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Appendix F: Natural Heritage Background Report

Ontario Clean Water Agency

Moose Creek Wastewater Treatment Lagoon EA

NATURAL HERITAGE BACKGROUND REPORT

CIMA+ file number: Z0028411
8 October, 2025 – Review 000

Ontario Clean Water Agency

Moose Creek Wastewater Treatment Lagoon EA

NATURAL HERITAGE BACKGROUND REPORT

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Confidentiality and Ownership

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Revision History			
Revision #	Reviewed by	Date	Description of the review

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Glossary of Terms

Adjacent Lands	Typically 120 m as per the *Provincial Planning Statement, 2024* , or wider to address other guidelines (i.e., MECP with respect to endangered or threatened species)
Existing WWTL Property	The property containing the existing Wastewater Treatment Lagoon
Work Area	Potential area to be disturbed by the expansion activities

List of Acronyms

ANSI	Area of Natural and Scientific Interest
ARA	Aquatic Resource Area
CASAR	Canadian Aquatic Species at Risk
CC	Coefficient of Conservation
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
COSSARO	Committee on the Status of Species at Risk in Ontario
DFO	Fisheries and Oceans Canada
ESA	*Endangered Species Act*, 2007(Provincial)
FA	*Fisheries Act, 1994* (Federal)
FWCA	*Fish and Wildlife Conservation Act*, 1997 (Provincial)
LIO	Land Information Ontario
LSW	Locally Significant Wetland
MBCA	*Migratory Birds Convention Act*, 1994 (Federal)
MECP	Ministry of Environment, Conservation and Parks
MNR	Ministry of Natural Resources
MNRF	Ministry of Natural Resources and Forestry (old name)
NAD 83	North American Datum 1983
NHIC	Natural Heritage Information Centre
NHRM	Natural Heritage Reference Manual
NHS	Natural Heritage System
OBBA	Ontario Breeding Bird Atlas
OCWA	Ontario Clean Water Agency
OMNR	Ontario Ministry of Natural Resources (old name)
ORAA	Ontario Reptile and Amphibian Atlas
PSW	Provincially Significant Wetlands
SAR	Species at Risk (in this report they refer to species that are provincially or federally listed as endangered or threatened and receive protection under ESA or SARA)
SARA	Species at Risk Act (Federal)
SARO	Species at Risk in Ontario
SWHTG	Significant Wildlife Habitat Technical Guide
WWTL	Wastewater Treatment Lagoon

List of Definitions

SRANK Definitions

S1	Critically Imperiled in the nation or state/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 state/province.
S2	Imperiled in the nation or state/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 nation or state/province.
S3	Vulnerable in the nation or state/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 nation or state/province.
?	Inexact Numeric Rank—Denotes inexact numeric rank
SNA	Not Applicable – A conservation status rank is not applicable because the species is not a suitable target for conservation activities.
S#B	Breeding
S#N	Non-Breeding

SARA Status Definitions

END	Endangered: a wildlife species facing imminent extirpation or extinction.
THR	Threatened: a wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.
SC	Special Concern: a wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats.

SARO Status Definitions

END	Endangered: A species facing imminent extinction or extirpation in Ontario which is a candidate for regulation under Ontario's ESA.
THR	Threatened: A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed.
SC	Special Concern: A species with characteristics that make it sensitive to human activities or natural events.

1. Introduction

CIMA Canada Inc. (CIMA+) has been retained by Ontario Clean Water Agency (OCWA) to complete the Municipal Class Environmental Assessment (EA) in support of upgrades to the existing Wastewater Treatment Lagoon (WWTL) in the Village of Moose Creek, United Counties of Stormont, Dundas, and Glengarry, Ontario.

1.1 Project Description and Location

The Township is expecting considerable planned growth in the next 25-30 years (86% population increase), therefore there is a need to increase the treatment capacity of the existing Moose Creek WWTL. The expansion will occur within the Existing Property, with disturbances restricted to within the "Work Area" (Figure 1).

