting and visit;
- Estimate and review of current lagoon capacity;
- Requests to suppliers for wastewater treatment plant upgrade or replacement options.

Before performing any final design or construction works, the following studies must be conducted:

- Environmental Impact Assessment (EIA): The project must first be registered with the EIA office;
- Environmental Risk Assessment (ERA): Effluent study to identify the Environmental Quality Objectives (EQO), the Effluent Discharge Objectives (EDO) and the receiving body of water mixing zone.

Should the above-mentioned studies conclude that a tertiary treatment process is not required, the following is recommended based on the current assessment:

- Relocation of the existing lagoon away from the head pond;
- Installation of a new lift station to move the sanitary sewerage to the new wastewater treatment plant, which would be located at a higher elevation;
- Installation of a UV system for disinfection, since recreational activities are practised in the receiving body of water;
- The new wastewater treatment system would consist of an aerated lagoon that could accommodate future loads, provide flexibility to the operators and meet limiting criteria for BOD, TSS and ammonia removal. The aeration diffusers should be a fine bubble system to provide adequate mixing and oxygen to microorganisms.
- The preferred location for the new wastewater treatment facility is presented in Appendix A. A preliminary geotechnical investigation would be required to identify whether it is possible to build the new lagoon in the proposed area.

The proposed wastewater treatment system would be comprised of two (2) basins built in series. The second basin would be further divided into two (2) sections using a floating baffle.

Preliminary Design and Construction Schedule

Based on our experience with similar projects, we recommend that the following activities be planned for the following two fiscal years in order for this project to be completed before the existing lagoon is in need of major repairs or no longer complies with its licensing requirements.

Table No. 5: Activities Planning

ITEM	2023-2024	2024-2025
EIA Study	X	
ERA Study	X	
Engineering – Design Phase	X	
Aerated Lagoon Construction		X
UV System (with Installation)		X
Engineering – Construction Phase		X

APPENDICES

APPENDIX A

Appendix A – Preliminary Sketches

Drawing Number 279-22-P1 Numero du Plan
Plot date SEPTEMBER 2022 Date du tracage

NOTES

1.- LOCATIONS OF EXISTING SANITARY SEWER MANHOLE AND PIPING SHOWN ARE APPROXIMATE.

NO.	DATE	REVISIONS	BY: PAR:
B	22/11/14	PRELIMINARY	A.P.
A	22/09/30	PRELIMINARY	A.K.

A DETAIL No
No DU DETAIL
B LOCATION DRAWING No
SUR DESSIN No
C DRAWING No
DESSIN No

Client / Client
NEW BRUNSWICK DEPT. OF TOURISM, HERITAGE AND CULTURE

Project / Projet
MACTAQUAC PROVINCIAL PARK LAGOON
MACTAQUAC, NB

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Drawing Title / Titre du Plan

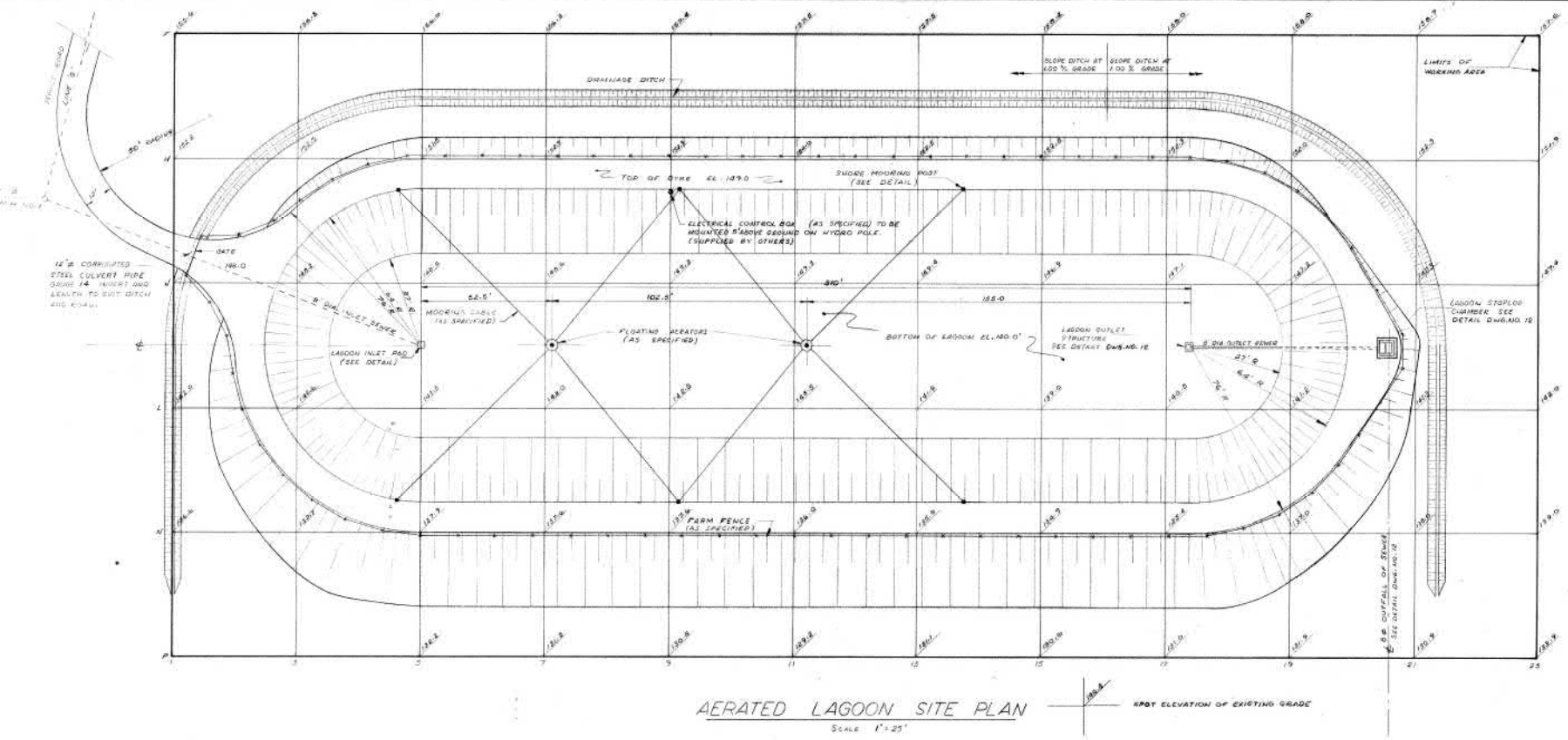
PLAN VIEW

Design by: Design par:	Drawn by: Dessine par:
G. ARSENEAU	P.B.
Checked by: Verifie par:	Date:
G. ARSENEAU	2022-09-30
Scale: Echelle:	Sheet: Feuille:
1:1250	1 of/de 1

Drawing Number: Numero du Plan: 279-22-P1 — Rev. B

APPENDIX B

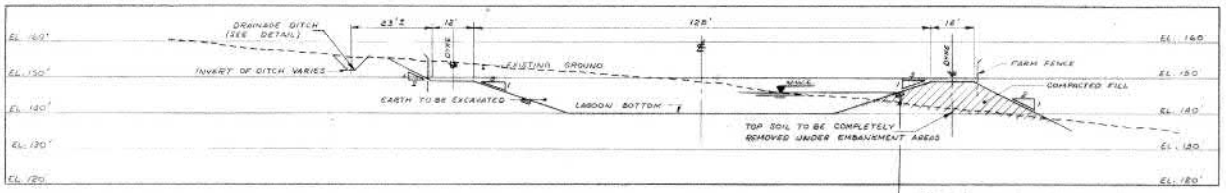
Appendix B – Original Drawings



AERATED LAGOON SITE PLAN

SCALE 1" = 25'

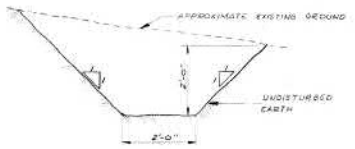
139.4 SPOT ELEVATION OF EXISTING GRADE



TYPICAL CROSS-SECTION

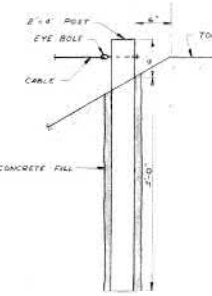
SCALE 1" = 20'

8" TO 4" CRUSHED ROCK FOR SLOPE PROTECTION 1' THICK AND 1' ABOVE AND BELOW NORMAL WATER LEVEL IN LAGOON TO BE PROVIDED COMPLETELY AROUND INSIDE SLOPE.



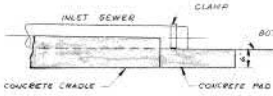
TYPICAL SECTION OF DRAINAGE DITCH

SCALE 1/2" = 1'-0"

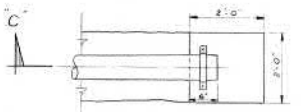


SHORE MOORING PO

SCALE 1" = 1'-0"



SECTION C-C

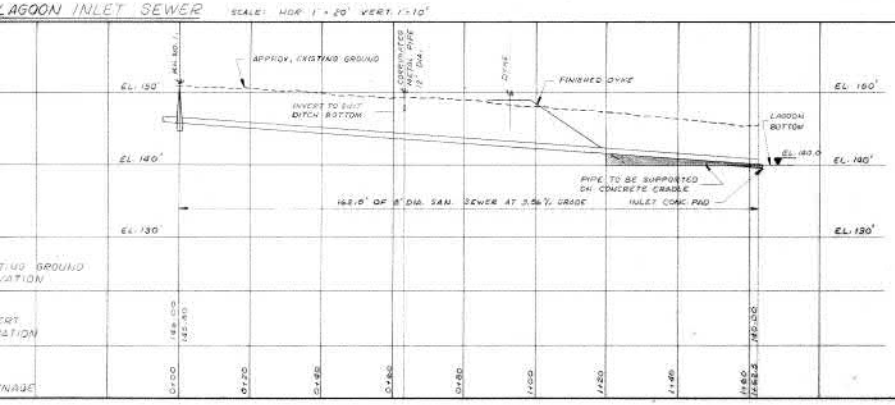


PLAN

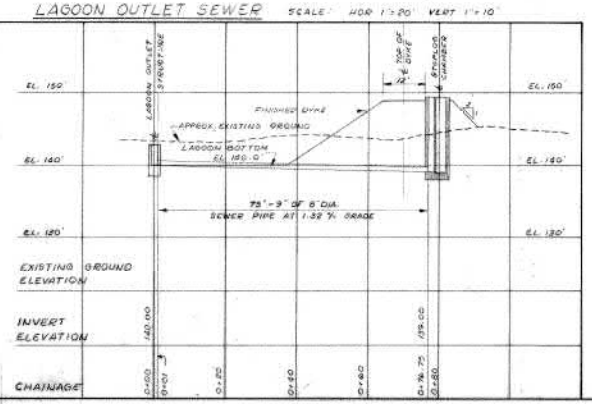
LAGOON INLET CONCRET

SCALE: 1/2" = 1'-0"

LAGOON INLET SEWER SCALE: HOR. 1" = 20' VERT. 1"=10'



LAGOON OUTLET SEWER SCALE: HOR 1"=20' VERT 1"=10'



DATE	REV. NO.	

PROVINCE OF NEW BRUNSWICK
DEPARTMENT OF NATURAL RESOURCE
PARKS BRANCH

MACTAQUAC PARK
WATER AND SEWAGE FACILITIES

CONTRACT M.P-1

AERATED LAGOON

REGISTERED PROFESSIONAL ENGINEER J. M. MIGNEY PROVINCE OF NEW BRUNSWICK

MACLAREN ATLANTIC LIMITED
CONSULTING ENGINEERS
MONCTON, N.B.

DATE: AUGUST 11, 1967 SCALE: AS NOTED

FILE M-5

APPENDIX C

Appendix C – Sampling Results

Report ID: 236567-IAS
Report Date: 20-Jun-17
Date Received: 30-May-17

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Larry Critchlow
Project #: Not Available

Analysis of Water

RPC Sample ID:			236567-1
Client Sample ID:			Mactaquac Lagoon
Date Sampled:			30-May-17
Analytes	**Units**	**RL**	
CBOD	mg/L	6	< 6
Solids - Total Suspended	mg/L	5	< 5

This report relates only to the sample(s) and information provided to the laboratory.

A. Ross Kean, M.Sc.
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst, B.Sc., C.Chem.
Analytical Chemist
Inorganic Analytical Chemistry

Report ID: 236567-IAS
Report Date: 20-Jun-17
Date Received: 30-May-17

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Larry Critchlow
Project #: Not Available

Analysis of Metals in Water

RPC Sample ID:					236567-2
Client Sample ID:					York Centennial Before Filter
Date Sampled:					30-May-17
Analytes	**Units**	**RL**	MAC	AO	
Arsenic	mg/L	0.001	0.01	-	0.020

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; MAC = Maximum Acceptable Concentration; AO = Aesthetic Objective

Guidelines are from Guidelines for Canadian Drinking Water Quality (February 2017).

Report ID: 236567-IAS
Report Date: 20-Jun-17
Date Received: 30-May-17

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Larry Critchlow
Project #: Not Available

Analysis of Metals in Water

RPC Sample ID:			236567-3
Client Sample ID:			York Centennial After Filter
Date Sampled:			30-May-17
Analytes	**Units**	**RL**	
Arsenic	mg/L	0.001	0.005

This report relates only to the sample(s) and information provided to the laborat

RL = Reporting Limit; MAC = Maximum Acceptable Concentration; AO = A

Guidelines are from Guidelines for Canadian Drinking Water Quality (February 2

Report ID: 236567-IAS
Report Date: 20-Jun-17
Date Received: 30-May-17

CERTIFICATE OF ANALYSIS
for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
CBOD	4.M07	APHA 5210 B	Seeding, incubation, DO measurement (meter)
Solids - Total Suspended	4.M05	APHA 2540 D	Filtration, Gravimetry
Arsenic	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES

Report ID: 241302-IAS
Report Date: 19-Jul-17
Date Received: 07-Jul-17

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Larry Critchlow
Project #: Not Available

Analysis of Water

RPC Sample ID:			241302-1
Client Sample ID:			Mactaquac Lagoon
Date Sampled:			7-Jul-17
Analytes	**Units**	**RL**	
CBOD	mg/L	6	< 6
Solids - Total Suspended	mg/L	5	10

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

A. Ross Kean, M.Sc.
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

Report ID: 241302-IAS
Report Date: 19-Jul-17
Date Received: 07-Jul-17

CERTIFICATE OF ANALYSIS
for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
CBOD	4.M07	APHA 5210 B	Seeding, Incubation, DO measurement (meter)
Solids - Total Suspended	4.M05	APHA 2540 D	Filtration, Gravimetry

Report ID: 246051-IAS
Report Date: 30-Aug-17
Date Received: 17-Aug-17

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Larry Critchlow
Project #: Not Available

Analysis of Water

RPC Sample ID:			246051-1
Client Sample ID:			Mactaquac Lagoon
Date Sampled:			17-Aug-17
Analytes	**Units**	**RL**	
CBOD	mg/L	6	< 6
Solids - Total Suspended	mg/L	5	< 5

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

Krista Skinner
Chemical Technician
Inorganic Analytical Chemistry

Report ID: 246051-IAS
Report Date: 30-Aug-17
Date Received: 17-Aug-17

CERTIFICATE OF ANALYSIS
for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
CBOD	4.M07	APHA 5210 B	Seeding, Incubation, DO measurement (meter)
Solids - Total Suspended	4.M05	APHA 2540 D	Filtration, Gravimetry

Report ID: 285786-IAS
Report Date: 29-Aug-18
Date Received: 20-Aug-18

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Larry Critchlow
Project #: Not Available

Analysis of Water

RPC Sample ID:			285786-5
Client Sample ID:			Mactaquac Lagoon
Date Sampled:			20-Aug-18
Analytes	**Units**	**RL**	
CBOD	mg/L	6	< 6
Solids - Total Suspended	mg/L	5	< 5

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

Peter Crowhurst
Analytical Chemist
Inorganic Analytical Chemistry

Brannen Burhoe
Chemical Technician
Inorganic Analytical Services

Report ID: 285786-IAS
Report Date: 29-Aug-18
Date Received: 20-Aug-18

CERTIFICATE OF ANALYSIS
for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
CBOD	4.M07	APHA 5210 B	Seeding, Incubation, DO measurement (meter)
Solids - Total Suspended	4.M05	APHA 2540 D	Filtration, Gravimetry

Report ID: 318553-IAS
Report Date: 02-Jul-19
Date Received: 20-Jun-19

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Larry Critchlow
Project #: Not Available

Analysis of Water

RPC Sample ID:			318553-1
Client Sample ID:			Mactaquac Lagoon
Date Sampled:			20-Jun-19
Analytes	**Units**	**RL**	
CBOD	mg/L	6	9
Solids - Total Suspended	mg/L	5	12

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

Ross Kean
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst
Analytical Chemist
Inorganic Analytical Chemistry

Report ID: 318553-IAS
Report Date: 02-Jul-19
Date Received: 20-Jun-19

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
CBOD	4.M07	APHA 5210 B	Seeding, Incubation, DO measurement (meter)
Solids - Total Suspended	4.M05	APHA 2540 D	Filtration, Gravimetry

Report ID: 327269-IAS
Report Date: 10-Sep-19
Date Received: 27-Aug-19

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Larry Critchlow
Project #: Not Available

Analysis of Water

RPC Sample ID:			327269-1
Client Sample ID:			Mactaquac Lagoon
Date Sampled:			27-Aug-19
Analytes	**Units**	**RL**	
CBOD	mg/L	6	11
Solids - Total Suspended	mg/L	5	7

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

Ross Kean
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst
Analytical Chemist
Inorganic Analytical Chemistry

Report ID: 327269-IAS
Report Date: 10-Sep-19
Date Received: 27-Aug-19

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
CBOD	4.M07	APHA 5210 B	Seeding, Incubation, DO measurement (meter)
Solids - Total Suspended	4.M05	APHA 2540 D	Filtration, Gravimetry

Report ID: 330554-IAS
Report Date: 02-Oct-19
Date Received: 23-Sep-19

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Larry Critchlow
Project #: Not Available

Analysis of Water

RPC Sample ID:			330554-1
Client Sample ID:			Mactaquac Lagoon
Date Sampled:			23-Sep-19
Analytes	**Units**	**RL**	
CBOD	mg/L	6	7
Solids - Total Suspended	mg/L	5	10

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

Ross Kean
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst
Analytical Chemist
Inorganic Analytical Chemistry

Report ID: 330554-IAS
Report Date: 02-Oct-19
Date Received: 23-Sep-19

CERTIFICATE OF ANALYSIS
for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
CBOD	4.M07	APHA 5210 B	Seeding, Incubation, DO measurement (meter)
Solids - Total Suspended	4.M05	APHA 2540 D	Filtration, Gravimetry

Report ID: 360137-IAS
Report Date: 23-Jul-20
Date Received: 16-Jul-20

CERTIFICATE OF ANALYSIS

for

Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Larry Critchlow
Project #: Not Available

Analysis of Water

RPC Sample ID:			360137-1
Client Sample ID:			Mactaquac Lagoon
Date Sampled:			16-Jul-20
Analytes	**Units**	**RL**	
CBOD	mg/L	6	< 6
Solids - Total Suspended	mg/L	5	< 5

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

Peter Crowhurst, B.Sc., C.Chem.
Director
Inorganic Analytical Chemistry

Brannen Burhoe
Supervisor
Inorganic Analytical Services

Report ID: 360137-IAS
Report Date: 23-Jul-20
Date Received: 16-Jul-20

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
CBOD	4.M07	APHA 5210 B	Seeding, Incubation, DO measurement (meter)
Solids - Total Suspended	4.M05	APHA 2540 D	Filtration, Gravimetry

Report ID: 363780-IAS
Report Date: 21-Aug-20
Date Received: 13-Aug-20

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Larry Critchlow
Project #: Not Available

Analysis of Water

RPC Sample ID:			363780-1
Client Sample ID:			Mactaquac Lagoon
Date Sampled:			13-Aug-20
Analytes	**Units**	**RL**	
CBOD	mg/L	6	< 6
Solids - Total Suspended	mg/L	5	< 5

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

Peter Crowhurst, B.Sc., C.Chem.
Director
Inorganic Analytical Chemistry

Brannen Burhoe
Supervisor
Inorganic Analytical Services

Report ID: 363780-IAS
Report Date: 21-Aug-20
Date Received: 13-Aug-20

CERTIFICATE OF ANALYSIS
for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
CBOD	4.M07	APHA 5210 B	Seeding, Incubation, DO measurement (meter)
Solids - Total Suspended	4.M05	APHA 2540 D	Filtration, Gravimetry

Report ID: 401633-IAS
Report Date: 06-Jul-21
Date Received: 25-Jun-21

CERTIFICATE OF ANALYSIS

for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Larry Critchlow
Project #: Not Available

Analysis of Water

RPC Sample ID:			401633-1
Client Sample ID:			Mactaquac Lagoon
Date Sampled:			25-Jun-21
Analytes	**Units**	**RL**	
CBOD	mg/L	6	< 6
Solids - Total Suspended	mg/L	5	12

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

Peter Crowhurst, B.Sc., C.Chem.
Director
Inorganic Analytical Chemistry

Brannen Burhoe
Supervisor
Inorganic Analytical Services

Report ID: 401633-IAS
Report Date: 06-Jul-21
Date Received: 25-Jun-21

CERTIFICATE OF ANALYSIS
for
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
CBOD	4.M07	APHA 5210 B	Seeding, Incubation, DO measurement (meter)
Solids - Total Suspended	4.M05	APHA 2540 D	Filtration, Gravimetry

Report/Rapport: 453945-ML-W1
Date: 19-Aug-22
Date Received/Reçu: 18-Aug-22

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

for/pour
Mactaquac Provincial Park
1256 Route 105
Mactaquac, NB E6L 1B5

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1368
Fax: 506.452.1395
www.rpc.ca

Attention: Larry Critchlow

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				453945-1
Client Sample ID/ID d'échantillon du client:				Mactaquac Lagoon
Date collected/Date du prélèvement				18-Aug-22
Time sampled/Heure du prélèvement				2:55:00 PM
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
E. coli	FFA01	18-Aug-22	MPN/100mL	1,553.1

This report relates only to the sample(s) and information provided to the laboratory.

Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.

Cathy Hay
Microbiology Supervisor
Applied and Experimental Bioscience

Estela Terruel
Microbiology Technician
Applied and Experimental Bioscience

APPENDIX D

Appendix D – Approval to Operate

APPROVAL TO OPERATE

S-3248

Pursuant to paragraph 8(1) of the *Water Quality Regulation - Clean Environment Act*, this Approval to Operate is hereby issued to:

Department of Tourism, Heritage and Culture

for the operation of the

Mactaquac Provincial Park Domestic Wastewater Treatment Plant

Description of Source:	**Aerated lagoon with a submerged discharge via a 200-mm pipe to the Saint John River (Head Pond). The facility is classified as a Class I wastewater treatment system under the ACWWVCP.**
Source Classification:	**Fees for Industrial Approvals Regulation - Clean Water Act** **Class 16**
Parcel Identifier:	**75132449**
Mailing Address:	**1256 Route 105 Hwy** **Mactaquac, NB E6L 1B5**
Conditions of Approval:	**See attached Schedule "A" of this Approval**
Supersedes Approval:	**S-3036**
Valid From:	**May 15, 2019**
Valid To:	**May 14, 2024**

Recommended by: _____

Issued by: _____ May 16, 2019

for the Minister of Environment and Local Government — Date

SCHEDULE "A"

A. DEFINITIONS

"Accredited" means accreditation to ISO/IEC 17025 by the Standards Council of Canada (SCC), the Canadian Association for Laboratory Accreditation Inc. (CALA), or accreditation to ISO/IEC 17025:2005 from another body that is recognized to grant such accreditation per ISO-IEC 17011 criteria.

"Approval Holder" means the name listed on the Certificate page of this Approval.

"CBOD" or **"Carbonaceous Biochemical Oxygen Demanding Matter"** means the carbonaceous matter that consumes, by biochemical oxidation, oxygen dissolved in water.

"Certified" means a valid certificate of qualification that states the class of the *Operator* issued by the Minister of the New Brunswick Department of Post-Secondary Education, Training and Labour.

"Department" means the New Brunswick Department of Environment and Local Government.

"Environmental Emergency" means a situation where there has been or will be an unauthorized wastewater deposit at a location other than at the *Final Discharge Point* and/or unplanned bypasses of at least one of the treatment processes normally applied to wastewater in the system. Unauthorized deposits include wastewater overflows that are the result of excessive rainfall or snowmelt.

"Final Discharge Point" means the point, other than an *Overflow Point*, of a wastewater works beyond which the *Approval Holder* or operator no longer exercises control over the quality of the wastewater before it is deposited as effluent to the environment.

"Lagoon" means a wastewater treatment facility where the average period during which wastewater is retained for treatment within the wastewater is five (5) days or more.

"Operator" means a person who directs, adjusts, inspects, tests or evaluates an operation or process that controls the effectiveness or efficiency of the wastewater works.

"Overflow Point" means a point of a wastewater work via which excess wastewater may be deposited in the environment and beyond which the *Approval Holder* or operator no longer exercises control over the quality of wastewater before it is deposited as effluent.

"Suspended Solids" means any solid matter contained in effluent that is retained on a filter of 2.0 micrometer (µm) or smaller pore size.

"Total Residual Chlorine" means the sum of free chlorine and combined chlorine, including inorganic chloramines.

B. TERMS AND CONDITIONS

EMERGENCY REPORTING

1. **Immediately** following the discovery of an *Environmental Emergency*, a designate representing the *Approval Holder* shall notify the Environment and Climate Change Canada's National Environmental Emergencies Centre (NEEC) **until personal contact is made** and provide all information, such as: location in latitude and longitudes, flow, time and a brief description known about the *Environmental Emergency*.

   The telephone number for the **Environment and Climate Change Canada's NEEC** is **1-800-565-1633.**

2. Within five (5) days of the time of initial notification, a copy of a Detailed Emergency Report shall be e-mailed or faxed to the Wastewater Approvals Coordinator or Engineer responsible for the regulation of the *Approval Holder*'s wastewater works. The Detailed Emergency Report shall include, as a minimum, the following: i) a description of the problem that occurred; ii) a description of the impact that occurred; iii) a description of what was done to minimize the impact; and iv) a description of what was done to prevent recurrence of the problem.

EFFLUENT PERFORMANCE STANDARDS

3. When the wastewater works is in operation, the *Approval Holder* shall ensure that the annual average concentration of contaminants in the final effluent from the wastewater works does not exceed the following limiting criteria:
   i. *$CBOD_5$*: 25 mg of $CBOD_5$/L (average); and,
   ii. *Suspended Solids:* 25 mg/L (average).

MONITORING AND SAMPLING

4. The *Approval Holder* shall collect a grab sample at the *Final Discharge Point* of the type and at the frequency indicated below:

Operation Type	**Monitoring Frequency[1]**	**Monitoring Parameters**
Yearly or Seasonal	Monthly during operation, but at least 10 days after any other sample	*$CBOD_5$*, *Suspended Solids*, and Flow

[1] When determining the annual average concentration of *Suspended Solids* in the final effluent, the *Approval Holder* shall not take into account any result that was obtained during the month of July, August, September or October, if that result was greater than the limiting criteria.

5. The *Approval Holder* shall ensure that all samples are collected using the methods described in the latest edition of the ISO 5667-10, Water quality - Sampling - Part 10: Guidance on sampling of waste waters.

6. The *Approval Holder* shall ensure that all parameters that are required to be analysed by this Approval, are analysed by *Accredited* laboratories whose accreditation includes the analytical method used to make the determination.

7. The *Approval Holder* shall ensure that all equipment used for monitoring parameters required by this Approval is calibrated in accordance with manufacturer's recommendations.

OPERATOR CERTIFICATION

8. Pursuant to Section 19 of the *Water Quality Regulation*, the Minister gives notice that the *Approval Holder* shall employ and have available a minimum of one (1) Class I Wastewater Treatment *Certified Operator*.

REPORTING

9. The *Approval Holder* shall submit to the *Department* **within 45 days of the end of each year**:

   i. All test results completed as part of the monitoring and sampling requirements of Condition 4 of this Approval;
   ii. A copy of the laboratory certificates;
   iii. A summary report of *Environmental Emergencies* that were reported through the Emergency Reporting procedure described in this Approval;
   iv. All monitoring sample results required by Schedule "B", if applicable; and,
   v. Operational highlights (e.g. new *Operators*, *Operator* certification, *Operator* training, etc.).

Prepared by: _____
Daniel Daley, MIT
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Authorizations Branch

Reviewed by: _____
Mark Glynn, P. Eng.
Manager, Permitting South
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REGISTERED PROFESSIONAL ENGINEER
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Mark L. Glynn
Signature
May 16, 2019
Date
Province du Nouveau-Brunswick
INGÉNIEUR IMMATRICULÉ

LET'S COLLECTIVELY BUILD

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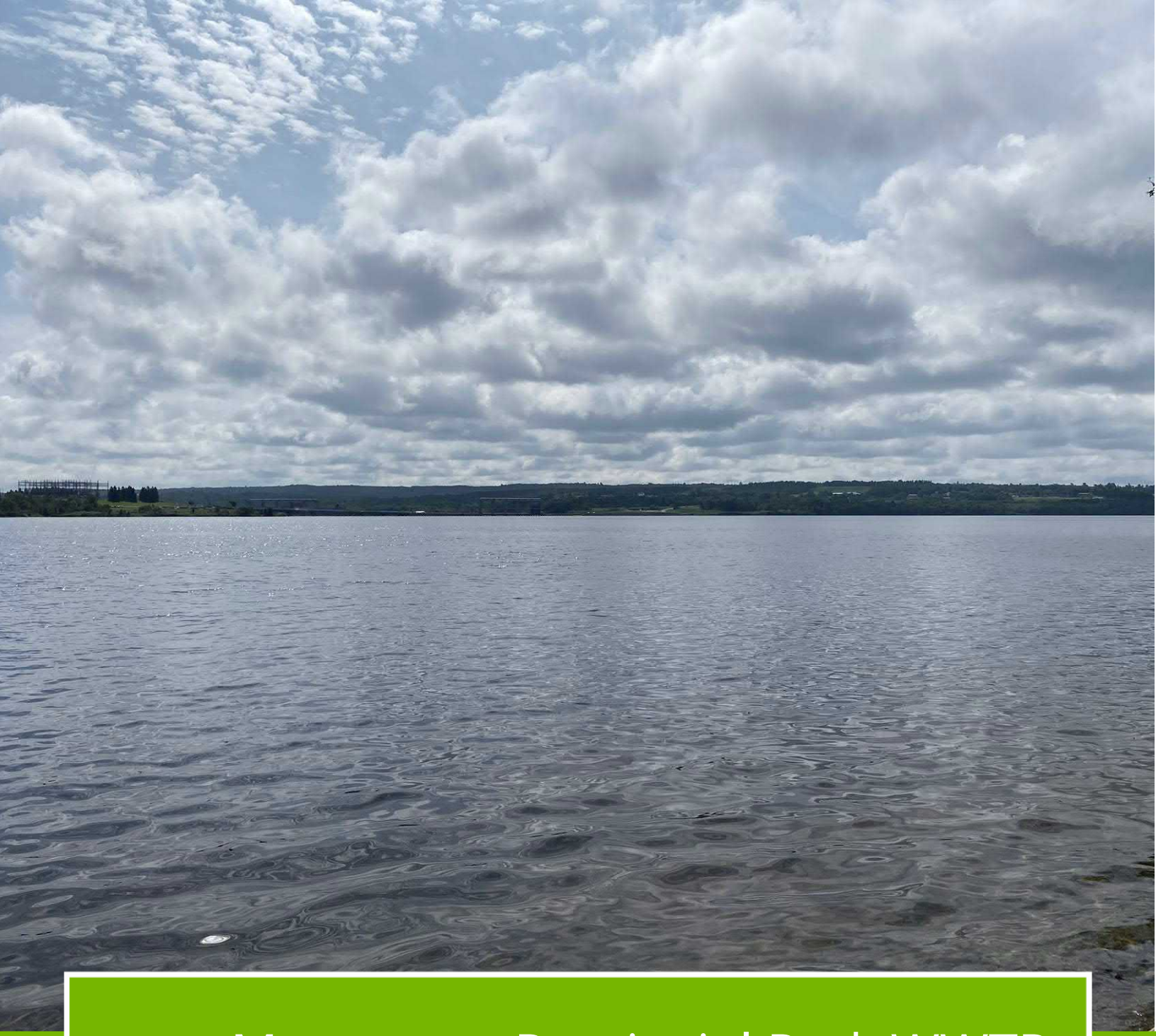
APPENDIX B

Appendix B – CBCL Environmental Risk Assessment



Mactaquac Provincial Park WWTP
Environmental Risk Assessment

DRAFT

CBCL

Project 233250.00 • December 2023

B	DRAFT	SHE	8-Dec-2023	AW
A	DRAFT	SHE	25-Oct-2023	AW
Rev.	Issue	Reviewed By:	Date	Issued By:

Project No. 233250.00

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December 8, 2023

Jonathan Burtt, B.Sc.F., EP
Environmental Specialist
Roy Consultants

Dear Jonathan:

RE: ***Mactaquac Proposed WWTP Environmental Risk Assessment DRAFT***

Enclosed, please find a copy of our Draft Environmental Risk Assessment (ERA) Report, to support the design of the proposed Mactaquac Provincial Park Wastewater Treatment Plant (WWTP), for your review.

This report outlines Environmental Quality Objectives for all parameters of potential concern listed in the Standard Method for a "very small" facility. Environmental Discharge Objectives were calculated for all parameters of potential concern.

If you have any questions or require clarification on the content presented in the attached report, please do not hesitate to contact the undersigned.

Yours very truly,

CBCL Limited

DRAFT

Prepared by:
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Project No.: 233250.00

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1 Background & Objectives

1.1 Introduction

CBCL Limited (CBCL) was engaged by Roy Consultants to complete an Environmental Risk Assessment (ERA) for the proposed Wastewater Treatment Plant (WWTP) at Mactaquac Provincial Park. As this is a proposed WWTP that has not yet been designed, this ERA is intended to serve as a tool to establish design effluent criteria for the design of a replacement WWTP. For this reason, the ERA was completed without the frequency of testing required by the Standard Method outlined in Technical Supplement 3 of the Canada-wide Strategy for the Management of Municipal Wastewater Effluent (Standard Method) for initial wastewater characterization. With the exception of the initial wastewater characterization sampling frequency, the ERA was completed in accordance with the Standard Method.

1.2 Background

In 2009, the Canadian Council of Ministers of the Environment (CCME) implemented the Canada-wide strategy (CWS) for the Management of Municipal Wastewater Effluent. The CWS provides a regulatory framework for managing municipal wastewater effluent focused on improved human health and environmental protection. The CWS requires that all wastewater facilities discharging effluent to surface waters meet the following National Performance Standards (NPS) as a minimum:

- Carbonaceous Biochemical Oxygen Demand for five days ($CBOD_5$) – 25 mg/L.
- Total Suspended Solids (TSS) – 25 mg/L.
- Total Residual Chlorine (TRC) – 0.02 mg/L.

The Wastewater Systems Effluent Regulations (WSER) are federal regulations for wastewater effluent in Canada that came into effect in 2015 under the Fisheries Act. The WSER include the above NPS as well as the following criteria:

- Un-ionized ammonia – 1.25 mg/L, expressed as nitrogen (N) at 15°C ± 1°C.

The NPS address the most common pollutants in municipal wastewater effluent; however, in addition to the NPS, the CWS requires all facilities develop site-specific Effluent Discharge Objectives (EDOs) to address substances not included in the NPS. EDOs address specific substances of concern for a particular discharge environment such as nutrients, metals, and pathogens identified through a site-specific ERA. EDOs are substance concentrations

that can be discharged in the effluent and still provide adequate protection of human health and the environment.

The ERA includes characterization of the effluent to determine substances of concern, and characterization of the receiving water to determine beneficial water uses, ambient water quality, assimilative capacity, and available dilution. A compliance monitoring program is then developed and implemented to ensure adherence to the established EDOs for the facility.

1.3 Facility Description

A replacement Wastewater Treatment Plant (WWTP) is proposed to service the Mactaquac Provincial Park as the condition of the existing facility was deemed inadequate. The replacement WWTP will include the installation of a new outfall to discharge effluent to the Mactaquac Park Arm within the Saint John River. The proposed new outfall location is shown in Figure 1.1.

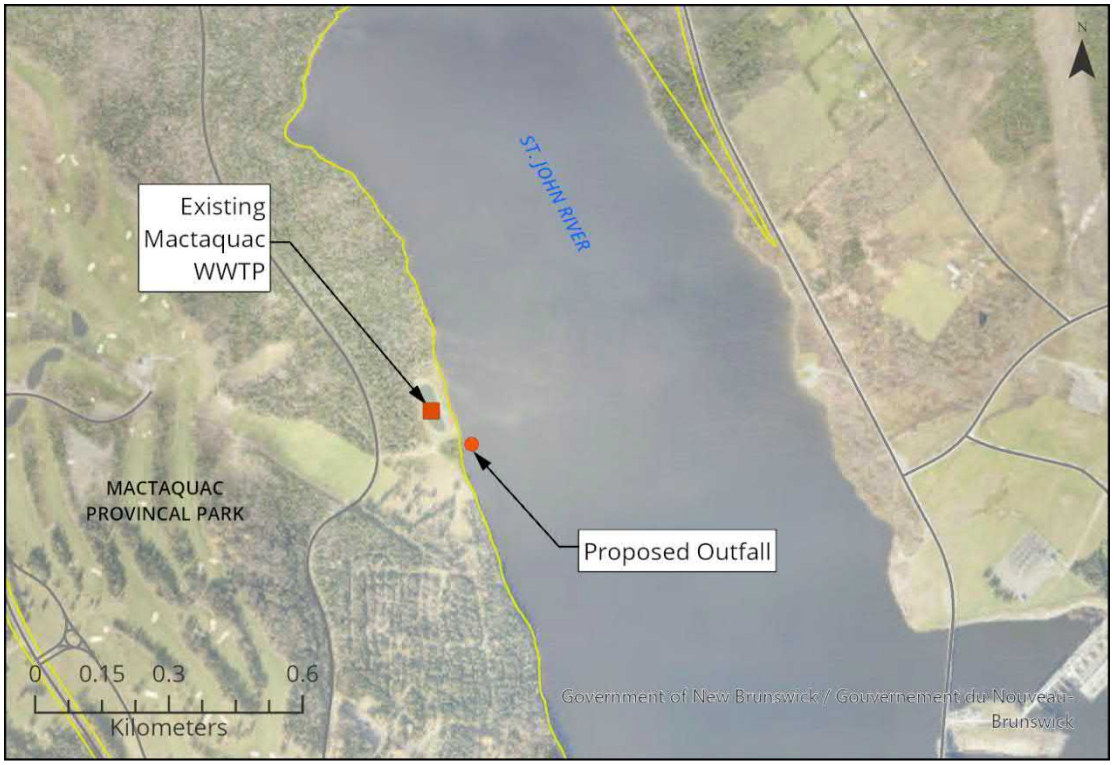

Figure 1.1: Proposed Outfall Location for Replacement WWTP

The design Average Day Flow (ADF) for the proposed WWTP is 340 m^3/d and the design Peak Day Flow (PDF) is 785 m^3/d. As the proposed WWTP is currently in the design phase, the effluent objectives developed in this ERA will be considered in technology selection and design of the proposed WWTP.

2 Initial Effluent Characterization

2.1 Substances of Potential Concern

An initial characterization program covering a one-year period is typically required by the Standard Method to characterize the effluent and identify substances of concern. As this ERA is being conducted for a WWTP that is scheduled for replacement, and the ERA is being conducted for the purpose of determining effluent objectives for the design of a new WWTP, the effluent characterization program has not been completed.

For the purposes of the ERA, the design ADF for the replacement WWTP of 340 m^3/d will be used. Based on the ADF, the facility is classified as a "very small facility" (≤500 m^3/d) as per the CCME municipal wastewater facility size categories.

The substances of potential concern for a "very small" facility, as per the Standard Method, are summarized in Table 2.1. There were no additional substances of potential concern identified to be monitored as there is no industrial input to the wastewater system.

Table 2.1: Substances of Potential Concern for a Very Small Facility

Substance Group	Substances
General Chemistry/Nutrients	Total Suspended Solids (TSS) Carbonaceous Biochemical Oxygen Demand ($CBOD_5$) Total Residual Chlorine (TRC) (if chlorination is used) Total Ammonia Nitrogen Total Kjeldahl Nitrogen (TKN) Total Phosphorus (TP) pH Temperature
Pathogens	*E. coli*

2.1.1 Whole Effluent Toxicity

Wastewater effluent potentially contains a variety of unknown and unidentified substances for which guidelines do not exist. In order to adequately protect against these unknown substances, Whole Effluent Toxicity (WET) tests are typically conducted to evaluate acute (short-term) and chronic (long-term) effects.

The Standard Method requires the following toxicity tests be conducted quarterly:

- Acute Toxicity – Rainbow Trout and *Daphnia magna.*
- Chronic Toxicity – Fathead Minnow and *Ceriodaphnia dubai*.

A draft for discussion, *Mixing Zone Assessment and Report Template*, dated July 6, 2016, that was prepared by a committee of representatives of the environment departments in Atlantic Canada noted that only *Ceriodaphnia dubai* is required for chronic toxicity. If the test does not pass, a fathead minnow test is required.

As the purpose of the ERA is to determine effluent discharge objectives for the design of a new WWTP, no WET tests were conducted at this time.

2.2 Effluent Characterization Results

As the purpose of this ERA is to determine design objectives for a new WWTP, effluent characterization data is not available; however, the proposed facility will be designed to remove solids, organics, and possibly ammonia.