1.1.1 Location

The Site includes parts of Lots 21 and 22, Concession 7, in the Geographic Township of Roxborough (centroid at UTM 18T 501175 m E, 5011870 m N; Latitude 45.2599468°N, Longitude -74.9846773°W).

1.2 Purpose and Scope

The MCEA requires the evaluation of impacts of the preferred alternative on natural heritage features, which has been divided into separate deliverables for a stepwise dissemination of information during the various stages of the MCEA process. The purpose of this Natural Heritage Background Report is to present the findings of a desktop screening for natural features and begin the process of evaluating significance based on available information. This report will be updated with the site investigations completed and a review of the alternative(s) to meet MCEA requirements. That information along with the assessment of the potential preferred alternative's impacts on the natural features and a list of avoidance and mitigation measures will be presented in a future the Natural Environment Assessment report (NEAR).

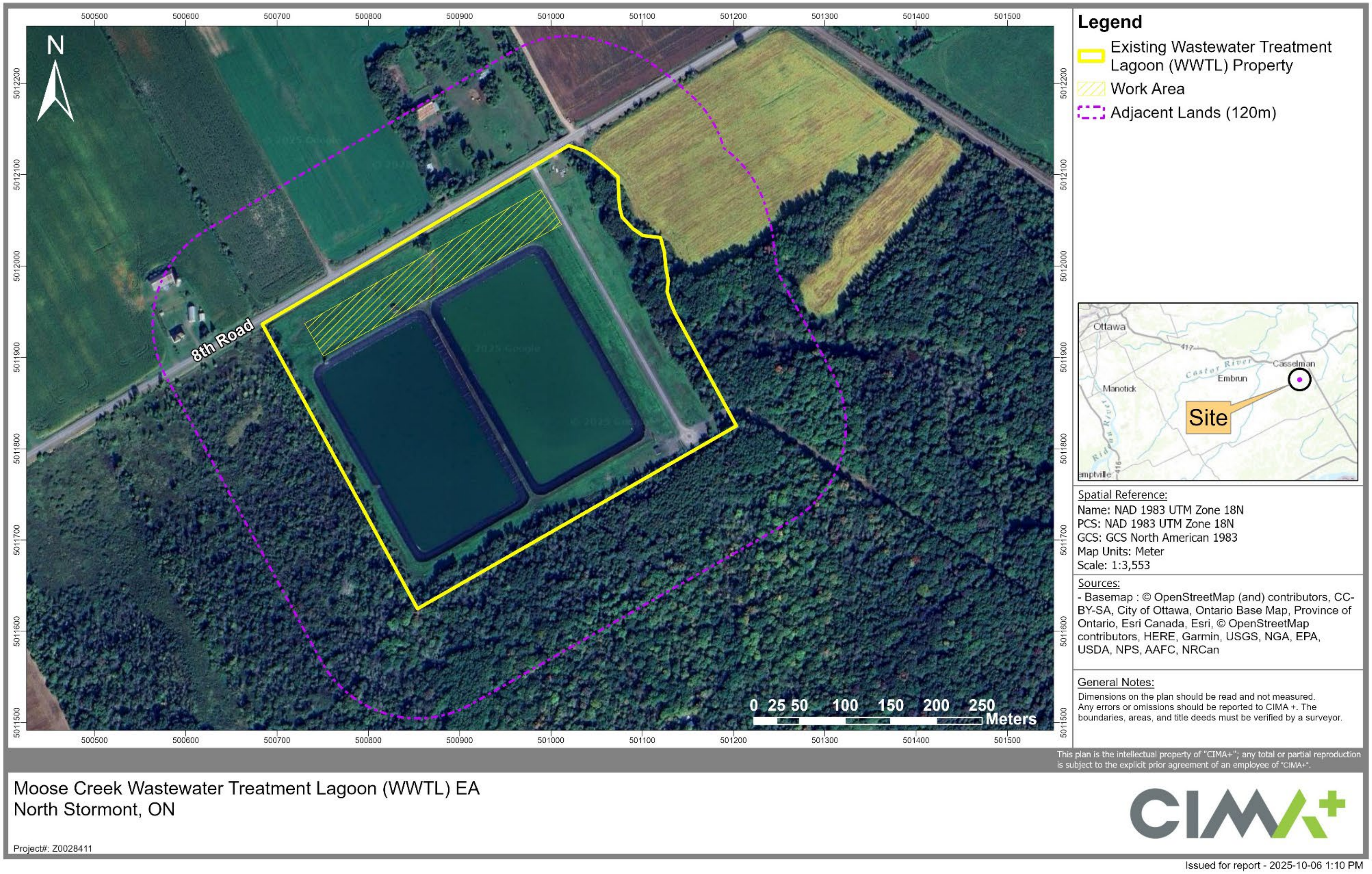


Figure 1: Location of Site and Adjacent Lands (120 m)

2. Legislative Context

This section provides a summary of the relevant regional, provincial, and federal Acts, regulations and policies that apply to the proposed expansion with respect to natural heritage features.

2.1 Provincial Policy Statement and Official Plans