3 Environmental Quality Objectives

Generic Environmental Quality Objectives (EQOs) are generated from established guidelines, typically the WSER, Canadian Environmental Quality Guidelines (CEQGs) and other guidelines specific to the jurisdiction.

Effluent is required to be non-acutely toxic at the end of pipe and non-chronically toxic at the edge of the mixing zone.

EQOs can be determined by three different approaches:

- Physical/chemical/pathogenic – describes the levels of particular substances of concern (metals, pathogens) that will protect water quality.
- Whole Effluent Toxicity (WET) – describes the proportion of effluent that can enter the receiving water without causing toxicological effects (both acute and chronic).
- Biological criteria (bio-assessment) – described the level of ecological integrity that must be maintained.

The following assessment follows the physical/chemical/pathogenic approach from the Standard Method outlined in the CCME guidelines.

3.1 Water Uses

EQOs are numerical values and narrative statements established to protect the receiving water, which in the case of the Mactaquac WWTP is the Mactaquac Park Arm within the Saint John River. In order to determine EQOs, the potential beneficial uses of the receiving water must be determined.

The following beneficial water uses have been identified for the Mactaquac Park Arm:

- Direct contact recreational activities like swimming and wading at the beach nearby (Mactaquac Beach).
- Secondary contact recreational activities like boating and fishing.
- Ecosystem health for fisheries and freshwater aquatic life.

3.2 Ambient Water Quality

Generic EQOs are first developed based on existing guidelines and are then adjusted based on site-specific factors, particularly background water quality. Water quality data was obtained for three locations in the Mactaquac Park Arm. An ambient water quality sample was collected by CBCL and Roy Consultants on August 15, 2023. The sample was collected upstream of the existing outfall. The sample collection location is indicated in Figure 3.1 and a summary of the ambient water quality data is shown in Table 3.1.

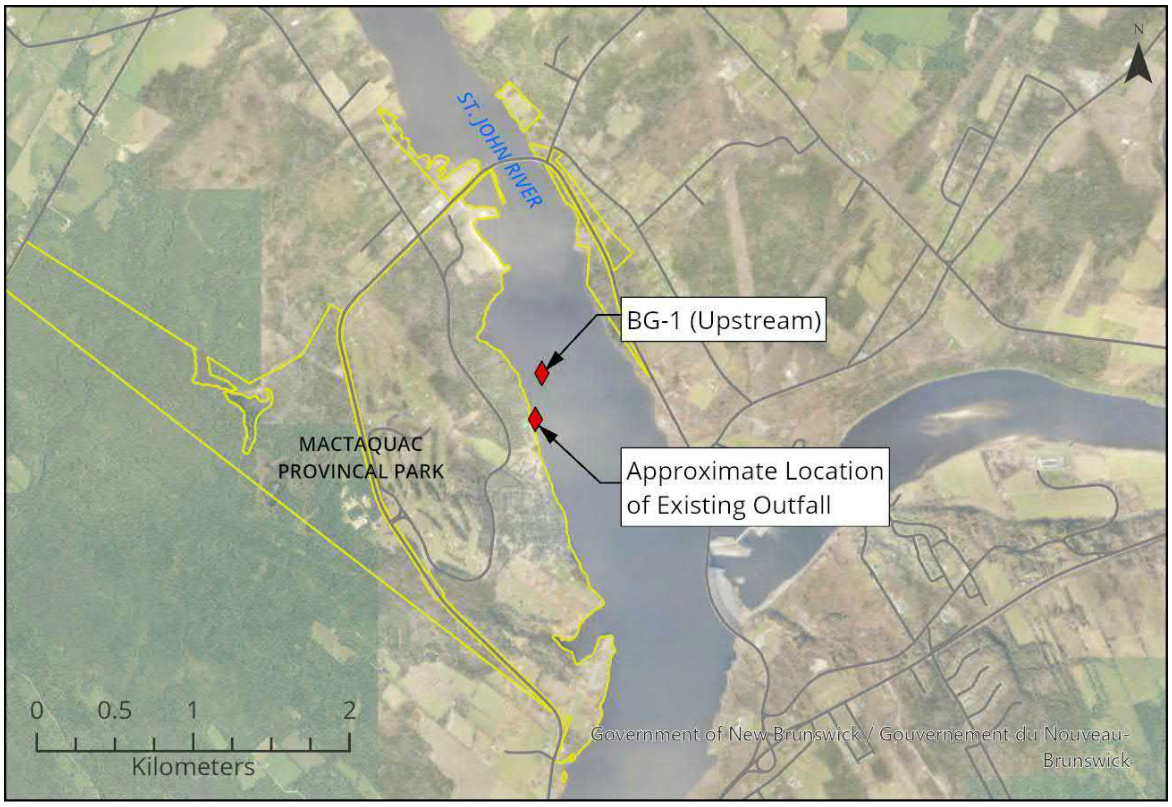

Figure 3.1: Ambient Water Quality Sample Location

Table 3.1: Ambient Water Quality Data

Parameter	Units	Value
Carbonaceous BOD	mg/L	<6
Total Suspended Solids	mg/L	<5
Nitrogen (Ammonia Nitrogen)	mg/L	<0.05
Total Kjeldahl Nitrogen	mg/L	<0.25
Total Phosphorus	mg/L	0.032
pH	-	7.48
Temperature	°C	21.4
Total Residual Chlorine	mg/L	<0.05
Total Coliforms	MPN/100 mL	110.6

Parameter	Units	Value
E. coli	MPN/100 mL	3.1
Dissolved Oxygen (DO)	mg/L	10.8

3.3 Physical/Chemical/Pathogenic Approach

The physical/chemical/pathogenic approach is intended to protect the receiving water by ensuring that water quality guidelines for particular substances are met. EQOs are established by specifying the level of a particular substance that will protect water quality. Substance levels that will protect water quality are taken from the CEQGs associated with the identified beneficial water uses. If more than one guideline applies, the most stringent is used. Typically, the Canadian Water Quality Guidelines (CWQGs) for the Protection of Aquatic Life are the most stringent and have been used for this assignment. The guidelines for Canadian Recreational Water have also been used to provide limits for pathogens *(E. coli)*.

The guidelines for the Protection of Aquatic Life provide recommendations for both freshwater and marine (including estuarine) environments. Since the receiving water in this case is a freshwater environment, the freshwater guidelines were used, where available.

Site-specific EQOs are derived in the following sections for each substance of potential concern.

3.3.1 General Chemistry/Nutrients

As noted in Table 2.1, the following general chemistry and nutrient parameters were identified as substances of potential concern for a very small facility:

- Carbonaceous Biochemical Oxygen Demand.
- Total Suspended Solids.
- Un-ionized Ammonia.
- Total Ammonia Nitrogen.
- Total Kjeldahl Nitrogen.
- Total Phosphorus.
- pH.
- Total Residual Chlorine.

Site specific EQOs for these substances are established in the following sections.

3.3.1.1 Oxygen Demand

Biochemical Oxygen Demand (BOD) is a measure of the oxygen required to oxidize organic material and certain inorganic materials over a given period of time, typically measured over five days (BOD_5). BOD has two components: carbonaceous oxygen demand and nitrogenous oxygen demand.

Carbonaceous Biological Oxygen Demand (CBOD) measures the amount of biodegradable carbonaceous material in the effluent that will require oxygen to break down over a given period of time, typically measured over five days ($CBOD_5$). The CBOD discharged in wastewater effluent reduced the amount of dissolved oxygen in the receiving water. Dissolved Oxygen (DO) is an essential parameter for the protection of aquatic life; and the higher the CBOD concentration, the less oxygen that is available for aquatic life.

Traditionally, performance standards have been set for BOD; however, the WSER dictate a limit for $CBOD_5$ due to variable effects of nitrogenous oxygen demand on the BOD_5 test.

There are no CWQGs for the protection of aquatic life for $CBOD_5$ in freshwater or in marine waters; however, the WSER requires that CBOD concentrations be less than **25 mg/L (at the discharge)**. For the purposes of this study, the EQO for CBOD was chosen based on this regulation.

3.3.1.2 Total Ammonia & Un-ionized Ammonia

The CWQG for the protection of aquatic life for total ammonia in freshwater is presented as a table based on pH and temperature. Total ammonia is comprised of un-ionized ammonia (NH_3) and ionized ammonia (NH_4^+, ammonium). Un-ionized ammonia is more toxic than ionized ammonia and the toxicity of total ammonia is related to the concentration of un-ionized ammonia present. The amount of un-ionized ammonia is variable depending on pH and temperature, which is why the total ammonia guideline is given by pH and temperature. Table 3.2 shows the CWQGs for total ammonia, as reproduced from the guidelines.

Table 3.2: CWQG for Total Ammonia (mg/L NH_3) for the Protection of Aquatic Life (freshwater)

Temp (˚C)	pH							
	6.0	6.5	7.0	7.5	8.0	8.5	9.0	10
0	231	73.0	23.1	7.32	2.33	0.749	0.250	0.042
5	153	48.3	15.3	4.84	1.54	0.502	0.172	0.034
10	102	32.4	10.3	3.26	1.04	0.343	0.121	0.029
15	69.7	22.0	6.98	2.22	0.715	0.239	0.089	0.026
20	48.0	15.2	4.82	1.54	0.499	0.171	0.067	0.024
25	33.5	10.6	3.37	1.08	0.354	0.125	0.053	0.022
30	23.7	7.5	2.39	0.767	0.256	0.094	0.043	0.021

Notes:

- It is recommended in the guidelines that the most conservative value be used for the pH and temperature closest to the measured conditions (e.g., the guideline for total ammonia at a temperature of 6.9˚C and pH of 7.9 would be 1.04 mg/L).
- According to the guideline, values falling outside of shaded area should be used with caution.
- Values in the table are for Total Ammonia (NH_3); they can be converted to Total Ammonia Nitrogen (N) by multiplying by 0.8224.

Based on Table 3.1, the background temperature of 21.4℃ and pH of 7.48, the EQO for total ammonia in the receiving water is **1.54 mg/L**.

The WSER requires that un-ionized ammonia concentrations be less than 1.25 mg/L at the discharge point. For the purposes of this study, the EQO for un-ionized ammonia was chosen based on the WSER limit of **1.25 mg/L at the discharge**.

3.3.1.3 Total Suspended Solids

The WSER specifies a TSS limit of 25 mg/L at the end of the pipe. The CWQG for the protection of aquatic life in fresh water for TSS is as follows:

- During periods of clear flow, maximum increase of 25 mg/L from background levels for any short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg/L from background levels for longer term exposures (e.g., inputs lasting between 24 h and 30 d).
- During periods of high flow, a maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. Should not increase more than 10% of background levels when background is >250 mg/L.

The background concentration of TSS was an average of 3 mg/L. A maximum average increase of 5 mg/L from background levels would result in an EQO of 8 mg/L. As this is below the WSER criteria, both an EQO of **8 mg/L (in the receiving water)** and the WSER criteria of **25 mg/L (at the discharge)** will be considered in determining the EDO.

3.3.1.4 Nutrients

There are no CWQGs for the protection of aquatic life for phosphorus or nitrogen; however, in both freshwater and marine environments, adverse secondary effects like eutrophication and oxygen depletion can occur.

Guidance frameworks have been established for freshwater systems and marine systems to provide an approach for developing site-specific water quality guidelines. These approaches are based on determining a baseline condition and evaluating various effects according to indicator variables. The approach is generally very time and resource intensive but can be completed on a more limited scale to establish interim guidelines.

The CCME document *Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems* recommends that phosphorus concentrations should not (i) exceed predefined 'trigger ranges'; and (ii) increase more than 50% over the baseline (reference) levels.

The Canadian Guidance Framework for phosphorus provides trigger ranges for total phosphorus, as follows:

- Ultra-oligotrophic <4 µg/L.
- Oligotrophic 4-10 µg/L.
- Mesotrophic 10-20 µg/L.
- Meso-eutrophic 20-35 µg/L.
- Eutrophic 35-100 µg/L.
- Hyper-eutrophic >100 µg/L.

The background phosphorus concentration of 32 µg/L falls at the top of the meso-eutrophic range; however, a Mactaquac Aquatic Ecosystem Study published in 2018 (Nguyen, 2018) estimated the trophic status of the water to be eutrophic based on the Myxophycean index, which is a ratio of Cyanobacteria to Desmidiales species. The trophic status estimation was also consistent with an assessment of trophic status based on secchi disc depth in the 2018 study; therefore, for the purpose of this study, a eutrophic trigger status will be applied.

Phosphorus concentrations should not exceed the upper limit of 100 µg/L for the eutrophic trigger range and should not increase more than 50% over the baseline level of 32 µg/L (or 48 µg/L). A concentration of **48 µg/L** will be applied as the EQO for phosphorus as it is the more conservative limit.

3.3.1.5 pH

The CWQG for the protection of aquatic life in fresh water is **6.5 to 9.0**. This pH range will be applied as the EQO.

3.3.1.6 Total Residual Chlorine

The WSER requires that TRC concentrations be less than 0.02mg/L. Due to this regulation, the EQO for TRC of **0.02mg/L** was chosen; however, the new WWTP will use ultraviolet (UV) disinfection rather than chlorine so the TRC limit will not be applicable.

3.3.2 Pathogens

3.3.2.1 *E. coli*

Pathogens are not included in the CCME WQGs for the protection of aquatic life. The Health Canada Guidelines for Canadian Recreational Water Quality specify a maximum *E. coli* concentration of 200 *E. coli* / 100 mL for freshwater for primary contact recreation and 1000 *E. coli* / 100 mL for secondary contact recreation.

The background concentration of *E.coli* was 3.1 MPN/100mL. An EQO of **200 *E. coli*/100 mL** will apply for primary contact in the receiving water. An EQO of **1000 *E. coli*/100 mL** based on the Guidelines for Canadian Recreational Water Quality for secondary contact for freshwater will apply elsewhere in the receiving water.

3.3.3 Summary

Table 3.3 provides a summary of the generic and site-specific EQOs determined for parameters of concern. The source of the EQO has been included in the table as follows:

- WSER – Wastewater Systems Effluent Regulations.
- CWQG Freshwater – CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life Freshwater.
- CGF, Freshwater – Canadian Guidance Framework for the Management of Freshwater Systems: Phosphorus
- HC Primary Contact – Health Canada Guidelines for Canadian Recreational Water Quality – Primary Contact Recreation.
- HC Secondary Contact – Health Canada Guidelines for Canadian Recreational Water Quality – Secondary Contact Recreation.

Table 3.3: EQO Summary

Parameter	Generic EQO	Background	Selected EQO	Source
Carbonaceous BOD (mg/L)	**25**	<6	**25**(1)	**WSER**
Total Suspended Solids (mg/L)	**25**	<5	**25**(1)	**WSER**
	8		8	CWQG, Freshwater
Nitrogen (Ammonia Nitrogen) (mg/L)	1.54	<0.05	1.54	CWQG, Freshwater
Un-ionized Ammonia (mg/L)	**1.25**	0.0	**1.25**(1)	**WSER**

Parameter	Generic EQO	Background	Selected EQO	Source
Total Phosphorus (mg/L)	0.048	0.032	0.048	CGF, Freshwater
pH	6.0-9.0	7.48	6.0-9.0	CWQG, Freshwater
Total Residual Chlorine (mg/L)	**0.02**	<0.05	**0.02**(1)	**WSER**
E. coli (MPN/100mL)	200	3.1	200	HC Primary Contact
	1,000		1,000	HC Secondary Contact

Notes:

- Bold indicates EQO is a WSER requirement.
- (1) EQO applies at the end of the pipe.

4 Mixing Zone Analysis

4.1 Methodology

4.1.1 Definition of a Mixing Zone

A mixing zone is the portion of the receiving water where effluent dilution occurs. Effluent does not instantaneously mix with the receiving water at the point of discharge. Rather, the effluent is mixed through natural processes and diluted with the receiving water. Depending on conditions like ambient currents, wind speeds, and water levels, mixing can take place over a large area, to the point where there is no measurable difference between the receiving water and the effluent mixed with receiving water.

The mixing process can be characterized into two distinct phases: near-field and far-field. Near-field mixing occurs at the outfall and is primarily influenced by the configuration of the outfall (e.g. pipe size, diffusers, etc.) in relation to the receiving water's currents and water levels at the point of discharge. Far-field mixing is influenced by the general bathymetry, ambient water circulation and stratification of the receiving water body.

A number of general criteria for allocating a mixing zone are recommended in the Standard Method including the following:

- The dimensions of a mixing zone should be restricted to avoid adverse effects on the designated uses of the receiving water system (i.e., the mixing zone should be as small as possible).
- Conditions outside of the mixing zone should be sufficient to support all of the designated uses of the receiving water system.
- A zone of passage for mobile aquatic organisms must be maintained.
- Placement of mixing zones must not block migration into tributaries.
- Changes to the nutrient status of the water body as a result of an effluent discharge should be avoided; eutrophication or toxic blooms of algae are unacceptable impacts.
- Mixing zones for adjacent wastewater discharges should not overlap, and
- Adverse effects on the aesthetic qualities of the receiving water system (e.g., odour, colour, scum, oil, floating debris) should be avoided (CCME, 2008).

The limits of the mixing zone may be defined for the following three categories of aquatic environments based on their physical characteristics:

- Streams and rivers.
- Lakes, reservoirs, and enclosed bays.
- Estuarine and marine waters.

Where several limits are in place, the first one to be reached sets the maximum extent of the mixing zone allowed for the dilution assessment. Nutrients and fecal coliforms are not allocated any maximum dilution. For fecal coliforms, the location of the water use must be considered and protected by the limits of the mixing zone.

Based on these general guidelines, mixing zone extents must be defined on a case-by-case basis that account for local conditions. It may also be based on arbitrary mixing zone limits for open water discharges, e.g., a 100 m (Environment Canada, 2006) or 250 m (NB Department of Environment, 2012) radius from the outfall and/or a dilution limit. The draft for discussion document *Mixing Zone Assessment and Report Templates* dated July 6, 2016, prepared by a committee of representatives of the environment departments in Atlantic Canada, provides guidance regarding mixing zones for ERAs in the Atlantic Provinces. This document recommends that chronic toxicity should be restricted to the edge of the allocated mixing zone. For lakes, the distance of interest for far-field dilution should be taken 100 m from the outfall.

Finally, the assessment shall be based on "critical conditions". For example, in the case of a river discharge, "critical conditions" can be defined as the seven-day average low river flow for a given return period. The Standard Method provides the following guidance on Effluent Discharge Objective (EDO) development:

"…reasonable and realistic but yet protective scenarios should be used. The objective is to simulate the critical conditions of the receiving water, where critical conditions are where the risk that the effluent will have an effect on the receiving environment is the highest – it does not mean using the highest effluent flow, the lowest river flow, and the highest background concentration simultaneously."

As a plausible worst-case condition used for the receiving water, the WWTP effluent was modelled based on average summer flow, rather than a maximum daily or hourly flow, as applying a critical high flow condition for the effluent simultaneously with a worst-case summer low flow condition in the receiving water would result in overly conservative EDOs as this scenario does not provide a reasonable or realistic representation of actual conditions.

4.1.2 Far-field Modelling Approach

CBCL developed a hydrodynamic model of the receiving coastal waters using the Danish Hydraulic Institute's MIKE21 model. MIKE21 is well suited to the study of outfall discharges in shallow river and coastal areas where depth-average currents drive the dispersion process.

The numerical model domain with location of the modelled outfall is shown in Figure 4.1. Model resolution in the area of the outfall is in the order of 5 to 10 m. The model was run for a simulated thirty-day period to ensure the effluent concentrations stabilize in the receiving waters after the initial effluent inputs period.

The hydrodynamic model has not been calibrated or validated due to the lack of local observations at the project site. For this type of desktop modelling study, we expect the modelled currents the site to be generally representative of local conditions under a typical summer flow regime, as there is reasonable confidence in the model bathymetry, as well as river flows used as boundary conditions. Non-river components generated by winds, waves or occasional boat wakes are not included.

4.1.3 Model Domain & Outfall Location

Local river bathymetry data was derived from the CHS Non-Navigable (NONNA) dataset. Interpolated bathymetry in the project area is presented in Figure 4.1. There was no recent site-specific bathymetric survey with high resolution in the proposed outfall area, which implies some uncertainty related to the local nearshore bathymetry. For modelling purposes, the discharge point is assumed to be approximately 30 m away from shore in 5 m water depth at coordinates N5091724.88 m E663872.22 m UTM19.

4.1.4 River Flows

Ambient flow at the project site is largely controlled by river flows and water levels regulated by the Mactaquac Dam. NB Power provided a 12-year time-series of hourly dam flows from 2009 to 2020, as shown in Figure 4.2.

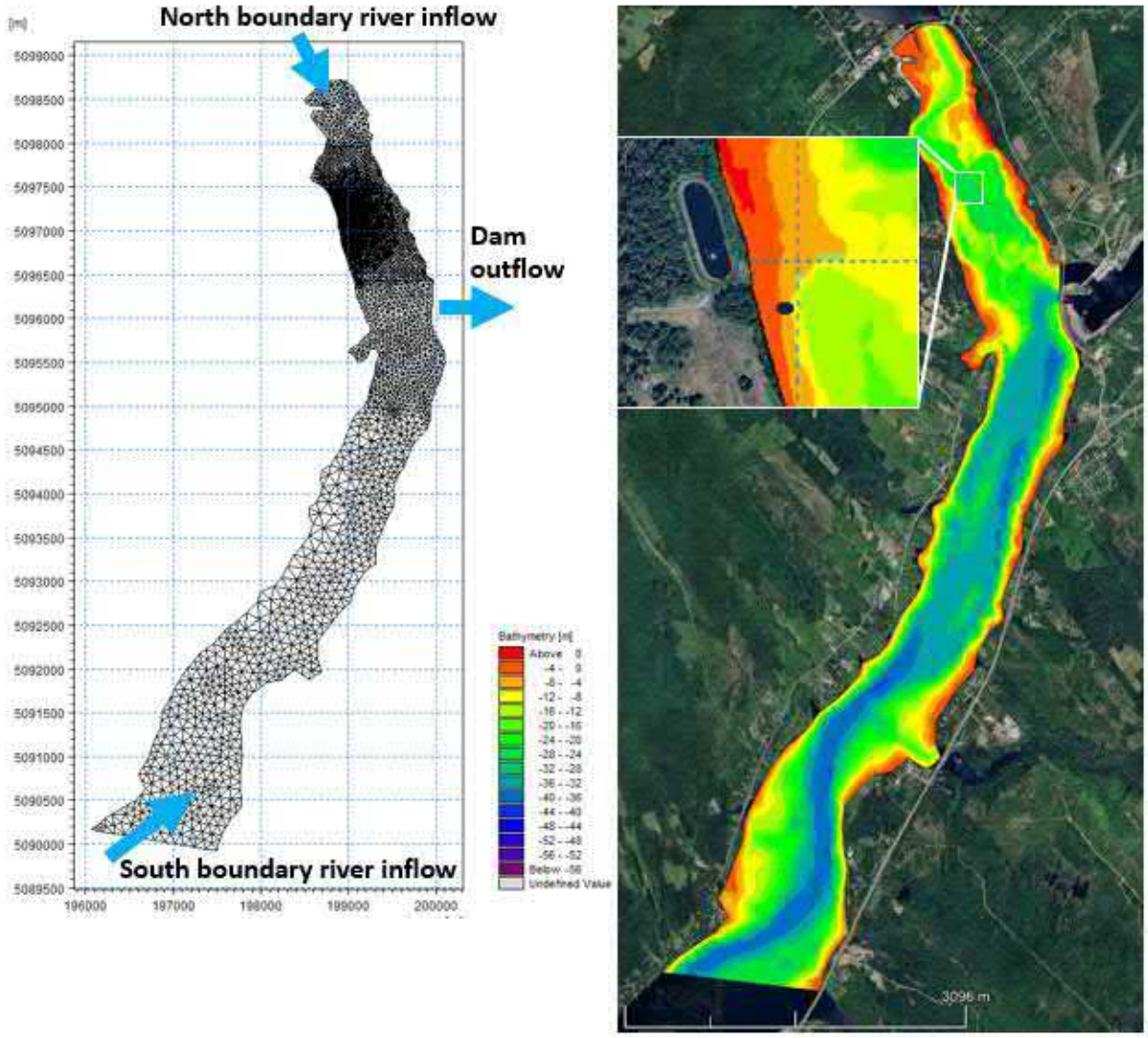

Figure 4.1: Numerical Modelling Mesh (Left), Bathymetry (right) and Outfall Location (inset)

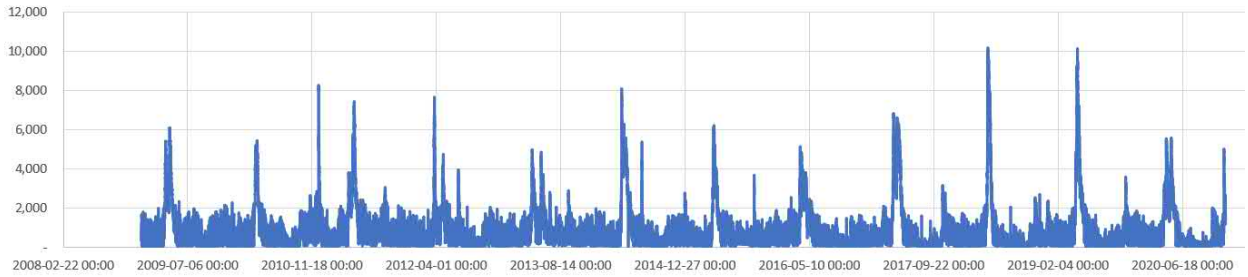

Figure 4.2: Numerical Time-series of hourly dam flows 2009-2020 (Source: NB Power)

CBCL completed a statistical analysis of the dam flows to estimate the low summer flow representative of the past 12 years, as well as the annual average. The flows were then pro-rated based on watershed area to derive boundary inflows to the model's south and north river branches, shown inTable 4.1.

Table 4.1: Model River Flow Inputs (m^3/s)

	Dam outflow	South boundary river inflow	North boundary river inflow
% of watershed area to the dam	100%	95%	5%
Low summer flow (m^3/s)	147	140	7
Annual average (m^3/s)	827	786	41

Notes:

- Table 4.1 is based on flow analyses from Mactaquac Dam measured over the 12-year period 2009-2020.
- Low summer flow was estimated as the average of the twelve 7-day annual minima calculated over the 12-year period 2009-2020.

The outfall is located within the north branch of the Mactaquac reservoir which receives only 5% of the watershed inflows to the dam; therefore, for the purposes of the mixing zone assessment, the receiving water body should be considered a lake.

4.1.5 Effluent Flows

- **The summer effluent flow used for modelling was 785 m^3/day (maximum), i.e., 0.009 m^3/s, while the average value is assumed at 340 m^3/day or 0.004 m^3/s.**
- Summer effluent flows represent a factor of approximately 800 to 1,700 times less than the low summer inflow for the north branch of the lake.
- The effluent flows are about 23 times less during the winter (Roy Consultants, 2022), which was not modelled.

4.2 Modelled Effluent Dilution

Composite images of average effluent concentrations for maximum summer effluent flow (shown in %, on a scale of 0 to 100%) are shown in Figure 4.3 through Figure 4.6. High effluent concentrations are mostly located along the shoreline where the water is shallower.

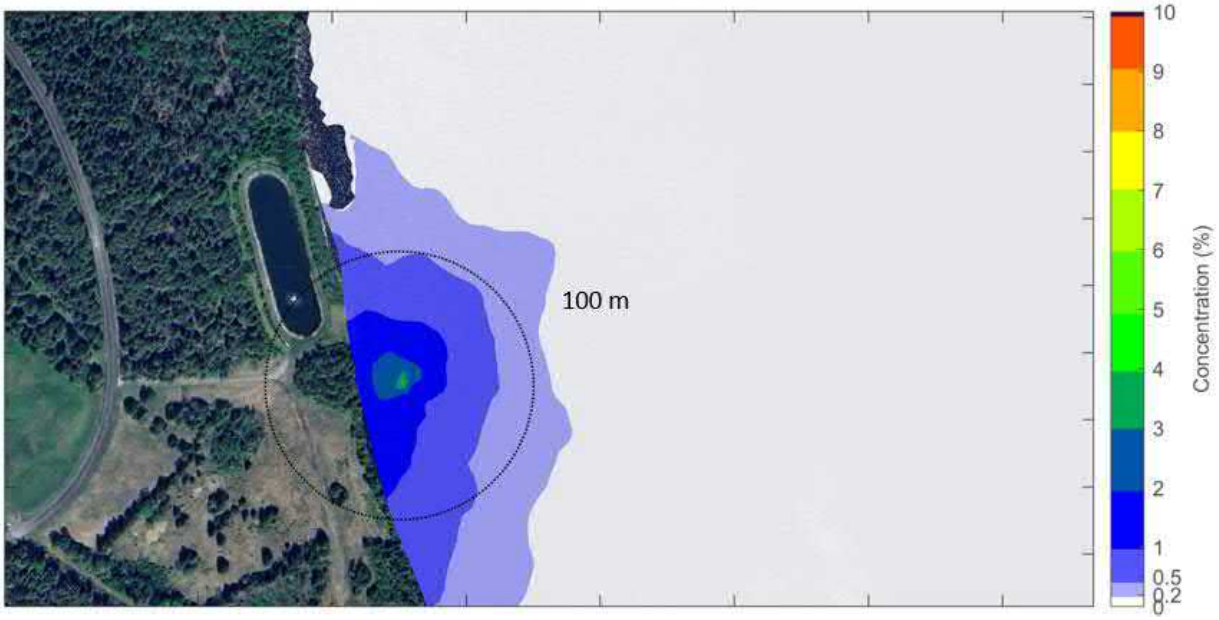

Figure 4.3: Composite Image of Modelled Mean Effluent Concentrations (%) During Low Summer River Flow.

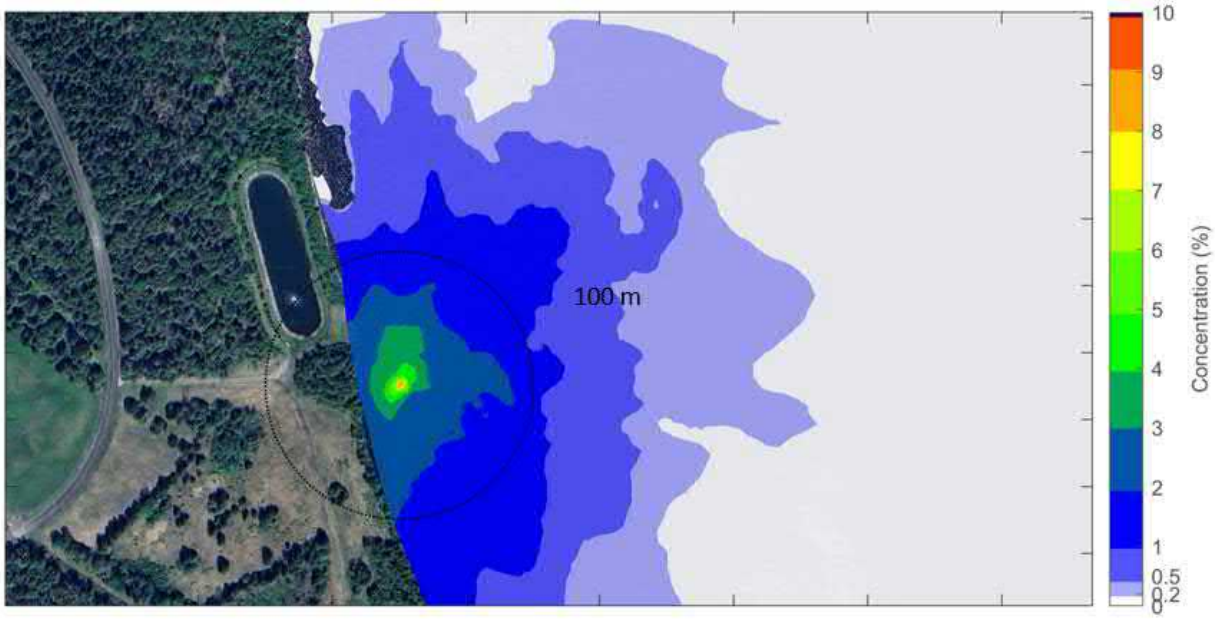

Figure 4.4 : Composite Image of Modelled Maximum Effluent Concentrations (%) During Low Summer River Flow

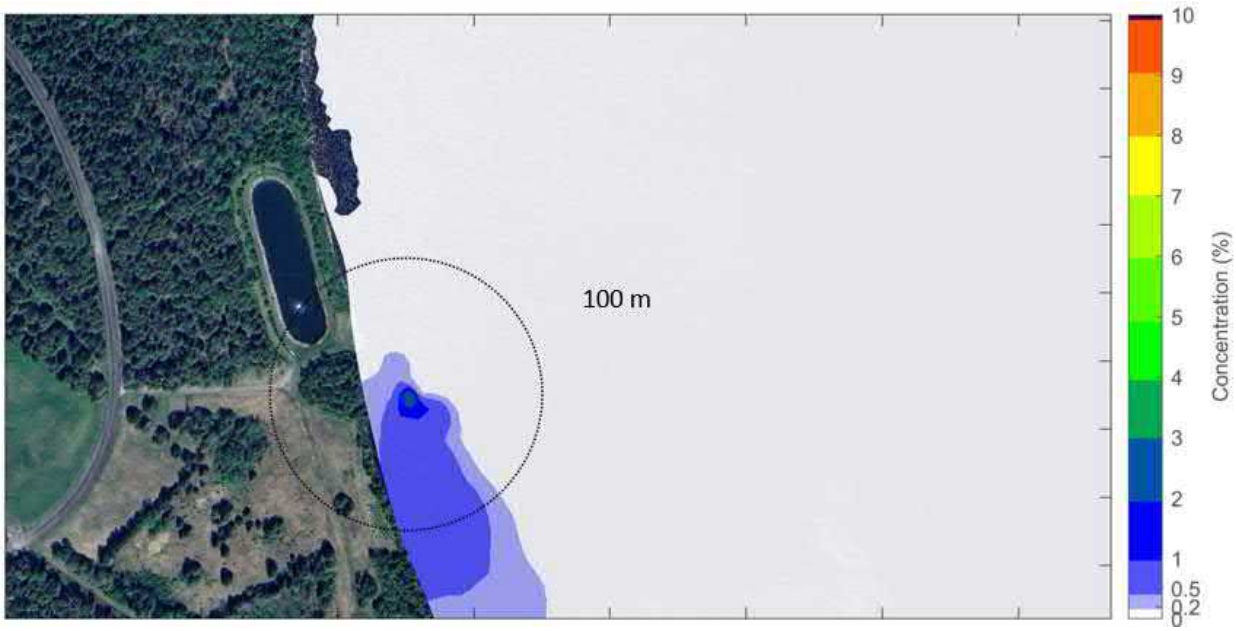

Figure 4.5: Composite Image of Modelled Mean Effluent Concentrations (%) During Annual Average River Flow.

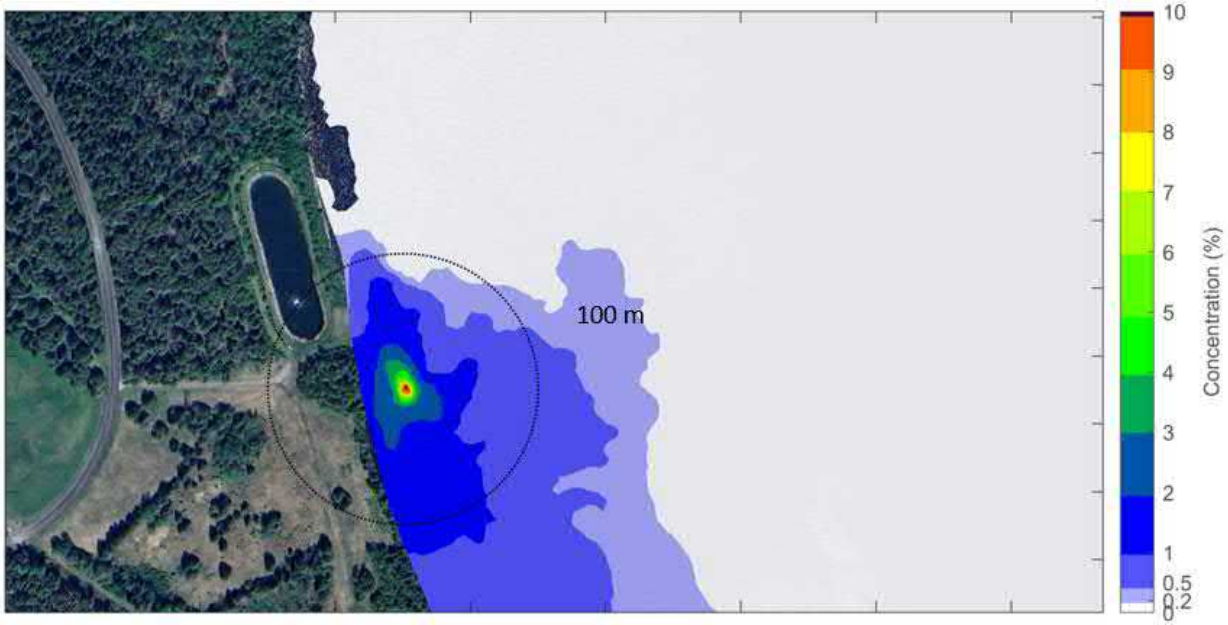

Figure 4.6: Composite Image of Modelled Maximum Effluent Concentrations (%) During Annual Average River Flow.

Effluent concentration peaks at any given location are short-lived because the plume is changing direction depending on ambient flows. A time series of modelled hourly concentrations is shown in Figure 4.7. These are modelled values taken along the 100 m distance from the outfall.

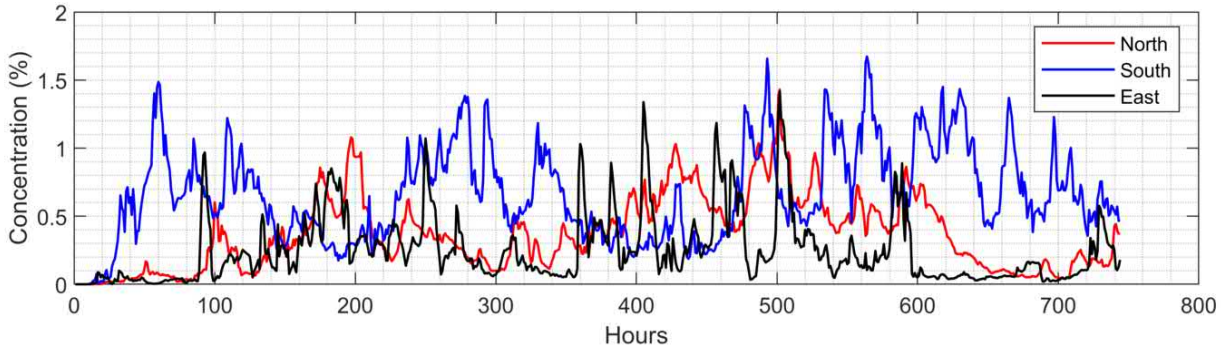

Figure 4.7: Time Series of Modelled Effluent Concentration 100 m From the Outfall During Low Summer River Flow (x-axis represents hours of simulation equivalent to one month).

Typically, a representative dilution criterion at the mixing zone limit is best calculated using an average value. We propose to use the one-day average effluent concentration criteria over the one-month modelling simulation, which covers a representative combination of site-specific conditions. Modelled dilution values at 100 m from the outfall are shown in Table 4.2. The dilution values are given as hourly maximum concentrations (as shown in Figure 4.7 and concentrations that are averaged over 1-, 7- and 30-day periods.

Table 4.2: Statistics of Modelled Effluent Concentration and Associated Dilution Values 100 m from The Outfall for Maximum Summer Effluent Flow Rate

River Flow		Hourly Maximum	Maximum 1-Day Average	Maximum 7-Day Average	1-Month Average
Low summer	Concentration	1.7 %	0.8 %	0.6 %	0.5 %
	Dilution	59:1	125:1	167:1	200:1
Annual average	Concentration	1.1 %	0.4 %	0.2 %	0.2 %
	Dilution	91:1	250:1	500:1	500:1

Note:

- The above values are for a maximum effluent flow of 785 m3/day. For the average effluent flow of 340 m3/day, concentrations should be scaled down and dilution ratios scaled up by a factor of 2.3.
- The statistics are based on the time-series extracted from 3 model output points located 100 m away from the outfall to the north, east, and south respectively, as shown on the times-series plot in Figure 4.7.

4.3 Limitations

The findings and recommendations are based on information collected to date at the time of writing, and on simplified mathematical formulations of complex dynamic natural processes. While the modeling effort incorporated as much relevant data as possible within the study schedule and budget, uncertainties associated with data gaps and modeling approximations are inherent to this type of study.

There was some uncertainty related to the nearshore bathymetry in the outfall area. For improved dilution modelling estimates, a high-resolution bathymetric survey in the area of the outfall would be recommended.

Results should be interpreted with caution and actual conditions encountered in the future may vary from predictions. The results presented herein are best used for the purposes of comparing scenarios. We recommend that results be revisited by the Client as new information becomes available.

5 Effluent Discharge Objectives

5.1 The Need for EDOs

Effluent Discharge Objectives (EDOs) represent the effluent substance concentrations that will protect the receiving environment and its designated water uses. They describe the effluent quality necessary to allow the EQOs to be met at the edge of the mixing zone. The EQOs are established in Chapter 3; see Table 3.4 for a summary of results.

EDOs should be calculated where reasonable potential of exceeding the EQOs at the edge of the mixing zone has been determined. Typically, substances with reasonable potential of exceeding the EQOs have been selected according to the simplified approach: If a sample result measured in the effluent exceeds the EQO, an EDO is determined. As there are a limited number of parameters considered as substances of potential concern for very small and small facilities, EDOs will be developed for all substances of potential concern.