The *Planning Act* (1990) provides the basis for land use planning in Ontario as well as the creation of Official Plans (OP). The Site and its adjacent lands (120 m) are situated within the Township of North Stormont. As per the Township's website, planning and development are subject to the OP of the United Counties of Stormont, Dundas, and Glengarry (SD&G). The OP follows guidelines set out in the Provincial Policy Statement (MMAH, 2024). The County's natural heritage system (NHS) is composed of:

- Habitat of endangered and threatened species;
- Provincially significant wetlands and locally significant wetlands;
- Coastal wetlands;
- Significant woodlands as identified on Schedule B2;
- Significant valleylands;
- Significant wildlife habitat;
- Significant Life and Earth Science Areas of Natural and Scientific Interest (ANSIs)
- Fish habitat & natural corridors (i.e., floodplains);
- Publicly owned lands (i.e., Conservation Areas, County forests, Crown lands); and,
- Watercourses (including municipal drains).

The natural heritage features are further discussed in .

Table 1: References for Natural Heritage Policies in the Official Plan

Natural Heritage Feature	Reference for UCSD&G Official Plan (approved Feb 2018, consol. Feb 2025)	Applicable Schedules
Habitat of endangered and threatened species	Features are to be identified on a case-by-case basis. Section 5.5.5 describes that development within habitat of SAR is not permitted, except in accordance with provincial with provincial and federal requirements. Where habitat of SAR is identified and reviewed by MECP, applicants will comply with the *Endangered Species Act*. Adjacent lands vary with the species.	Not depicted on Schedules