5.2 Physical/Chemical/Pathogenic EDOs

For this assessment, EDOs were calculated using the dilution values obtained at the design average daily flow of 340 m^3/d. This resulted in a dilution of 1:288 at the edge of a 100 m mixing zone based on the maximum 1-day average effluent concentration at low summer river flow.

Parameters for which there is a WSER criteria were not allowed any dilution; therefore, the EDO equals the WSER criteria. The Standard Method does not allocate any maximum dilution for nutrients and fecal coliforms. For nutrients, it recommends a case-by-case analysis. For fecal coliforms, the location of the water use must be protected by the limits of the mixing zone.

The dilution values were used to determine an EDO by back-calculating from the EQOs. When the background concentration of a substance was less than the detection limit, the background concentration was not included in the calculation of the EDO.

5.3 Effluent Discharge Objectives

Substances of concern for which an EDO was developed are listed in Table 5.1 with the associated EQO and EDO.

Table 5.1: Effluent Discharge Objectives at Proposed Design Conditions

Parameter	Background	Selected EQO	Source	Dilution Factor	EDO
$CBOD_5$ (mg/L)	<6	25	WSER	-	25
Nitrogen (Ammonia Nitrogen) (mg/L)	<0.05	1.54	CWQG Freshwater	288	436
Unionized NH_3 (mg/L)	0.0	1.25	WSER	-	1.25
Total Phosphorus (mg/L)	0.032	0.048	CGF Freshwater	460[(1)]	7.4
TSS (mg/L)	<5	8	CWQG Freshwater	288	1,441
		25	WSER	-	25
TRC (mg/L)	<0.05	0.02	WSER	-	0.02
E.coli (MPN/100 mL)	3.1	200	HC Primary Contact	288	56,612
		1000	HC Secondary Contact	288	286,612

Notes:

(1) Based on 1-month average dilution at low summer river flow and average day flow from the WWTP.

Phosphorus limits are complex as the simplified ERA procedure requires several assumptions that typically generate a low discharge objective. These limits can require costly upgrades that may turn out to be unnecessary. The reactions of phosphorus compounds within the stream can cause some of the phosphorus to settle, removing it from the water column and decreasing the potential for the waterbody to become eutrophic. Therefore, we recommend an environmental monitoring approach for phosphorus which requires regular sampling in the effluent and periodic sampling in the receiving environment both upstream and downstream of the outfall prior to determining a total phosphorus limit, if needed.

6 Compliance Monitoring

The Standard Method utilizes the results of the ERA to recommend parameters for compliance monitoring according to the following protocol:

- The WSER requirements for CBOD, TSS, and un-ionized ammonia must be monitored to ensure they are continuously being achieved. Minimum monitoring frequencies are specified in the guidelines based on the size of the facility. Monitoring of these substances cannot be reduced or eliminated.
- Nutrients, such as ammonia and phosphorus, and pathogens for which an EDO was developed should be included in the monitoring program using the same sampling frequency as CBOD and TSS.
- For additional substances, the guidelines require that all substances with average effluent values above 80% of the EDO be monitored.
- If monitoring results for the additional substances are consistently below 80% of the EDO, the monitoring frequency can be reduced.
- If average monitoring results subsequently exceed 80% of the EDO, the monitoring frequency must return to the initial monitoring frequency.
- If monitoring results are below 80% of the EDO for a minimum of 20 consecutive samples spread over a period of at least one-year, monitoring for the substance can be eliminated.

Although the Standard Method results in recommending parameters for compliance monitoring, the provincial regulator ultimately stipulates the compliance monitoring required as part of the Approval to Operate (A.T.O). In New Brunswick, the New Brunswick Department of Environment and Local Government has been using the results of the ERA to update the compliance monitoring program listed in the A.T.O when the existing A.T.O expires. At this time, it is premature to use the results of this ERA to provide recommendations on parameters to monitor for compliance, as the purpose of this ERA was to provide design criteria for the design of a new WWTP.

7 References

ACWWA. (2006). *Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.*

CCME. (2004). Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems . *Canadian Water Quality Guidelines for the Protection of Aquatic Life* .

CCME. (2007). *Canadian Guidance Framework for the Management of Nutrients in Nearshore Marine Systems.* Retrieved from https://www.ccme.ca/fr/res/2007-canadian-guidance-framework-for-the-management-of-nutrients-in-nearshore-marine-systems-ssd-1387-en.pdf

CCME. (2008). *Technical Supplement 3. Canada-wide Strategy for the Management of Municipal Wastewater Effluent. Standard Method and Contracting Provisions for the Environmental Risk Assessment.*

CCME. (2009). *Canada-wide Strategy for the Management of Municipal Wastewater Effluent.* Retrieved from https://ccme.ca/en/res/mwwe_strategy_e.pdf

Environment Canada. (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment, and Disposal.

Fisher et al. (1979). *Mixing in Inland and Coastal Waters.* London: Academic Press.

Fisheries Act. (n.d.). *Wastewater Systems Effluent Regulations .* Retrieved from SOR/2012-139.

Health Canada . (2012). *Guidelines for Canadian Recreational Water Quality - Third Edition.* Retrieved from https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-recreational-water-quality-third-edition.html

Mixing Zone Assessment and Report Template Draft only - For discussion (July 7, 2016). (2016).

NB Department of Environment & Local Government. (2012). *Memo.*

NB Department of Environment and Local Government . (2023). *Chart for Temperature, Water. Saint John River below Mactaquac Dam, Route 102* . Retrieved from https://www.elgegl.gnb.ca/WaterNB-NBEau/en/Sample/LocationResultChart?id=2

Nguyen, H. (2018). Spatiotemporal Variation of Plankton Communities Induced by Hyrdopower Dams: A Case Study in the Mactaquac Reservoir and Saint John River, New Brunswick, Canada. *M.Sc. Thesis* . University of New Brunswick.

Roy Consultants. (2022). *Design Brief, Rev. 1, Wastewater Treatment Plant Assessment Mactaquac Provinical Park, Fredericton, NB.*

Thomann, R. V., & Mueller, J. A. (1987). *Principles of Surface Water Quality Modeling and Control.*

DRAFT

Prepared by:
Helena Steeves, M.A.Sc., P.Eng
Process Engineer

Reviewed by:
Sarah Ensslin, M.Sc., P.Eng.
Process Engineer

APPENDIX A

Laboratory Certificates

Report ID: 494484-IAS
Report Date: 21-Aug-23
Date Received: 15-Aug-23

CERTIFICATE OF ANALYSIS

for
CBCL Ltd
14 King Street, P.O. Box 20040
Saint John, NB E2L 5B2

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Amy Winchester
Project #: 233250.00
Location: Mactaquac, NB

Analysis of Water

RPC Sample ID:			494484-1	494484-2	494484-3
Client Sample ID:			DS-01	SA-02 V/S	SA-03 Outfall
Date Sampled:			15-Aug-23	15-Aug-23	15-Aug-23
Analytes	**Units**	**RL**			
Chlorine - Total	mg/L	0.05	< 0.05	< 0.05	< 0.05
Ammonia (as N)	mg/L	0.05	< 0.05	< 0.05	< 0.05
Kjeldahl Nitrogen	mg/L	0.25	0.3	< 0.25	< 0.25
Nitrate + Nitrite (as N)	mg/L	0.05	0.30	0.23	0.20
Nitrate (as N)	mg/L	0.05	0.30	0.23	0.20
Nitrite (as N)	mg/L	0.05	< 0.05	< 0.05	< 0.05
Nitrogen - Organic	mg/L	0.25	0.3	< 0.25	< 0.25
Phosphorus - Total	mg/L	0.002	0.042	0.032	0.026
CBOD	mg/L	6	< 6	< 6	< 6
Solids - Total Suspended	mg/L	5	8	< 5	< 5

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

Matthew Norman
Senior Chemist
Inorganic Analytical Chemistry

Lisa Ferrish
Supervisor
Inorganic Analytical Services

Report ID: 494484-IAS
Report Date: 21-Aug-23
Date Received: 15-Aug-23

CERTIFICATE OF ANALYSIS

for

CBCL Ltd
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rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Amy Winchester
Project #: 233250.00
Location: Mactaquac, NB

Analysis of Metals in Water

RPC Sample ID:			494484-1	494484-2	494484-3
Client Sample ID:			DS-01	SA-02 V/S	SA-03 Outfall
Date Sampled:			15-Aug-23	15-Aug-23	15-Aug-23
Analytes	**Units**	**RL**			
Sodium	µg/L	50	3520	3460	3320

Report ID: 494484-IAS
Report Date: 21-Aug-23
Date Received: 15-Aug-23

CERTIFICATE OF ANALYSIS
for
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Saint John, NB E2L 5B2

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
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Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	IAS-M47	APHA 4500-NH_3 G	Phenate Colourimetry
Kjeldahl Nitrogen	IAS-M16	APHA 4500-NORG	Digestion, Phenate Colourimetry
Nitrate + Nitrite (as N)	IAS-M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
Nitrite (as N)	IAS-M49	APHA 4500-NO2- B	Ferrous Ammonium Sulfate Colourimetry
Phosphorus - Total	IAS-M17	APHA 4500-P E	Digestion, Manual Colourimetry
CBOD	IAS-M07	APHA 5210 B	Seeding, Incubation, DO measurement (meter)
Solids - Total Suspended	IAS-M05	APHA 2540 D	Filtration, Gravimetry
Sodium	IAS-M01/IAS-M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES

Report/Rapport: 494484-ML-W1
Date: 16-Aug-23
Date Received/Reçu: 15-Aug-23

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

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Attention: Amy Winchester

Project/Job #: 233250.00

Client Location: Mactaquac, NB

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				494484-1	494484-2	494484-3
Client Sample ID/ID d'échantillon du client:				DS-01	SA-02 V/S	SA-03 Outfall
Date collected/Date du prélèvement				15-Aug-23	15-Aug-23	15-Aug-23
Time sampled/Heure du prélèvement				9:10:00 AM	9:45:00 AM	10:50:00 AM
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**			
Total Coliforms/Coliformes totaux	MICRO10	15-Aug-23	MPN/100mL	307.6	110.6	579.4
E. coli	MICRO10	15-Aug-23	MPN/100mL	12.1	3.1	5.2

This report relates only to the sample(s) and information provided to the laboratory.

Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.

Corrie Maston
Acting Micro Supervisor
Applied and Experimental Bioscience

Morgan Armour
Microbiology Technician
Applied and Experimental Bioscience

CBCL

Solutions today | Tomorrow IN mind

www.CBCL.ca

APPENDIX C

Appendix C – Migratory Bird Survey Report

Aster Group Environmental Services Co-op
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Mactaquac Breeding Birds Survey Report

For
Jon Burtt
B.Sc.F., EP
spécialiste en environnement / environmental Specialist

Submitted by

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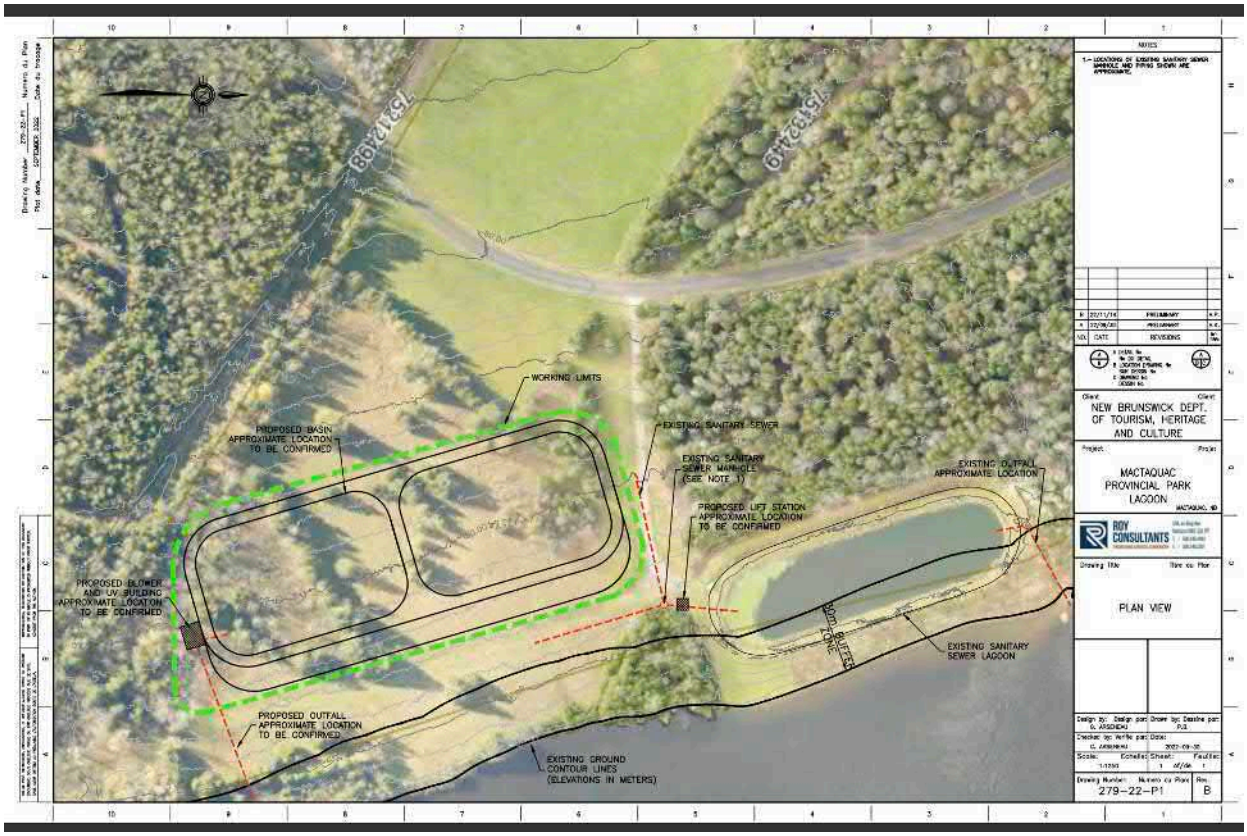

Location of the old and Proposed Sanitary Sewer Lagoon

Introduction
Upon request of Jon Burtt, a breeding bird survey was carried out at the proposed future site of the Mactaquac Provincial Park's new sanitary sewer lagoon.

Methods
An evening area search for breeding birds was carried out on June 9th from 8pm to 8:45 pm followed by a Nightjar (Common Nighthawks & Eastern Whip-poor-wills) survey. Although the Nightjar survey carried out followed some of the 2023 surveys protocols, it was not meant to replace an official survey. According to the 2023 protocols surveys must be carried out 1.6 kms apart and should be carried out for both species from June 15 and July 15. Three locations, about 150 metres apart (please see map below, Mac1, Mac2 &Mac3), less than the official 1.6m kms apart were used to survey for Nightjars. The points were closer together to better determine possible breeding locations on the site. Finally, another Nightjar survey is planned after June 15, using the same points.

A Bird Breeding survey was carried out on June 10th, 2023 from 6:30 am to 8 am. Seven, 10-minute Point Counts (M1 to M7) were used (please see map below). Point Counts were about at least 100 metres apart to provide better coverage of the site.

Locations of Survey Locations

Maritime Breeding Bird Atlases breeding codes were used to determine breeding status. A legend for the breeding codes can be found by clicking on the Maritime Breeding Bird Atlases link or in the excel sheets with the raw data.

Results

Weather conditions were fair to good. Winds were light, temperatures were cool around 10 Celsius and there were a few light showers.

No species at risk were found breeding at the site. No Nightjars were heard or seen. An adult and immature Bald Eagle (*Haliaeetus leucocephalus*) used trees for perches just below the lagoon.

Twenty-seven species were observed, most were probably breeding. The table summarizes the results. A complete set of the raw data is available as an appendix.

Species	#	Breeding Status
Alder Flycatcher	4	Probable
American Crow	1	
American Crow	4	Probable
American Goldfinch	5	Probable
American Redstart	5	Probable
American Robin	2	Probable
Bald Eagle	2	
Black and White Warbler	1	Probable
Black-capped Chickadee	8	Probable
Blackburnian warbler	1	Probable
Blue Jay	1	Probable
Cedar Waxwing	20	Probable
Chipping Sparrow	1	Probable
Common Grackle	1	Probable
Common Yellowthroat	1	Probable
Downy Woodpecker	1	Probable
Hairy Woodpecker	1	Probable
Mallard	1	Probable
Nashville Warbler	2	Probable
Northern Flicker	1	Probable
Northern Parula	6	Probable

Red-eyed Vireo	10	Probable
Song Sparrow	3	Probable
Veery	4	Probable
White-throated Sparrow	5	Probable
Winter Wren	3	Probable

Recommendations

According to Environment and Climate Change Canada, clearing should take place of side of the breeding season from mid April to the end of September. Some of the species found on site are late breeders, such as Cedar Waxwings, (*Bombycilla cedrorum*) American Goldfinches (*Spinus tristis*) and Red-eyed Vireos (*Vireo olivaceus).*

Clearing during the breeding season for owls (late February to April) should be avoided unless an owl survey is carried out before during the month of April. There is some potential habitat for Great-horned Owl (*Bubo virginianus*) on site.

Looking North

Cedar Stand at the North-est Corner

Looking towards the South-est

ROY CONSULTANTS

ENGINEERING SERVICES D'INGÉNIERIE

Canadian Nightjar Survey

Mactaquac Provincial Park

1265 Route 105
Mactaquac, New Brunswick

Our File No.: 093-23
August 24, 2023

Prepared for:

Martin MacMullin
Project Coordinator
NB Tourism, Heritage and Culture
PO Box 6000
Fredericton, NB E3B 5H1

Prepared by:

ROY CONSULTANTS

August 24, 2023

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Project Coordinator
NB Tourism, Heritage and Culture
PO Box 6000
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Our File No.: 093-23

M. MacMullin:

Subject: Summary of Canadian Nightjar Survey
Mactaquac Provincial Park
1265 Route 105, Mactaquac, NB

We are pleased to submit our report describing the findings of the Nightjar survey completed at the above-referenced site.

Should you have any questions or need further assistance, do not hesitate to contact the undersigned at your convenience. We thank you for the opportunity to assist you with this matter.

Yours truly,

Anabelle Hébert
ENVIRONMENTAL Technologist

AH/

TABLE OF CONTENTS

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APPENDICES 5

INTRODUCTION

Roy Consultants completed a Canadian Nightjar survey in the vicinity of a proposed project within the Provincial Park. The Park, identified as SNB parcel identification number 75132449, is comprised of a 435.07-hectare provincial park, including a campground, golf course and clubhouse, and public beach. The park is owned and operated by the NB Department of Tourism, Heritage and Culture (THC). The Provincial Park would like to replace its existing wastewater treatment lagoon. The Nightjar survey is required for the proposed project footprint due to the characteristics of the nearby site.

This survey is part of the Environmental Impact Assessment (EIA) required for upgrading the existing wastewater treatment system, as required by the NB *Environmental Impact Assessment Regulation*, which requires registration for the proposed project, which is an undertaking per Schedule A, item n) "*all sewage disposal or sewage treatment facilities, other than domestic, on-site facilities*".

1 SURVEY

On July 4, 2023, a Nightjar survey was conducted within the surrounding area of the proposed lagoon upgrades. The survey was conducted according to the method listed in the *Canadian Nightjar Survey: Protocol 2019 – Birds Canada, in collaboration with Environment and Climate Change Canada (*with 2023 revisions*).*

Since the area of the provincial park to be studied is smaller than the land surfaces proposed in the protocol (1.6km apart), a project-specific trajectory was created so that the area of the proposed project could be adequately surveyed. A survey trajectory was determined in collaboration with Roland Chiasson, B.S, M.E.S, B.Ed., a Wildlife Biologist for Aster Group. The survey consisted of three “survey stops” at specific locations within the park in order to cover potential nightjar habitats.

2 RESULTS

The following section shows the details of the stops that were made during the Nightjar survey.

Table No. 1: Survey Stop Locations

Location	Habitat and Description	GPS Coordinates
1	Next to the existing lagoon.	N45º57'33.6'' W66º53'10.6''
2	On ATV trail	N45º57'27.4'' W66º53'07.5''
3	Paved Road	N45º57'29.9'' W66º53'18.2''

Location 1: 20:55, July 4, 2023. The first stop is near the existing pond. No nightjars observed or heard in this area. Common birds present were: Veery (*Catharus fuscescens)*, Cedar Waxwing (*Bombycilla cedrorum)*, Song Sparrow (*Melospiza melodia),* Black-and-White Warbler (*Mniotilta varia)* and American Crow (*Corvus brachyrhynchos)*.

Location 2 (21:05): In the ATV Trail. No Nightjar observed or heard in this area of the park. Boats were heard on the Mactaquac Headpond (Saint John River). Birds observed in the area were Song Sparrow (*Melospiza melodia)*, Black-and-White Warbler (*Mniotilta varia),* Veery (*Catharus fuscescens)*, American Crow (*Corvus brachyrhynchos)* and Northern Cardinal (*Cardinalis cardinalis)*.

Location 3 (21:20): On the paved road, near the golf course. No Nightjar observed or heard in this area of the park. Birds observed were Veery (*Catharus fuscescens)*, American Crow (*Corvus brachyrhynchos)*, Black-capped Chickadee (*Poecile atricapillus)* and Common Loon (*Gavia immer)*.

The survey was conducted after a short period of rainfall (1 hour), it was approximately 85% cloudy, the survey start temperature was at 20ºC during the survey and 19ºC at the end of it. The wind scale varied from 0-1 with a wind direction to the East. The survey area contains habitat that may be suitable for Nightjar nesting, but no Nightjar were observed at the time of the survey.

Refer to Appendix A for a map of the site with stops points.

3 CONCLUSION

The main objective of the survey is to determine if there are any Nightjar species within the vicinity of the subject site. The subject site consists of a wastewater treatment lagoon and adjacent field and forested area within Mactaquac Provincial Park, identified as SNB parcel identification number 75132449. The 435.07-hectare provincial park includes a campground, golf course and clubhouse, and public beach and is owned and operated by the NB Department of Tourism, Heritage and Culture (THC).

No Nightjar species were detected during the survey. The Nightjar survey was completed per the requirements of the *Nightjar Survey: Protocol 2019 – Birds Canada, in collaboration with Environment and Climate Change Canada (*with 2023 revisions*).*

4 CLOSURE

This report was prepared by Roy Consultants for the exclusive use of the NB Tourism, Heritage and Culture. The data contained herein may not be republished or relied upon for any other purpose or by any other third party without the express written permission of the author.

Anabelle Hébert, Environmental Technologist, completed survey and the report. The report which was reviewed by Jon Burtt, EP, Environmental Specialist.

APPENDICES

APPENDIX A

Appendix A – Survey Location

Mactaquac Provincial Park

Nightjar survey

Legend

St John River

1

2

3

Google Earth

Image © 2023 Airbus

N

600 ft

APPENDIX B

Appendix B – Site Photos

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 1: Existing Lagoon Close to Location 1

Photo No. 2: Lagoon Access Road Between Locations 1 and 3

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 3: Location 3 (Nightjar Habitat)

Photo No. 4: Nightjar Habitat (Close to location 2)

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 5: Nightjar Habitat

Photo No. 6: View from Location 1

APPENDIX C

Appendix C – Field Data Sheets

1. SURVEY INFO: Fill this out before you start. Don't forget to fill in "End Temperature" at the end of your survey!

Observer Name: Anabelle Hebert	**Co-Observer Name:**	
Address:	**Email:**	**Phone:**
Route Name: Mactaquac provincial park	**Date:** July 4th, 2023	

Comments: _____

2. STOP CONDITIONS: Record the conditions at each survey stop.

Start Temperature: 20°c

Stop	Start Time (24 hr)	Wind (circle)	Wind direction	Cloud (10ths of sky covered)	Moon (circle)	Noise (circle)	# Cars	Comments
1	20:55	(0) 1 2 3	—	80%.	Y (N)	0 (1) 2 3	0	45°57'37.6" 066, 53' 10.6"
2	21:05	(0) 1 2 3	—	85%.	Y (N)	0 (1) (2) 3	0	45°57'27.4" 66, 53' 07.5" boats on river
3	21:20	0 (1) 2 3	East	55%-	Y (N)	0 1 2 3		45'57'29.9 66, 53'18.2"
4		0 1 2 3			Y N	0 1 2 3		
5		0 1 2 3			Y N	0 1 2 3		
6		0 1 2 3			Y N	0 1 2 3		
7		0 1 2 3			Y N	0 1 2 3		
8		0 1 2 3			Y N	0 1 2 3		
9		0 1 2 3			Y N	0 1 2 3		
10		0 1 2 3			Y N	0 1 2 3		
11		0 1 2 3			Y N	0 1 2 3		
12		0 1 2 3			Y N	0 1 2 3		

End Temperature: 19°c

Code	Wind Description	Cloud Description	Noise Description
0	Calm: smoke rises vertically	0=No clouds	None or slight (e.g., distant traffic)
1	Light air: smoke drifts, leaves and wind vanes are stopped	1=10% cover	Moderate (e.g., airplane, moderate traffic)
2	Light breeze: wind felt on exposed skin, leaves rustle, wind vanes begin to move	2=20% cover	High (e.g., fairly constant traffic)
3	Gentle breeze: leaves and small twigs constantly moving, light flags extended	3=30% cover	Excessive (e.g., construction, frog chorus)
4	Do not survey	4=40% cover, etc.	N/A

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APPENDIX D

Appendix D – Vegetation Survey Report

ROY CONSULTANTS

ENGINEERING SERVICES D'INGÉNIERIE

Rare Plant Survey

Mactaquac Provincial Park

1265 Route 105
Mactaquac, New

Our File No.: 093-23
September 5, 2023

Prepared for:

Martin MacMullin
Project Coordinator
NB Tourism, Heritage and Culture
PO Box 6000
Fredericton, NB E3B 5H1

Prepared by:

ROY CONSULTANTS

September 5, 2023

Martin MacMullin
Project Coordinator
NB Tourism, Heritage and Culture
PO Box 6000
Fredericton, NB E3B 5H1
martin.macmullin@gnb.ca

Our File No.: 093-23

M. MacMullin:

Subject: Summary of Rare Plant Survey
Mactaquac Provincial Park
1265 Route 105, Mactaquac, NB

We are pleased to submit our report describing the findings of the Rare Plant survey completed at the above-referenced site.

Should you have any questions or need further assistance, do not hesitate to contact the undersigned at your convenience. We thank you for the opportunity to assist you with this matter.

Yours truly,

Anabelle Hébert
ENVIRONMENTAL Technologist

AH/

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ASBESTOS SAMPLING SUMMARY REPORT

INTRODUCTION

Roy Consultants completed a plant survey as part of an Environmental Impact Assessment for a proposed new wastewater treatment lagoon in Mactaquac Provincial Park, Mactaquac, NB. The Park, identified as SNB parcel identification number 75132449, is comprised of a 435.07-hectare provincial park, including a campground, golf course and clubhouse, and public beach. The park is owned and operated by the NB Department of Tourism, Heritage and Culture (THC). The subject site consists of an existing wastewater treatment plant lagoon, and a partially wooded / field area immediately adjacent to the existing lagoon where the new lagoon will be built.

This survey is part of the Environmental Impact Assessment (EIA) required for upgrading the existing wastewater treatment system, as required by the NB *Environmental Impact Assessment Regulation*, which requires registration for the proposed project, which is an undertaking per Schedule A, item n) "*all sewage disposal or sewage treatment facilities, other than domestic, on-site facilities*".

1 SURVEY

On July 4, 2023, a rare plant survey was conducted within the surrounding limits of the proposed project. The survey was conducted according to a method of stopping at 10 sample plot locations to cover as many different habitats as possible. The 10 locations are within the area that may potentially be impacted by the proposed project.

The survey area consisted of the vegetation surrounding the existing lagoon, a tree line of mature mixed forest, an open field, and a field regenerating in mixed deciduous and coniferous vegetation.

Environment and Climate Change Canada (ECCC) estimated 18.3 mm of precipitation near Mactaquac on July 4, 2023. Roy Consultants' field personnel noted sunny weather with an ambient outdoor air temperature of 25°C during field activities on July 4, 2023.

2 RESULTS

85 species of plants were identified during the survey. No species of conservation concern were identified during the survey.

Different habitats were identified and are summarized in table 1 and shown in Appendix C. Photo of different habitats and survey points are listed in Appendix B. Locations of waypoints and total trajectory are shown in Appendix A.

Table No. 1: Survey Locations and Habitat

Location	Habitat and Description	GPS Coordinates
1	Next to the existing lagoon. Mature tree line with lower vegetation surrounding the lagoon.	N45º57'34.4'' W66º53'10.9''
2	At the beginning of the lagoon service road. Short vegetation with mature trees.	N45º57'32.9'' W66º53'15.8''
3	Field section, along the Mactaquac Provincial Park access road.	N45º57'31.5'' W66º53'15.6''
4	Mixed vegetation, beginning of a forest line.	N45º57'29.4'' W66º53'14.4''
5	Wooden area near the lagoon access road.	N45º57'32.9'' W66º53'13.0''
6	Small but mature wooden area along the lagoon access road.	N45º57'32.8'' W66º53'12.1''
7	Wooden patch next to a field.	N45º57'30.9'' W66º53'12.0''
8	Mature forested area close to the campground.	N45º57'27.9'' W66º53'10.9''
9	Field section along existing ski-doo trail.	N45º57'31.0'' W66º53'09.7''
10	Wooden section close to the lagoon entrance.	N45º57'34.0'' W66º53'08.8''

3 LOCATIONS

3.1 Location 1:

Vegetation is cut short around the lagoon. Multiple species of summer flowers are present. No trees or mature trees are present around the lagoon. There is a mature tree line present outside the gates that are delimitating the lagoon. Common service berries (*Amelanchier Arborea*) are dominant in this section of the Park. Some species, more associated with wetlands are present around the lagoon (i.e., *Typha Latifolia*). The topography in this section of the park is relatively flat. The diversity of species present represents the terrain well and it was expected to find these species in this area. Species identification was repetitive along the followed path. No rare or endangered species were identified in this section of the survey.

3.2 Location 2:

Specimens at this site are very similar to the ones encountered at the first survey stop. The area is dry and visually looking like an open field with some matures trees presents. Eastern White cedars (*Thuja occidentalis*) are dominant in this section of the provincial park. The specimen variety consists of common plants that can be found in the Mactaquac region. No rare or endangered species were identified in this area of the survey.

3.3 Location 3:

This location consists of an open field, vegetation is short (herb) with no canopy layer. Vegetation height ranges from approximately 1 to 12 inches. Common Buttercup (*Ranunculus acris*) are followed by Common Timothy Grass (*Phleum pratense*). No rare or endangered species were identified in this area of the survey.

3.4 Location 4:

Consist of a forested area with mature vegetation. Some newer vegetation that is not yet mature is also present in some sections of this area. Consist of a mix of herbs and canopy strata with a mix of common plants and trees. Dominant trees are Balsam Poplar (*Populus balsamifera*) and Chokecherry (*Prunus virginia*). Dominant herbs are Fireweed (*Chamaenerion angustifolium*). No rare or endangered species were identified in this area of the survey.

3.5 Location 5:

This wooden area is very similar to other surveyed plots. Consists of a mix of low herbaceous and mature vegetation. The ground is very wet in some areas but no species typical of wetland are present. Water ponding can be seen in various areas of this section. Eastern White Cedar (*Thuja occidentalis*) are dominant in this section of the survey. The forest floor is covered with Dwarf Red

Strawberries (*Rubus pubescens*). No rare or endangered species were identified in this area of the survey.

3.6 Location 6:

Small, forested area with sparse herbaceous vegetation. The forest floor is covered with rocks of various sizes. Moss is growing on the rocks indicating they have been here for some time. No vegetation is growing under or between the rocks. The forested area is primarily Eastern White Cedar (*Thuja occidentalis*) and Balsam Fir (*Abies balsamea*). The ground around the trees is covered with multiples species of Ferns. No rare or endangered species were identified in this area of the survey.

3.7 Location 7:

This location consists of a mixture of field and wooden area. The vegetation is immature and the ground is mostly covered by low plant species (i.e. : Common buttercups (*Ranunculus acris*)). Ground is dominated by Sensitive fern (*Onoclea sensibilis)*. There is a lot of water on the ground, can see little channels where the water is circulating. Various Carex are present but none of them identified or similar to a rare or endangered species. No rare or endangered species were identified in this area of the survey.

3.8 Location 8:

Thick forested patch. Vegetation is very dense and it's difficult to walk in it. The ground is mostly covered with Dwarf red raspberries (*Rubus pubescens*). Raspberries form a dense carpet on the ground. Strawberries (*Fraga virgniana*), Fireweed (*Chamaenerion angustifolium*) and Sensitive ferns (*Onoclea sensibilis)* are present in large quantities. Mature vegetation is representative of the site and very similar to other surveyed locations with Eastern White Cedar (*Thuja occidentalis*) as the dominant species. No rare or endangered species were identified in this area of the survey.

3.9 Location 9:

Field area that is next to the ATV/snowmobile trail. This area is similar to other surveyed fields in the park. The main difference in this area is that there is an accumulation of water on the ground. Some sections have more than six (6) inches of water. No vegetation associated with wetland identified. The tallest vegetation is speckled alder (*Alnus incana*) and they are roughly five (5) feet high. The rest of the vegetation consists of common plants and shrubs that are known to grow in this area of the province. No rare or endangered species were identified in this area of the survey.

3.10 Location 10:

Wooden area with sparse ground vegetation other than ferns (*Fem*) and Coltsfoot (*Tussilago*). Trees in this area are all mature and some of them have roots in the St John River due to shoreline erosion. Eastern White Cedar (*Thuja occidentalis*) is dominant in this section of the park. No rare or endangered species were identified in this area of the survey.

Pictures are presented in Appendix B, and a full list of identified species is available in Appendix C.

4 DISCUSSION

Prior to completing the vegetation survey, information was requested from the Atlantic Canada Conservation Data Centre (ACCDC) for observations of rare and/or endangered flora species within a 5 km radius of the project site. According to the ACCDC report, four (4) Species at Risk have been reported within the 5km radius. A review of each species' habitat requirements was completed and compared with site characteristics prior to the survey.

No flora of conservation concern or Species at Risk were identified during the survey.

Atlantic Canada Conservation Data Centre (ACCDC) S-Rank www.accdc.com/en/rank-definitions.html	
S-RANK DEFINITIONS	
SX	Presumed Extirpated - Species or community is believed to be extirpated from the province. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
SH	Possibly Extirpated (Historical)—Species or community occurred historically in the province, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or community could become SH without such a 20-40 year delay if the only known occurrences in a province were destroyed or if it had been extensively and unsuccessfully looked for. The SH rank is reserved for species or communities for which some effort has been made to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.
S1	Critically Imperiled - Critically imperiled in the province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the province.
S2	Imperiled - Imperiled in the province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the province.
S3	Vulnerable - Vulnerable in the province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
S4	Apparently Secure - Uncommon but not rare; some cause for long-term concern due to declines or other factors.
S5	Secure - Common, widespread, and abundant in the province.
SNR	Unranked - Provincial conservation status not yet assessed.
SU	Unrankable – Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
SNA	Not Applicable - A conservation status rank is not applicable because the species is not a suitable target for conservation activities.
S#S#	Range Rank - A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).
SH	Possibly Extirpated (Historical)—Species or community occurred historically in the province, and there is some possibility that it may be rediscovered. Its presence may not have been

	verified in the past 20-40 years. A species or community could become SH without such a 20-40 year delay if the only known occurrences in a province were destroyed or if it had been extensively and unsuccessfully looked for. The SH rank is reserved for species or communities for which some effort has been made to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.
Not Provided	Species is not known to occur in the province.

5 CONCLUSION

The main objective of the plant survey is to determine if there are any flora species of conservation concern or Species at Risk within the project footprint. The flora survey covered the area surrounding the existing lagoon (to be decommissioned) and the proposed new lagoon location.

Generally, biodiversity for mature trees was low at every surveyed location. Eastern White Cedar are clearly dominant. Field survey sections had a higher concentration of deciduous trees and shrubs, while the forested area is mainly coniferous.

Some sections of the park are already disturbed and maintained in order to allow access to the existing lagoon. Based on historical aerial photographs of the survey area, it was once active farmland. Vegetation was cut short in many surveyed locations, especially along the service road and the ATV trail.

No species of conservation concern or Species at Risk were identified within the survey area. Species present in the surveyed area are mostly common and are present in other sections of the park, and the province.

6 CLOSURE

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Anabelle Hébert, Environmental Technologist, completed survey and the report. The report was reviewed by Jon Burtt, EP, Environmental Specialist.