Natural Heritage Feature	Reference for UCSD&G Official Plan (approved Feb 2018, consol. Feb 2025)	Applicable Schedules
Provincially and locally significant wetlands (PSW, LSW)	Section 5.5.6 notes that no development is permitted in PSWs. LSWs shall be identified as constraints, and their underlying land use designation will apply. Unclassified wetlands will be evaluated for significance (provincially or locally) as per OWES to determine the type of protection they will receive. Agricultural uses are not restricted in wetlands, and legally existing uses may continue. The OP states that applicants are to refer to the most current provincial mapping where wetlands are mapped on Schedules. Adjacent lands are 120 m. Development within adjacent lands of a PSW will be subject to an approved study. Development within adjacent lands of a LSW is subject to an approved study where required by the municipality.	Schedule B3
Coastal wetlands	Section 5.5.6. Significant coastal wetlands are to be identified through site-specific assessments. Adjacent lands are 120 m. Development in, or within the adjacent lands of coastal wetlands is subject to an approved study.	Not depicted on Schedules
Significant woodlands	Section 5.5.4. Significant woodlands have been assessed by the County as per the criteria in the *Natural Heritage Reference Manual*. Permitted land uses are based on the underlying land use designation and are subject to the development criteria outlined in the section. Adjacent lands are 120 m.	Schedule B2
Significant valleylands	Section 5.5.5 states that no valleylands have been identified within the County.	Not applicable
Significant wildlife habitat	Section 5.5.5. Potential significant wildlife habitat is to be assessed on a case-by-case basis by a qualified professional. Adjacent lands are 120 m. Development on the adjacent lands of significant wildlife habitat shall require an approved study.	Not depicted on Schedules
Areas of Natural and Scientific Interest (ANSI)	Section 5.5.5. Development on the adjacent lands of significant ANSIs shall require an approved study. Adjacent lands are defined as 50 m from earth science ANSIs or 120 m from life science ANSIs.	Schedule B1, B3
Fish habitat / Watercourses	All waterbodies have the potential to be fish habitat (Section 5.5.3). Fish habitat is defined under the *Fisheries Act* (FA). The FA, managed by Fisheries and Oceans Canada (DFO), is the authority for decision-making with respect to fish and fish habitat. Any	Schedule B1, B3

Natural Heritage Feature	Reference for UCSD&G Official Plan (approved Feb 2018, consol. Feb 2025)	Applicable Schedules
	demonstrated alteration or disturbance to fish habitat shall require approval from DFO. Adjacent lands are 120 m.	

2.2 Provincial – Other

2.2.1 Endangered Species Act

The *Endangered Species Act, 2007* (ESA) prohibits killing or damaging the habitat of species that are listed on the SAR in Ontario list. Endangered (END) indicates that the species lives in the wild in Ontario but is facing imminent extinction or extirpation. Threatened (THR) indicates the species lives in the wild in Ontario, is not endangered, but is likely to become endangered if steps are not taken to address the factors threatening it. Note that species listed as special concern are not afforded protection under the Act.

The ESA is applicable on private and provincial lands. It can also sometimes be applicable to federal lands. The relevant sections to the project are:

- Prohibition on killing or harming of END or THR individuals (Section 9)
- Prohibition on damage to END or THR habitat (Section 10)

Note: Amendments to ESA are now in effect as part of Bill 5 (passed on June 05, 2025), and eventually the ESA will be replaced with the *Species Conservation Act, 2025* (SCA) (not yet in effect).

2.2.2 Fish and Wildlife Conservation Act

In addition to the protections offered by the statutes and policies noted above, the *Fish and Wildlife Conservation Act* (FWCA)*, 1997*, administered by the Ministry of Natural Resources (MNR), needs to be considered. This *Act* imposes restrictions on the hunting, trapping, and fishing of wildlife, as well as the possession of animals (live or dead). These restrictions include the capturing or harassing of specially protected wildlife or any wild bird species (not a game bird and not listed as an exception) regardless of its live stage (egg, adult) (Part II 5 (1)). It also protects nests or eggs of wild bird species (other than American crow, brown-headed cowbird, common grackle, house sparrow, red-winged blackbird, or starling) (Part II 7(1)). In case of conflicting provisions with the *Endangered Species Act, 2007*, the Act providing greater protection for the animal, invertebrate, or fish in question will prevail.

2.2.3 Conservation Authorities Act

On April 1, 2024, changes to the *Conservation Authorities Act* and a new regulation (O. Reg. 41/24) under the *Act* came into effect. Note that O.Reg. 41/24, Prohibited Activities, Exemptions, and Permits, replaces all previous Conservation Authority development regulations.