APPENDICES

APPENDIX A

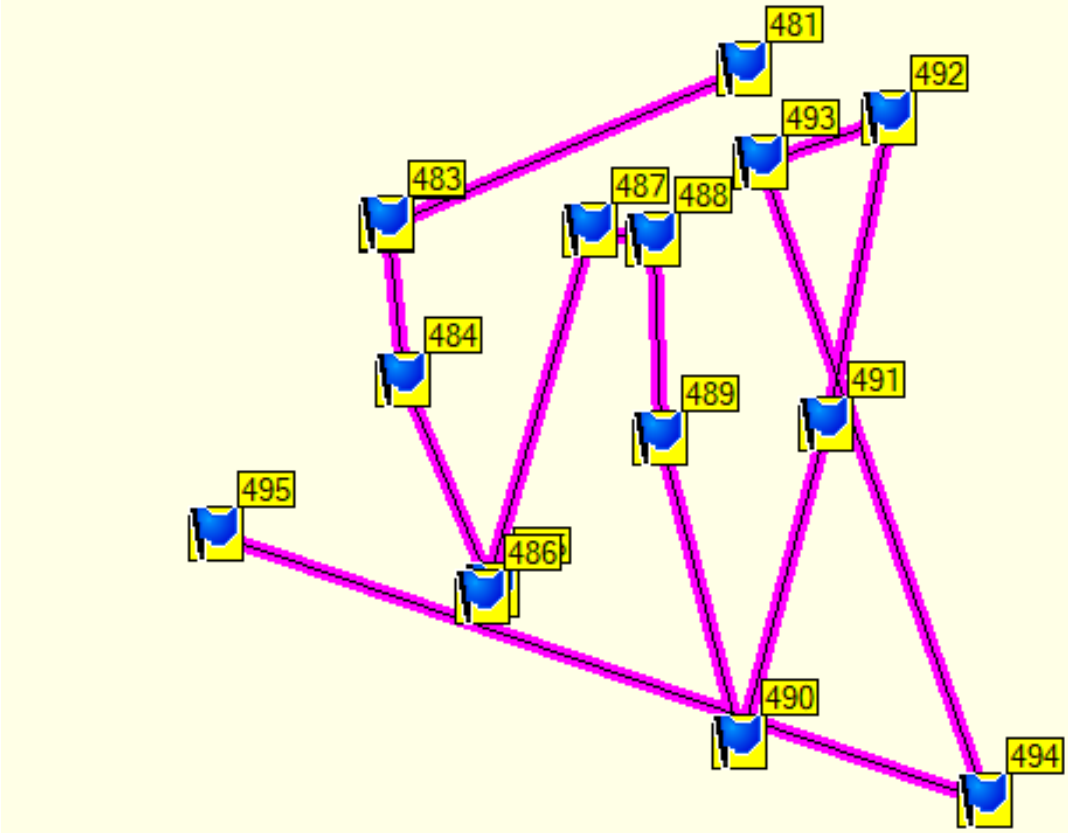
Appendix A – Figures

	Client : **NB Tourism, Heritage and Culture**	Reference : Google Earth © 2023	
	Project : **Mactaquac Provincial Park 1265 Route 105, Mactaquac, NB**		
	Title : **Surveyed Section**	File no.: 093-23	Figure no. 1

CONFIDENTIAL DOCUMENT

	Client : **NB Tourism, Heritage and Culture**	Reference : Google Earth © 2023
	Project : **Mactaquac Provincial Park 1265 Route 105, Mactaquac, NB**	
	Title : **Survey Locations**	File no.: 093-23 | Figure no. 2

CONFIDENTIAL DOCUMENT



	Client : **NB Tourism, Heritage and Culture**	Reference : Google Earth © 2023
	Project : **Mactaquac Provincial Park** **1265 Route 105, Mactaquac, NB**	
	Title : **Survey Locations / GPS Tracks**	File no.: 093-23 | Figure no. 3

CONFIDENTIAL DOCUMENT

APPENDIX B

Appendix B – Sites Photos / Survey Locations

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 1: Existing Lagoon

Photo No. 2: Location 1 (Around the Existing Lagoon)

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 3: Lagoon Access Road (From Location 2)

Photo No. 4: View of Location 2

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 5: Location 3 (Field)

Photo No. 6: View From Location 3

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 7: View of Location 4

Photo No. 8: Trees at Location 4

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No.9: View of Location 5 Woods

Photo No. 10: Location 5

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 11: Rocks at Location 6

Photo No. 12: Near Location 6

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 13: Water on the Ground at Location 6

Photo No. 14: Location 7 Wooden Area

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 15: Location 7

Photo No. 16: Location 8 Wooden Area

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 17: Near Location 8

Photo No. 18: Near Location 9

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 19: Location 9

Photo No. 20: Location 10

SITE PHOTOS
Mactaquac Provincial Park
Mactaquac, NB

Photo No. 21: Location 10

Photo No. 22: Near Location 10

APPENDIX C

Appendix C – Plant List

ID	Scientific Name	Common Name	S Rank
1	Trifolium pratense	Red Clover	SNA
2	Leucanthemum vulgare	Oxeye Daisy	SNA
3	Stellaria graminea	Little Starwort	SNA
4	Eviyeron strigorus	Daisy Fleabane	SN5
5	Vicia cracca	Trufted Vetch	SNA
6	Galium mollugo	Hedge bedstraw	SNA
7	Chamaenerion angustifolium	Fireweed	S5
8	Ranuculus acris	Common Buttercup	SNA
9	Plheum pratense	Common Timothy	SNA
10	Typha latifolia	Broadleaf Cattail	S5
11	Lysimahia ciliata	Fringed Yellow Strife	S5
12	Onoclea sensibilis	Sensitive Fern	S5
13	Fragaria vesca	Woodland Strawberry	S4
14	Cirsium avense	Creeping Thistle	SNA
15	Achillea millefolium	Common Yarrow	SNA
16	Lysimachia nummularia	Creeping Yellow Loosestrife	SNA
17	Taraxacum officinale	Common Dandelion	SNA
18	Solidago juncea	Early Goldenrod	S5
19	Lathyrus pratensis	Meadow Vetchling	SNA
20	Argostis capillaris	Colonial Bent Grass	SNA
21	Thalictrum pubescens	Tall Meadow Rue	S5
22	Trifolium repens	White Clover	SNA
23	Verbascum Thapsus	Common Mullein	SNA
24	Acer rubrum	Red Maple	S5
25	Acer saccharum	Sugar Maple	S5
26	Thuja occidentalis	Eastern White Cedar	S5
27	Prunus virginiana	Chokecherry	S5
28	Amelanchier Arborea	Downy Service Berry	S4
29	Prunus serotina	Black Cherry	S5
30	Populus tremuloides	Trembling Aspen	S5
31	Populus alba	White Poplar	SNA
32	Picea mariana	Black Spruce	S5
33	Picea glauca	White Spruce	S5
34	Abies balsamea	Balsam Fir	S5
35	Prunella vulgaris	Common Selfheal	S5
36	Scirpus hattonianus	Mosquito Bulrush	S5
37	Luzula multiflora	Common Wood Rush	S5
38	Elymus repens	Quack Grass	SNA
39	Juncus tenuis	Slender Pathrush	S5
40	Carex flava	Yellow Sedge	S5
41	Calamagrostis canadensis	Bluejoint Reed Grass	S5
42	Poa pratensis	Kentucky Blue Grass	S5
43	Potentilla simplex	Old Field Cinquefoil	S5
44	Equisetum arvense	Field Horsetail	S5
45	Pilosella aurantiaca	Orange Hawkweed	SNA

46	Hieracium lachenalii	Common Hawkweed	SNA
47	Doellingeria umbellata	Flat-top White Asther	S5
48	Rubus pubescens	Dwarf Red Raspberry	S5
49	Galium palustre	Common Marsh Bedstraw	S5
50	Juncus effusus	Common Soft Rush	S5
51	Geum macrophyllum	Large Leaf Avens	S5
52	Carex vulpinoidea	Fox Sedge	S4
53	Packera paupercula	Balsam Groundsel	S4
54	Alnus incana	Grey Alder	S5
55	Carex gracilima	Graceful Sedge	S5
56	Ulota crispa	Crisped Pincushion Moss	S5
57	Fraxinus americana	White Ash	S3
58	Matteuccia struthiopteris	Ostrich Fern	S5
59	Rhytidiadelphus triquetus	Rough Neck Goose Moss	S5
60	Solidago Flexicaulis	Zigzag Goldenrod	S5
61	Osmundastrum connamomeum	Cinnamon Fern	S6
62	Iris versicolor	Harlequin Blue Flag	S5
63	Sisyrinchium Montanum	Strict Blue-Eyed Grass	S5
64	Anemone virginiana	Virginia Anemone	S4
65	Betula papyrifera	White Birch	S5
66	Spiraea tomentosa	Steeplebush	S5
67	Rubus chamaenorus	Cloudberry	S4
68	Anemonastrum canadense	Canada Anemone	S5
69	Betula alleghaniensis	Yellow Birch	S5
70	Barbarea vulgraris	Yellow Rocket	SNA
71	Pilosella officinarum	Mouse-Ear Hawkweed	SNA
72	Tiarella cordifolia	Heart-Leaved Foamflower	S4
73	Pteridium aquilinum	Common Bracken	S5
74	Claytosmunda claytoniana	Interrupted Fern	S5
75	Cornus canadensis	Bunchberry	S5
76	Tsuga canadensis	Eastern Hemlock	S5
78	Fragaria virginiana	Wild Strawberry	S5
79	Equisetum variegatum	Woodland Horsetail	S5
80	Pisosella piloselloides	Tall Hawkweed	SNA
81	Rubus idaeus	Red Raspberry	S5
82	Plantago major	Common Plantain	SNA
83	Trifolium arvense	Rabbit's Foot Clover	SNA
84	Potentilla anserina	Common Silverweed	S5
85	Tanacetum vulgare	Common Tansy	SNA

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APPENDIX E

Appendix E – Fish Habitat Survey Report

ROY CONSULTANTS

ENGINEERING SERVICES D'INGÉNIERIE

Fish and Aquatic Habitat Survey

Our File No.: 093-23-C
November 9, 2023

Park Wastewater Treatment Lagoon Replacement
Mactaquac, NB

Prepared for:

Mr. Martin MacMullin
Project Coordinator
NB Tourism, Heritage and Culture
PO Box 6000
Fredericton, NB E3B 5H1

Prepared by:

ROY CONSULTANTS

With the collaboration of:

MAKO Diving & Marine Services
2492 NB-640
Hanwell, NB E3C 2B9
Tel. : (506)-349-5110

November 9, 2023

Mr. Martin MacMullin
Project Coordinator
NB Tourism, Heritage and Culture
PO Box 6000
Fredericton, NB E3B 5H1

Our File No.: [093-23-C[1]]

Dear Mr. MAcMullin:

Subject: Fishes and Habitat Survey
Wastewater Lagoon Upgrades, Mactaquac Provincial Park
Mactaquac, New Brunswick

We are pleased to present you with this report for the aforementioned subject studied.

We appreciate the opportunity to assist NB Tourism, Heritage and Culture in this project and we trust this report is to your entire satisfaction. However, should you have any questions or comments, or should you require further assistance, please do not hesitate to contact the undersigned.

Yours truly,

[Signature #1]

Marie-Josée Garand, Ph.D., EP
Environnemental Specialist

MG/mh

CC: Kevin McWhirter, THC

Enc.:

[1] Ref.: (Y:)\2023\(C)\093-23-C Mactaquac Fish Habitat Report 9Nov2023).docx

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1 INTRODUCTION

The Department of Tourism, Heritage and Culture mandated Roy Consultants to complete an Environmental Impact Assessment (EIA) for a proposed wastewater treatment lagoon project at Mactaquac Provincial Park, in Mactaquac, New Brunswick. The project is considered an 'undertaking' under schedule A of the NB *Environmental Impact Assessment* item n) "*all sewage disposal or sewage treatment facilities, other than domestic, on-site facilities*". The Park is owned and operated by the NB Department of Tourism, Heritage and Culture (THC). Roy Consultants, in coordination with CBCL Inc. and Mako Diving and Marine Services, completed an underwater survey of the near-shore area projected to be the mixing zone of the proposed new wastewater system discharge pipe. The purpose of the survey was to characterize the habitat within this area in comparison with existing headpond information, and identify any aquatic flora and fauna observed during the survey.

The survey area is the anticipated mixing zone of the outfall of the proposed new wastewater treatment lagoon. It is anticipated that the outfall will be in approximately 3m to 5m of water; however, the precise location has not been determined as of the writing of this report. The survey area is located on the western shore of Mactaquac Lake, also referred to as the Mactaquac Headpond, the impounded portion of the Saint John River above the NB Power Mactaquac Hydro-electric Dam. Little to no flow was observed during the dive survey. Due to its location approximately 1km from the Mactaquac Dam, the area flows similarly to a lake with minimal flow; however, during some periods / times of the year, when all dam spillways are opened due to heavy precipitation or snowmelt, some current may occur. Maximum depth of the headpond near this location is approximately 27m (80 feet).

Previous surveys (Canadian River Institute, 2019) report 14 species of fish in the Mactaquac Headpond (see Table 1). According to the Watershed & Aquatic Research & Monitoring Laboratory of the University of New Brunswick, three (3) species of freshwater mussels have been observed in the Headpond (table 1). The American Eel has a SARA and COSEWIC status of Threatened, and the Banded Killifish has a SARA status of Special Concern and COSEWIC status of Not at Risk.

Table 1. Aquatic Fauna Species of the Mactaquac Headpond (CRI)

Common Name	Scientific Name	Conservation Rank
	Fishes	
American Eel	*Anguilla rostrata*	T, Threatened, S4N
Banded Killifish	*Fundulus diaphanus*	Special Concern, NAR, S5
Blacknose Dace	*Rhinichthys atratulus*	S5
Brown Bullhead	*Ameiurus nebulosus*	S5
Chain Pickerel	*Esox niger*	NAR, SNA (Exotic)
Common Shiner	*Notropis cornutus*	S5
Fallfish	*Semotilus corporalis*	S5
Golden Shiner	*Notemigonus crysoleucas*	S5
Largemouth Bass	*Micropterus salmoides*	SNA
Pumpkinseed	*Lepomis gibbosus*	S5
Smallmouth Bass	*Micropterus dolomieui*	SNA
White Perch	*Morone americana*	S5

White Sucker	*Catostomus commersoni*	S5
Yellow Perch	*Perca flavascens*	S5
Freshwater Mussels		
Tidewater Mucket	*Leptodea ochracea*	S3
Eastern Floater	*Pyganodon cataracta*	S5
Eastern Lampmussel	*Lampsilis radiata*	S5

In addition to the species above, the Atlantic Canada Conservation Data Centre (ACCDC) report No. 7693 identified the aquatic species within a 5km radius of the subject site listed in table 2:

Table 2: ACCDC Aquatic Species (Report No. 7693)

Common Name	Scientific Name	Conservation Rank
Fishes		
Atlantic Salmon – Outer Bay of Fundy Population	*Salmo salar pop. 7*	Endangered, Endangered, SNR
Shortnose Sturgeon	*Acipenser brevirostrum*	Special Concern, Special Concern, Special Concern, S3
Freshwater Mussels		
Yellow Lampmussel	*Lampsilis cariosa*	Special Concern, Special Concern, Special Concern, S3
Tidewater Mucket	*Leptodea ochracea*	S3

2 SURVEY METHODOLOGY

On Tuesday, August 15, 2023, Roy Consultants completed an underwater survey of the area approximately 100m downstream of the proposed wastewater lagoon discharge location (Figure A).

Figure A: Project Location (Red Star)

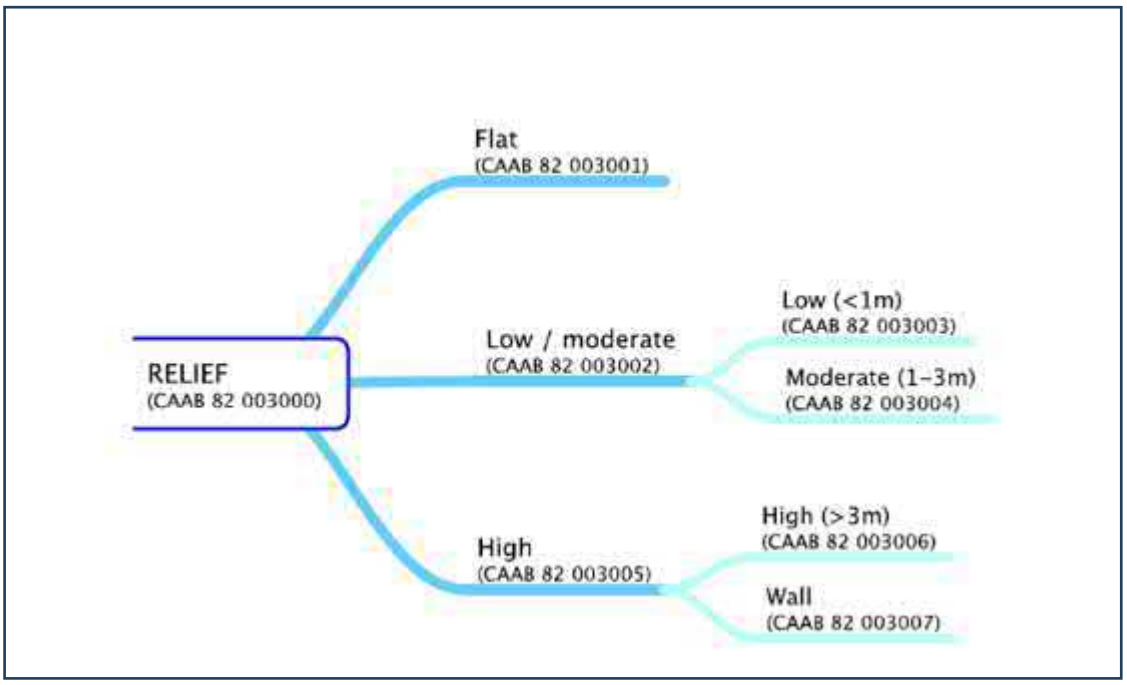
Mako Diving and Marine Services (hereafter referred to as “Mako”) provided the diving platform and conducted the dive. Two transects approximately 100m in length were dived, parallel to shore. Video was collected using a GoPro Hero 8. In addition to the dive survey, a shoreline/shallow water survey was conducted along the corresponding shoreline on August 29th, 2023. Figure B shows the location of the survey transects and bathymetry.

Figure B: Location of Survey

Observations were obtained along the three transects via video and in shallow water (0 to 1.5m in depth), macrofloral and macrofaunal species were catalogued along the transects, and relative abundance were then mapped for each transect. Due to recent heavy rains prior to the survey, and the cloudy weather conditions, deeper video could not be obtained. The description of the fish habitats is based on visual observation of the following: relief, substrate, macroflora and macrofauna. The classification used for the abiotic components, the relief and substrate, is the CATAMI Classification Scheme for Scoring Marine Biota and Substrata in Underwater Imagery (Althaus F. *et al.* 2013). The classes are broad enough to accommodate the poor visibility conditions during the survey.

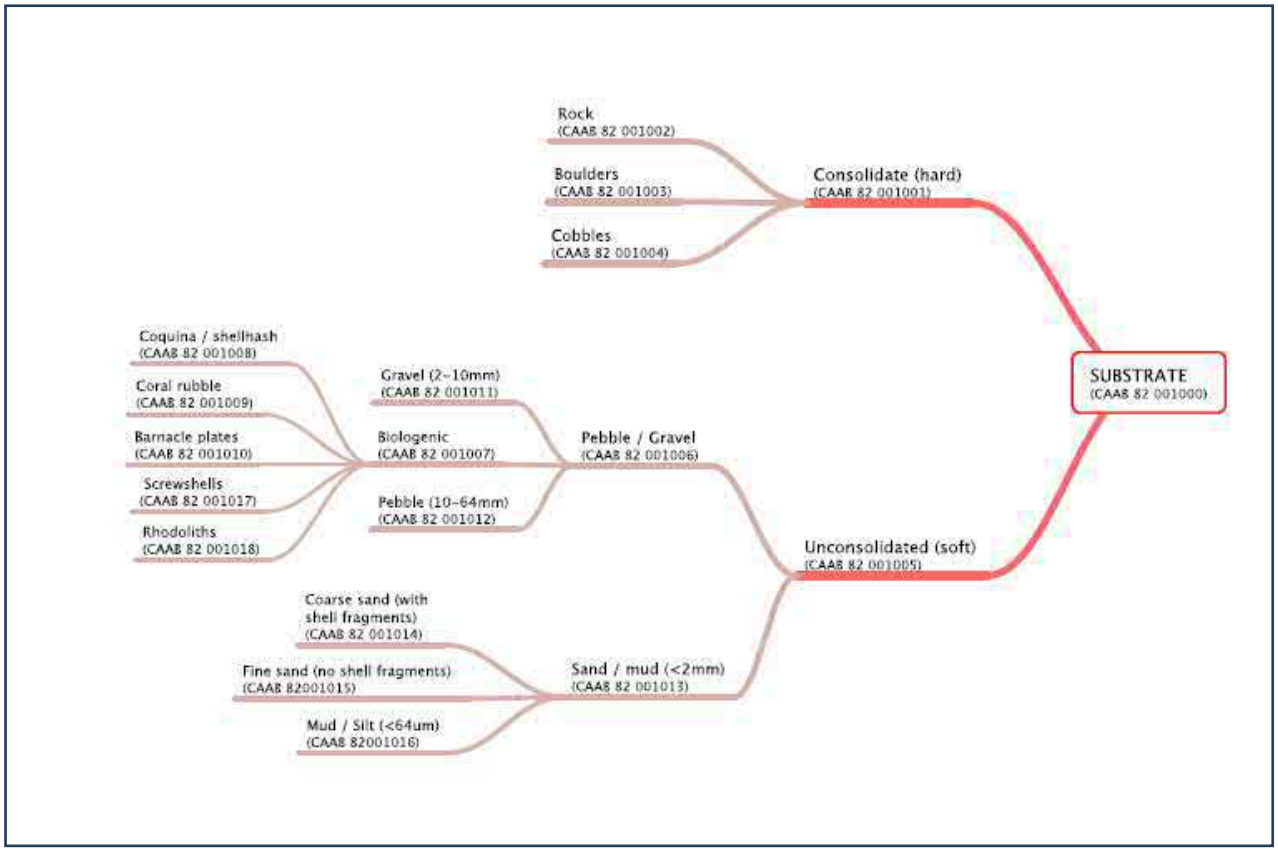
In the context of the CATAMI classification, the relief is the height and rugosity structure of the substrate scores for a sequence of images because the height and rugosity of a location can only be interpreted in relation to their surroundings. The relief scored from images is useful in this survey because bathymetric data were taken only for two points. The CATAMI classification for relief is presented in Figure C.

Figure C. Hierarchical structure for the relief of the CATAMI Classification (Source: Althaus *et. al.* 2013)



For the substrate, the visibility was not sufficient to accurately use the Wentworth classification which is conventional for this type of study (1922). Again, the CATAMI classes for substrates (see Figure D) accounts for this while providing consistent identifiers.

Figure D. Hierarchical structure for the Substrate the CATAMI Classification (Source: Althaus *et. al*. 2013)



Aquatic flora and fauna were identified to the lowest possible taxonomic class using available field guides and information available on the receiving water. For quantification purposes, the following categories were used to define abundance:

Table 3: Abundance Classification (MLIN, 2023)

ABUNDANCE DESCRIPTOR	DESCRIPTION
Very Low Density	Species that are found in very low numbers in their appropriate habitats. Equivalent to less than Rare on the MNCR SACFOR abundance scale.
Low Density	Species that are found in low numbers in their appropriate habitats. Equivalent to Occasional and Rare on the MNCR SACFOR abundance scale.
Moderate Density	Species that are found in moderate numbers in their appropriate habitats. Equivalent to Common and Frequent on the MNCR SACFOR abundance scale.
High Density	Species that are found in high numbers in their appropriate habitats. Equivalent to Superabundant and Abundant on the MNCR SACFOR abundance scale.

3 RESULTS

The detailed results of the underwater fish habitat survey are presented in Table 3. A photo log of the observations is provided in Appendix A. The relief varied from flat to high, which is congruent with the bathymetry of the area which drops abruptly from less than 1 m to 15 meters deep at approximately 40 meters from the shore. The substrate was mostly cobbles or sand/mud, with some rocky outcrops. Except in the third transect, no macroflora was observed. The species observed, both submerged aquatic plants, belong to the Myriophyllum and Potagamon genera. Associated with the sediment beds, freshwater mussels belonging to the Unionidea family varied in abundance from low to high density. From the footage, it was only possible to identify them to the family rank. Three species of fishes were identified: the Smallmouth Bass (*Micropterus dolomieui*), the Redbreast Sunfish (*Lepomis auritus*) and the Banded Killifish (*Fundulus diaphanous*). Of those species, only the Redbreast Sunfish had not been previously observed. It is listed under the federal SARA in Schedule 3 as species of Special Concern. The Redbreast Sunfish is at the northern fringe of its range in New Brunswick.

Table 3: Results

Transect distance (m)	Relief	Substrate	Macroflora	Macrofauna	Bioturbation
Transect 1					
0-5	Flat	Sand/Mud	no	Moderate density of freshwater mussels	Vegetation debris
5-10	Moderate	Sand/Mud	no	Moderate density of freshwater mussels	no
10-15	No visibility				
15-20	Flat	Sand/Mud	no	Moderate density of freshwater mussels	no
20-25	Flat	Sand/Mud	no	High density of freshwater mussels	no
25-30	No visibility				
30-35	No visibility				
35-40	No visibility				
40-45	Moderate	no	no	no	no
45-50	No visibility				
50-55	No Visibility				
55-60	No visibility				
60-65	No visibility				
65-70	Flat	Sand/Mud	no	Low density freshwater mussels; one unidentified fish	Burrows
70-75	Flat	Sand/Mud	no	Very low density of *Fundulus diaphanus* (1)	no
75-80	Flat	Sand/Mud	no	no	no

80-85	Flat	Sand/Mud	no	Low density *Micropterus dolomieui* (1)	no
85-90	Low	Rock	no	no	no
90-95	Low	Rock	no	no	no
95-100	Flat	Sand/Mud	no	Low density freshwater mussels	Burrows
Transect 2					
0-5	Flat	Sand/Mud	no	Moderate density of freshwater mussels	Burrows
5-10	Moderate	Rock	no	no	no
10-15	Moderate	Rock	no	no	no
15-20	Low	Sand/Mud	no	Moderate density of possibly *Lepomis auritus* (2)	no
20-25	Low	Sand/Mud	no	Low density *Fundulus diaphanus*	no
25-30	Low	Sand/Mud	no	Moderate density freshwater mussels	no
30-35	Low	Sand/Mud	no	Moderate density of *Fundulus diaphanus* (3); low density freshwater mussels	no
35-40	Low	Sand/Mud	no	Low density Fundulus diaphanus; moderate density freshwater mussels	no
40-45	high	Rock	no	Low density *Fundulus diaphanus* (1)	no
45-50	high	Rock	no	Moderate density *Fundulus diaphanus* (2)	no
50-55	high	Rock	no	no	no
55-60	high	Rock	no	Moderate density *Fundulus diaphanus* (2)	no
60-65	Moderate	Sand/Mud	no	Low density of Fundulus diaphanus (1); low density of *Micropterus dolomieui* (1)	no
65-70	Moderate	Rock	no	Low density of *Fundulus diaphanus* (1); low density of *Micropterus diaphanus (1)*	no
70-75	Moderate	Sand/Mud	no	Very low density of freshwater mussels	no
75-80	Flat	Sand/Mud	no	no	no
80-85	No visibility				
85-90	nv**	nv	nv	Unidentified fish (1)	no
90-95	Flat	Sand/Mud	no	High density of freshwater mussels	no
95-100	Flat	Sand/Mud	no	High density of freshwater mussels	no
Transect 3					

0-5	Flat	Cobbles	no*	no	no
5-10	Flat	Cobbles	no	no	no
10-15	Flat	Cobbles	no	no	no
15-20	Flat	Cobbles	no	no	no
20-25	Flat	Cobbles	no	no	no
25-30	Flat	Cobbles	Very low density *Myriophyllum sp.*	no	no
30-35	Flat	Cobbles	Very low density *Myriophyllum*	no	no
35-40	Flat	Cobbles	Very low density *Potagamon sp.*	no	no
40-45	Flat	Cobbles	Very low *Potagamon sp.*	no	no
45-50	Flat	Cobbles	Moderate density *Potagamon sp.*	no	no
50-55	Flat	Cobbles	Moderate density *Potagamon sp.*	no	no
55-60	Flat	Cobbles	Unidentified submergent	no	no
60-65	Flat	Cobbles	Unidentified submergent	no	no
65-70	Flat	Cobbles	no	no	no
70-75	Flat	Cobbles	no	no	no
75-80	Flat	Cobbles	no	no	no
80-85	Flat	Cobbles	no	no	no
85-90	Flat	Cobbles	no	no	no
90-95	Flat	Cobbles	no	no	no
95-100	Flat	Cobbles	no	no	no

The following sections provide an overview of each transect.

3.1 Transect 1

Transect 1 was completed by Mako, using SCUBA gear along a pre-determined transect approximately 115m in length. The transect was completed from north to south. There was a lack of visibility for 40% of the transect.

The substrate of Transect 1 consisted sand/mud. Due to the lack of resolution, it was not possible to identify more precisely the substrate. These finding are consistent with the granulometry of the sediments reported in previous studies. No macroflora was observed along Transect 1. Freshwater mussels (*Unionidea* family) were observed in moderate density. The two species of fish identified, the Banded Killifish and the Smallmouth Bass, prefer slow moving, and cool to warm waters of lake and rivers.

3.2 Transect 2

Transect 2 was completed by Mako, using SCUBA gear along a pre-determined transect approximately 115m in length. The transect was completed from south to north. The visibility was

adequate for most of the transect. The substrate alternates between unconsolidated sand/mud and bedrock covered by a thin veneer of sediments. In addition of the previous species observed in transect one, there is a potential sighting of Redbreast Sunfish.

3.3 Transect 3

Transect 3 was completed by walking parallel to the shoreline along a transect approximately 115m in length. Observations were recorded using a digital camera or logged in writing in 10m segments. Observations covered water depth from the high-water mark to approximately 1.5m. Water levels along this transect may fluctuate based on the operation of the Mactaquac hydroelectric dam. The substrate of Transect 3 is primarily cobbles. The observable macroflora consisted of two genera with very low densities, except for *Potagamon* sp. in the 40-55 m segment of the transect which showed a moderate density.

4 GENERAL FISH HABITAT

The study area consisted of a typical lake shoreline, which increased in depth significantly 15m towards the east. Two habitat types were observed within the study area:

1. In the shallow area represented by transect 3, the bottom consists primarily of cobbles: Macroflora was sparse. The section with vegetation is adequate for the reproduction of the Banded Killifish.
2. The deeper area surveyed in transect 1 and 2 consists mostly in unconsolidated fine to medium sediments suitable for freshwater mussels and providing reproduction sites for Sunfish and Smallmouth Bass.
3. Fauna species observed during the survey consisted of Smallmouth Bass, Banded Killifish, and Redbreast Sunfish. Freshwater mussels belonging to the *Unionidea* family varied in abundance from low to high density, where present within the survey area.
4. Macroflora observed were from the *Myriophyllum* and *Potagamon* genera.

5 CLOSING

This report was prepared by Roy Consultants for the exclusive use of the proponent. Field work was conducted by Jon Burtt, EP and reporting by Marie-Josée Garand, PhD, EP. The information contained herein may not be republished or relied upon for any other purpose or by any other third party without the express written notice of the author.

6 REFERENCES

Althaus F., Hill N., Edwards L., Ferrari R., et al. (2013). CATAMI Classification Scheme for scoring marine biota and substrata in underwater imagery – A pictorial guide to the Collaborative and Annotation Tools for Analysis of Marine Imagery and Video (CATAMI) classification scheme. Version 1. http://catami.org/classification; Accessed on 3 Novembre 2023.

Dolson-Edge, R., Bruce, M., Samways, K., Gautreau, M., & Curry, R. A. (2019). Mactaquac Aquatic Ecosystem Study Report Series 2019-066, BASELINE BIOLOGICAL CONDITIONS IN THE SAINT JOHN RIVER.

Gautreau, M. and Curry, A. (2020). Inland Fish of New Brunswick. Canadian River Institute. 208 pages.

MLIN (Marine Life Information Network). Typical Abundance. Accessed 3 November 2023 at https://www.marlin.ac.uk/glossarydefinition/typicalabundance

Wentworth, C. K. (1922). A scale of grade and class terms for clastic sediments. The journal of geology, 30(5), 377-392.

APPENDIX A

APPENDIX A: SITE PHOTOS

Fish Habitat Survey – Site Photos
093-23 Mactaquac Park Wastewater Treatment Lagoon Replacement

Photo No. 1: Transect 1, 20-25m. High Density of Freshwater Mussels

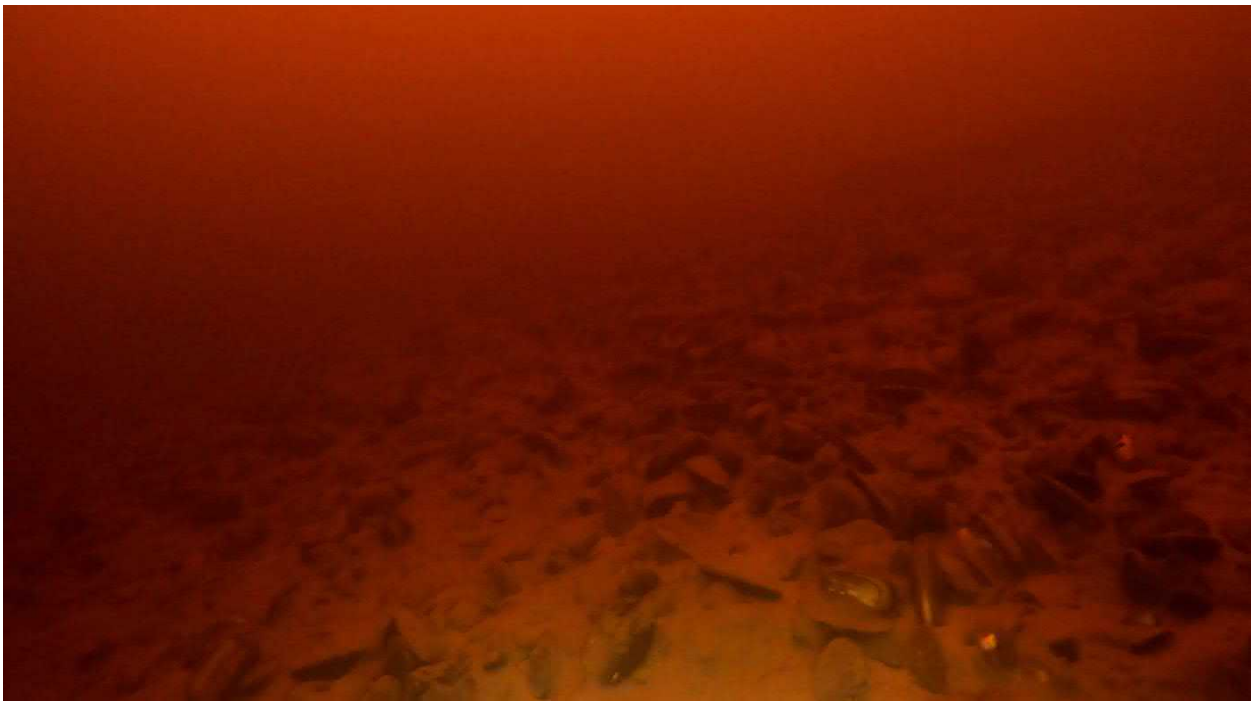


Photo 2. Transect 1, 60-65m. Mud/sand with Burrows and Unidentified Fish.

Photo No. 3: Transect 1, 80-85 m. Unconsolidated Mud/sand and Smallmouth Bass

Photo No. 4: Transect 1, 85-90m. Rock Outcrop

Photo No.5: View of the Mactaquac Arm at the Beginning of Transect 2

Photo No. 6: Transect 2, 0-5m. Mud/sand Substrate with Burrows and Freshwater Mussels

Photo No. 7: Transect 2, 5-10m. High Relief Rocky Ledge

Photo No. 8: Transect 2. 10-15 m High Relief Bedrock Outcrop

Photo No. 9: Transect 2, 15-20m. Possible Redbreast Sunfish

Photo No. 10: Transect 2, 20-25m. Banded Killifish

Photo No. 11: Transect 2, 30-35m. Banded Killifish

Photo No. 12: Transect 2, 60-65m. Smallmouth Bass

Photo No. 13: Transect 2, 85-90m. Unidentified Fish

Photo No. 14: 95-100m. Unconsolidated Mud/sand Substrate with Freshwater Mussels

Photo No. 15: Transect 3. Near-shore Consolidated Cobbles Substrate

Photo No. 16: Transect 3. Myriophyllum sp.

Photo No. 16: Transect 3. Potagamon sp.

Fish Habitat Survey – Site Photos
093-23 Mactaquac Park Wastewater Treatment Lagoon Replacement

Photo No. 17: Transect 3. View of the shore at the end of transect

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APPENDIX F

Appendix F – ACCDC Report 7693

DATA REPORT 7693: Mactaquac Provincial Park, NB

Prepared 29 May 2023
by J. Pender, Conservation Data Analyst

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- 1.1 Data List
- 1.2 Restrictions
- 1.3 Additional Information
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- 2.2 Fauna
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- Map 3: Special Areas

4.0 Rare Species Lists
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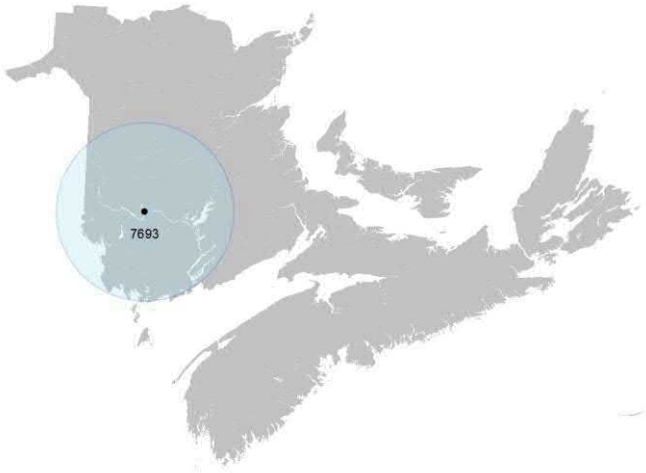
- 4.3 Location Sensitive Species
- 4.4 Source Bibliography

5.0 Rare Species within 100 km
- 5.1 Source Bibliography



Map 1. A 100 km buffer around the study area

1.0 PREFACE

The Atlantic Canada Conservation Data Centre (AC CDC; www.accdc.com) is part of a network of NatureServe data centres and heritage programs serving 50 states in the U.S.A, 10 provinces and 1 territory in Canada, plus several Central and South American countries. The NatureServe network is more than 30 years old and shares a common conservation data methodology. The AC CDC was founded in 1997, and maintains data for the jurisdictions of New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador. Although a non-governmental agency, the AC CDC is supported by 6 federal agencies and 4 provincial governments, as well as through outside grants and data processing fees.

Upon request and for a fee, the AC CDC queries its database and produces customized reports of the rare and endangered flora and fauna known to occur in or near a specified study area. As a supplement to that data, the AC CDC includes locations of managed areas with some level of protection, and known sites of ecological interest or sensitivity.

1.1 DATA LIST

Included datasets:

Filename	Contents
MactaquacProNB_7693ob.xls	Rare or legally-protected Flora and Fauna in your study area
MactaquacProNB_7693ob100km.xls	A list of Rare and legally protected Flora and Fauna within 100 km of your study area
MactaquacProNB_7693msa.xls	Managed and Biologically Significant Areas in your study area
MactaquacProNB_7693ff_py.xls	Rare Freshwater Fish in your study area (DFO database)

1.2 RESTRICTIONS

The AC CDC makes a strong effort to verify the accuracy of all the data that it manages, but it shall not be held responsible for any inaccuracies in data that it provides. By accepting AC CDC data, recipients assent to the following limits of use:

a) Data is restricted to use by trained personnel who are sensitive to landowner interests and to potential threats to rare and/or endangered flora and fauna posed by the information provided.
b) Data is restricted to use by the specified Data User; any third party requiring data must make its own data request.
c) The AC CDC requires Data Users to cease using and delete data 12 months after receipt, and to make a new request for updated data if necessary at that time.
d) AC CDC data responses are restricted to the data in our Data System at the time of the data request.
e) Each record has an estimate of locational uncertainty, which must be referenced in order to understand the record's relevance to a particular location. Please see attached Data Dictionary for details.
f) AC CDC data responses are not to be construed as exhaustive inventories of taxa in an area.
g) The absence of a taxon cannot be inferred by its absence in an AC CDC data response.

1.3 ADDITIONAL INFORMATION

The accompanying Data Dictionary provides metadata for the data provided.

Please direct any additional questions about AC CDC data to the following individuals:

Plants, Lichens, Ranking Methods, All other Inquiries
Sean Blaney
Senior Scientist / Executive Director
(506) 364-2658
sean.blaney@accdc.ca

Animals (Fauna)
John Klymko
Zoologist
(506) 364-2660
john.klymko@accdc.ca

Data Management, GIS
James Churchill
Conservation Data Analyst / Field Biologist
(902) 679-6146
james.churchill@accdc.ca

Billing
Jean Breau
Financial Manager / Executive Assistant
(506) 364-2657
jean.breau@accdc.ca

Questions on the biology of Federal Species at Risk can be directed to AC CDC: (506) 364-2658, with questions on Species at Risk regulations to: Samara Eaton, Canadian Wildlife Service (NB and PE): (506) 364-5060 or Julie McKnight, Canadian Wildlife Service (NS): (902) 426-4196.

For provincial information about rare taxa and protected areas, or information about game animals, deer yards, old growth forests, archeological sites, fish habitat etc., in New Brunswick, please contact Hubert Askanas, Energy and Resource Development: (506) 453-5873.

For provincial information about rare taxa and protected areas, or information about game animals, deer yards, old growth forests, archeological sites, fish habitat etc., in Nova Scotia, please contact Donna Hurlburt, NS DLF: (902) 679-6886. To determine if location-sensitive species (section 4.3) occur near your study site please contact a NS DLF Regional Biologist:

Western: Emma Vost
(902) 670-8187
Emma.Vost@novascotia.ca

Western: Sarah Spencer
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Sarah.Spencer@novascotia.ca

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Eastern: Maureen Cameron-MacMillan
(902) 295-2554
Maureen.Cameron-MacMillan@novascotia.ca

Eastern: Elizabeth Walsh
(902) 563-3370
Elizabeth.Walsh@novascotia.ca

For provincial information about rare taxa and protected areas, or information about game animals, fish habitat etc., in Prince Edward Island, please contact Garry Gregory, PEI Dept. of Communities, Land and Environment: (902) 569-7595.

2.0 RARE AND ENDANGERED SPECIES

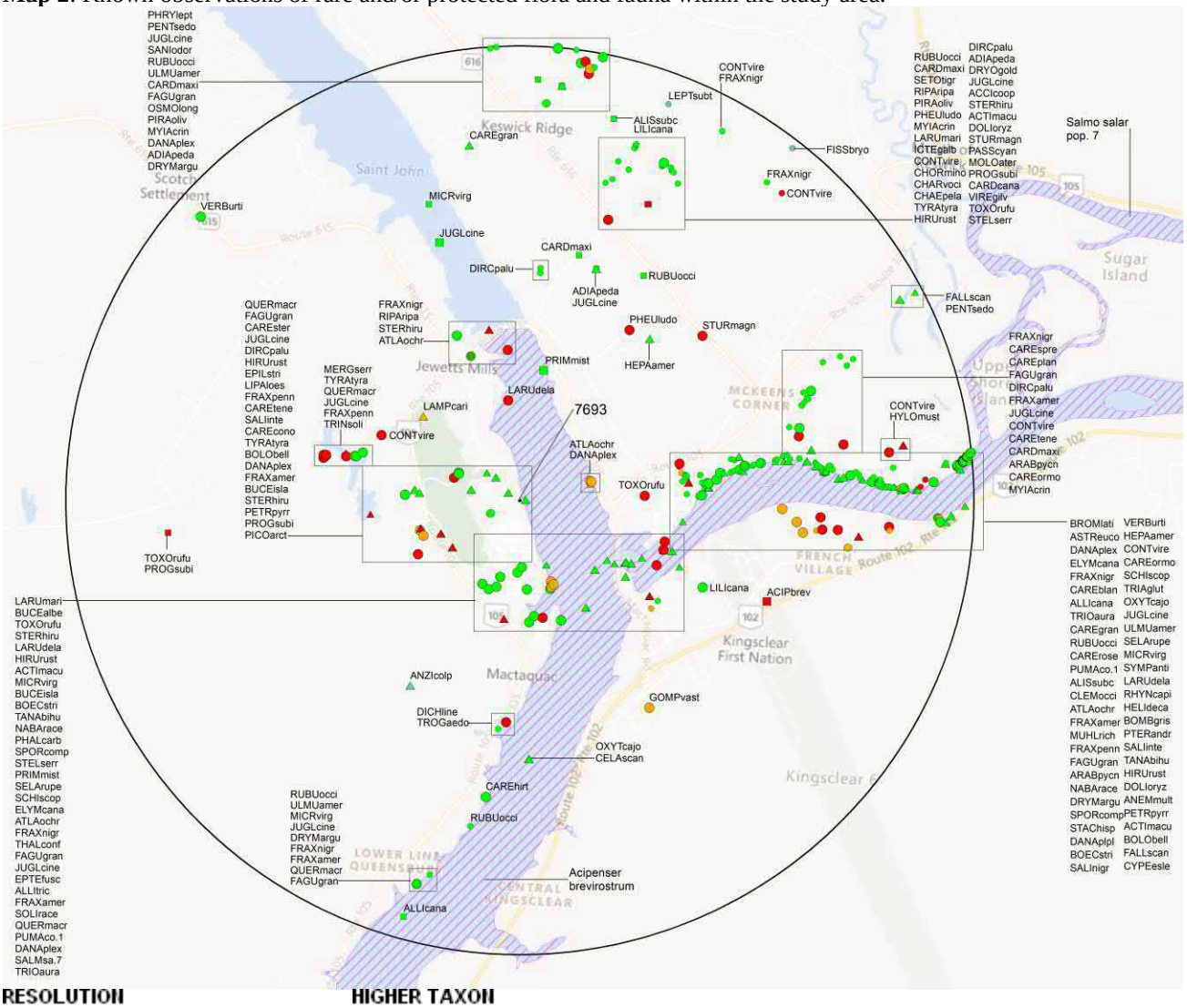
2.1 FLORA

The study area contains 339 records of 66 vascular and 4 records of 3 nonvascular flora (Map 2 and attached: *ob.xls), excluding 'location-sensitive' species.