2.3 Federal

2.3.1 Fisheries Act

The *Fisheries Act* (FA), last amended 28 August 2019, is administered by DFO and is intended to provide a framework for the management of threats to fish and fish habitat, including the prevention of pollution, regardless of their attachment to a fishery. In this part of Canada, "fish" refers to freshwater mussels and fish. The most relevant sections to works, undertakings and activities are:

- Prohibition of the Death of Fish (Section 34.4 (1));
- Prohibition of the Harmful alteration, disruption, or destruction of Fish Habitat (Section 35 (1));
- Prohibition on discharging deleterious substances (Section 36); and,
- The provisional Ministerial powers to ensure the free passage of fish or the protection of fish or fish habitat with respect to existing obstructions (Section 34.3).

Subsection 2(1) of the Act defines fish habitat as "water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration area".

Under the updated Fisheries Act, certain types of waterbodies remain that do not require DFO review. Generally, these are projects that will occur on a waterbody that is not connected to fish habitat and does not contain fish at any time of year.

2.3.2 Migratory Birds Convention Act

The *Migratory Birds Convention Act, 1994* (MBCA) regulates the protection and conservation of migratory birds as populations and individuals. It also offers protection for nests containing a live bird or viable eggs for most migratory bird species. Schedule 1 under the Migratory Bird Regulations (2022) lists 18 species that may reuse nests and whose nests are protected year-round regardless of occupation, unless the nest has been reported and deemed abandoned after a waiting period. Species listed under Schedule 1 that occur in Ontario include great egret, great blue heron, cattle egret, green heron, snowy egret, black-crowned night heron, and pileated woodpecker. The Migratory Bird Regulations (2022) prohibit the disturbance, damage, or destruction of migratory bird nests or eggs. These prohibitions and regulations apply to any areas where migratory birds and their nests are found in Canada.

2.3.3 Species at Risk Act

Federally protected species are listed in 'Schedule 1' of the *Species at Risk Act* (SARA). The application of SARA varies depending on the species and the level of government with jurisdiction over the land. In general, the relevant sections are:

- Prohibition of killing, harming, harassment, capturing or taking of an individual listed as extirpated, endangered, or threatened (Section 32(1))
- Prohibition of possessing, collecting, buying, selling, or trading an individual listed as extirpated, endangered, or threatened (Section 32(2))
- Prohibition against the damaging or destruction of residences of species listed as endangered or threatened. For extirpated species, the recovery strategy must also recommend the reintroduction of the species into the wild in Canada (Section 33)

However, on lands that are not federal, Sections 32 and 33 do not apply except for aquatic species (those listed as "fish" under the *Fisheries Act* or a migratory bird as per the *Migratory Birds Convention Act, 1994* (MBCA), unless a federal order has been created. It is highlighted, that bird species with defined residences, that the residences are protected year-round on all lands (the nests are protected during the nesting period) (CWS, 2025).

3. Methodology

3.1 Study Area

The potential areas of impact for the proposed upgrades includes a small portion of the existing WWTL property, identified as the Work Area on Figure 1. For the purposes of this background review, the Study Area will be the entire WWTL property and their adjacent lands. As per the Provincial Policy Statement (2024), the "Adjacent Lands" typically refer to the 120 m around the Site for most natural heritage features. Note that the Study Area is widened when completing the background review and when analyzing the potential for species at risk (SAR) as their protected habitats vary with the species being considered.

3.2 Background Review

Information on known natural heritage features was collected through a preliminary background review. When completing a desktop review, a larger area (~5 km) is applied to obtain a better understanding of the local characteristics and occurrences of species at risk. The data was then reviewed and analyzed for applicable site-specific information. Information from government websites, available consulting reports, and personal knowledge has also been included as appropriate. Data sources included:

- Aerial/Satellite Imagery (ESRI, 2021)
- Atlas of the Mammals of Ontario (Dobbyn, 1994)
- eBird (eBird, 2025)
- Canadian Wildlife Federation (CWF)
- Fisheries and Oceans (DFO) Canadian Aquatic Species at Risk Mapping (DFO, 2025)
- Geographic information from Land Information Ontario (LIO, 2021)
- Global Biodiversity Information Facility (2025)
- Geographic information from Land Information Ontario (LIO)
- iNaturalist (2025)
- Ministry of Natural Resources and Forestry's (MNRF) Natural Heritage Information Center (NHIC) Make A Map – search was completed in May 2025 (NHIC, 2025).
- Ontario Breeding Bird Atlas (Atlas 2- 2001 - 2005)
- United Counties of Stormont, Dundas & Glengarry Official Plan (approved Feb 2018, consol. Feb 2025)

4. Background Data

4.1 Summary of Known Natural Heritage Features

The property is situated in Ecoregion 6E. It is outside the Urban Settlement Area and Urban Service Limit (Schedule A3C for Moose Creek). The existing sewage lagoon is also depicted on Schedule A3C. Based on OCWA's Annual Reports and the Township of North Stormont, the existing WWTL property contains a sewage collection system, pumping station, and two facultative cells that make up the sewage lagoon system (OCWA, 2019).

A review of information from NHIC, provincial atlases, and satellite imagery identifies the following natural heritage features as present or potentially present within the property (Figure 2, Table 2):

- Habitat for endangered or threatened species (Potential);
- Unevaluated wetlands (LIO);
- Significant woodlands (Known);
- Significant wildlife habitat (Potential); and,
- Watercourse / Fish Habitat (Known).

In addition, several natural heritage features were identified within 2 km of the Site:

- Areas of Natural and Scientific Interest (ANSI) – Moose Creek Bog (Life Science);
- Evaluated wetlands – Other (Moose Creek Wetland);
- Significant woodlands;
- Fish habitat; and
- Unevaluated wetlands.

Information on natural heritage features is summarized in Table 2 .

Table 2: Summary of Natural Features on-Site and the Adjacent Lands

Natural Heritage Feature	Present on Property	Present within Adjacent Lands (120m) of Property	Comments
Habitat of Endangered and Threatened Species (SAR)	Potential for endangered or threatened species needs to be determined following assessment of the suitable habitats in or near the Site. The list in Table 3 of potential SAR is based on a review of the satellite imagery and background information on potential species.		Discussed in 6.1.1.

Natural Heritage Feature	Present on Property	Present within Adjacent Lands (120m) of Property	Comments
Wetlands	No PSWs or LSWs identified on OP Schedules or provincial mapping. No coastal wetlands are present in this area. Unevaluated wetlands are present on Property and the adjacent lands on provincial mapping, but they are outside of the work area. Portions of wetland habitat will be classified and delineated edge of wetland within Property as per the *Ontario Wetland Evaluation System*.		Discussed in 6.1.2.
Significant woodlands	Present in the property but not within the work area (as identified on Schedule B2) and its adjacent lands.		Discussed in 6.1.3.
Significant valleylands	No valleylands identified by the County.		Not discussed further.
Significant Wildlife Habitat	Potential for significant wildlife habitat needs to be determined following assessment of suitable habitats in or near the Site. To be assessed based on provincial reference documents (i.e., *Significant Wildlife Habitat Technical Guide*)		Discussed in 6.1.4.
Areas of Natural and Scientific Interest (ANSI)	None identified on provincial databases.		Not discussed further.
Fish Habitat / Watercourses	Present within the property but not the work area.		Discussed in 6.1.5.