2.2 FAUNA

The study area contains 121 records of 39 vertebrate and 29 records of 7 invertebrate fauna (Map 2 and attached data files - see 1.1 Data List), excluding 'location-sensitive species'. Please see section 4.3 to determine if 'location-sensitive' species occur near your study site.

Map 2: Known observations of rare and/or protected flora and fauna within the study area.



3.0 SPECIAL AREAS

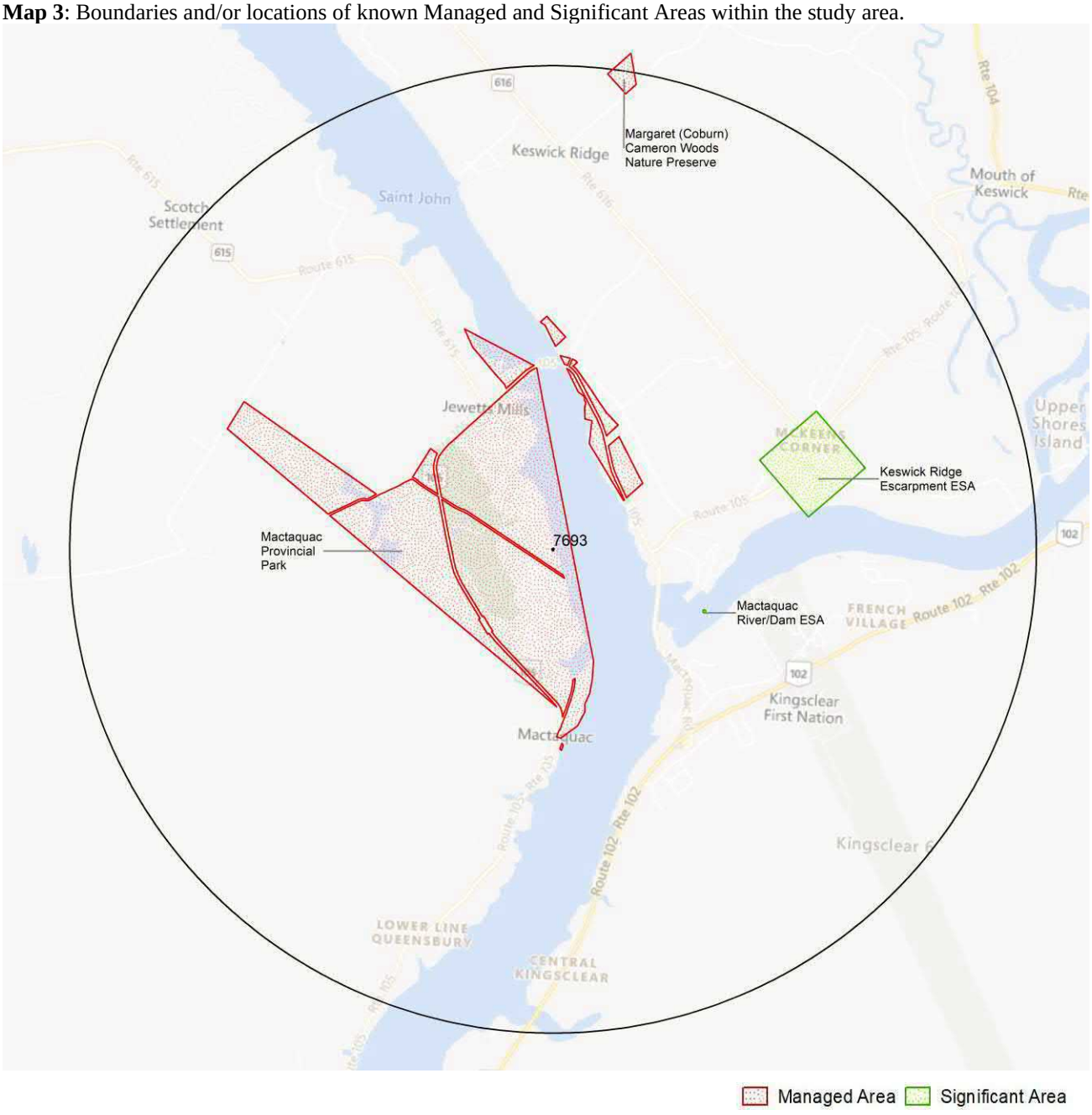
3.1 MANAGED AREAS

The GIS scan identified 2 managed areas in the vicinity of the study area (Map 3 and attached file: *msa.xls).

3.2 SIGNIFICANT AREAS

The GIS scan identified 2 biologically significant sites in the vicinity of the study area (Map 3 and attached file: *msa.xls).

Map 3: Boundaries and/or locations of known Managed and Significant Areas within the study area.



4.0 RARE SPECIES LISTS

Rare and/or endangered taxa (excluding "location-sensitive" species, section 4.3) within the study area listed in order of concern, beginning with legally listed taxa, with the number of observations per taxon and the distance in kilometers from study area centroid to the closest observation (± the precision, in km, of the record). [P] = vascular plant, [N] = nonvascular plant, [A] = vertebrate animal, [I] = invertebrate animal, [C] = community. Note: records are from attached files *ob.xls/*ob.shp only.

4.1 FLORA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
N	*Anzia colpodes*	Black-foam Lichen	Threatened	Threatened		S1S2	1	2.4 ± 1.0
N	*Scytinium subtile*	Appressed Jellyskin Lichen				S3?	2	4.7 ± 0.0
N	*Fissidens bryoides*	Lesser Pocket Moss				S3S4	1	4.9 ± 0.0
P	*Juglans cinerea*	Butternut	Endangered	Endangered	Endangered	S1	29	0.7 ± 0.0
P	*Fraxinus nigra*	Black Ash	Threatened			S3S4	11	0.7 ± 0.0
P	*Symphyotrichum anticostense*	Anticosti Aster	Special Concern	Special Concern	Endangered	S3	4	2.4 ± 0.0
P	*Pterospora andromedea*	Woodland Pinedrops			Endangered	S1	16	2.3 ± 0.0
P	*Helianthus decapetalus*	Ten-rayed Sunflower				S1	4	4.7 ± 1.0
P	*Carex blanda*	Eastern Woodland Sedge				S1	1	1.9 ± 0.0
P	*Carex sterilis*	Sterile Sedge				S1	1	0.5 ± 0.0
P	*Rhynchospora capillacea*	Slender Beakrush				S1	3	3.4 ± 0.0
P	*Allium canadense*	Canada Garlic				S1	11	2.5 ± 0.0
P	*Sporobolus compositus*	Rough Dropseed				S1	12	1.3 ± 0.0
P	*Selaginella rupestris*	Rock Spikemoss				S1	9	1.5 ± 0.0
P	*Alisma subcordatum*	Southern Water Plantain				S1?	2	4.3 ± 7.0
P	*Sanicula odorata*	Clustered Sanicle				S2	1	5.0 ± 0.0
P	*Astragalus eucosmus*	Elegant Milk-vetch				S2	6	2.5 ± 0.0
P	*Quercus macrocarpa*	Bur Oak				S2	4	0.7 ± 0.0
P	*Micranthes virginiensis*	Early Saxifrage				S2	15	1.8 ± 1.0
P	*Osmorhiza longistylis*	Smooth Sweet Cicely				S2S3	2	4.6 ± 5.0
P	*Hepatica americana*	Round-lobed Hepatica				S2S3	8	2.3 ± 1.0
P	*Dirca palustris*	Eastern Leatherwood				S2S3	6	0.4 ± 1.0
P	*Phryma leptostachya*	American Lopseed				S2S3	3	4.8 ± 0.0
P	*Verbena urticifolia*	White Vervain				S2S3	5	4.7 ± 0.0
P	*Allium tricoccum*	Wild Leek				S2S3	1	1.9 ± 0.0
P	*Elymus canadensis*	Canada Wild Rye				S2S3	11	1.4 ± 1.0
P	*Nabalus racemosus*	Glaucous Rattlesnakeroot				S3	5	0.8 ± 0.0
P	*Solidago racemosa*	Racemose Goldenrod				S3	1	1.4 ± 1.0
P	*Tanacetum bipinnatum ssp. huronense*	Lake Huron Tansy				S3	3	1.4 ± 1.0
P	*Arabis pycnocarpa*	Cream-flowered Rockcress				S3	3	2.1 ± 1.0
P	*Cardamine maxima*	Large Toothwort				S3	5	2.8 ± 2.0
P	*Boechera stricta*	Drummond's Rockcress				S3	6	1.2 ± 0.0
P	*Triosteum aurantiacum*	Orange-fruited Tinker's Weed				S3	5	1.4 ± 0.0
P	*Oxytropis campestris var. johannensis*	Field Locoweed				S3	2	2.8 ± 1.0
P	*Fraxinus pennsylvanica*	Red Ash				S3	8	1.3 ± 0.0
P	*Primula mistassinica*	Mistassini Primrose				S3	2	1.4 ± 1.0
P	*Anemone multifida*	Cut-leaved Anemone				S3	1	1.8 ± 0.0
P	*Clematis occidentalis*	Purple Clematis				S3	2	4.0 ± 1.0
P	*Rubus occidentalis*	Black Raspberry				S3	15	2.0 ± 0.0
P	*Salix nigra*	Black Willow				S3	1	2.0 ± 0.0
P	*Salix interior*	Sandbar Willow				S3	4	0.1 ± 1.0
P	*Carex conoidea*	Field Sedge				S3	1	1.1 ± 1.0
P	*Carex granularis*	Limestone Meadow Sedge				S3	5	1.9 ± 0.0
P	*Carex hirtifolia*	Pubescent Sedge				S3	1	3.3 ± 0.0
P	*Carex ormostachya*	Necklace Spike Sedge				S3	1	3.3 ± 1.0

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
P	*Carex plantaginea*	Plantain-Leaved Sedge				S3	1	3.3 ± 0.0
P	*Carex rosea*	Rosy Sedge				S3	4	1.9 ± 0.0
P	*Carex sprengelii*	Longbeak Sedge				S3	1	3.7 ± 0.0
P	*Cyperus esculentus var. leptostachyus*	Perennial Yellow Nutsedge				S3	1	4.9 ± 0.0
P	*Bromus latiglumis*	Broad-Glumed Brome				S3	1	2.3 ± 0.0
P	*Dichanthelium linearifolium*	Narrow-leaved Panic Grass				S3	1	2.5 ± 0.0
P	*Muhlenbergia richardsonis*	Mat Muhly				S3	9	2.5 ± 0.0
P	*Schizachyrium scoparium*	Little Bluestem				S3	3	1.3 ± 1.0
P	*Adiantum pedatum*	Northern Maidenhair Fern				S3	11	2.7 ± 5.0
P	*Dryopteris goldieana*	Goldie's Woodfern				S3	1	4.0 ± 0.0
P	*Penthorum sedoides*	Ditch Stonecrop				S3S4	2	4.9 ± 0.0
P	*Fagus grandifolia*	American Beech				S3S4	11	0.7 ± 0.0
P	*Stachys hispida*	Smooth Hedge-Nettle				S3S4	2	2.0 ± 0.0
P	*Fraxinus americana*	White Ash				S3S4	9	0.4 ± 0.0
P	*Epilobium strictum*	Downy Willowherb				S3S4	4	1.2 ± 1.0
P	*Fallopia scandens*	Climbing False Buckwheat				S3S4	2	4.7 ± 1.0
P	*Thalictrum confine*	Northern Meadow-rue				S3S4	1	1.1 ± 1.0
P	*Drymocallis arguta*	Tall Wood Beauty				S3S4	19	2.1 ± 1.0
P	*Ulmus americana*	White Elm				S3S4	9	2.8 ± 0.0
P	*Carex tenera*	Tender Sedge				S3S4	3	0.5 ± 1.0
P	*Lilium canadense*	Canada Lily				S3S4	2	2.2 ± 0.0
P	*Triantha glutinosa*	Sticky False-Asphodel				S3S4	4	3.3 ± 1.0
P	*Liparis loeselii*	Loesel's Twayblade				S3S4	1	0.2 ± 1.0
P	*Celastrus scandens*	Climbing Bittersweet				SX	1	2.8 ± 1.0

4.2 FAUNA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
A	*Salmo salar pop. 7*	Atlantic Salmon - Outer Bay of Fundy population	Endangered		Endangered	SNR	1	1.3 ± 0.0
A	*Sturnella magna*	Eastern Meadowlark	Threatened	Threatened	Threatened	S1B	2	2.7 ± 0.0
A	*Hylocichla mustelina*	Wood Thrush	Threatened	Threatened	Threatened	S1S2B	1	4.3 ± 1.0
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened		S2B	3	1.9 ± 1.0
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Threatened	S2S3B,S2M	1	3.6 ± 7.0
A	*Hirundo rustica*	Barn Swallow	Special Concern	Threatened	Threatened	S2B	9	0.8 ± 0.0
A	*Bucephala islandica*	Barrow's Goldeneye	Special Concern	Special Concern	Special Concern	S2S3N,S3M	7	1.1 ± 1.0
A	*Acipenser brevirostrum*	Shortnose Sturgeon	Special Concern	Special Concern	Special Concern	S3	1	2.9 ± 10.0
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Special Concern	S3B	13	1.7 ± 0.0
A	*Dolichonyx oryzivorus*	Bobolink	Special Concern	Threatened	Threatened	S3B	4	3.6 ± 7.0
A	*Chordeiles minor*	Common Nighthawk	Special Concern	Special Concern	Threatened	S3B,S4M	1	3.6 ± 7.0
A	*Cardellina canadensis*	Canada Warbler	Special Concern	Threatened	Threatened	S3S4B	1	3.6 ± 7.0
A	*Accipiter cooperii*	Cooper's Hawk	Not At Risk			S1S2B	1	3.6 ± 7.0
A	*Sterna hirundo*	Common Tern	Not At Risk			S3B,SUM	9	0.9 ± 2.0
A	*Puma concolor pop. 1*	Cougar - Eastern population	Data Deficient		Endangered	SU	2	1.3 ± 1.0
A	*Progne subis*	Purple Martin				S1B	3	0.9 ± 1.0
A	*Stelgidopteryx serripennis*	Northern Rough-winged Swallow				S1S2B	2	1.7 ± 0.0
A	*Troglodytes aedon*	House Wren				S1S2B	3	2.4 ± 0.0
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2B	2	0.9 ± 2.0
A	*Tringa solitaria*	Solitary Sandpiper				S2B,S4S5M	1	2.2 ± 0.0
A	*Phalacrocorax carbo*	Great Cormorant				S2N	1	1.7 ± 0.0
A	*Toxostoma rufum*	Brown Thrasher				S2S3B	4	1.4 ± 0.0
A	*Icterus galbula*	Baltimore Oriole				S2S3B	2	3.6 ± 7.0
A	*Larus delawarensis*	Ring-billed Gull				S2S3B,S4N,S5M	5	1.1 ± 0.0
A	*Larus marinus*	Great Black-backed Gull				S3	4	1.7 ± 0.0

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
A	*Picoides arcticus*	Black-backed Woodpecker				S3	1	1.3 ± 0.0
A	*Charadrius vociferus*	Killdeer				S3B	2	3.6 ± 7.0
A	*Myiarchus crinitus*	Great Crested Flycatcher				S3B	4	3.6 ± 0.0
A	*Piranga olivacea*	Scarlet Tanager				S3B	3	3.6 ± 7.0
A	*Pheucticus ludovicianus*	Rose-breasted Grosbeak				S3B	5	2.2 ± 0.0
A	*Passerina cyanea*	Indigo Bunting				S3B	1	3.6 ± 7.0
A	*Molothrus ater*	Brown-headed Cowbird				S3B	1	3.6 ± 7.0
A	*Setophaga tigrina*	Cape May Warbler				S3B,S4S5M	1	3.6 ± 7.0
A	*Mergus serrator*	Red-breasted Merganser				S3B,S4S5N,S5M	1	2.0 ± 1.0
A	*Bucephala albeola*	Bufflehead				S3N	2	1.7 ± 0.0
A	*Eptesicus fuscus*	Big Brown Bat				S3S4	3	1.8 ± 1.0
A	*Tyrannus tyrannus*	Eastern Kingbird				S3S4B	9	1.7 ± 0.0
A	*Vireo gilvus*	Warbling Vireo				S3S4B	1	3.6 ± 7.0
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S4M	4	1.7 ± 0.0
I	*Danaus plexippus*	Monarch	Endangered	Special Concern	Special Concern	S2S3?B	14	0.8 ± 0.0
I	*Danaus plexippus plexippus*	Monarch	Endangered	Special Concern		S2S3?B	2	4.2 ± 0.0
I	*Lampsilis cariosa*	Yellow Lampmussel	Special Concern	Special Concern	Special Concern	S3	1	1.4 ± 1.0
I	*Boloria bellona*	Meadow Fritillary				S3	2	0.4 ± 0.0
I	*Gomphurus vastus*	Cobra Clubtail				S3	1	2.7 ± 0.0
I	*Atlanticoncha ochracea*	Tidewater Mucket				S3	7	0.8 ± 0.0
I	*Bombus griseocollis*	Brown-belted Bumble Bee				S3S4	2	4.9 ± 0.0

4.3 LOCATION SENSITIVE SPECIES

The Department of Natural Resources in each Maritimes province considers a number of species "location sensitive". Concern about exploitation of location-sensitive species precludes inclusion of precise coordinates in this report. Those intersecting your study area are indicated below with "YES".

New Brunswick

Scientific *Name*	Common Name	SARA	Prov Legal Prot	Known within the Study Site?
Chrysemys picta picta	**Eastern Painted Turtle**	**Special Concern**		**YES**
Chelydra serpentina	**Snapping Turtle**	**Special Concern**	**Special Concern**	**YES**
Glyptemys insculpta	Wood Turtle	Threatened	Threatened	No
Haliaeetus leucocephalus	**Bald Eagle**		**Endangered**	**YES**
Falco peregrinus pop. 1	Peregrine Falcon - anatum/tundrius pop.		Endangered	No
Cicindela marginipennis	Cobblestone Tiger Beetle	Endangered	Endangered	No
Coenonympha nipisiquit	Maritime Ringlet	Endangered	Endangered	No
Bat hibernaculum or bat species occurrence		[Endangered][1]	[Endangered][1]	No

1 *Myotis lucifugus* (Little Brown Myotis), *Myotis septentrionalis* (Long-eared Myotis), and *Perimyotis subflavus* (Tri-colored Bat or Eastern Pipistrelle) are all Endangered under the Federal Species at Risk Act and the NB Species at Risk Act.

4.4 SOURCE BIBLIOGRAPHY

The recipient of these data shall acknowledge the AC CDC and the data sources listed below in any documents, reports, publications or presentations, in which this dataset makes a significant contribution.

# recs	CITATION
53	Benedict, B. Connell Herbarium Specimens. University New Brunswick, Fredericton. 2003.
53	Lepage, D. 2014. Maritime Breeding Bird Atlas Database. Bird Studies Canada, Sackville NB, 407,838 recs.
48	Blaney, C.S; Korol, J.B.; Crowell, I. 2023. 2022 AC CDC Botany program field data. Atlantic Canada Conservation Data Centre, 5293 records.
48	iNaturalist.ca. 2023. iNaturalist Data Export December 2022. iNaturalist.org; iNaturalist.ca.
45	Blaney, C.S. 2000. Fieldwork 2000. Atlantic Canada Conservation Data Centre. Sackville NB, 1265 recs.
38	iNaturalist. 2020. iNaturalist Data Export 2020. iNaturalist.org and iNaturalist.ca, Web site: 128728 recs.
28	Wisniowski, C. & Dowding, A. 2019. NB species occurrence data for 2016-2018. Nature Trust of New Brunswick.
23	eBird. 2014. eBird Basic Dataset. Version: EBD_relNov-2014. Ithaca, New York. Nov 2014. Cornell Lab of Ornithology, 25036 recs.
21	Goltz, J.P. 2012. Field Notes, 1989-2005. , 1091 recs.
20	Benedict, B. Connell Herbarium Specimens (Data) . University New Brunswick, Fredericton. 2003.
16	Clayden, S.R. 1998. NBM Science Collections databases: vascular plants. New Brunswick Museum, Saint John NB, 19759 recs.
15	Tims, J. & Craig, N. 1995. Environmentally Significant Areas in New Brunswick (NBESA). NB Dept of Environment & Nature Trust of New Brunswick Inc, 6042 recs. https://doi.org/10.1037/arc0000014.
10	Mazerolle, D.M. 2018. Atlantic Canada Conservation Data Centre botanical fieldwork 2018. Atlantic Canada Conservation Data Centre, 13515 recs.
9	Hinds, H.R. 1986. Notes on New Brunswick plant collections. Connell Memorial Herbarium, unpubl, 739 recs.
8	Benedict, B. Connell Herbarium Specimen Database Download 2004. Connell Memorial Herbarium, University of New Brunswick. 2004.
8	Department of Natural Resources and Energy Development. 2022. Pinedrops (Pterospora andromedea) records for New Brunswick. Government of New Brunswick, 12 records.
8	Erskine, A.J. 1992. Maritime Breeding Bird Atlas Database. NS Museum & Nimbus Publ., Halifax, 82,125 recs.
5	Benedict, B. Connell Herbarium Specimens. University New Brunswick, Fredericton. 2000.
4	Klymko, J. 2018. Maritimes Butterfly Atlas database. Atlantic Canada Conservation Data Centre.
3	Neily, T. H. 2018. Lichen and Bryophyte records, AEI 2017-2018. Tom Neily; Atlantic Canada Conservation Data Centre.
2	Chapman, C.J. 2018. Atlantic Canada Conservation Data Centre botanical fieldwork 2018. Atlantic Canada Conservation Data Centre, 11171 recs.
2	eBird. 2020. eBird Basic Dataset. Version: EBD_relNov-2019. Ithaca, New York. Nov 2019, Cape Breton Bras d'Or Lakes Watershed subset. Cornell Lab of Ornithology.
2	Erskine, A.J. 1999. Maritime Nest Records Scheme (MNRS) 1937-1999. Canadian Wildlife Service, Sackville, 313 recs.
2	iNaturalist. 2018. iNaturalist Data Export 2018. iNaturalist.org and iNaturalist.ca, Web site: 11700 recs.
2	iNaturalist. 2020. iNaturalist butterfly records selected for the Maritimes Butterfly Atlas. iNaturalist.
2	Litvak, M.K. 2001. Shortnose Sturgeon records in four NB rivers. UNB Saint John NB. Pers. comm. to K. Bredin, 6 recs.
2	McAlpine, D.F. 1998. NBM Science Collections databases to 1998. New Brunswick Museum, Saint John NB, 241 recs.
2	NatureServe Canada. 2019. iNaturalist Maritimes Butterfly Records. iNaturalist.org and iNaturalist.ca.
2	Newell, R.E. 2000. E.C. Smith Herbarium Database. Acadia University, Wolfville NS, 7139 recs.
2	Scott, Fred W. 1998. Updated Status Report on the Cougar (Puma Concolor couguar) [Eastern population]. Committee on the Status of Endangered Wildlife in Canada, 298 recs.
2	Stantec. 2014. Energy East Pipeline Corridor Species Occurrence Data. Stantec Inc., 4934 records.
1	Blaney, C.S.; Mazerolle, D.M.; Belliveau, A.B. 2015. Atlantic Canada Conservation Data Centre Fieldwork 2015. Atlantic Canada Conservation Data Centre, # recs.

# recs	CITATION
1	Canadian Wildlife Service. 2019. Canadian Protected and Conserved Areas Database (CPCAD). December 2019. ECCC.https://www.canada.ca/en/environment-climate-change/services/national-wildlife-areas/protected-conserved-areas-database.html.
1	Dept of Fisheries & Oceans. 2001. Atlantic Salmon Maritime provinces overview for 2000. DFO.
1	Goltz, J.P. 2023. Record of Andropogon gerardii at Pokiok, York Co., NB and other rare spp. records. pers. comm., 1 record.
1	Hinds, H.R. 1999. Connell Herbarium Database. University New Brunswick, Fredericton, 131 recs.
1	Jolicoeur, G. 2008. Anticosti Aster at Chapel Bar, St John River. QC DOE? Pers. comm. to D.M. Mazerolle, 1 rec.
1	Mills, E. Connell Herbarium Specimens, 1957-2009. University New Brunswick, Fredericton. 2012.
1	Nature Trust of New Brunswick (NTNB). 2020. Nature Preserves and Conservation Easements (Received: 18 September, 2020). NTNB.
1	Richardson, D., Anderson, F., Cameron, R, McMullin, T., Clayden, S. 2014. Field Work Report on Black Foam Lichen (Anzia colpodes). COSEWIC.
1	Sabine, D.L. 2005. 2001 Freshwater Mussel Surveys. New Brunswick Dept of Natural Resources & Energy, 590 recs.
1	Sabine, M. 2016. Black Ash records from the NB DNR Forest Development Survey. New Brunswick Department of Natural Resources.
1	Shortt, R. Connell Herbarium Black Ash specimens. University New Brunswick, Fredericton. 2019.
1	Sollows, M.C,. 2008. NBM Science Collections databases: mammals. New Brunswick Museum, Saint John NB, download Jan. 2008, 4983 recs.
1	Sollows, M.C. 2009. NBM Science Collections databases: molluscs. New Brunswick Museum, Saint John NB, download Jan. 2009, 6951 recs (2957 in Atlantic Canada).

5.0 RARE SPECIES WITHIN 100 KM

A 100 km buffer around the study area contains 27263 records of 160 vertebrate and 2460 records of 95 invertebrate fauna; 16174 records of 358 vascular and 1371 records of 177 nonvascular flora (attached: *ob100km.xls).

Taxa within 100 km of the study site that are rare and/or endangered in the province in which the study site occurs (including “location-sensitive” species). All ranks correspond to the province in which the study site falls, even for out-of-province records. Taxa are listed in order of concern, beginning with legally listed taxa, with the number of observations per taxon and the distance in kilometers from study area centroid to the closest observation (± the precision, in km, of the record).

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
A	*Myotis lucifugus*	Little Brown Myotis	Endangered	Endangered	Endangered	S1	56	18.3 ± 1.0	NB
A	*Myotis septentrionalis*	Northern Myotis	Endangered	Endangered	Endangered	S1	15	18.3 ± 1.0	NB
A	*Perimyotis subflavus*	Tricolored Bat	Endangered	Endangered	Endangered	S1	3	95.8 ± 0.0	NB
A	*Osmerus mordax pop. 2*	Rainbow Smelt - Lake Utopia Large-bodied population	Endangered	Threatened	Threatened	S1	2	87.1 ± 10.0	NB
A	*Sterna dougallii*	Roseate Tern	Endangered	Endangered	Endangered	S1B	2	98.2 ± 5.0	NB
A	*Salmo salar pop. 1*	Atlantic Salmon - Inner Bay of Fundy population	Endangered	Endangered	Endangered	S2	437	25.6 ± 0.0	NB
A	*Melanerpes erythrocephalus*	Red-headed Woodpecker	Endangered	Threatened		SNA	1	68.7 ± 7.0	NB
A	*Empidonax virescens*	Acadian Flycatcher	Endangered	Endangered		SNA	2	16.3 ± 0.0	NB
A	*Icteria virens*	Yellow-Breasted Chat	Endangered	Endangered		SNA	4	67.7 ± 7.0	NB
A	*Salmo salar pop. 7*	Atlantic Salmon - Outer Bay of Fundy population	Endangered		Endangered	SNR	44	1.3 ± 0.0	NB
A	*Lasionycteris noctivagans*	Silver-haired Bat	Endangered			SUB,S1?M	4	59.2 ± 10.0	NB
A	*Lasiurus borealis*	Eastern Red Bat	Endangered			SUB,S2?M	7	22.4 ± 0.0	NB
A	*Lasiurus cinereus*	Hoary Bat	Endangered			SUB,S2?M	7	18.3 ± 1.0	NB
A	*Rangifer tarandus pop. 2*	Caribou - Atlantic-Gaspé population	Endangered	Endangered	Extirpated	SX	4	44.8 ± 1.0	NB
A	*Colinus virginianus*	Northern Bobwhite	Endangered	Endangered			4	75.5 ± 0.0	NB
A	*Sturnella magna*	Eastern Meadowlark	Threatened	Threatened	Threatened	S1B	41	2.7 ± 0.0	NB
A	*Asio flammeus*	Short-eared Owl	Threatened	Special Concern	Special Concern	S1S2B	15	54.3 ± 0.0	NB
A	*Ixobrychus exilis*	Least Bittern	Threatened	Threatened	Threatened	S1S2B	29	11.7 ± 7.0	NB
A	*Hylocichla mustelina*	Wood Thrush	Threatened	Threatened	Threatened	S1S2B	236	4.3 ± 1.0	NB
A	*Hydrobates leucorhous*	Leach's Storm-Petrel	Threatened			S1S2B	1	99.8 ± 0.0	NB
A	*Catharus bicknelli*	Bicknell's Thrush	Threatened	Threatened	Threatened	S2B	3	75.8 ± 7.0	NB
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened		S2B	467	1.9 ± 1.0	NB
A	*Glyptemys insculpta*	Wood Turtle	Threatened	Threatened	Threatened	S2S3	2129	5.4 ± 1.0	NB
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Threatened	S2S3B,S2M	590	3.6 ± 7.0	NB
A	*Acipenser oxyrinchus*	Atlantic Sturgeon	Threatened		Threatened	S3B,S3N	2	50.7 ± 1.0	NB
A	*Tringa flavipes*	Lesser Yellowlegs	Threatened			S3M	79	6.0 ± 0.0	NB
A	*Limosa haemastica*	Hudsonian Godwit	Threatened			S3M	2	95.9 ± 0.0	NB
A	*Anguilla rostrata*	American Eel	Threatened		Threatened	S4N	142	9.6 ± 1.0	NB
A	*Coturnicops noveboracensis*	Yellow Rail	Special Concern	Special Concern	Special Concern	S1?B,SUM	3	49.4 ± 7.0	NB
A	*Histrionicus histrionicus pop. 1*	Harlequin Duck - Eastern population	Special Concern	Special Concern	Endangered	S1B,S1S2N,S2M	8	5.1 ± 0.0	NB
A	*Antrostomus vociferus*	Eastern Whip-Poor-Will	Special Concern	Threatened	Threatened	S2B	100	13.0 ± 7.0	NB
A	*Hirundo rustica*	Barn Swallow	Special Concern	Threatened	Threatened	S2B	1161	0.8 ± 0.0	NB
A	*Salmo salar pop. 12*	Atlantic Salmon - Gaspe - Southern Gulf of St. Lawrence population	Special Concern		Special Concern	S2S3	456	49.2 ± 0.0	NB
A	*Balaenoptera physalus*	Fin Whale	Special Concern	Special Concern		S2S3	2	98.6 ± 0.0	NB
A	*Euphagus carolinus*	Rusty Blackbird	Special Concern	Special Concern	Special Concern	S2S3B,S3M	252	6.2 ± 0.0	NB
A	*Bucephala islandica*	Barrow's Goldeneye	Special Concern	Special Concern	Special Concern	S2S3N,S3M	50	1.1 ± 1.0	NB
A	*Acipenser brevirostrum*	Shortnose Sturgeon	Special Concern	Special Concern	Special Concern	S3	12	2.9 ± 10.0	NB
A	*Chelydra serpentina*	Snapping Turtle	Special Concern	Special Concern	Special Concern	S3	344	1.8 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Special Concern	S3B	901	1.7 ± 0.0	NB
A	*Contopus cooperi*	Olive-sided Flycatcher	Special Concern	Special Concern	Threatened	S3B	742	6.8 ± 7.0	NB
A	*Dolichonyx oryzivorus*	Bobolink	Special Concern	Threatened	Threatened	S3B	1025	3.6 ± 7.0	NB
A	*Coccothraustes vespertinus*	Evening Grosbeak	Special Concern	Special Concern		S3B,S3S4N,SUM	336	5.7 ± 0.0	NB
A	*Chordeiles minor*	Common Nighthawk	Special Concern	Special Concern	Threatened	S3B,S4M	546	3.6 ± 7.0	NB
A	*Phalaropus lobatus*	Red-necked Phalarope	Special Concern	Special Concern		S3M	3	92.0 ± 0.0	NB
A	*Podiceps auritus*	Horned Grebe	Special Concern	Special Concern	Special Concern	S3N	36	34.4 ± 0.0	NB
A	*Cardellina canadensis*	Canada Warbler	Special Concern	Threatened	Threatened	S3S4B	1767	3.6 ± 7.0	NB
A	*Phocoena phocoena*	Harbour Porpoise	Special Concern		Spec.Concern	S4	27	76.7 ± 100.0	NB
A	*Chrysemys picta*	Painted Turtle	Special Concern	Special Concern		S4	29	15.6 ± 0.0	NB
A	*Chrysemys picta picta*	Eastern Painted Turtle	Special Concern	Special Concern		S4	288	2.0 ± 0.0	NB
A	*Phocoena phocoena pop. 1*	Harbour Porpoise - Northwest Atlantic Population	Special Concern		Special Concern	SNR	1	95.7 ± 0.0	NB
A	*Fulica americana*	American Coot	Not At Risk			S1B	13	20.0 ± 0.0	NB
A	*Falco peregrinus pop. 1*	Peregrine Falcon - anatum/tundrius	Not At Risk		Endangered	S1B,S3M	111	19.0 ± 0.0	NB
A	*Bubo scandiacus*	Snowy Owl	Not At Risk			S1N,S2S3M	14	18.9 ± 0.0	NB
A	*Accipiter cooperii*	Cooper's Hawk	Not At Risk			S1S2B	40	3.6 ± 7.0	NB
A	*Buteo lineatus*	Red-shouldered Hawk	Not At Risk			S1S2B	63	6.8 ± 7.0	NB
A	*Sorex dispar*	Long-tailed Shrew	Not At Risk			S2	7	72.2 ± 5.0	NB
A	*Chlidonias niger*	Black Tern	Not At Risk			S2B	351	18.8 ± 5.0	NB
A	*Podiceps grisegena*	Red-necked Grebe	Not At Risk			S2N,S3M	23	20.1 ± 0.0	NB
A	*Globicephala melas*	Long-finned Pilot Whale	Not At Risk			S2S3	1	95.8 ± 1.0	NB
A	*Desmognathus fuscus*	Northern Dusky Salamander	Not At Risk			S3	9	16.3 ± 0.0	NB
A	*Desmognathus fuscus pop. 2*	Northern Dusky Salamander - Quebec / New Brunswick population	Not At Risk			S3	96	9.1 ± 1.0	NB
A	*Sterna hirundo*	Common Tern	Not At Risk			S3B,SUM	225	0.9 ± 2.0	NB
A	*Haliaeetus leucocephalus*	Bald Eagle	Not At Risk		Endangered	S4	1092	1.7 ± 0.0	NB
A	*Lynx canadensis*	Canada Lynx	Not At Risk		Endangered	S4	40	19.7 ± 0.0	NB
A	*Canis lupus*	Grey Wolf	Not At Risk		Extirpated	SX	2	26.6 ± 1.0	NB
A	*Puma concolor pop. 1*	Cougar - Eastern population	Data Deficient		Endangered	SU	60	1.3 ± 1.0	NB
A	*Calidris canutus rufa*	Red Knot rufa subspecies	E,SC	Endangered	Endangered	S2M	3	96.7 ± 0.0	NB
A	*Morone saxatilis*	Striped Bass	E,SC			S3S4B,S3S4N	11	9.6 ± 1.0	NB
A	*Salmo salar*	Atlantic Salmon	E,T,SC			S2S3	4	82.9 ± 0.0	NB
A	*Thryothorus ludovicianus*	Carolina Wren				S1	43	11.7 ± 7.0	NB
A	*Salvelinus alpinus*	Arctic Char				S1	1	86.0 ± 1.0	NB
A	*Vireo flavifrons*	Yellow-throated Vireo				S1?B	10	21.4 ± 7.0	NB
A	*Tringa melanoleuca*	Greater Yellowlegs				S1?B,S4S5M	166	6.0 ± 0.0	NB
A	*Aythya americana*	Redhead				S1B	8	71.3 ± 7.0	NB
A	*Gallinula galeata*	Common Gallinule				S1B	25	16.3 ± 0.0	NB
A	*Antigone canadensis*	Sandhill Crane				S1B	12	51.4 ± 0.0	NB
A	*Bartramia longicauda*	Upland Sandpiper				S1B	38	31.9 ± 7.0	NB
A	*Phalaropus tricolor*	Wilson's Phalarope				S1B	21	22.2 ± 7.0	NB
A	*Leucophaeus atricilla*	Laughing Gull				S1B	4	19.7 ± 1.0	NB
A	*Rissa tridactyla*	Black-legged Kittiwake				S1B	1	99.8 ± 0.0	NB
A	*Uria aalge*	Common Murre				S1B	1	99.8 ± 0.0	NB
A	*Fratercula arctica*	Atlantic Puffin				S1B	1	99.8 ± 0.0	NB
A	*Progne subis*	Purple Martin				S1B	284	0.9 ± 1.0	NB
A	*Aythya marila*	Greater Scaup				S1B,S2N,S4M	39	41.7 ± 7.0	NB
A	*Oxyura jamaicensis*	Ruddy Duck				S1B,S2S3M	20	18.8 ± 5.0	NB
A	*Aythya affinis*	Lesser Scaup				S1B,S4M	92	16.4 ± 0.0	NB
A	*Eremophila alpestris*	Horned Lark				S1B,S4N,S5M	30	7.9 ± 7.0	NB
A	*Sterna paradisaea*	Arctic Tern				S1B,SUM	3	98.2 ± 5.0	NB
A	*Chroicocephalus ridibundus*	Black-headed Gull				S1N,S2M	5	19.7 ± 1.0	NB
A	*Branta bernicla*	Brant				S1N,S2S3M	12	34.4 ± 0.0	NB
A	*Calidris alba*	Sanderling				S1N,S3S4M	20	20.1 ± 0.0	NB

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A	*Butorides virescens*	Green Heron				S1S2B	21	15.8 ± 0.0	NB
A	*Nycticorax nycticorax*	Black-crowned Night-heron				S1S2B	7	51.0 ± 0.0	NB
A	*Empidonax traillii*	Willow Flycatcher				S1S2B	103	7.2 ± 1.0	NB
A	*Stelgidopteryx serripennis*	Northern Rough-winged Swallow				S1S2B	26	1.7 ± 0.0	NB
A	*Troglodytes aedon*	House Wren				S1S2B	32	2.4 ± 0.0	NB
A	*Calidris bairdii*	Baird's Sandpiper				S1S2M	5	96.1 ± 0.0	NB
A	*Melanitta americana*	American Scoter				S1S2N,S3M	77	12.1 ± 199.0	NB
A	*Microtus chrotorrhinus*	Rock Vole				S2?	5	92.1 ± 1.0	NB
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2B	553	0.9 ± 2.0	NB
A	*Cistothorus palustris*	Marsh Wren				S2B	396	16.2 ± 0.0	NB
A	*Mimus polyglottos*	Northern Mockingbird				S2B	104	6.8 ± 7.0	NB
A	*Pooecetes gramineus*	Vesper Sparrow				S2B	82	27.1 ± 7.0	NB
A	*Mareca strepera*	Gadwall				S2B,S3M	60	19.2 ± 30.0	NB
A	*Tringa solitaria*	Solitary Sandpiper				S2B,S4S5M	115	2.2 ± 0.0	NB
A	*Pinicola enucleator*	Pine Grosbeak				S2B,S4S5N,S4S5M	94	11.5 ± 0.0	NB
A	*Phalacrocorax carbo*	Great Cormorant				S2N	8	1.7 ± 0.0	NB
A	*Somateria spectabilis*	King Eider				S2N	1	99.6 ± 0.0	NB
A	*Larus hyperboreus*	Glaucous Gull				S2N	80	12.1 ± 50.0	NB
A	*Melanitta perspicillata*	Surf Scoter				S2N,S4M	31	19.8 ± 0.0	NB
A	*Melanitta deglandi*	White-winged Scoter				S2N,S4M	14	90.0 ± 9.0	NB
A	*Asio otus*	Long-eared Owl				S2S3	16	9.4 ± 0.0	NB
A	*Picoides dorsalis*	American Three-toed Woodpecker				S2S3	26	11.4 ± 7.0	NB
A	*Toxostoma rufum*	Brown Thrasher				S2S3B	108	1.4 ± 0.0	NB
A	*Icterus galbula*	Baltimore Oriole				S2S3B	258	3.6 ± 7.0	NB
A	*Somateria mollissima*	Common Eider				S2S3B,S2S3N,S4M	274	12.1 ± 199.0	NB
A	*Larus delawarensis*	Ring-billed Gull				S2S3B,S4N,S5M	401	1.1 ± 0.0	NB
A	*Pluvialis dominica*	American Golden-Plover				S2S3M	9	22.0 ± 0.0	NB
A	*Calcarius lapponicus*	Lapland Longspur				S2S3N,SUM	6	21.7 ± 0.0	NB
A	*Larus marinus*	Great Black-backed Gull				S3	345	1.7 ± 0.0	NB
A	*Picoides arcticus*	Black-backed Woodpecker				S3	85	1.3 ± 0.0	NB
A	*Loxia curvirostra*	Red Crossbill				S3	143	11.7 ± 7.0	NB
A	*Spinus pinus*	Pine Siskin				S3	277	6.8 ± 7.0	NB
A	*Prosopium cylindraceum*	Round Whitefish				S3	3	46.8 ± 0.0	NB
A	*Salvelinus namaycush*	Lake Trout				S3	7	44.0 ± 0.0	NB
A	*Sorex maritimensis*	Maritime Shrew				S3	1	7.6 ± 1.0	NB
A	*Spatula clypeata*	Northern Shoveler				S3B	96	5.3 ± 0.0	NB
A	*Charadrius vociferus*	Killdeer				S3B	560	3.6 ± 7.0	NB
A	*Tringa semipalmata*	Willet				S3B	6	29.3 ± 0.0	NB
A	*Cepphus grylle*	Black Guillemot				S3B	40	87.2 ± 7.0	NB
A	*Coccyzus erythropthalmus*	Black-billed Cuckoo				S3B	201	11.7 ± 7.0	NB
A	*Myiarchus crinitus*	Great Crested Flycatcher				S3B	449	3.6 ± 7.0	NB
A	*Piranga olivacea*	Scarlet Tanager				S3B	351	3.6 ± 7.0	NB
A	*Pheucticus ludovicianus*	Rose-breasted Grosbeak				S3B	920	2.2 ± 0.0	NB
A	*Passerina cyanea*	Indigo Bunting				S3B	151	3.6 ± 7.0	NB
A	*Molothrus ater*	Brown-headed Cowbird				S3B	277	3.6 ± 7.0	NB
A	*Setophaga tigrina*	Cape May Warbler				S3B,S4S5M	178	3.6 ± 7.0	NB
A	*Mergus serrator*	Red-breasted Merganser				S3B,S4S5N,S5M	98	2.0 ± 1.0	NB
A	*Anas acuta*	Northern Pintail				S3B,S5M	61	11.7 ± 7.0	NB
A	*Anser caerulescens*	Snow Goose				S3M	7	8.0 ± 0.0	NB
A	*Numenius phaeopus hudsonicus*	Whimbrel				S3M	3	63.2 ± 0.0	NB
A	*Arenaria interpres*	Ruddy Turnstone				S3M	17	63.1 ± 0.0	NB
A	*Calidris pusilla*	Semipalmated Sandpiper				S3M	52	5.6 ± 12.0	NB
A	*Calidris melanotos*	Pectoral Sandpiper				S3M	16	5.3 ± 0.0	NB
A	*Limnodromus griseus*	Short-billed Dowitcher				S3M	32	29.3 ± 0.0	NB