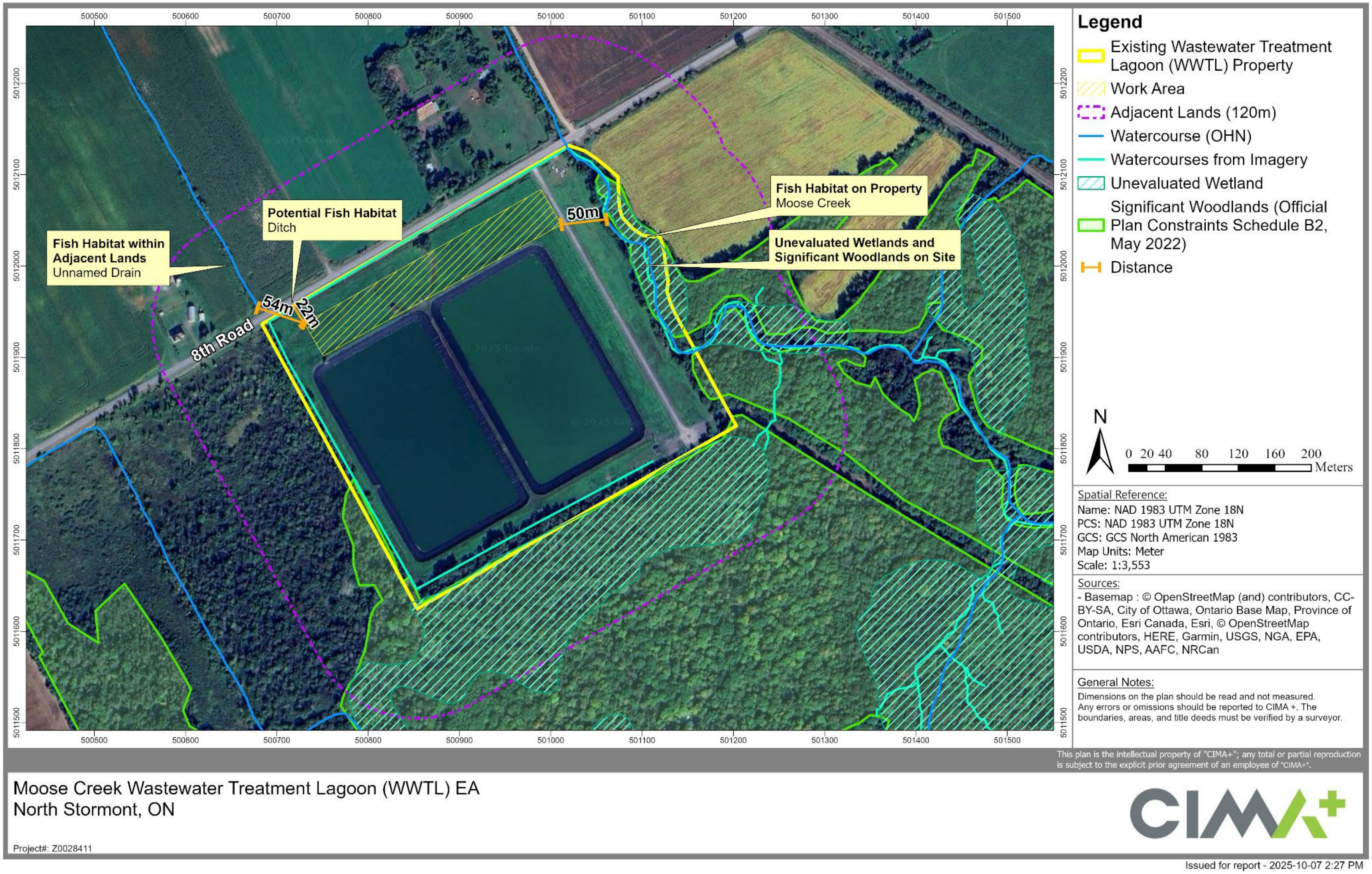


Figure 2: Summary of Known and Candidate Natural Heritage Features

4.2 Endangered and Threatened Species and their Habitat

Endangered and threatened SAR are protected under the provincial ESA. The federal SARA applies only to fish and bird species with defined residences on private land. Together, both provincially and federally protected species are referred to as SAR herein. Likelihood of presence based on habitat suitability and provincial or federal guidance was not evaluated in this report.