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A	*Phalaropus fulicarius*	Red Phalarope				S3M	2	96.1 ± 0.0	NB
A	*Bucephala albeola*	Bufflehead				S3N	530	1.7 ± 0.0	NB
A	*Calidris maritima*	Purple Sandpiper				S3N	34	90.0 ± 9.0	NB
A	*Perisoreus canadensis*	Canada Jay				S3S4	402	6.8 ± 7.0	NB
A	*Poecile hudsonicus*	Boreal Chickadee				S3S4	242	13.4 ± 7.0	NB
A	*Eptesicus fuscus*	Big Brown Bat				S3S4	54	1.8 ± 1.0	NB
A	*Synaptomys cooperi*	Southern Bog Lemming				S3S4	19	16.0 ± 1.0	NB
A	*Tyrannus tyrannus*	Eastern Kingbird				S3S4B	759	1.7 ± 0.0	NB
A	*Vireo gilvus*	Warbling Vireo				S3S4B	303	3.6 ± 7.0	NB
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S4M	768	1.7 ± 0.0	NB
A	*Melospiza lincolnii*	Lincoln's Sparrow				S3S4B,S4M	373	6.8 ± 7.0	NB
A	*Gallinago delicata*	Wilson's Snipe				S3S4B,S5M	960	5.6 ± 12.0	NB
A	*Setophaga striata*	Blackpoll Warbler				S3S4B,S5M	56	11.7 ± 7.0	NB
A	*Pluvialis squatarola*	Black-bellied Plover				S3S4M	47	29.3 ± 0.0	NB
A	*Morus bassanus*	Northern Gannet				SHB	8	56.7 ± 0.0	NB
C	*Quercus macrocarpa - Acer rubrum / Onoclea sensibilis - Carex arcta Forest*	Bur Oak - Red Maple / Sensitive Fern - Northern Clustered Sedge Forest				S2	1	55.4 ± 0.0	NB
C	*Acer saccharinum / Onoclea sensibilis - Lysimachia terrestris Forest*	Silver Maple / Sensitive Fern - Swamp Yellow Loosestrife Forest				S3	1	39.6 ± 0.0	NB
C	*Acer saccharum - Fraxinus americana / Gymnocarpium dryopteris - Deparia acrostichoides Forest*	Sugar Maple - White Ash / Common Oak Fern - Silvery Glade Fern Forest				S3	2	78.5 ± 0.0	NB
C	*Acer saccharum - Fraxinus americana / Polystichum acrostichoides Forest*	Sugar Maple - White Ash / Christmas Fern Forest				S3S4	2	60.2 ± 0.0	NB
I	*Bombus bohemicus*	Ashton Cuckoo Bumble Bee	Endangered	Endangered		S1	17	17.0 ± 5.0	NB
I	*Danaus plexippus*	Monarch	Endangered	Special Concern	Special Concern	S2S3?B	593	0.8 ± 0.0	NB
I	*Danaus plexippus plexippus*	Monarch	Endangered	Special Concern		S2S3?B	3	4.2 ± 0.0	NB
I	*Bombus affinis*	Rusty-patched Bumble Bee	Endangered	Endangered		SH	2	18.8 ± 5.0	NB
I	*Gomphurus ventricosus*	Skillet Clubtail	Special Concern	Endangered	Endangered	S2	121	16.8 ± 1.0	NB
I	*Cicindela marginipennis*	Cobblestone Tiger Beetle	Special Concern	Endangered	Endangered	S2S3	224	52.2 ± 0.0	NB
I	*Ophiogomphus howei*	Pygmy Snaketail	Special Concern	Special Concern	Special Concern	S2S3	22	38.4 ± 0.0	NB
I	*Alasmidonta varicosa*	Brook Floater	Special Concern	Special Concern	Special Concern	S3	16	38.4 ± 0.0	NB
I	*Lampsilis cariosa*	Yellow Lampmussel	Special Concern	Special Concern	Special Concern	S3	110	1.4 ± 1.0	NB
I	*Bombus terricola*	Yellow-banded Bumble Bee	Special Concern	Special Concern		S4	287	8.2 ± 0.0	NB
I	*Coccinella transversoguttata richardsoni*	Transverse Lady Beetle	Special Concern			SH	17	17.1 ± 5.0	NB
I	*Appalachina sayana*	Spike-lip Crater Snail	Not At Risk			S3?	3	8.2 ± 0.0	NB
I	*Cicindela scutellaris*	Festive Tiger Beetle				S1	9	27.6 ± 0.0	NB
I	*Conotrachelus juglandis*	Butternut Curculio				S1	3	21.0 ± 0.0	NB
I	*Haematopota rara*	Shy Cleg				S1	1	16.0 ± 1.0	NB
I	*Corythucha juglandis*	a lace bug				S1	1	21.1 ± 0.0	NB
I	*Tharsalea dorcas*	Dorcas Copper				S1	20	56.4 ± 0.0	NB
I	*Tharsalea dorcas claytoni*	Clayton's Copper Butterfly				S1	1	74.7 ± 0.0	NB
I	*Erora laeta*	Early Hairstreak				S1	10	11.1 ± 7.0	NB
I	*Somatochlora septentrionalis*	Muskeg Emerald				S1	1	20.4 ± 1.0	NB
I	*Polites origenes*	Crossline Skipper				S1?	8	6.1 ± 0.0	NB
I	*Leucanthiza dircella*	Leatherwood Leafminer Moth				S1S2	1	75.0 ± 0.0	NB
I	*Icaricia saepiolus*	Greenish Blue				S1S2	4	18.3 ± 2.0	NB
I	*Pachydiplax longipennis*	Blue Dasher				S1S2	4	47.0 ± 0.0	NB
I	*Cicindela ancocisconensis*	Appalachian Tiger Beetle				S2	5	62.9 ± 0.0	NB
I	*Encyclops caeruleus*	Cerulean Long-horned Beetle				S2	3	17.0 ± 0.0	NB
I	*Scaphinotus viduus*	Bereft Snail-eating Beetle				S2	3	38.4 ± 13.0	NB

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I	*Brachyleptura circumdata*	Dark-shouldered Long-horned Beetle				S2	6	36.1 ± 0.0	NB
I	*Satyrium calanus*	Banded Hairstreak				S2	28	6.1 ± 0.0	NB
I	*Satyrium calanus falacer*	Falacer Hairstreak				S2	1	21.5 ± 1.0	NB
I	*Strymon melinus*	Gray Hairstreak				S2	5	39.6 ± 2.0	NB
I	*Somatochlora brevicincta*	Quebec Emerald				S2	8	98.3 ± 0.0	NB
I	*Chrysops aestuans*	Furious Deer Fly				S2S3	1	52.7 ± 0.0	NB
I	*Hybomitra frosti*	Frost's Horse Fly				S2S3	1	54.8 ± 0.0	NB
I	*Tabanus vivax*	Vivacious Horse Fly				S2S3	1	63.0 ± 0.0	NB
I	*Ophiogomphus colubrinus*	Boreal Snaketail				S2S3	41	15.4 ± 0.0	NB
I	*Sphaeroderus nitidicollis*	Polished Snail-eating Beetle				S3	1	48.1 ± 0.0	NB
I	*Sphaeroderus canadensis*	Canada Snail-eating Beetle				S3	1	95.7 ± 0.0	NB
I	*Lepturopsis biforis*	Two-spotted Long-horned Beetle				S3	1	72.0 ± 0.0	NB
I	*Orthosoma brunneum*	Moist Long-horned Beetle				S3	1	57.5 ± 5.0	NB
I	*Pronocera collaris*	Redneck Longhorn Beetle				S3	1	19.0 ± 0.0	NB
I	*Elaphrus americanus*	Boreal Elaphrus Beetle				S3	1	36.4 ± 0.0	NB
I	*Semanotus terminatus*	Light Long-horned Beetle				S3	1	19.0 ± 0.0	NB
I	*Desmocerus palliatus*	Elderberry Borer				S3	9	11.9 ± 0.0	NB
I	*Agonum excavatum*	Excavated Harp Ground Beetle				S3	1	36.4 ± 0.0	NB
I	*Clivina americana*	America Pedunculate Ground Beetle				S3	1	36.4 ± 0.0	NB
I	*Olisthopus parmatus*	Tawny-bordered Harp Ground Beetle				S3	1	48.1 ± 0.0	NB
I	*Tachys scitulus*	Handsome Riverbank Ground Beetle				S3	1	36.4 ± 0.0	NB
I	*Carabus serratus*	Serrated Ground Beetle				S3	1	65.5 ± 0.0	NB
I	*Hippodamia parenthesis*	Parenthesis Lady Beetle				S3	7	19.0 ± 0.0	NB
I	*Stenocorus vittiger*	Shrub Long-horned Beetle				S3	1	36.4 ± 0.0	NB
I	*Mioptachys flavicauda*	Yellow-tipped Riverbank Ground Beetle				S3	1	19.0 ± 0.0	NB
I	*Badister neopulchellus*	Red-black Spotted Beetle				S3	1	36.4 ± 0.0	NB
I	*Gonotropis dorsalis*	Birch Fungus Weevil				S3	1	19.0 ± 0.0	NB
I	*Naemia seriata*	Seaside Lady Beetle				S3	3	98.7 ± 0.0	NB
I	*Ceruchus piceus*	Black Stag Beetle				S3	2	32.7 ± 0.0	NB
I	*Staphylinus ornaticauda*	Ornate-rumped Rove Beetle				S3	1	16.2 ± 0.0	NB
I	*Saperda vestita*	Linden Borer				S3	2	9.5 ± 0.0	NB
I	*Saperda imitans*	Oblique-banded Long-horned Beetle				S3	1	83.7 ± 1.0	NB
I	*Saperda lateralis*	Red-edged Long-horned Beetle				S3	2	84.6 ± 0.0	NB
I	*Dicerca caudata*	Tailed Jewel Borer				S3	1	40.4 ± 0.0	NB
I	*Epargyreus clarus*	Silver-spotted Skipper				S3	39	20.2 ± 0.0	NB
I	*Hesperia sassacus*	Indian Skipper				S3	22	11.7 ± 7.0	NB
I	*Euphyes bimacula*	Two-spotted Skipper				S3	25	10.9 ± 0.0	NB
I	*Satyrium acadica*	Acadian Hairstreak				S3	20	6.5 ± 2.0	NB
I	*Callophrys eryphon*	Western Pine Elfin				S3	2	79.7 ± 7.0	NB
I	*Plebejus idas*	Northern Blue				S3	2	96.9 ± 0.0	NB
I	*Plebejus idas empetri*	Crowberry Blue				S3	17	91.4 ± 0.0	NB
I	*Argynnis aphrodite*	Aphrodite Fritillary				S3	24	11.7 ± 7.0	NB
I	*Boloria eunomia*	Bog Fritillary				S3	7	46.6 ± 0.0	NB
I	*Boloria bellona*	Meadow Fritillary				S3	83	0.4 ± 0.0	NB
I	*Boloria chariclea*	Arctic Fritillary				S3	1	89.8 ± 2.0	NB
I	*Nymphalis l-album*	Compton Tortoiseshell				S3	26	6.4 ± 2.0	NB
I	*Gomphurus vastus*	Cobra Clubtail				S3	136	2.7 ± 0.0	NB
I	*Celithemis martha*	Martha's Pennant				S3	15	80.2 ± 0.0	NB
I	*Ladona exusta*	White Corporal				S3	12	31.2 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
I	*Enallagma pictum*	Scarlet Bluet				S3	12	60.1 ± 0.0	NB
I	*Ischnura kellicotti*	Lilypad Forktail				S3	21	26.9 ± 0.0	NB
I	*Arigomphus furcifer*	Lilypad Clubtail				S3	25	35.2 ± 0.0	NB
I	*Alasmidonta undulata*	Triangle Floater				S3	47	37.2 ± 0.0	NB
I	*Atlanticoncha ochracea*	Tidewater Mucket				S3	181	0.8 ± 0.0	NB
I	*Philomycus flexuolaris*	Winding Mantleslug				S3	9	7.2 ± 0.0	NB
I	*Striatura ferrea*	Black Striate Snail				S3	1	17.2 ± 1.0	NB
I	*Neohelix albolabris*	Whitelip Snail				S3	3	17.2 ± 1.0	NB
I	*Spurwinkia salsa*	Saltmarsh Hydrobe				S3	34	57.3 ± 0.0	NB
I	*Pantala hymenaea*	Spot-Winged Glider				S3B	6	19.0 ± 0.0	NB
I	*Dinothenarus capitatus*	Helmet Rove Beetle				S3S4	1	83.9 ± 0.0	NB
I	*Paracardiophorus propinquus*	Kindred Heart Click Beetle				S3S4	3	35.9 ± 0.0	NB
I	*Pedilus elegans*	Elegant Fire-coloured Beetle				S3S4	1	76.4 ± 1.0	NB
I	*Collops vittatus*	Banded Soft-winged Flower Beetle				S3S4	3	16.4 ± 0.0	NB
I	*Nitidula bipunctata*	Two-dots Sap Beetle				S3S4	1	19.0 ± 0.0	NB
I	*Bombus griseocollis*	Brown-belted Bumble Bee				S3S4	16	4.9 ± 0.0	NB
I	*Lanthus vernalis*	Southern Pygmy Clubtail				S3S4	4	17.4 ± 0.0	NB
I	*Somatochlora forcipata*	Forcipate Emerald				S3S4	24	7.3 ± 1.0	NB
I	*Somatochlora tenebrosa*	Clamp-Tipped Emerald				S3S4	12	17.2 ± 0.0	NB
N	*Pannaria lurida*	Wrinkled Shingle Lichen	Threatened	Threatened		S1?	208	57.5 ± 0.0	NB
N	*Heterodermia squamulosa*	Scaly Fringe Lichen	Threatened			S1?	2	79.8 ± 0.0	NB
N	*Anzia colpodes*	Black-foam Lichen	Threatened	Threatened		S1S2	3	2.4 ± 1.0	NB
N	*Fuscopannaria leucosticta*	White-rimmed Shingle Lichen	Threatened			S2	279	10.5 ± 0.0	NB
N	*Peltigera hydrothyria*	Eastern Waterfan	Threatened	Threatened		S2S3	9	49.4 ± 0.0	NB
N	*Pectenia plumbea*	Blue Felt Lichen	Special Concern	Special Concern	Special Concern	S1	38	95.8 ± 0.0	NB
N	*Pseudevernia cladonia*	Ghost Antler Lichen	Not At Risk			S2S3	8	68.8 ± 0.0	NB
N	*Aphanorrhegma serratum*	Lidded Earth Moss				S1	1	82.3 ± 0.0	NB
N	*Imbribryum muehlenbeckii*	Muehlenbeck's Bryum Moss				S1	1	89.4 ± 1.0	NB
N	*Sphagnum macrophyllum*	Sphagnum				S1	4	69.6 ± 0.0	NB
N	*Leptogium hirsutum*	Jellyskin Lichen				S1	36	75.4 ± 0.0	NB
N	*Coccocarpia palmicola*	Salted Shell Lichen				S1	2	81.0 ± 0.0	NB
N	*Cladonia krogiana*	Krog's Pixie Lichen				S1	1	91.1 ± 0.0	NB
N	*Atrichum angustatum*	Lesser Smoothcap Moss				S1?	1	58.1 ± 2.0	NB
N	*Pseudocalliergon trifarium*	Three-ranked Spear Moss				S1?	1	94.0 ± 0.0	NB
N	*Dichelyma falcatum*	a Moss				S1?	2	18.5 ± 10.0	NB
N	*Dicranum bonjeanii*	Bonjean's Broom Moss				S1?	1	18.4 ± 1.0	NB
N	*Entodon brevisetus*	a Moss				S1?	1	85.5 ± 1.0	NB
N	*Oxyrrhynchium hians*	Light Beaked Moss				S1?	2	18.4 ± 1.0	NB
N	*Niphotrichum ericoides*	Dense Rock Moss				S1?	1	33.5 ± 3.0	NB
N	*Splachnum pensylvanicum*	Southern Dung Moss				S1?	2	19.3 ± 0.0	NB
N	*Platylomella lescurii*	a Moss				S1?	1	76.7 ± 1.0	NB
N	*Pilophorus fibula*	New England Matchstick Lichen				S1?	1	86.4 ± 0.0	NB
N	*Peltigera venosa*	Fan Pelt Lichen				S1?	2	52.0 ± 0.0	NB
N	*Pallavicinia lyellii*	Lyell's Ribbonwort				S1S2	1	56.4 ± 0.0	NB
N	*Reboulia hemisphaerica*	Purple-margined Liverwort				S1S2	1	93.8 ± 1.0	NB
N	*Solenostoma obovatum*	Egg Flapwort				S1S2	1	91.5 ± 0.0	NB
N	*Brachythecium acuminatum*	Acuminate Ragged Moss				S1S2	3	18.4 ± 10.0	NB
N	*Ptychostomum salinum*	Saltmarsh Bryum				S1S2	1	97.3 ± 1.0	NB
N	*Pseudocampylium radicale*	Long-stalked Fine Wet Moss				S1S2	1	18.4 ± 1.0	NB
N	*Ditrichum pallidum*	Pale Cow-hair Moss				S1S2	3	16.6 ± 1.0	NB
N	*Drummondia prorepens*	a Moss				S1S2	1	69.4 ± 1.0	NB
N	*Fissidens taxifolius*	Yew-leaved Pocket Moss				S1S2	4	57.8 ± 0.0	NB
N	*Sphagnum platyphyllum*	Flat-leaved Peat Moss				S1S2	3	16.6 ± 1.0	NB
N	*Tomentypnum falcifolium*	Sickle-leaved Golden Moss				S1S2	1	99.4 ± 1.0	NB
N	*Pseudotaxiphyllum distichaceum*	a Moss				S1S2	2	17.1 ± 1.0	NB

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N	*Haplocladium microphyllum*	Tiny-leaved Haplocladium Moss				S1S2	1	94.2 ± 1.0	NB
N	*Pilophorus cereolus*	Powdered Matchstick Lichen				S1S2	1	86.4 ± 0.0	NB
N	*Calypogeia neesiana*	Nees' Pouchwort				S1S3	1	96.5 ± 1.0	NB
N	*Fuscocephaloziopsis connivens*	Forcipated Pincerwort				S1S3	1	95.4 ± 0.0	NB
N	*Cephaloziella elachista*	Spurred Threadwort				S1S3	1	94.4 ± 5.0	NB
N	*Porella pinnata*	Pinnate Scalewort				S1S3	2	64.9 ± 1.0	NB
N	*Amphidium mougeotii*	a Moss				S2	2	89.1 ± 8.0	NB
N	*Anomodon viticulosus*	a Moss				S2	5	94.7 ± 0.0	NB
N	*Cirriphyllum piliferum*	Hair-pointed Moss				S2	1	63.3 ± 1.0	NB
N	*Cynodontium strumiferum*	Strumose Dogtooth Moss				S2	1	89.1 ± 8.0	NB
N	*Dicranella palustris*	Drooping-Leaved Fork Moss				S2	2	73.8 ± 100.0	NB
N	*Didymodon ferrugineus*	Rusty Beard Moss				S2	3	60.3 ± 0.0	NB
N	*Ditrichum flexicaule*	Flexible Cow-hair Moss				S2	1	91.0 ± 1.0	NB
N	*Fontinalis hypnoides*	a moss				S2	1	22.3 ± 0.0	NB
N	*Anomodon tristis*	a Moss				S2	1	37.6 ± 1.0	NB
N	*Hypnum pratense*	Meadow Plait Moss				S2	3	70.7 ± 1.0	NB
N	*Isothecium myosuroides*	Slender Mouse-tail Moss				S2	2	91.0 ± 1.0	NB
N	*Meesia triquetra*	Three-ranked Cold Moss				S2	2	56.0 ± 0.0	NB
N	*Physcomitrium immersum*	a Moss				S2	7	5.1 ± 0.0	NB
N	*Platydictya jungermannioides*	False Willow Moss				S2	1	97.2 ± 0.0	NB
N	*Seligeria calcarea*	Chalk Brittle Moss				S2	1	91.0 ± 1.0	NB
N	*Seligeria brevifolia*	Shortleaf Bristle Moss				S2	1	61.1 ± 1.0	NB
N	*Sphagnum lindbergii*	Lindberg's Peat Moss				S2	3	92.4 ± 1.0	NB
N	*Tetraplodon mnioides*	Entire-leaved Nitrogen Moss				S2	3	93.8 ± 0.0	NB
N	*Thamnobryum alleghaniense*	a Moss				S2	3	15.4 ± 0.0	NB
N	*Tortula mucronifolia*	Mucronate Screw Moss				S2	1	99.7 ± 0.0	NB
N	*Ulota phyllantha*	a Moss				S2	2	97.2 ± 0.0	NB
N	*Anomobryum julaceum*	Slender Silver Moss				S2	1	18.4 ± 1.0	NB
N	*Usnea ceratina*	Warty Beard Lichen				S2	1	80.2 ± 0.0	NB
N	*Cladonia incrassata*	Powder-foot British Soldiers Lichen				S2	1	82.1 ± 0.0	NB
N	*Leptogium corticola*	Blistered Jellyskin Lichen				S2	4	7.9 ± 0.0	NB
N	*Leptogium milligranum*	Stretched Jellyskin Lichen				S2	6	58.1 ± 0.0	NB
N	*Nephroma laevigatum*	Mustard Kidney Lichen				S2	2	56.5 ± 0.0	NB
N	*Peltigera lepidophora*	Scaly Pelt Lichen				S2	4	52.0 ± 0.0	NB
N	*Anomodon minor*	Blunt-leaved Anomodon Moss				S2?	1	70.4 ± 1.0	NB
N	*Ptychostomum pallescens*	Tall Clustered Bryum				S2?	2	55.5 ± 1.0	NB
N	*Dichelyma capillaceum*	Hairlike Dichelyma Moss				S2?	2	31.7 ± 4.0	NB
N	*Dicranum spurium*	Spurred Broom Moss				S2?	3	89.3 ± 2.0	NB
N	*Schistostega pennata*	Luminous Moss				S2?	5	18.4 ± 1.0	NB
N	*Seligeria diversifolia*	a Moss				S2?	1	62.3 ± 0.0	NB
N	*Sphagnum angermanicum*	a Peatmoss				S2?	1	67.4 ± 1.0	NB
N	*Plagiomnium rostratum*	Long-beaked Leafy Moss				S2?	1	97.8 ± 1.0	NB
N	*Collema leptaleum*	Crumpled Bat's Wing Lichen				S2?	7	5.1 ± 0.0	NB
N	*Physcia subtilis*	Slender Rosette Lichen				S2?	1	58.7 ± 0.0	NB
N	*Buxbaumia aphylla*	Brown Shield Moss				S2S3	4	10.4 ± 0.0	NB
N	*Calliergonella cuspidata*	Common Large Wetland Moss				S2S3	4	74.6 ± 0.0	NB
N	*Drepanocladus polygamus*	Polygamous Hook Moss				S2S3	1	56.1 ± 1.0	NB
N	*Palustriella falcata*	Curled Hook Moss				S2S3	1	91.0 ± 1.0	NB
N	*Didymodon rigidulus*	Rigid Screw Moss				S2S3	3	18.2 ± 8.0	NB
N	*Ephemerum serratum*	a Moss				S2S3	1	5.2 ± 0.0	NB
N	*Fissidens bushii*	Bush's Pocket Moss				S2S3	6	61.0 ± 1.0	NB
N	*Isopterygiopsis pulchella*	Neat Silk Moss				S2S3	1	69.8 ± 1.0	NB
N	*Neckera complanata*	a Moss				S2S3	3	91.0 ± 1.0	NB
N	*Orthotrichum elegans*	Showy Bristle Moss				S2S3	5	16.0 ± 3.0	NB

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N	*Codriophorus fascicularis*	Clustered Rock Moss				S2S3	1	88.7 ± 0.0	NB
N	*Scorpidium scorpioides*	Hooked Scorpion Moss				S2S3	5	74.5 ± 1.0	NB
N	*Seligeria campylopoda*	a Moss				S2S3	1	60.3 ± 0.0	NB
N	*Sphagnum centrale*	Central Peat Moss				S2S3	1	80.0 ± 0.0	NB
N	*Sphagnum subfulvum*	a Peatmoss				S2S3	4	83.6 ± 0.0	NB
N	*Taxiphyllum deplanatum*	Imbricate Yew-leaved Moss				S2S3	2	60.3 ± 0.0	NB
N	*Zygodon viridissimus*	a Moss				S2S3	2	82.7 ± 5.0	NB
N	*Schistidium agassizii*	Elf Bloom Moss				S2S3	2	82.5 ± 2.0	NB
N	*Loeskeobryum brevirostre*	a Moss				S2S3	1	91.0 ± 1.0	NB
N	*Sphaerophorus globosus*	Northern Coral Lichen				S2S3	2	95.4 ± 0.0	NB
N	*Chaenotheca xyloxena*	a lichen				S2S3	2	96.6 ± 0.0	NB
N	*Dendriscocaulon umhausense*	a lichen				S2S3	1	87.5 ± 0.0	NB
N	*Lichenomphalia umbellifera*	Green-pea Mushroom Lichen				S2S3	2	97.0 ± 0.0	NB
N	*Polychidium muscicola*	Eyed Mossthorns Woollybear Lichen				S2S3	3	74.3 ± 0.0	NB
N	*Punctelia caseana*	Case's Speckled-back Lichen				S2S3	3	72.9 ± 0.0	NB
N	*Cynodontium tenellum*	Delicate Dogtooth Moss				S3	2	89.1 ± 8.0	NB
N	*Hypnum curvifolium*	Curved-leaved Plait Moss				S3	2	74.2 ± 0.0	NB
N	*Tortella fragilis*	Fragile Twisted Moss				S3	1	37.8 ± 0.0	NB
N	*Schistidium maritimum*	a Moss				S3	2	97.2 ± 0.0	NB
N	*Collema nigrescens*	Blistered Tarpaper Lichen				S3	8	73.8 ± 0.0	NB
N	*Solorina saccata*	Woodland Owl Lichen				S3	3	52.0 ± 0.0	NB
N	*Ahtiana aurescens*	Eastern Candlewax Lichen				S3	5	71.6 ± 0.0	NB
N	*Cladonia strepsilis*	Olive Cladonia Lichen				S3	2	89.3 ± 2.0	NB
N	*Hypotrachyna catawbiensis*	Powder-tipped Antler Lichen				S3	4	89.3 ± 2.0	NB
N	*Scytinium lichenoides*	Tattered Jellyskin Lichen				S3	3	51.9 ± 0.0	NB
N	*Nephroma bellum*	Naked Kidney Lichen				S3	2	68.0 ± 0.0	NB
N	*Peltigera degenii*	Lustrous Pelt Lichen				S3	1	77.4 ± 0.0	NB
N	*Leptogium laceroides*	Short-bearded Jellyskin Lichen				S3	9	60.8 ± 0.0	NB
N	*Peltigera membranacea*	Membranous Pelt Lichen				S3	9	19.3 ± 0.0	NB
N	*Cladonia botrytes*	Wooden Soldiers Lichen				S3	1	84.1 ± 0.0	NB
N	*Cladonia deformis*	Lesser Sulphur-cup Lichen				S3	2	89.2 ± 0.0	NB
N	*Aulacomnium androgynum*	Little Groove Moss				S3?	6	80.7 ± 1.0	NB
N	*Dicranella rufescens*	Red Forklet Moss				S3?	2	18.0 ± 4.0	NB
N	*Sphagnum lescurii*	a Peatmoss				S3?	2	80.2 ± 1.0	NB
N	*Sphagnum inundatum*	a Sphagnum				S3?	2	48.1 ± 0.0	NB
N	*Rostania occultata*	Crusted Tarpaper Lichen				S3?	1	5.1 ± 0.0	NB
N	*Cystocoleus ebeneus*	Rockgossamer Lichen				S3?	1	75.4 ± 0.0	NB
N	*Scytinium subtile*	Appressed Jellyskin Lichen				S3?	6	4.7 ± 0.0	NB
N	*Anomodon rugelii*	Rugel's Anomodon Moss				S3S4	9	71.5 ± 0.0	NB
N	*Barbula convoluta*	Lesser Bird's-claw Beard Moss				S3S4	1	18.2 ± 8.0	NB
N	*Brachytheciastrum velutinum*	Velvet Ragged Moss				S3S4	6	18.0 ± 4.0	NB
N	*Dicranella cerviculata*	a Moss				S3S4	3	97.3 ± 1.0	NB
N	*Dicranella varia*	a Moss				S3S4	3	98.4 ± 2.0	NB
N	*Dicranum majus*	Greater Broom Moss				S3S4	4	80.3 ± 15.0	NB
N	*Fissidens bryoides*	Lesser Pocket Moss				S3S4	4	4.9 ± 0.0	NB
N	*Elodium blandowii*	Blandow's Bog Moss				S3S4	3	69.8 ± 1.0	NB
N	*Heterocladium dimorphum*	Dimorphous Tangle Moss				S3S4	1	82.5 ± 2.0	NB
N	*Isopterygiopsis muelleriana*	a Moss				S3S4	7	18.0 ± 4.0	NB
N	*Myurella julacea*	Small Mouse-tail Moss				S3S4	2	89.1 ± 8.0	NB
N	*Orthotrichum speciosum*	Showy Bristle Moss				S3S4	1	6.8 ± 0.0	NB
N	*Physcomitrium pyriforme*	Pear-shaped Urn Moss				S3S4	8	5.1 ± 0.0	NB
N	*Pogonatum dentatum*	Mountain Hair Moss				S3S4	1	97.3 ± 1.0	NB
N	*Sphagnum torreyanum*	a Peatmoss				S3S4	4	80.5 ± 1.0	NB

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N	*Sphagnum austinii*	Austin's Peat Moss				S3S4	1	98.4 ± 1.0	NB
N	*Sphagnum contortum*	Twisted Peat Moss				S3S4	1	96.3 ± 0.0	NB
N	*Sphagnum quinquefarium*	Five-ranked Peat Moss				S3S4	1	91.0 ± 1.0	NB
N	*Tetraphis geniculata*	Geniculate Four-tooth Moss				S3S4	5	93.2 ± 0.0	NB
N	*Tetraplodon angustatus*	Toothed-leaved Nitrogen Moss				S3S4	1	97.3 ± 1.0	NB
N	*Tomentypnum nitens*	Golden Fuzzy Fen Moss				S3S4	1	57.0 ± 3.0	NB
N	*Weissia controversa*	Green-Cushioned Weissia				S3S4	2	5.2 ± 0.0	NB
N	*Abietinella abietina*	Wiry Fern Moss				S3S4	1	58.2 ± 0.0	NB
N	*Trichostomum tenuirostre*	Acid-Soil Moss				S3S4	5	60.3 ± 0.0	NB
N	*Scorpidium revolvens*	Limprichtia Moss				S3S4	2	61.5 ± 0.0	NB
N	*Rauiella scita*	Smaller Fern Moss				S3S4	6	64.6 ± 3.0	NB
N	*Pannaria rubiginosa*	Brown-eyed Shingle Lichen				S3S4	54	9.8 ± 0.0	NB
N	*Pseudocyphellaria holarctica*	Yellow Specklebelly Lichen				S3S4	141	7.0 ± 0.0	NB
N	*Scytinium teretiusculum*	Curly Jellyskin Lichen				S3S4	4	16.2 ± 0.0	NB
N	*Montanelia panniformis*	Shingled Camouflage Lichen				S3S4	1	75.4 ± 0.0	NB
N	*Cladonia terrae-novae*	Newfoundland Reindeer Lichen				S3S4	2	89.3 ± 2.0	NB
N	*Cladonia floerkeana*	Gritty British Soldiers Lichen				S3S4	1	91.9 ± 0.0	NB
N	*Cladonia parasitica*	Fence-rail Lichen				S3S4	2	71.5 ± 0.0	NB
N	*Nephroma parile*	Powdery Kidney Lichen				S3S4	23	5.1 ± 0.0	NB
N	*Nephroma resupinatum*	a lichen				S3S4	9	56.0 ± 0.0	NB
N	*Protopannaria pezizoides*	Brown-gray Moss-shingle Lichen				S3S4	35	55.2 ± 0.0	NB
N	*Parmelia fertilis*	Fertile Shield Lichen				S3S4	1	90.8 ± 0.0	NB
N	*Usnea strigosa*	Bushy Beard Lichen				S3S4	4	74.8 ± 0.0	NB
N	*Fuscopannaria sorediata*	a Lichen				S3S4	25	9.5 ± 1.0	NB
N	*Stereocaulon condensatum*	Granular Soil Foam Lichen				S3S4	1	91.1 ± 0.0	NB
N	*Pannaria conoplea*	Mealy-rimmed Shingle Lichen				S3S4	91	24.3 ± 0.0	NB
N	*Physcia tenella*	Fringed Rosette Lichen				S3S4	1	99.9 ± 0.0	NB
N	*Anaptychia palmulata*	Shaggy Fringed Lichen				S3S4	19	12.8 ± 0.0	NB
N	*Peltigera neopolydactyla*	Undulating Pelt Lichen				S3S4	3	12.9 ± 0.0	NB
N	*Grimmia anodon*	Toothless Grimmia Moss				SH	2	99.4 ± 10.0	NB
N	*Leucodon brachypus*	a Moss				SH	2	29.4 ± 10.0	NB
N	*Orthotrichum gymnostomum*	Aspen Bristle Moss				SH	1	31.3 ± 10.0	NB
N	*Thelia hirtella*	a Moss				SH	1	73.8 ± 100.0	NB
N	*Cyrto-hypnum minutulum*	Tiny Cedar Moss				SH	3	98.8 ± 10.0	NB
P	*Juglans cinerea*	Butternut	Endangered	Endangered	Endangered	S1	889	0.7 ± 0.0	NB
P	*Polemonium vanbruntiae*	Van Brunt's Jacob's-ladder	Threatened	Threatened	Threatened	S1	41	86.6 ± 1.0	NB
P	*Fraxinus nigra*	Black Ash	Threatened			S3S4	1272	0.7 ± 0.0	NB
P	*Symphyotrichum praealtum*	Willow-leaved Aster	Threatened	Threatened		SNA	1	96.2 ± 1.0	NB
P	*Isoetes prototypus*	Prototype Quillwort	Special Concern	Special Concern	Endangered	S1	23	13.8 ± 0.0	NB
P	*Symphyotrichum anticostense*	Anticosti Aster	Special Concern	Special Concern	Endangered	S3	63	2.4 ± 0.0	NB
P	*Pterospora andromedea*	Woodland Pinedrops			Endangered	S1	52	2.3 ± 0.0	NB
P	*Cryptotaenia canadensis*	Canada Honewort				S1	4	54.6 ± 1.0	NB
P	*Antennaria parlinii ssp. fallax*	Parlin's Pussytoes				S1	9	66.9 ± 0.0	NB
P	*Antennaria howellii ssp. petaloidea*	Pussy-Toes				S1	1	87.8 ± 1.0	NB
P	*Bidens discoidea*	Swamp Beggarticks				S1	4	47.1 ± 0.0	NB
P	*Pseudognaphalium obtusifolium*	Eastern Cudweed				S1	2	69.0 ± 0.0	NB
P	*Helianthus decapetalus*	Ten-rayed Sunflower				S1	23	4.7 ± 1.0	NB
P	*Hieracium paniculatum*	Panicled Hawkweed				S1	7	18.8 ± 0.0	NB
P	*Andersonglossum boreale*	Northern Wild Comfrey				S1	14	63.4 ± 0.0	NB
P	*Barbarea orthoceras*	American Yellow Rocket				S1	1	98.1 ± 1.0	NB
P	*Cardamine parviflora*	Small-flowered Bittercress				S1	3	83.0 ± 0.0	NB
P	*Cardamine concatenata*	Cut-leaved Toothwort				S1	16	9.6 ± 1.0	NB
P	*Draba arabisans*	Rock Whitlow-Grass				S1	3	91.8 ± 0.0	NB
P	*Draba cana*	Lance-leaved Draba				S1	10	16.4 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
P	*Draba glabella*	Rock Whitlow-Grass				S1	8	50.2 ± 1.0	NB
P	*Mononeuria groenlandica*	Greenland Stitchwort				S1	2	80.8 ± 0.0	NB
P	*Chenopodiastrum simplex*	Maple-leaved Goosefoot				S1	7	7.6 ± 1.0	NB
P	*Blitum capitatum*	Strawberry-Blite				S1	4	17.8 ± 6.0	NB
P	*Callitriche terrestris*	Terrestrial Water-Starwort				S1	1	83.6 ± 0.0	NB
P	*Hypericum virginicum*	Virginia St. John's-wort				S1	16	35.2 ± 0.0	NB
P	*Viburnum acerifolium*	Maple-leaved Viburnum				S1	11	96.0 ± 1.0	NB
P	*Drosera anglica*	English Sundew				S1	2	56.0 ± 0.0	NB
P	*Drosera linearis*	Slender-Leaved Sundew				S1	6	56.0 ± 0.0	NB
P	*Corema conradii*	Broom Crowberry				S1	1	97.7 ± 4.0	NB
P	*Vaccinium boreale*	Northern Blueberry				S1	1	82.5 ± 0.0	NB
P	*Vaccinium corymbosum*	Highbush Blueberry				S1	10	65.6 ± 0.0	NB
P	*Hylodesmum glutinosum*	Large Tick-trefoil				S1	9	56.8 ± 1.0	NB
P	*Lespedeza capitata*	Round-headed Bush-clover				S1	11	59.5 ± 0.0	NB
P	*Gentiana rubricaulis*	Purple-stemmed Gentian				S1	18	60.8 ± 0.0	NB
P	*Ribes cynosbati*	Prickly Gooseberry				S1	1	59.9 ± 0.0	NB
P	*Proserpinaca pectinata*	Comb-leaved Mermaidweed				S1	1	85.2 ± 0.0	NB
P	*Pycnanthemum virginianum*	Virginia Mountain Mint				S1	4	83.1 ± 0.0	NB
P	*Decodon verticillatus*	Swamp Loosestrife				S1	28	10.5 ± 0.0	NB
P	*Polygala verticillata*	Whorled Milkwort				S1	2	63.1 ± 0.0	NB
P	*Lysimachia hybrida*	Lowland Yellow Loosestrife				S1	18	80.4 ± 0.0	NB
P	*Lysimachia quadrifolia*	Whorled Yellow Loosestrife				S1	14	79.9 ± 0.0	NB
P	*Hepatica acutiloba*	Sharp-lobed Hepatica				S1	11	75.9 ± 0.0	NB
P	*Coptidium lapponicum*	Lapland Buttercup				S1	1	86.6 ± 1.0	NB
P	*Crataegus jonesiae*	Jones' Hawthorn				S1	6	16.7 ± 1.0	NB
P	*Potentilla canadensis*	Canada Cinquefoil				S1	9	16.7 ± 0.0	NB
P	*Rubus flagellaris*	Northern Dewberry				S1	2	18.0 ± 0.0	NB
P	*Galium brevipes*	Limestone Swamp Bedstraw				S1	6	50.8 ± 5.0	NB
P	*Saxifraga paniculata ssp. laestadii*	Laestadius' Saxifrage				S1	8	91.0 ± 1.0	NB
P	*Agalinis tenuifolia*	Slender Agalinis				S1	17	15.6 ± 0.0	NB
P	*Gratiola lutea*	Golden Hedge-hyssop				S1	2	85.7 ± 0.0	NB
P	*Pedicularis canadensis*	Canada Lousewort				S1	22	10.4 ± 0.0	NB
P	*Viola sagittata var. ovata*	Arrow-Leaved Violet				S1	15	15.3 ± 0.0	NB
P	*Carex annectens*	Yellow-Fruited Sedge				S1	1	61.0 ± 0.0	NB
P	*Carex atlantica ssp. atlantica*	Atlantic Sedge				S1	1	61.2 ± 1.0	NB
P	*Carex backii*	Rocky Mountain Sedge				S1	5	16.3 ± 1.0	NB
P	*Carex blanda*	Eastern Woodland Sedge				S1	4	1.9 ± 0.0	NB
P	*Carex merritt-fernaldii*	Merritt Fernald's Sedge				S1	9	94.1 ± 0.0	NB
P	*Carex salina*	Saltmarsh Sedge				S1	2	99.9 ± 1.0	NB
P	*Carex sterilis*	Sterile Sedge				S1	12	0.5 ± 0.0	NB
P	*Carex grisea*	Inflated Narrow-leaved Sedge				S1	18	10.5 ± 1.0	NB
P	*Carex saxatilis*	Russet Sedge				S1	14	91.2 ± 10.0	NB
P	*Cyperus diandrus*	Low Flatsedge				S1	8	5.2 ± 0.0	NB
P	*Eleocharis flavescens var. olivacea*	Bright-green Spikerush				S1	7	79.0 ± 0.0	NB
P	*Rhynchospora capillacea*	Slender Beakrush				S1	3	3.4 ± 0.0	NB
P	*Scirpus pendulus*	Hanging Bulrush				S1	1	86.5 ± 0.0	NB
P	*Sisyrinchium angustifolium*	Narrow-leaved Blue-eyed-grass				S1	6	34.9 ± 0.0	NB
P	*Juncus greenei*	Greene's Rush				S1	1	94.7 ± 0.0	NB
P	*Juncus subtilis*	Creeping Rush				S1	1	67.4 ± 5.0	NB
P	*Allium canadense*	Canada Garlic				S1	13	2.5 ± 0.0	NB
P	*Goodyera pubescens*	Downy Rattlesnake-Plantain				S1	7	5.4 ± 2.0	NB
P	*Malaxis monophyllos var. brachypoda*	North American White Adder's-mouth				S1	12	38.7 ± 0.0	NB
P	*Platanthera flava var. herbiola*	Pale Green Orchid				S1	18	31.1 ± 10.0	NB
P	*Platanthera macrophylla*	Large Round-Leaved Orchid				S1	4	16.7 ± 1.0	NB
P	*Spiranthes casei*	Case's Ladies'-Tresses				S1	6	10.4 ± 0.0	NB

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P	*Bromus pubescens*	Hairy Wood Brome Grass				S1	6	54.9 ± 0.0	NB
P	*Cinna arundinacea*	Sweet Wood Reed Grass				S1	56	38.7 ± 0.0	NB
P	*Danthonia compressa*	Flattened Oat Grass				S1	4	34.8 ± 0.0	NB
P	*Dichanthelium xanthophysum*	Slender Panic Grass				S1	6	70.2 ± 0.0	NB
P	*Dichanthelium dichotomum*	Forked Panic Grass				S1	20	87.1 ± 1.0	NB
P	*Glyceria obtusa*	Atlantic Manna Grass				S1	20	70.3 ± 0.0	NB
P	*Sporobolus compositus*	Rough Dropseed				S1	17	1.3 ± 0.0	NB
P	*Potamogeton friesii*	Fries' Pondweed				S1	6	14.8 ± 5.0	NB
P	*Potamogeton nodosus*	Long-leaved Pondweed				S1	19	7.3 ± 2.0	NB
P	*Potamogeton strictifolius*	Straight-leaved Pondweed				S1	2	91.0 ± 0.0	NB
P	*Xyris difformis*	Bog Yellow-eyed-grass				S1	22	83.6 ± 0.0	NB
P	*Asplenium ruta-muraria var. cryptolepis*	Wallrue Spleenwort				S1	4	91.0 ± 1.0	NB
P	*Dryopteris clintoniana*	Clinton's Wood Fern				S1	12	60.7 ± 0.0	NB
P	*Sceptridium oneidense*	Blunt-lobed Moonwort				S1	8	33.6 ± 0.0	NB
P	*Sceptridium rugulosum*	Rugulose Grapefern				S1	5	46.9 ± 0.0	NB
P	*Selaginella rupestris*	Rock Spikemoss				S1	9	1.5 ± 0.0	NB
P	*Cuscuta campestris*	Field Dodder				S1?	3	63.0 ± 10.0	NB
P	*Polygonum aviculare ssp. neglectum*	Narrow-leaved Knotweed				S1?	7	6.1 ± 0.0	NB
P	*Galium trifidum ssp. subbiflorum*	Three-petaled Bedstraw				S1?	1	67.4 ± 1.0	NB
P	*Alisma subcordatum*	Southern Water Plantain				S1?	9	4.3 ± 7.0	NB
P	*Carex laxiflora*	Loose-Flowered Sedge				S1?	3	54.8 ± 0.0	NB
P	*Carex appalachica*	Appalachian Sedge				S1?	1	66.8 ± 0.0	NB
P	*Sisyrinchium mucronatum*	Michaux's Blue-eyed-grass				S1?	3	64.1 ± 0.0	NB
P	*Wolffia columbiana*	Columbian Watermeal				S1?	12	16.4 ± 0.0	NB
P	*Galium kamtschaticum*	Northern Wild Licorice				S1S2	3	50.2 ± 0.0	NB
P	*Galearis spectabilis*	Showy Orchis				S1S2	77	47.9 ± 0.0	NB
P	*Spiranthes ochroleuca*	Yellow Ladies'-tresses				S1S2	3	49.1 ± 0.0	NB
P	*Potamogeton bicupulatus*	Snailseed Pondweed				S1S2	5	60.6 ± 0.0	NB
P	*Eriophorum russeolum ssp. albidum*	Smooth-fruited Russet Cottongrass				S1S3	2	74.3 ± 0.0	NB
P	*Spiranthes cernua*	Nodding Ladies'-Tresses				S1S3	17	10.3 ± 0.0	NB
P	*Spiranthes arcisepala*	Appalachian Ladies'-tresses				S1S3	13	19.7 ± 0.0	NB
P	*Spiranthes incurva*	Sphinx Ladies'-tresses				S1S3	1	19.5 ± 0.0	NB
P	*Neottia bifolia*	Southern Twayblade			Endangered	S2	16	25.0 ± 0.0	NB
P	*Sanicula trifoliata*	Large-Fruited Sanicle				S2	26	47.9 ± 0.0	NB
P	*Sanicula odorata*	Clustered Sanicle				S2	28	5.0 ± 0.0	NB
P	*Hieracium robinsonii*	Robinson's Hawkweed				S2	1	68.9 ± 0.0	NB
P	*Betula minor*	Dwarf White Birch				S2	1	9.7 ± 0.0	NB
P	*Atriplex glabriuscula var. franktonii*	Frankton's Saltbush				S2	1	96.2 ± 1.0	NB
P	*Hypericum x dissimulatum*	Disguised St. John's-wort				S2	5	33.0 ± 0.0	NB
P	*Viburnum dentatum var. lucidum*	Northern Arrow-Wood				S2	204	46.6 ± 0.0	NB
P	*Astragalus eucosmus*	Elegant Milk-vetch				S2	12	2.5 ± 0.0	NB
P	*Quercus macrocarpa*	Bur Oak				S2	234	0.7 ± 0.0	NB
P	*Nuphar x rubrodisca*	Red-disk Yellow Pond-lily				S2	18	21.0 ± 0.0	NB
P	*Polygaloides paucifolia*	Fringed Milkwort				S2	25	21.4 ± 0.0	NB
P	*Persicaria amphibia var. emersa*	Long-root Smartweed				S2	69	16.7 ± 0.0	NB
P	*Geum fragarioides*	Barren Strawberry				S2	27	47.8 ± 1.0	NB
P	*Micranthes virginiensis*	Early Saxifrage				S2	17	1.8 ± 1.0	NB
P	*Scrophularia lanceolata*	Lance-leaved Figwort				S2	12	11.6 ± 100.0	NB
P	*Viola canadensis*	Canada Violet				S2	87	60.6 ± 0.0	NB
P	*Carex cephaloidea*	Thin-leaved Sedge				S2	35	11.9 ± 0.0	NB
P	*Carex albicans var. emmonsii*	White-tinged Sedge				S2	8	49.4 ± 0.0	NB
P	*Cyperus lupulinus ssp. macilentus*	Hop Flatsedge				S2	72	47.9 ± 0.0	NB
P	*Calypso bulbosa var. americana*	Calypso				S2	40	16.7 ± 1.0	NB
P	*Coeloglossum viride*	Long-bracted Frog Orchid				S2	7	20.2 ± 5.0	NB
P	*Cypripedium parviflorum var.*	Small Yellow Lady's-Slipper				S2	14	16.9 ± 50.0	NB

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P	*Platanthera huronensis*	Fragrant Green Orchid				S2	3	39.0 ± 0.0	NB
P	*Elymus hystrix*	Spreading Wild Rye				S2	52	46.3 ± 1.0	NB
P	*Festuca subverticillata*	Nodding Fescue				S2	32	70.6 ± 0.0	NB
P	*Botrychium minganense*	Mingan Moonwort				S2	1	99.7 ± 0.0	NB
P	*Schizaea pusilla*	Little Curlygrass Fern				S2	17	98.5 ± 0.0	NB
P	*Coryphopteris simulata*	Bog Fern				S2	28	46.3 ± 0.0	NB
P	*Toxicodendron radicans var. radicans*	Eastern Poison Ivy				S2?	19	5.8 ± 1.0	NB
P	*Symphyotrichum novi-belgii var. crenifolium*	New York Aster				S2?	1	16.3 ± 1.0	NB
P	*Humulus lupulus var. lupuloides*	Common Hop				S2?	5	15.7 ± 5.0	NB
P	*Rubus x recurvicaulis*	arching dewberry				S2?	5	49.6 ± 1.0	NB
P	*Osmorhiza longistylis*	Smooth Sweet Cicely				S2S3	17	4.6 ± 5.0	NB
P	*Symphyotrichum racemosum*	Small White Aster				S2S3	13	33.4 ± 0.0	NB
P	*Canadanthus modestus*	Great Northern Aster				S2S3	12	73.0 ± 0.0	NB
P	*Alnus serrulata*	Smooth Alder				S2S3	63	48.0 ± 1.0	NB
P	*Cuscuta cephalanthi*	Buttonbush Dodder				S2S3	1	90.3 ± 0.0	NB
P	*Gentiana linearis*	Narrow-Leaved Gentian				S2S3	24	18.5 ± 1.0	NB
P	*Hedeoma pulegioides*	American False Pennyroyal				S2S3	13	11.9 ± 0.0	NB
P	*Aphyllon uniflorum*	One-flowered Broomrape				S2S3	15	21.7 ± 0.0	NB
P	*Polygala senega*	Seneca Snakeroot				S2S3	35	11.2 ± 1.0	NB
P	*Persicaria careyi*	Carey's Smartweed				S2S3	17	18.5 ± 1.0	NB
P	*Hepatica americana*	Round-lobed Hepatica				S2S3	72	2.3 ± 1.0	NB
P	*Ranunculus sceleratus*	Cursed Buttercup				S2S3	5	18.5 ± 0.0	NB
P	*Rosa acicularis ssp. sayi*	Prickly Rose				S2S3	35	66.6 ± 0.0	NB
P	*Cephalanthus occidentalis*	Common Buttonbush				S2S3	75	34.7 ± 0.0	NB
P	*Galium obtusum*	Blunt-leaved Bedstraw				S2S3	7	6.7 ± 0.0	NB
P	*Euphrasia randii*	Rand's Eyebright				S2S3	2	96.9 ± 0.0	NB
P	*Dirca palustris*	Eastern Leatherwood				S2S3	114	0.4 ± 1.0	NB
P	*Phryma leptostachya*	American Lopseed				S2S3	108	4.8 ± 0.0	NB
P	*Verbena urticifolia*	White Vervain				S2S3	36	4.7 ± 0.0	NB
P	*Viola novae-angliae*	New England Violet				S2S3	19	53.2 ± 10.0	NB
P	*Carex comosa*	Bearded Sedge				S2S3	14	56.7 ± 0.0	NB
P	*Carex rostrata*	Narrow-leaved Beaked Sedge				S2S3	10	67.1 ± 0.0	NB
P	*Carex vacillans*	Estuarine Sedge				S2S3	2	89.2 ± 1.0	NB
P	*Scirpus atrovirens*	Dark-green Bulrush				S2S3	2	83.7 ± 0.0	NB
P	*Juncus ranarius*	Seaside Rush				S2S3	1	94.6 ± 0.0	NB
P	*Allium tricoccum*	Wild Leek				S2S3	24	1.9 ± 0.0	NB
P	*Corallorhiza maculata var. occidentalis*	Spotted Coralroot				S2S3	12	16.0 ± 1.0	NB
P	*Corallorhiza maculata var. maculata*	Spotted Coralroot				S2S3	7	16.7 ± 1.0	NB
P	*Elymus canadensis*	Canada Wild Rye				S2S3	38	1.4 ± 1.0	NB
P	*Piptatheropsis canadensis*	Canada Ricegrass				S2S3	6	39.2 ± 5.0	NB
P	*Puccinellia phryganodes ssp. neoarctica*	Creeping Alkali Grass				S2S3	6	87.0 ± 0.0	NB
P	*Piptatheropsis pungens*	Slender Ricegrass				S2S3	5	68.4 ± 0.0	NB
P	*Potamogeton vaseyi*	Vasey's Pondweed				S2S3	12	12.2 ± 0.0	NB
P	*Isoetes tuckermanii ssp. acadiensis*	Acadian Quillwort				S2S3	10	18.9 ± 1.0	NB
P	*Botrychium tenebrosum*	Swamp Moonwort				S2S3	1	77.1 ± 0.0	NB
P	*Panax trifolius*	Dwarf Ginseng				S3	15	15.3 ± 0.0	NB
P	*Artemisia campestris ssp. caudata*	Tall Wormwood				S3	153	5.3 ± 0.0	NB
P	*Nabalus racemosus*	Glaucous Rattlesnakeroot				S3	77	0.8 ± 0.0	NB
P	*Solidago racemosa*	Racemose Goldenrod				S3	25	1.4 ± 1.0	NB
P	*Tanacetum bipinnatum ssp. huronense*	Lake Huron Tansy				S3	44	1.4 ± 1.0	NB
P	*Ionactis linariifolia*	Flax-leaved Aster				S3	70	64.5 ± 1.0	NB

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P	*Pseudognaphalium macounii*	Macoun's Cudweed				S3	12	10.3 ± 0.0	NB
P	*Impatiens pallida*	Pale Jewelweed				S3	5	58.3 ± 0.0	NB
P	*Turritis glabra*	Tower Mustard				S3	14	52.9 ± 0.0	NB
P	*Arabis pycnocarpa*	Cream-flowered Rockcress				S3	16	2.1 ± 1.0	NB
P	*Cardamine maxima*	Large Toothwort				S3	137	2.8 ± 2.0	NB
P	*Boechera stricta*	Drummond's Rockcress				S3	17	1.2 ± 0.0	NB
P	*Sagina nodosa*	Knotted Pearlwort				S3	2	94.6 ± 0.0	NB
P	*Stellaria humifusa*	Saltmarsh Starwort				S3	2	87.0 ± 0.0	NB
P	*Stellaria longifolia*	Long-leaved Starwort				S3	15	18.4 ± 10.0	NB
P	*Oxybasis rubra*	Red Goosefoot				S3	6	90.8 ± 1.0	NB
P	*Hudsonia tomentosa*	Woolly Beach-heath				S3	4	81.2 ± 0.0	NB
P	*Cornus obliqua*	Silky Dogwood				S3	288	48.9 ± 1.0	NB
P	*Lonicera oblongifolia*	Swamp Fly Honeysuckle				S3	149	44.5 ± 0.0	NB
P	*Triosteum aurantiacum*	Orange-fruited Tinker's Weed				S3	183	1.4 ± 0.0	NB
P	*Viburnum lentago*	Nannyberry				S3	134	42.3 ± 0.0	NB
P	*Rhodiola rosea*	Roseroot				S3	9	90.3 ± 5.0	NB
P	*Astragalus alpinus var. brunetianus*	Alpine Milk-Vetch				S3	17	5.6 ± 1.0	NB
P	*Oxytropis campestris var. johannensis*	Field Locoweed				S3	18	2.8 ± 1.0	NB
P	*Bartonia paniculata ssp. iodandra*	Branched Bartonia				S3	16	70.5 ± 0.0	NB
P	*Gentianella amarella ssp. acuta*	Northern Gentian				S3	11	31.5 ± 0.0	NB
P	*Geranium bicknellii*	Bicknell's Crane's-bill				S3	18	39.8 ± 0.0	NB
P	*Myriophyllum farwellii*	Farwell's Water Milfoil				S3	35	19.3 ± 5.0	NB
P	*Myriophyllum humile*	Low Water Milfoil				S3	18	33.0 ± 0.0	NB
P	*Myriophyllum quitense*	Andean Water Milfoil				S3	71	80.4 ± 0.0	NB
P	*Proserpinaca palustris*	Marsh Mermaidweed				S3	51	30.5 ± 0.0	NB
P	*Utricularia resupinata*	Inverted Bladderwort				S3	17	52.1 ± 0.0	NB
P	*Fraxinus pennsylvanica*	Red Ash				S3	222	1.3 ± 0.0	NB
P	*Rumex pallidus*	Seabeach Dock				S3	5	61.4 ± 1.0	NB
P	*Rumex occidentalis*	Western Dock				S3	1	17.9 ± 1.0	NB
P	*Podostemum ceratophyllum*	Horn-leaved Riverweed				S3	52	33.9 ± 0.0	NB
P	*Primula mistassinica*	Mistassini Primrose				S3	31	1.4 ± 1.0	NB
P	*Pyrola minor*	Lesser Pyrola				S3	2	62.3 ± 0.0	NB
P	*Anemone multifida*	Cut-leaved Anemone				S3	7	1.8 ± 0.0	NB
P	*Clematis occidentalis*	Purple Clematis				S3	37	4.0 ± 1.0	NB
P	*Ranunculus flabellaris*	Yellow Water Buttercup				S3	24	21.2 ± 0.0	NB
P	*Amelanchier gaspensis*	Gasp ├⌐ Serviceberry				S3	1	60.5 ± 0.0	NB
P	*Amelanchier canadensis*	Canada Serviceberry				S3	18	18.4 ± 1.0	NB
P	*Crataegus scabrida*	Rough Hawthorn				S3	9	57.9 ± 1.0	NB
P	*Rubus occidentalis*	Black Raspberry				S3	160	2.0 ± 0.0	NB
P	*Salix candida*	Sage Willow				S3	12	14.1 ± 1.0	NB
P	*Salix myricoides*	Bayberry Willow				S3	16	5.2 ± 0.0	NB
P	*Salix nigra*	Black Willow				S3	194	2.0 ± 0.0	NB
P	*Salix interior*	Sandbar Willow				S3	52	0.1 ± 1.0	NB
P	*Comandra umbellata*	Bastard's Toadflax				S3	2	63.2 ± 10.0	NB
P	*Agalinis purpurea var. parviflora*	Small-flowered Purple False Foxglove				S3	16	13.2 ± 0.0	NB
P	*Castilleja septentrionalis*	Northeastern Paintbrush				S3	9	62.0 ± 0.0	NB
P	*Valeriana uliginosa*	Swamp Valerian				S3	59	44.5 ± 0.0	NB
P	*Viola adunca*	Hooked Violet				S3	11	44.6 ± 1.0	NB
P	*Symplocarpus foetidus*	Eastern Skunk Cabbage				S3	85	29.5 ± 0.0	NB
P	*Carex adusta*	Lesser Brown Sedge				S3	12	43.8 ± 10.0	NB
P	*Carex arcta*	Northern Clustered Sedge				S3	63	31.1 ± 0.0	NB
P	*Carex conoidea*	Field Sedge				S3	24	1.1 ± 1.0	NB
P	*Carex garberi*	Garber's Sedge				S3	16	37.7 ± 0.0	NB
P	*Carex granularis*	Limestone Meadow Sedge				S3	9	1.9 ± 0.0	NB
P	*Carex gynocrates*	Northern Bog Sedge				S3	52	55.8 ± 2.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
P	*Carex hirtifolia*	Pubescent Sedge				S3	86	3.3 ± 0.0	NB
P	*Carex livida*	Livid Sedge				S3	6	72.7 ± 0.0	NB
P	*Carex ormostachya*	Necklace Spike Sedge				S3	29	3.3 ± 1.0	NB
P	*Carex plantaginea*	Plantain-Leaved Sedge				S3	181	3.3 ± 0.0	NB
P	*Carex prairea*	Prairie Sedge				S3	35	69.7 ± 0.0	NB
P	*Carex rosea*	Rosy Sedge				S3	268	1.9 ± 0.0	NB
P	*Carex sprengelii*	Longbeak Sedge				S3	63	3.7 ± 0.0	NB
P	*Carex tenuiflora*	Sparse-Flowered Sedge				S3	37	55.1 ± 0.0	NB
P	*Carex vaginata*	Sheathed Sedge				S3	24	44.5 ± 0.0	NB
P	*Cyperus esculentus var. leptostachyus*	Perennial Yellow Nutsedge				S3	95	4.9 ± 0.0	NB
P	*Cyperus squarrosus*	Awned Flatsedge				S3	46	20.7 ± 0.0	NB
P	*Eriophorum gracile*	Slender Cottongrass				S3	20	51.2 ± 0.0	NB
P	*Blysmopsis rufa*	Red Bulrush				S3	1	94.6 ± 0.0	NB
P	*Elodea nuttallii*	Nuttall's Waterweed				S3	12	18.6 ± 5.0	NB
P	*Juncus brachycephalus*	Small-Head Rush				S3	7	49.5 ± 0.0	NB
P	*Juncus vaseyi*	Vasey Rush				S3	11	66.4 ± 0.0	NB
P	*Najas gracillima*	Thread-Like Naiad				S3	11	47.1 ± 0.0	NB
P	*Cypripedium reginae*	Showy Lady's-Slipper				S3	168	44.5 ± 0.0	NB
P	*Goodyera oblongifolia*	Menzies' Rattlesnake-plantain				S3	1	45.2 ± 0.0	NB
P	*Neottia auriculata*	Auricled Twayblade				S3	10	9.9 ± 0.0	NB
P	*Platanthera grandiflora*	Large Purple Fringed Orchid				S3	71	8.1 ± 0.0	NB
P	*Platanthera orbiculata*	Small Round-leaved Orchid				S3	36	16.7 ± 1.0	NB
P	*Spiranthes lucida*	Shining Ladies'-Tresses				S3	27	26.0 ± 50.0	NB
P	*Agrostis mertensii*	Northern Bent Grass				S3	2	19.8 ± 0.0	NB
P	*Bromus latiglumis*	Broad-Glumed Brome				S3	34	2.3 ± 0.0	NB
P	*Dichanthelium linearifolium*	Narrow-leaved Panic Grass				S3	14	2.5 ± 0.0	NB
P	*Leersia virginica*	White Cut Grass				S3	58	5.4 ± 1.0	NB
P	*Muhlenbergia richardsonis*	Mat Muhly				S3	34	2.5 ± 0.0	NB
P	*Schizachyrium scoparium*	Little Bluestem				S3	63	1.3 ± 1.0	NB
P	*Zizania aquatica*	Southern Wild Rice				S3	2	56.5 ± 0.0	NB
P	*Zizania aquatica var. aquatica*	Eastern Wild Rice				S3	6	18.4 ± 5.0	NB
P	*Adiantum pedatum*	Northern Maidenhair Fern				S3	502	2.7 ± 5.0	NB
P	*Asplenium trichomanes*	Maidenhair Spleenwort				S3	9	12.0 ± 0.0	NB
P	*Anchistea virginica*	Virginia chain fern				S3	44	13.6 ± 0.0	NB
P	*Dryopteris goldieana*	Goldie's Woodfern				S3	313	4.0 ± 0.0	NB
P	*Woodsia alpina*	Alpine Cliff Fern				S3	6	91.0 ± 1.0	NB
P	*Isoetes tuckermanii ssp. tuckermanii*	Tuckerman's Quillwort				S3	22	24.4 ± 0.0	NB
P	*Diphasiastrum x sabinifolium*	Savin-leaved Ground-cedar				S3	15	21.4 ± 0.0	NB
P	*Huperzia appressa*	Mountain Firmoss				S3	1	98.2 ± 1.0	NB
P	*Sceptridium dissectum*	Dissected Moonwort				S3	56	15.3 ± 0.0	NB
P	*Botrychium lanceolatum ssp. angustisegmentum*	Narrow Triangle Moonwort				S3	27	8.3 ± 0.0	NB
P	*Botrychium simplex*	Least Moonwort				S3	16	8.3 ± 0.0	NB
P	*Ophioglossum pusillum*	Northern Adder's-tongue				S3	9	47.2 ± 0.0	NB
P	*Selaginella selaginoides*	Low Spikemoss				S3	3	91.1 ± 6.0	NB
P	*Crataegus submollis*	Quebec Hawthorn				S3?	19	6.2 ± 1.0	NB
P	*Crataegus succulenta*	Fleshy Hawthorn				S3?	1	18.4 ± 5.0	NB
P	*Platanthera hookeri*	Hooker's Orchid				S3?	50	12.2 ± 1.0	NB
P	*Arnica lanceolata*	Lance-leaved Arnica				S3S4	27	36.7 ± 0.0	NB
P	*Bidens hyperborea*	Estuary Beggarticks				S3S4	1	94.6 ± 0.0	NB
P	*Solidago altissima*	Tall Goldenrod				S3S4	49	5.3 ± 0.0	NB
P	*Symphyotrichum boreale*	Boreal Aster				S3S4	166	5.8 ± 10.0	NB
P	*Betula pumila*	Bog Birch				S3S4	46	32.0 ± 0.0	NB
P	*Mertensia maritima*	Sea Lungwort				S3S4	12	94.5 ± 1.0	NB
P	*Subularia aquatica ssp. americana*	American Water Awlwort				S3S4	18	27.6 ± 0.0	NB
P	*Lobelia cardinalis*	Cardinal Flower				S3S4	448	19.2 ± 1.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
P	*Callitriche hermaphroditica*	Northern Water-starwort				S3S4	8	21.4 ± 0.0	NB
P	*Viburnum edule*	Squashberry				S3S4	13	25.9 ± 1.0	NB
P	*Crassula aquatica*	Water Pygmyweed				S3S4	3	47.7 ± 1.0	NB
P	*Penthorum sedoides*	Ditch Stonecrop				S3S4	97	4.9 ± 0.0	NB
P	*Elatine americana*	American Waterwort				S3S4	8	47.9 ± 1.0	NB
P	*Hedysarum americanum*	Alpine Hedysarum				S3S4	36	60.1 ± 0.0	NB
P	*Fagus grandifolia*	American Beech				S3S4	562	0.7 ± 0.0	NB
P	*Geranium robertianum*	Herb Robert				S3S4	24	89.2 ± 1.0	NB
P	*Stachys hispida*	Smooth Hedge-Nettle				S3S4	17	2.0 ± 0.0	NB
P	*Stachys pilosa*	Hairy Hedge-Nettle				S3S4	9	5.3 ± 0.0	NB
P	*Teucrium canadense*	Canada Germander				S3S4	1	85.6 ± 0.0	NB
P	*Utricularia radiata*	Little Floating Bladderwort				S3S4	124	46.7 ± 0.0	NB
P	*Utricularia gibba*	Humped Bladderwort				S3S4	40	20.9 ± 0.0	NB
P	*Fraxinus americana*	White Ash				S3S4	433	0.4 ± 0.0	NB
P	*Epilobium strictum*	Downy Willowherb				S3S4	69	1.2 ± 1.0	NB
P	*Fallopia scandens*	Climbing False Buckwheat				S3S4	50	4.7 ± 1.0	NB
P	*Littorella americana*	American Shoreweed				S3S4	41	28.0 ± 0.0	NB
P	*Thalictrum confine*	Northern Meadow-rue				S3S4	133	1.1 ± 1.0	NB
P	*Drymocallis arguta*	Tall Wood Beauty				S3S4	70	2.1 ± 1.0	NB
P	*Rosa palustris*	Swamp Rose				S3S4	184	28.0 ± 0.0	NB
P	*Rubus pensilvanicus*	Pennsylvania Blackberry				S3S4	18	17.8 ± 0.0	NB
P	*Galium boreale*	Northern Bedstraw				S3S4	18	9.2 ± 0.0	NB
P	*Galium labradoricum*	Labrador Bedstraw				S3S4	127	52.6 ± 0.0	NB
P	*Salix pedicellaris*	Bog Willow				S3S4	99	30.2 ± 3.0	NB
P	*Geocaulon lividum*	Northern Comandra				S3S4	6	61.9 ± 0.0	NB
P	*Parnassia glauca*	Fen Grass-of-Parnassus				S3S4	13	9.1 ± 10.0	NB
P	*Agalinis neoscotica*	Nova Scotia Agalinis				S3S4	8	15.8 ± 0.0	NB
P	*Limosella australis*	Southern Mudwort				S3S4	1	91.0 ± 5.0	NB
P	*Ulmus americana*	White Elm				S3S4	353	2.8 ± 0.0	NB
P	*Boehmeria cylindrica*	Small-spike False-nettle				S3S4	176	6.9 ± 0.0	NB
P	*Juniperus horizontalis*	Creeping Juniper				S3S4	1	94.6 ± 0.0	NB
P	*Carex capillaris*	Hairlike Sedge				S3S4	13	67.3 ± 0.0	NB
P	*Carex eburnea*	Bristle-leaved Sedge				S3S4	10	64.2 ± 1.0	NB
P	*Carex exilis*	Coastal Sedge				S3S4	110	52.0 ± 0.0	NB
P	*Carex haydenii*	Hayden's Sedge				S3S4	125	5.8 ± 0.0	NB
P	*Carex lupulina*	Hop Sedge				S3S4	142	5.0 ± 0.0	NB
P	*Carex tenera*	Tender Sedge				S3S4	88	0.5 ± 1.0	NB
P	*Carex wiegandii*	Wiegand's Sedge				S3S4	64	38.7 ± 0.0	NB
P	*Carex recta*	Estuary Sedge				S3S4	6	59.5 ± 0.0	NB
P	*Carex atratiformis*	Scabrous Black Sedge				S3S4	4	74.1 ± 0.0	NB
P	*Cladium mariscoides*	Smooth Twigrush				S3S4	178	8.2 ± 0.0	NB
P	*Cyperus dentatus*	Toothed Flatsedge				S3S4	252	5.5 ± 0.0	NB
P	*Eleocharis quinqueflora*	Few-flowered Spikerush				S3S4	37	6.8 ± 0.0	NB
P	*Rhynchospora capitellata*	Small-headed Beakrush				S3S4	53	35.1 ± 0.0	NB
P	*Trichophorum clintonii*	Clinton's Clubrush				S3S4	121	39.0 ± 1.0	NB
P	*Bolboschoenus fluviatilis*	River Bulrush				S3S4	59	37.3 ± 0.0	NB
P	*Triglochin gaspensis*	Gasp ├─ Arrowgrass				S3S4	8	89.2 ± 1.0	NB
P	*Lilium canadense*	Canada Lily				S3S4	230	2.2 ± 0.0	NB
P	*Triantha glutinosa*	Sticky False-Asphodel				S3S4	92	3.3 ± 1.0	NB
P	*Corallorhiza maculata*	Spotted Coralroot				S3S4	19	12.0 ± 0.0	NB
P	*Liparis loeselii*	Loesel's Twayblade				S3S4	29	0.2 ± 1.0	NB
P	*Neottia cordata*	Heart-leaved Twayblade				S3S4	42	28.6 ± 2.0	NB
P	*Platanthera obtusata*	Blunt-leaved Orchid				S3S4	44	43.0 ± 0.0	NB
P	*Calamagrostis pickeringii*	Pickering's Reed Grass				S3S4	97	66.3 ± 0.0	NB
P	*Calamagrostis stricta*	Slim-stemmed Reed Grass				S3S4	3	78.7 ± 0.0	NB
P	*Eragrostis pectinacea*	Tufted Love Grass				S3S4	19	6.0 ± 1.0	NB
P	*Stuckenia filiformis*	Thread-leaved Pondweed				S3S4	11	56.2 ± 0.0	NB
P	*Potamogeton praelongus*	White-stemmed Pondweed				S3S4	23	38.2 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
P	*Potamogeton richardsonii*	Richardson's Pondweed				S3S4	44	14.4 ± 0.0	NB
P	*Xyris montana*	Northern Yellow-Eyed-Grass				S3S4	33	34.5 ± 0.0	NB
P	*Cryptogramma stelleri*	Steller's Rockbrake				S3S4	1	94.6 ± 0.0	NB
P	*Asplenium viride*	Green Spleenwort				S3S4	15	80.8 ± 0.0	NB
P	*Dryopteris fragrans*	Fragrant Wood Fern				S3S4	21	39.7 ± 0.0	NB
P	*Equisetum palustre*	Marsh Horsetail				S3S4	14	5.5 ± 0.0	NB
P	*Polypodium appalachianum*	Appalachian Polypody				S3S4	54	11.2 ± 1.0	NB
P	*Solidago ptarmicoides*	Upland White Goldenrod				SX	3	57.6 ± 1.0	NB
P	*Celastrus scandens*	Climbing Bittersweet				SX	4	2.8 ± 1.0	NB

5.1 SOURCE BIBLIOGRAPHY (100 km)

The recipient of these data shall acknowledge the AC CDC and the data sources listed below in any documents, reports, publications or presentations, in which this dataset makes a significant contribution.

# recs	CITATION
7209	Lepage, D. 2014. Maritime Breeding Bird Atlas Database. Bird Studies Canada, Sackville NB, 407,838 recs.
3862	Erskine, A.J. 1992. Maritime Breeding Bird Atlas Database. NS Museum & Nimbus Publ., Halifax, 82,125 recs.
2618	iNaturalist.ca. 2023. iNaturalist Data Export December 2022. iNaturalist.org; iNaturalist.ca.
2428	Pardieck, K.L., Ziolkowski Jr., D.J., Lutmerding, M., Aponte, V.I., and Hudson, M-A.R. 2020. North American Breeding Bird Survey Dataset 1966 - 2019: U.S. Geological Survey data release, https://doi.org/10.5066/P9J6QUF6
2007	eBird. 2014. eBird Basic Dataset. Version: EBD_relNov-2014. Ithaca, New York. Nov 2014. Cornell Lab of Ornithology, 25036 recs.
1540	Berrigan, L. 2019. Maritimes Marsh Monitoring Project 2013, 2014, 2016, 2017, and 2018 data. Bird Studies Canada, Sackville, NB.
1382	Blaney, C.S.; Mazerolle, D.M.; Belliveau, A.B. 2014. Atlantic Canada Conservation Data Centre Fieldwork 2014. Atlantic Canada Conservation Data Centre, # recs.
1055	Blaney, C.S. & Mazerolle, D.M. 2011. NB WTF Fieldwork on Magaguadavic & Lower St Croix Rivers. Atlantic Canada Conservation Data Centre, 4585 recs.
989	iNaturalist. 2020. iNaturalist Data Export 2020. iNaturalist.org and iNaturalist.ca, Web site: 128728 recs.
842	Blaney, C.S.; Mazerolle, D.M.; Belliveau, A.B. 2015. Atlantic Canada Conservation Data Centre Fieldwork 2015. Atlantic Canada Conservation Data Centre, # recs.
838	Cowie, F. 2007. Electrofishing Population Estimates 1979-98. Canadian Rivers Institute, 2698 recs.
821	Askanas, H. 2016. New Brunswick Wood Turtle Database. New Brunswick Department of Energy and Resource Development.
813	Stantec. 2014. Energy East Pipeline Corridor Species Occurrence Data. Stantec Inc., 4934 records.
789	Blaney, C.S.; Mazerolle, D.M. 2009. Fieldwork 2009. Atlantic Canada Conservation Data Centre. Sackville NB, 13395 recs.
675	Benedict, B. Connell Herbarium Specimens. University New Brunswick, Fredericton. 2003.
670	Blaney, C.S; Korol, J.B.; Crowell, I. 2023. 2022 AC CDC Botany program field data. Atlantic Canada Conservation Data Centre, 5293 records.
663	Wallace, S. 2021. Wood Turtle Radio Tracking data from the Nashwaaksis Stream. University of New Brunswick.
636	Goltz, J.P. 2012. Field Notes, 1989-2005. , 1091 recs.
584	Brooks, Delaney. 2023. Port of Saint John Waterbird Survey since 2019. Nature NB.
538	Wisniowski, C. & Dowding, A. 2019. NB species occurrence data for 2016-2018. Nature Trust of New Brunswick.
516	Clayden, S.R. 1998. NBM Science Collections databases: vascular plants. New Brunswick Museum, Saint John NB, 19759 recs.
500	Morrison, Guy. 2011. Maritime Shorebird Survey (MSS) database. Canadian Wildlife Service, Ottawa, 15939 surveys. 86171 recs.
469	Blaney, C.S.; Mazerolle, D.M.; Belliveau, A.B. 2013. Atlantic Canada Conservation Data Centre Fieldwork 2013. Atlantic Canada Conservation Data Centre, 9000+ recs.
464	Wallace, S. 2020. Stewardship Department species occurrence data on NTNB preserves. Nature Trust of New Brunswick.
448	Benedict, B. Connell Herbarium Specimens (Data) . University New Brunswick, Fredericton. 2003.
399	Watts, Todd. 2021. Bird Species at Risk records, NB. Peskotomuhkati Nation at Skutik.
363	Blaney, C.S.; Mazerolle, D.M. 2008. Fieldwork 2008. Atlantic Canada Conservation Data Centre. Sackville NB, 13343 recs.
355	Mazerolle, D.M. 2020. Atlantic Canada Conservation Data Centre botanical fieldwork 2019. Atlantic Canada Conservation Data Centre.
354	New Brunswick Department of Natural Resources and Energy Development. 2023. Wood turtle records from 2016-2021. New Brunswick Department of Natural Resources and Energy Development, 637 records.
347	Tims, J. & Craig, N. 1995. Environmentally Significant Areas in New Brunswick (NBESA). NB Dept of Environment & Nature Trust of New Brunswick Inc, 6042 recs. https://doi.org/10.1037/arc0000014.
339	Wallace, Shaylyn. 2023. Painted Turtle and Snapping Turtle records since 2015. New Brunswick Department of Energy and Resource Development.
337	Chapman-Lam, C.J. 2022. Atlantic Canada Conservation Data Centre 2021 botanical fieldwork. Atlantic Canada Conservation Data Centre, 15099 recs.
333	Blaney, C.S. 2000. Fieldwork 2000. Atlantic Canada Conservation Data Centre. Sackville NB, 1265 recs.
326	Mazerolle, D.M. 2018. Atlantic Canada Conservation Data Centre botanical fieldwork 2018. Atlantic Canada Conservation Data Centre, 13515 recs.
322	Blaney, C.S. 2020. Sean Blaney 2020 field data. Atlantic Canada Conservation Data Centre, 4407 records.
321	MacDougall, A.; Bishop, G.; et al. 1998. 1997 Appalachian Hardwood Field Data. Nature Trust of New Brunswick, 4473 recs.
278	Blaney, C.S.; Mazerolle, D.M.; Klymko, J; Spicer, C.D. 2006. Fieldwork 2006. Atlantic Canada Conservation Data Centre. Sackville NB, 8399 recs.
277	Wisniowski, C. & Dowding, A. 2020. NB species occurrence data for 2020. Nature Trust of New Brunswick.
273	Watts, T. 2021. Fuscopannaria leucosticta, Pannaria lurida and Fraxinus nigra records from western Charlotte County, New Brunswick. Peskotomuhkati Nation at Skutik, 273 records.

# recs	CITATION
243	Sollows, M.C. 2009. NBM Science Collections databases: molluscs. New Brunswick Museum, Saint John NB, download Jan. 2009, 6951 recs (2957 in Atlantic Canada).
228	Blaney, C.S. 2003. Fieldwork 2003. Atlantic Canada Conservation Data Centre. Sackville NB, 1042 recs.
224	Nature Trust of New Brunswick. 2022. Nature Trust of New Brunswick 2022 staff and volunteer observations of species occurence data. Nature Trust of New Brunswick.
214	Hinds, H.R. 1986. Notes on New Brunswick plant collections. Connell Memorial Herbarium, unpubl, 739 recs.
211	Clayden, S.R. 2007. NBM Science Collections databases: vascular plants. New Brunswick Museum, Saint John NB, download Mar. 2007, 6914 recs.
199	Klymko, J. 2020. Atlantic Canada Conservation Data Centre zoological fieldwork 2019. Atlantic Canada Conservation Data Centre.
198	Chapman, C.J. 2019. Atlantic Canada Conservation Data Centre 2019 botanical fieldwork. Atlantic Canada Conservation Data Centre, 11729 recs.
198	Churchill, J.L.; Klymko, J.D. 2016. Bird Species at Risk Inventory on the Acadia Research Forest, 2016. Atlantic Canada Conservation Data Centre, 1043 recs.
196	Blaney, C.S. 2019. Sean Blaney 2019 field data. Atlantic Canada Conservation Data Centre, 4407 records.
180	Brunelle, P.-M. (compiler). 2009. ADIP/MDDS Odonata Database: data to 2006 inclusive. Atlantic Dragonfly Inventory Program (ADIP), 24200 recs.
178	Hicks, Andrew. 2009. Coastal Waterfowl Surveys Database, 2000-08. Canadian Wildlife Service, Sackville, 46488 recs (11149 non-zero).
177	Klymko, J. 2019. Atlantic Canada Conservation Data Centre zoological fieldwork 2018. Atlantic Canada Conservation Data Centre.
168	Anonymous. 2017. Observations from protected sources. Atlantic Canada Conservation Data Centre.
168	Nature Trust of New Brunswick. 2021. Nature Trust of New Brunswick site inventory data submitted in April 2021. Nature Trust of New Brunswick, 2189 records.
161	Blaney, C.S.; Mazerolle, D.M.; Oberndorfer, E. 2007. Fieldwork 2007. Atlantic Canada Conservation Data Centre. Sackville NB, 13770 recs.
159	Belliveau, A.G. 2016. Atlantic Canada Conservation Data Centre Fieldwork 2016. Atlantic Canada Conservation Data Centre, 10695 recs.
157	Sollows, M.C,. 2008. NBM Science Collections databases: mammals. New Brunswick Museum, Saint John NB, download Jan. 2008, 4983 recs.
156	Blaney, C.S.; Spicer, C.D.; Mazerolle, D.M. 2005. Fieldwork 2005. Atlantic Canada Conservation Data Centre. Sackville NB, 2333 recs.
155	Tranquilla, L. 2015. Maritimes Marsh Monitoring Project 2015 data. Bird Studies Canada, Sackville NB, 5062 recs.
149	Watts, Todd. 2021. Todd Watts rare species data 2021. Peskotomakuti First Nation at Skutik, 152 records.
147	Sollows, M.C. 2008. NBM Science Collections databases: herpetiles. New Brunswick Museum, Saint John NB, download Jan. 2008, 8636 recs.
140	eBird. 2020. eBird Basic Dataset. Version: EBD_relNov-2019. Ithaca, New York. Nov 2019, Cape Breton Bras d'Or Lakes Watershed subset. Cornell Lab of Ornithology.
140	Mazerolle, D.M. 2017. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre.
138	Benedict, B. Connell Herbarium Specimen Database Download 2004. Connell Memorial Herbarium, University of New Brunswick. 2004.
133	Porter, Caitlin. 2021. Field data for 2020 in various locations across the Maritimes. Atlantic Canada Conservation Data Centre, 3977 records.
130	Sabine, M. 2016. Black Ash records from the NB DNR Forest Development Survey. New Brunswick Department of Natural Resources.
127	Bishop, G. & Papoulias, M.; Arnold (Chaplin), M. 2005. Grand Lake Meadows field notes, Summer 2005. New Brunswick Federation of Naturalists, 1638 recs.
126	SwiftWatch. 2022. Total Chimney Swift counts from roost watches for the duration of the SwiftWatch program (2011-2021). Birds Canada.
117	Blaney, C.S. & Mazerolle, D.M. 2011. Field data from NCC properties at Musquash Harbour NB & Goose Lake NS. Atlantic Canada Conservation Data Centre, 1739 recs.
117	Klymko, J. 2018. Maritimes Butterfly Atlas database. Atlantic Canada Conservation Data Centre.
112	Churchill, J.L. 2018. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre, 2318 recs.
103	Bagnell, B.A. 2001. New Brunswick Bryophyte Occurrences. B&B Botanical, Sussex, 478 recs.
101	Blaney, C.S.; Mazerolle, D.M. 2012. Fieldwork 2012. Atlantic Canada Conservation Data Centre, 13,278 recs.
101	Blaney, C.S.; Spicer, C.D.; Popma, T.M.; Hanel, C. 2002. Fieldwork 2002. Atlantic Canada Conservation Data Centre. Sackville NB, 2252 recs.
99	Sabine, D.L. 2005. 2001 Freshwater Mussel Surveys. New Brunswick Dept of Natural Resources & Energy, 590 recs.
96	Blaney, C.S.; Spicer, C.D. 2001. Fieldwork 2001. Atlantic Canada Conservation Data Centre. Sackville NB, 981 recs.
96	Mazerolle, D.M. 2016. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre.
94	Richardson, Leif. 2018. Maritimes Bombus records from various sources. Richardson, Leif.
93	Chapman-Lam, Colin J. 2022. Atlantic Canada Conservation Data Centre 2022 contracted project work. Atlantic Canada Conservation Data Centre.
92	Blaney, C.S.; Spicer, C.D.; Rothfels, C. 2004. Fieldwork 2004. Atlantic Canada Conservation Data Centre. Sackville NB, 1343 recs.
92	Chapman-Lam, C.J. 2021. Atlantic Canada Conservation Data Centre 2020 botanical fieldwork. Atlantic Canada Conservation Data Centre, 17309 recs.
91	Erskine, A.J. 1999. Maritime Nest Records Scheme (MNRS) 1937-1999. Canadian Wildlife Service, Sackville, 313 recs.
90	Chapman, C.J. 2018. Atlantic Canada Conservation Data Centre botanical fieldwork 2018. Atlantic Canada Conservation Data Centre, 11171 recs.
79	Watts, Todd. 2023. Searching coastal Charlotte County for Pectenia plumbea. Peskotomuhkati Nation at Skutik.
78	Beardmore, T. 2017. Wood turtle data: observations May 2017. Nashwaaksis Stream, NB. Natural Resources Canada, 78 records.
78	O'Malley, Z., Z.G. Compson, J.M. Orlofske, D.J. Baird, R.A. Curry, and W.A. Monk. 2021. Riparian and in channel habitat properties linked to dragonfly emergence. Scientific Reports, 10(17665):1-12.
76	Belland, R.J. Maritimes moss records from various herbarium databases. 2014.
75	Belliveau, A.G. 2018. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre.
75	Haughian, S.R. 2018. Description of Fuscopannaria leucosticta field work in 2017. New Brunswick Museum, 314 recs.
74	Klymko, J.J.D. 2018. 2017 field data. Atlantic Canada Conservation Data Centre.
74	Nature Trust of New Brunswick. 2020. Nature Trust of New Brunswick 2020 staff observations of species occurence data. Nature Trust of New Brunswick, 133 records.
73	iNaturalist. 2020. iNaturalist butterfly records selected for the Maritimes Butterfly Atlas. iNaturalist.
71	Cowie, Faye. 2007. Surveyed Lakes in New Brunswick. Canadian Rivers Institute, 781 recs.
66	Robinson, S.L. 2015. 2014 field data.
63	Honeyman, K. 2019. Unique Areas Database, 2018. J.D. Irving Ltd.
62	Wilhelm, S.I. et al. 2011. Colonial Waterbird Database. Canadian Wildlife Service, Sackville, 2698 sites, 9718 recs (8192 obs).
60	Scott, Fred W. 1998. Updated Status Report on the Cougar (Puma Concolor couguar) [Eastern population]. Committee on the Status of Endangered Wildlife in Canada, 298 recs.
58	iNaturalist. 2018. iNaturalist Data Export 2018. iNaturalist.org and iNaturalist.ca, Web site: 11700 recs.
57	McAlpine, D.F. 1998. NBM Science Collections: Wood Turtle records. New Brunswick Museum, Saint John NB, 329 recs.

# recs	CITATION
54	Klymko, J.J.D. 2016. 2015 field data. Atlantic Canada Conservation Data Centre.
54	Thomas, A.W. 1996. A preliminary atlas of the butterflies of New Brunswick. New Brunswick Museum.
52	Neily, T. H. 2018. Lichen and Bryophyte records, AEI 2017-2018. Tom Neily; Atlantic Canada Conservation Data Centre.
50	McAlpine, D.F. 1998. NBM Science Collections databases to 1998. New Brunswick Museum, Saint John NB, 241 recs.
49	Belliveau, A.G. 2020. E.C. Smith Herbarium and Atlantic Canada Conservation Data Centre Fieldwork 2019, 2020. E.C. Smith Herbarium.
49	Klymko, J. 2016. Atlantic Canada Conservation Data Centre Fieldwork 2016. Atlantic Canada Conservation Data Centre.
46	Manthorne, A. 2014. MaritimesSwiftwatch Project database 2013-2014. Bird Studies Canada, Sackville NB, 326 recs.
45	Speers, L. 2008. Butterflies of Canada database: New Brunswick 1897-1999. Agriculture & Agri-Food Canada, Biological Resources Program, Ottawa, 2048 recs.
45	Spicer, C.D. 2002. Fieldwork 2002. Atlantic Canada Conservation Data Centre. Sackville NB, 211 recs.
44	Blaney, C.S.; Mazerolle, D.M. 2010. Fieldwork 2010. Atlantic Canada Conservation Data Centre. Sackville NB, 15508 recs.
44	Nussey, Pat & NCC staff. 2019. AEI tracked species records, 2016-2019. Chapman, C.J. (ed.) Atlantic Canada Conservation Data Centre, 333.
40	Mills, E. Connell Herbarium Specimens, 1957-2009. University New Brunswick, Fredericton. 2012.
39	e-Butterfly. 2016. Export of Maritimes records and photos. Maxim Larrivee, Sambo Zhang (ed.) e-butterfly.org.
38	McAlpine, D.F. New Brunswick Museum bee specimens. New Brunswick Museum. 2013.
37	Paquet, Julie. 2018. Atlantic Canada Shorebird Survey (ACSS) database 2012-2018. Environment Canada, Canadian Wildlife Service.
37	Sabine, D.L. Bombus terricola specimens in Dwayne Sabine's personal collection. pers. comm. 2022.
36	Patrick, Allison. 2021. Animal and plant records from NCC properties from 2019 and 2020. Nature Conservancy Canada.
35	Bateman, M.C. 2001. Coastal Waterfowl Surveys Database, 1965-2001. Canadian Wildlife Service, Sackville, 667 recs.
30	Klymko, J. 2021. Atlantic Canada Conservation Data Centre zoological fieldwork 2020. Atlantic Canada Conservation Data Centre.
28	Benedict, B. Connell Herbarium Specimens, Digital photos. University New Brunswick, Fredericton. 2005.
27	Sabine, M. 2016. NB DNR staff incidental Black Ash observations. New Brunswick Department of Natural Resources.
27	Shortt, R. Connell Herbarium Black Ash specimens. University New Brunswick, Fredericton. 2019.
26	Hinds, H.R. 1999. Connell Herbarium Database. University New Brunswick, Fredericton, 131 recs.
26	Klymko, J.J.D.; Robinson, S.L. 2014. 2013 field data. Atlantic Canada Conservation Data Centre.
24	Haughian, Sean. 2021. Update to lichen data from 2017-2021. Nova Scotia Museum.
24	Shortt, R. UNB specimen data for various tracked species formerly considered secure. Connell Memorial Herbarium, UNB, Fredericton NB. 2019.
23	Department of Natural Resources and Energy Development. 2022. Wood Turtle records for New Brunswick. Government of New Brunswick, 28 records.
23	Hughes, C. Bombus specimens in the AFC insect collection. Atlantic Forestry Centre. 2022.
22	Klymko, J.J.D. 2016. 2014 field data. Atlantic Canada Conservation Data Centre.
21	Porter, Caitlin. 2020. Observations for 26 EcoGifts sites in southwest New Brunswick. Atlantic Canada Conservation Data Centre, 1073 records.
21	Sabine, M. 2016. Black Ash records from NB DNR permanent forest sampling Plots. New Brunswick Department of Natural Resources, 39 recs.
20	Klymko, John. 2023. Atlantic Canada Conservation Data Centre zoological fieldwork 2022. Atlantic Canada Conservation Data Centre.
19	Benedict, B. Connell Herbarium Specimens. University New Brunswick, Fredericton. 2000.
19	McMullin, R.T. 2022. Maritimes lichen records. Canadian Museum of Nature.
19	NatureServe Canada. 2019. iNaturalist Maritimes Butterfly Records. iNaturalist.org and iNaturalist.ca.
19	Stewart, J.I. 2010. Peregrine Falcon Surveys in New Brunswick, 2002-09. Canadian Wildlife Service, Sackville, 58 recs.
18	Klymko, John. 2022. Atlantic Canada Conservation Data Centre zoological fieldwork 2021. Atlantic Canada Conservation Data Centre.
17	Canadian National Collection of Insects Arachnids, and Nematodes Bombus specimen database export. Government of Canada. 2022.
17	Spicer, C.D. 2001. Powerline Corridor Botanical Surveys, Charlotte & Saint John Counties. A M E C International, 1269 recs.
16	Hughes, Cory. 2020. Atlantic Forestry Centre Coccinella transversoguttata collections. Canadian Forest Service, Atlantic Forestry Centre.
16	Kennedy, Joseph. 2010. New Brunswick Peregrine records, 2009. New Brunswick Dept Natural Resources, 19 recs (14 active).
15	Birds Canada. 2022. Maritimes Swiftwatch project data for 2022. Pers. comm., 155 records.
15	Blaney, C.S. 2017. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre.
15	Webster, R.P. 2006. Survey for Suitable Salt Marshes for the Maritime Ringlet, New Populations of the Cobblestone Tiger Beetle, & New Localities of Three Rare Butterfly Species. New Brunswick WTF Report, 28 recs.
14	Downes, C. 1998-2000. Breeding Bird Survey Data. Canadian Wildlife Service, Ottawa, 111 recs.
13	Edsall, J. 2001. Lepidopteran records in New Brunswick, 1997-99. , Pers. comm. to K.A. Bredin. 91 recs.
12	Blaney, C.S.; Mazerolle, D.M. 2011. Fieldwork 2011. Atlantic Canada Conservation Data Centre. Sackville NB.
11	Blaney, C.S. & Korol, J.B.; Crowell, I. 2022. Polemonium vanbruntiae data from Dipper Harbour Creek, NB, Sept 28 2022. ACCDC, 48 records.
11	Department of Natural Resources and Energy Development. 2022. Pinedrops (Pterospora andromedea) records for New Brunswick. Government of New Brunswick, 12 records.
11	Tingley, S. (compiler). 2001. Butterflies of New Brunswick. , Web site: www.geocities.com/Yosemite/8425/buttrfly. 142 recs.
11	Vladimir King Trajkovic. 2018. Brook Floater (Alasmidonta varicosa) records from MREAC surveys 2010-2017. Miramichi River Environmental Assessment Committee.
11	Webster, R.P. 2004. Lepidopteran Records for National Wildlife Areas in New Brunswick. Webster, 1101 recs.
11	Webster, R.P. Database of R.P. Webster butterfly collection. 2017.
10	Doucet, D.A. 2008. Fieldwork 2008: Odonata. ACCDC Staff, 625 recs.
10	Edsall, J. 2007. Personal Butterfly Collection: specimens collected in the Canadian Maritimes, 1961-2007. J. Edsall, unpubl. report, 137 recs.
10	Klymko, J. Dataset of butterfly records at the New Brunswick Museum not yet accessioned by the museum. Atlantic Canada Conservation Data Centre. 2016.
10	Wisniowski, C. 2018. Optimizing wood turtle conservation in New Brunswick through collaboration, strategic planning, and landowner outreach. Nature Trust of New Brunswick, 10 records.
9	Bateman, M.C. 2000. Waterfowl Brood Surveys Database, 1990-2000. Canadian Wildlife Service, Sackville, unpublished data. 149 recs.

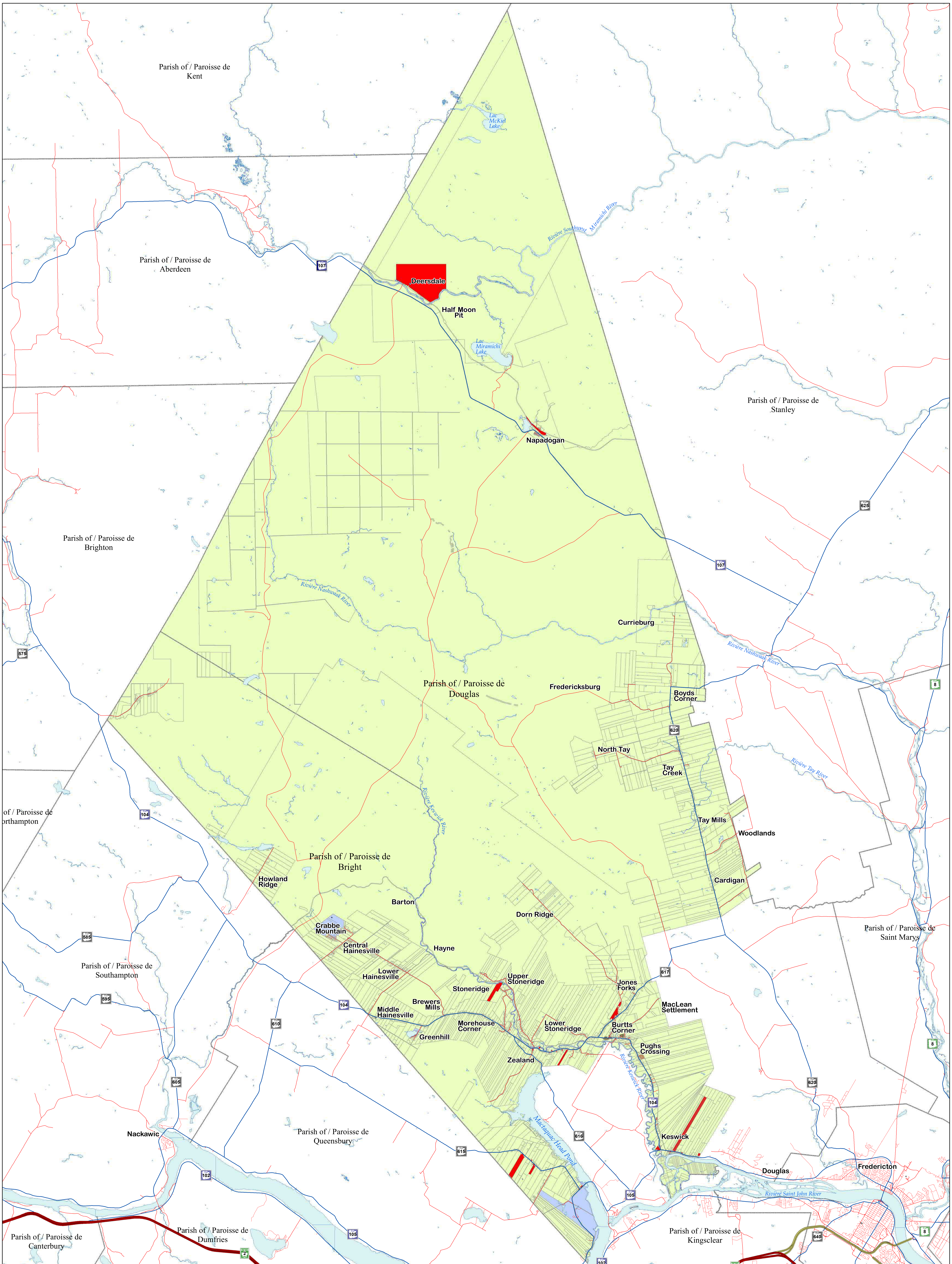
# recs	CITATION
9	Blaney, C.S. 2016. Atlantic Canada Conservation Data Centre Fieldwork 2016. Atlantic Canada Conservation Data Centre, 6719 recs.
8	Doucet, D.A. & Edsall, J.; Brunelle, P.-M. 2007. Miramichi Watershed Rare Odonata Survey. New Brunswick ETF & WTF Report, 1211 recs.
8	Goltz, J.P. & Bishop, G. 2005. Confidential supplement to Status Report on Prototype Quillwort (Isoetes prototypus). Committee on the Status of Endangered Wildlife in Canada, 111 recs.
8	King, Amelia. 2020. Belleisle Watershed Coalition Turtle Watch Data. Belleisle Watershed Coalition.
8	Litvak, M.K. 2001. Shortnose Sturgeon records in four NB rivers. UNB Saint John NB. Pers. comm. to K. Bredin, 6 recs.
8	Munro, Marian K. Nova Scotia Provincial Museum of Natural History Herbarium Database. Nova Scotia Provincial Museum of Natural History, Halifax, Nova Scotia. 2013.
8	Sollows, M.C,. 2009. NBM Science Collections databases: Coccinellid & Cerambycid Beetles. New Brunswick Museum, Saint John NB, download Feb. 2009, 569 recs.
8	Webster, R.P. Atlantic Forestry Centre Insect Collection, Maritimes butterfly records. Natural Resources Canada. 2014.
8	Young, Elva. 2019. Epargyreus clarus records from Charlotte County. Young, Elva, pers. comm.
7	Chaput, G. 2002. Atlantic Salmon: Maritime Provinces Overview for 2001. Dept of Fisheries & Oceans, Atlantic Region, Science Stock Status Report D3-14. 39 recs.
7	Goltz, J.P. 1994. In the Footsteps of Our Ancestors. NB Naturalists, 21 (2-4): 20. 8 recs.
7	Keppie, D.M. 2005. Rare Small Mammal Records in NB, PE. Pers. comm. to K. Bredin; PE 1 rec., NB 24 recs, 23 recs.
7	Klymko, J.J.D. 2012. Insect fieldwork & submissions, 2003-11. Atlantic Canada Conservation Data Centre. Sackville NB, 1337 recs.
6	Cronin, P. & Ayer, C.; Dubee, B.; Hooper, W.C.; LeBlanc, E.; Madden, A.; Pettigrew, T.; Seymour, P. 1998. Fish Species Management Plans (draft). NB DNRE Internal Report. Fredericton, 164pp.
6	Dowding, A.; Mandula, M. 2017. Observation of Hepatica acutiloba in New Brunswick. Nature Trust New Brunswick.
6	e-Butterfly. 2019. Export of Maritimes records and photos. McFarland, K. (ed.) e-butterfly.org.
6	McAlpine, D.F. 1983. Status & Conservation of Solution Caves in New Brunswick. New Brunswick Museum, Publications in Natural Science, no. 1, 28pp.
6	Pike, E., Tingley, S. & Christie, D.S. 2000. Nature NB Listserve. University of New Brunswick, listserv.unb.ca/archives/naturenb. 68 recs.
6	Popma, T.M. 2003. Fieldwork 2003. Atlantic Canada Conservation Data Centre. Sackville NB, 113 recs.
6	Sabine, D.L. Dwayne Sabine's Bombus terricola and Bombus queen records. Dwayne L. Sabine. 2018.
6	Toner, M. 2005. Lynx Records 1996-2005. NB Dept of Natural Resources, 48 recs.
5	Beardmore, T. 2017. 2017 Butternut observations. Natural Resources Canada.
5	Bredin, K.A. 2001. WTF Project: Freshwater Mussel Fieldwork in Freshwater Species data. Atlantic Canada Conservation Data Centere, 101 recs.
5	Goltz, J.P. 2001. Botany Ramblings April 29-June 30, 2001. N.B. Naturalist, 28 (2): 51-2. 8 recs.
5	Marshall, L. 1998. Atlantic Salmon: Southwest New Brunswick outer-Fundy SFA 23. Dept of Fisheries & Oceans, Atlantic Region, Science. Stock Status Report D3-13. 6 recs.
5	Miramichi River Environmental Assessment Committee. 2013. Wood Turtle (Glyptemys insculpta) Miramichi Watershed Synopsis 2013. Vladimir King Trajkovic (ed.) Miramichi River Environmental Assessment Committee.
5	Moldowan, Patrick Chrysemys picta records from COSEWIC status report. pers. comm. 2021.
5	Richardson, D., Anderson, F., Cameron, R, Pepper, C., Clayden, S. 2015. Field Work Report on the Wrinkled Shingle lichen (Pannaria lurida). COSEWIC.
5	Speers, L. 2001. Butterflies of Canada database. Agriculture & Agri-Food Canada, Biological Resources Program, Ottawa, 190 recs.
5	Vickruck, J. 2022. Bombus specimens collected in the 2021 and 2022 field seasons by Jessica Vickruck's research program. Fredericton Research and Development Centre.
4	Bredin, K.A. 2003. NB Freshwater Mussel Fieldwork. Atlantic Canada Conservation Data Centere, 20 recs.
4	Clayden, S.R. 2012. NBM Science Collections databases: vascular plants. New Brunswick Museum, Saint John NB, 57 recs.
4	Layberry, R.A. 2012. Lepidopteran records for the Maritimes, 1974-2008. Layberry Collection, 1060 recs.
4	Newell, R.E. 2000. E.C. Smith Herbarium Database. Acadia University, Wolfville NS, 7139 recs.
4	Patrick, A.; Horne, D.; Noseworthy, J. et. al. 2017. Field data for Nova Scotia and New Brunswick, 2015 and 2017. Nature Conservancy of Canada.
4	Sabine, D.L. 2011. Dorcas Copper records from 2001 Fieldwork. New Brunswick Dept of Natural Resources, 4 recs.
4	Simpson, D. Collection sites for Black Ash seed lots preserved at the National Tree Seed Centre in Fredericton NB. National Tree Seed Centre, Canadian Forest Service. 2016.
4	Wallace, Shaylyn. 2023. Wood Turtle records collected in 2022. New Brunswick Department of Energy and Resource Development.
4	Wilhelm, S.I. et al. 2019. Colonial Waterbird Database. Canadian Wildlife Service.
3	Basquill, S.P. 2003. Fieldwork 2003. Atlantic Canada Conservation Data Centre, Sackville NB, 69 recs.
3	Bishop, G. 2012. Field data from September 2012 Anticosti Aster collection trip. , 135 rec.
3	Blaney, C.S. Miscellaneous specimens received by ACCDC (botany). Various persons. 2001-08.
3	Brunelle, P.-M. 2005. Wood Turtle observations. Pers. comm. to S.H. Gerriets, 21 Sep. 3 recs, 3 recs.
3	Clayden, S.R. 2006. Pseudevernia cladonia records. NB Museum. Pers. comm. to S. Blaney, Dec, 4 recs.
3	Doucet, D.A. 2008. Wood Turtle Records 2002-07. Pers. comm. to S. Gerriets, 7 recs, 7 recs.
3	Edsall, J. 1993. Spring 1993 Report. New Brunswick Bird Info Line, 3 recs.
3	Forbes, G. 2001. Bog Lemming, Phalarope records, NB. , Pers. comm. to K.A. Bredin. 6 recs.
3	Forbes, G. 2021. Chrysemys picta record from Waasis, New Brunswick. pers. comm.
3	Kennedy, Joseph. 2010. New Brunswick Peregrine records, 2010. New Brunswick Dept Natural Resources, 16 recs (11 active).
3	Lautenschlager, R.A. 2005. Survey for Species at Risk on the Canadian Forest Service's Acadia Research Forest near Fredericton, New Brunswick. Atlantic Canada Conservation Data Centre, 6. 3 recs.
3	Nash, Vicky. 2018. Hammond River Angling Association Wood Turtle observations. Hammond River Angling Association, 3 recs.
3	Newell, R.E. 2008. Vascular Plants of Muzroll Lake. Pers. comm. to C.S. Blaney, 1 pg. 43 recs.
3	Richardson, D., Anderson, F., Cameron, R, McMullin, T., Clayden, S. 2014. Field Work Report on Black Foam Lichen (Anzia colpodes). COSEWIC.
3	Trajkovic, V.K. 2017. Wood turtles inventroy miramichi watershed 2017. Miramichi River Environmental Action Committee, 22 records.
3	Wallace, S. 2022. Email to Sean Blaney regarding NB DNRED Ranger Wood Turtle sightings from 2021. NB DNRED, 5 records.
2	Anon. 2017. Export of Maritimes Butterfly records. Global Biodiversity Information Facility (GBIF).
2	Bagnell, B.A. 2003. Update to New Brunswick Rare Bryophyte Occurrences. B&B Botanical, Sussex, 5 recs.
2	Basquill, S.P., Porter, C. 2019. Bryophyte and lichen specimens submitted to the E.C. Smith Herbarium. NS Department of Lands and Forestry.

# recs	CITATION
2	Brown, Constance Lynn. 2023. Wood turtle records for New Brunswick. University of New Brunswick. Pers. comm., 2 records.
2	Chaput, G. 1999. Atlantic Salmon: Miramichi & SFA 16 Rivers. Dept of Fisheries & Oceans, Atlantic Region, Science Stock Status Report D3-05. 6 recs.
2	Clayden, S.R. 2005. Confidential supplement to Status Report on Ghost Antler Lichen (Pseudevernia cladonia). Committee on the Status of Endangered Wildlife in Canada, 27 recs.
2	Clayden, S.R. 2020. Email to Sean Blaney regarding Pilophorus cereus and P. fibula at Fidele Lake area, Charlotte County, NB. pers. comm., 2 records.
2	Deseta, N. 2021. Email to John Klymko regarding Riparia riparia observations. Nashwaak Watershed Association Inc.
2	Doucet, D.A. & Edsall, J. 2007. Ophiogomphus howei records. Atlantic Canada Conservation Data Centre, Sackville NB, 21 recs.
2	Doucet, D.A. 2007. Lepidopteran Records, 1988-2006. Doucet, 700 recs.
2	Edsall, J. 1992. Summer 1992 Report. New Brunswick Bird Info Line, 2 recs.
2	Forbes, Graham. 2022. Email to Sean Blaney and Connie Brown, re: Snapping Turtle nest sites in Fredericton observed in 2022. University of New Brunswick, NB Cooperative Fish and Wildlife Research Unit, 2 records.
2	Goltz, J. 2017. Harlequin Duck observations. New Brunswick Department of Agriculture, Aquaculture and Fisheries.
2	Goltz, J.P. 2002. Botany Ramblings: 1 July to 30 September, 2002. N.B. Naturalist, 29 (3):84-92. 7 recs.
2	Goltz, J.P. 2023. Record of Andropogon gerardii at Pokiok, York Co., NB and other rare spp. records. pers. comm., 1 record.
2	Hay, G.U. 1883. Botany of the Upper St. John. Bulletin of the Natural History Society of New Brunswick, 2:21-31. 2 recs.
2	Hay, G.U. 1885. Report of Committee on Botany for 1885. Natural History Society of New Brunswick, 42-48.
2	Hayes, Jodi. 2022. Email to AC CDC regarding Snapping Turtle, NB.
2	Klymko, J. Bombus specimen data from 2020 blue vane trapping in New Brunswick. Atlantic Canada Conservation Data Centre. 2022.
2	LaPaix, R.W. 2014. Trans-Canada Energy East Pipeline Environmental Assessment, Records from 2013-14. Stantec Consulting, 5 recs.
2	Manthorne, A. 2019. Incidental aerial insectivore observations. Birds Canada.
2	McIntosh, W. 1904. Supplementary List of the Lepidoptera of New Brunswick. Bulletin of the Natural History Society of New Brunswick, 23: 355-357.
2	Sabine, D.L. 2013. Dwaine Sabine butterfly records, 2009 and earlier.
2	Scott, F.W. 1988. Status Report on the Gaspé Shrew (Sorex gaspensis) in Canada. Committee on the Status of Endangered Wildlife in Canada, 12 recs.
2	Toner, M. 2001. Lynx Records 1973-2000. NB Dept of Natural Resources, 29 recs.
2	Webster, R.P. Reggie Webster's records of Encyclops caerulea . pers. collection. 2018.
1	Allen, Cory. 2021. Email to John Klymko regarding Glyptemys insculpta observation. Personal communication.
1	Amirault, D.L. 1997-2000. Unpublished files. Canadian Wildlife Service, Sackville, 470 recs.
1	Atlantic Canada Bank Swallow Working Group. 2022. 2021 Bank Swallow colony records. Birds Canada.
1	Belliveau, A.G. E.C. Smith Herbarium Specimen Database 2019. E.C. Smith Herbarium, Acadia University. 2019.
1	Benedict, B. 2006. Argus annotation: Salix pedicellaris. Pers. comm to C.S. Blaney, June 21, 1 rec.
1	Bishop, G., Bagnell, B.A. 2004. Site Assessment of Musquash Harbour, Nature Conservancy of Canada Property - Preliminary Botanical Survey. B&B Botanical, 12pp.
1	Boulanger, L.W. & Wood, G.W., Osgood, E.A., and Dirks, C.O. 1967. Native bees associated with the low bush blueberry in Maine and eastern Canada. Maine Agricultural Experiment Station and Canada Agricultural Research Station., Technical Series Bulletin T 26. 22 pp.
1	Bredin, K.A. 2001. NB Freshwater Mussel Fieldwork. Atlantic Canada Conservation Data Centere, 16 recs.
1	Brunelle, P.-M. (compiler). 2010. ADIP/MDDS Odonata Database: NB, NS Update 1900-09. Atlantic Dragonfly Inventory Program (ADIP), 935 recs.
1	Brunton, D.F. 2016. Record of Potamogeton vaseyi in Joslin Creek, NB. pers. comm., 1 record.
1	Buchanan, Jean. 2021. Email to Sean Blaney regarding Wood Turtle, Chipman, NB. pers. comm.
1	Burgess, Todd. 2023. Snapping Turtle sighting near Crabbe Mountain, NB. Pers. comm., 1 record.
1	Calhoun, J.C. Butterfly records databased at the McGuire Center for Lepidoptera and Biodiversity. Calhoun, J.C. 2020.
1	Clayden, S.R. 2007. NBM Science Collections. Pers. comm. to D. Mazerolle, 1 rec.
1	Clayden, S.R. 2022. Email to Sean Blaney regarding Heterodermia squamulosa record in Loch Alva PNA. , 1 record.
1	Dadswell, M.J. 1979. Status Report on Shortnose Sturgeon (Acipenser brevirostrum) in Canada. Committee on the Status of Endangered Wildlife in Canada, 15 pp.
1	DeMerchant, A. 2019. Bank Swallow colony observation. NB Department of Energy and Resource Development, Pers. comm. to J.L. Churchill.
1	e-Butterfly. 2018. Selected Maritimes butterfly records from 2016 and 2017. Maxim Larrivee, Sambo Zhang (ed.) e-butterfly.org.
1	Edsall, J. 1993. Summer 1993 Report. New Brunswick Bird Info Line, 2 recs.
1	Forbes, G.J. 2020. Email regarding a Snapping Turtle (Chelydra serpentina) occurrence in New Brunswick, from Graham Forbes to John Klymko. pers. comm, 1 record.
1	Forbes, Graham. 2021. Email to John Klymko regarding Glyptemys insculpta observation. Personal communication.
1	Goltz, J.P. 2020. Email to Sean Blaney regarding Anchistea virginica (Virginia Chain-fern) at Magaguadavic Lake, NB. pers. comm., 1 record.
1	Hinds, H.R. 2000. Flora of New Brunswick (2nd Ed.). University New Brunswick, 694 pp.
1	Houghton, Andrew. 2021. Email to Sean Blaney re: nesting Snapping Turtle, NB. pers. comm.
1	Jessop, B. 2004. Acipenser oxyrinchus locations. Dept of Fisheries & Oceans, Atlantic Region, Pers. comm. to K. Bredin. 1 rec.
1	Jolicoeur, G. 2008. Anticosti Aster at Chapel Bar, St John River. QC DOE? Pers. comm. to D.M. Mazerolle, 1 rec.
1	Klymko, J. 2019. Maritimes Hemiptera records harvested from iNaturalist . iNaturalist.
1	Klymko, J. Henry Hensel's Butterfly Collection Database. Atlantic Canada Conservation Data Centre. 2016.
1	Klymko, J. Univeriste de Moncton insect collection butterfly record dataset. Atlantic Canada Conservation Data Centre. 2017.
1	Klymko, J., Sabine, D. 2015. Verification of the occurrence of Bombus affinis (Hymenoptera: Apidae) in New Brunswick, Canada. Journal of and Acadian Entomological Society, 11: 22-25.
1	MacFarlane, Wayne. 2018. Skunk Cabbage observation on Long Island, Kings Co. NB. Pers. comm., 1 records.
1	Madden, A. 1998. Wood Turtle records in northern NB. New Brunswick Dept of Natural Resources & Energy, Campbellton, Pers. comm. to S.H. Gerriets. 16 recs.
1	Mandula, M. 2017. Nature Trust of New Brunswick Site Report: Jackson Falls, NB – new rare plant station. Nature Trust of New Brunswick, 2 pp.

# recs	CITATION
1	McAlpine, D.F. & Cox, S.L., McCabe, D.A., Schnare, J.-L. 2004. Occurrence of the Long-tailed Shrew (Sorex dispar) in the Nerepis Hills NB. Northeastern Naturalist, vol 11 (4) 383-386. 1 rec.
1	McAlpine, D.F. 2020. Email to John Klymko about Epargyreus clarus record from Grand Bay, NB. Pers. comm.
1	Mersey Tobetic Research Institute. 2021. 2020 Monarch records from the MTRI monitoring program. Mersey Tobetic Research Institute, 72 records.
1	Munro, Marian C., Newell, R.E, & Hill, Nicholas M. 2014. Nova Scotia Plants. Nova Scotia Provincial Museum of Natural History, Halifax, Nova Scotia, First edition.
1	NatureServe Canada. 2018. iNaturalist Maritimes Butterfly Records. iNaturalist.org and iNaturalist.ca.
1	Newell, R.E. 2005. E.C. Smith Digital Herbarium. E.C. Smith Herbarium, Irving Biodiversity Collection, Acadia University, Web site: http://luxor.acadiau.ca/library/Herbarium/project/. 582 recs.
1	Norton, Barb. 2010. Personal communication concerning Botrychium oneidense near Ayers Lake, NB. , One record.
1	Ogden, K. Nova Scotia Museum butterfly specimen database. Nova Scotia Museum. 2017.
1	Olsen, R. Herbarium Specimens. Nova Scotia Agricultural College, Truro. 2003.
1	Parkinson, K. 2017. Wood Turtle record in the Meduxnekeag Valley Nature Preserve. Pers. comm. to AC CDC.
1	Sabine, D.L. & Goltz, J.P. 2006. Discovery of Utricularia resupinata at Little Otter Lake, CFB Gagetown. Pers. comm. to D.M. Mazerolle, 1 rec.
1	Sabine, D.L. 2004. Specimen data: Whittaker Lake & Marysville NB. Pers. comm. to C.S. Blaney, 2pp, 4 recs.
1	Singleton, J. 2004. Primula mistassinica record for Nashwaak NB. Pers. comm. to C.S. Blaney, 1 rec.
1	Taylor, Eric B. 1997. Status of the Sympatric Smelt (genus Osmerus) Populations of Lake Utopia, New Brunswick. Committee on the Status of Endangered Wildlife in Canada, 1 rec.
1	Toner, M. 2005. Listera australis population at Bull Pasture Plains. NB Dept of Natural Resources. Pers. comm. to S. Blaney, 8 recs.
1	Toner, M. 2009. Wood Turtle Sightings. NB Dept of Natural Resources. Pers. comm. to S. Gerriets, Jul 13 & Sep 2, 2 recs.
1	Toner, M. 2011. Wood Turtle sighting. NB Dept of Natural Resources. Pers. com. to S. Gerriets, Sep 2, photo, 1 rec.
1	Torenvliet, Ed. 2010. Wood Turtle roadkill. NB Dept of Transport. Pers. com. to R. Lautenschlager, Aug. 20, photos, 1 rec.
1	Walker, E.M. 1942. Additions to the List of Odonates of the Maritime Provinces. Proc. Nova Scotian Inst. Sci., 20. 4: 159-176. 2 recs.
1	Wallace, Shaylyn. 2022. Canada Lynx observation in New Brunswick. , 1 record.
1	Watts, T. 2021. Emails to Sean Blaney regarding Black Tern colony at King Brook Lake, Charlotte Co. and Third Lake, York Co., NB. Peskotomuhkati Nation at Skutik, 2 records.
1	Webster, R.P. & Edsall, J. 2007. 2005 New Brunswick Rare Butterfly Survey. Environmental Trust Fund, unpublished report, 232 recs.
1	Webster, R.P. Email to John Klymko detailing records of butterflies collected by Reggie Webster in June 2017. Webster, R.P. 2017.

APPENDIX G

Appendix G – Zoning Map



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Schedule A / Annexe A
Central York Planning Area Zoning Map
Carte de zonage du secteur d'aménagement de York Centrale

Residential - "R" Zone
Zone résidentielle - Zone «R»

Mixed Use - "MU" Zone
Zone d'usage mixte - Zone «UM»

Rural - "RU" Zone
Zone rurales - Zone «RU»

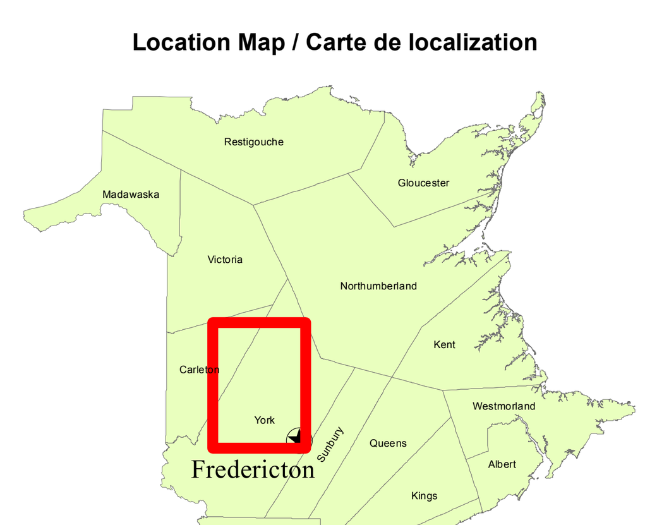
Commercial & Light Industrial - "CLI" Zone
Zone commerciale et d'industrie légère - Zone «CIL»

Park and Recreation - "PR" Zone
Zone parc et loisirs - Zone «PL»

kilomètres 0 2.5 5 7.5 10 kilometres

Échelle 1:105,000 Scale

Location Map / Carte de localization



Regional Service Commission 11
Commissions de services régionaux 11
New Nouveau Brunswick

Prepared by Regional Service Commission 11
Preparée par la Commissions de services régionaux 11
Drawn by / dessiné par Jonathan Dixon
Verified by / vérifié par Dallas Gillis
For the original map, please refer to the Office of the Registrar or service commission.
Pour la version originale de la carte, veuillez vous adresser au Bureau d'enregistrement ou à la commission de services.
June 2013 Juin

APPENDIX H

Appendix H – Site Photos

Photo 1: Existing Lagoon Looking South

Photo 2: Existing lagoon Aeration, Looking East

Photo 3: Existing Lagoon, Looking North

Photo 4: Existing Lagoon and Mactaquac Headpond, Looking Southeast

Photo 5: Lagoon Berm and Headpond Shoreline, Looking North (Note top of berm at left)

Photo 6: Mactaquac Headpond Shoreline, Looking South

Photo 9: Proposed Lagoon Location, Looking South

Photo 10: Proposed Lagoon Location, Looking Southwest

Photo 11: Proposed Lagoon Location, Looking Southeast

Photo 12: Proposed Lagoon Location, Looking North

Photo 13: Proposed Lagoon Location, Looking Northeast from Southwest Corner

Photo 14: Subject Site from Headpond (Note existing lagoon berm right of photo)

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