A list of potential endangered and threatened species was compiled using various sources (Table 3). The NHIC database provides information available to the public on SAR documented as occurring within the general area. It should be noted that not all information for all species is available to the public. Furthermore, the absence of a record does not necessarily indicate that the species is absent from the area. The purpose of the NHIC database is to help determine what species may occur within the Site. In addition, bird species observed as part of the OBBA were reviewed, and any SAR were considered to potentially occur within the subject lands. Similarly, SAR reptiles and/or SAR amphibians listed on the ORAA within the vicinity of the Site were also included in the assessment. Finally, added to this list were species that often occur within the general area based on personal experience and/or observations.

Note that there was the potential for restricted species to occur in the general area. Data on these species' occurrences is not publicly available due to their sensitivity to exploitation or disturbance. Information on the restricted species will be reviewed and addressed as appropriated in the NHAR.

The resulting list includes 17 SAR:

- 8 birds;
- 7 mammals; and,
- 2 plants.

These are discussed further in Section 6.1.1.

4.3 Fish Communities

The Site is situated in the Horse Creek - South Nation River watershed. The watershed drains an area of approximately 69,860ha and originates at Ottawa River, with South Nation River being the main watercourse within the watershed (OMNR, 2020).

While no water features were identified from the background information on the existing WWTL property there is an unidentified ditch running along the perimeter which may connect to Moose Creek. Moose Creek is roughly 22 km in length, flowing north – east towards South Nation River. Information on the fish communities in Moose Creek was obtained from the provincial Aquatic Resource databases (LIO), DFO Canadian Aquatic Species at Risk Mapping (CASAR), and iNaturalist. A total of 25 warm to coldwater species were compiled across these sources, which included:

- 4 sport fish (Northern Pike, Smallmouth Bass, Sauger, Walleye)
- No fish species with an SRank of 1-3 were identified.
- No provincially listed endangered or threatened freshwater mussels or fish species or their habitat within the property or adjacent lands.
- DFO's CASAR database did not indicate the presence of any federally listed endangered or threatened fish or mussels or their critical habitat in the vicinity.

Results are tabulated in Appendix B.

5. Existing Conditions – Desktop Review

5.1 Vegetation Communities

The vegetation communities on the Property were examined using available imagery. A majority of the Property appears to be a cultural meadow with a single tree present along the fenceline in the north. The surrounding boundary of the property and the adjacent lands appear to be a mix mixed treed swamp (primarily to the south) and deciduous forest (east and west). The work area appears to be entirely cultural meadow with no woody vegetation. Additional information will be provided from the site investigations in the NHAR.

6. Evaluation of Significance

The following section evaluates identified or potential natural features and the results from the background review. This will be reviewed and validated with the site investigation's notes to assess whether the feature is present in the NHAR. If a potential natural feature is present, its significance will be assessed based on the Natural Heritage Reference Manual (OMNR, 2010) or other provincial/federal guidelines, as applicable. The OP policies were also considered.

The following were absent on the Property and the adjacent lands:

- Areas of national and scientific interest (ANSIs);
- Provincially significant wetlands;
- Locally significant wetlands;
- Significant Valleylands.

Features identified as present, potentially present, or assumed present, and these are discussed in further detail in the subsections below, were:

- Habitat of endangered and/or threatened species;
- Significant woodland;
- Unevaluated wetlands;
- Significant Wildlife Habitat; and
- Fish habitat / watercourses.

6.1.1 Habitat of Endangered and Threatened Species

An initial assessment of potential SAR and SAR habitat is provided below based on the findings of the site investigations. These remain candidate SAR based on the desktop review.

As noted in Section 4.2, a list of 17 endangered or threatened species were identified as potentially occurring. These species are described in Table 3 with their status, preferred habitats, and guidelines. The likelihood of the species or its habitat being present is then evaluated based on the data collected from the site investigations, as well as legislative requirements.

For some species, the federal and/or provincial governments provide guidelines on what habitats should receive automatic protection. This is usually based on distances from known sightings or suitable habitat. Federally, the habitat is typically classed based on function, while provincially, it is categorized as either regulated or general habitat. Regulated habitat has a detailed description and is prescribed in an Ontario Regulation (O.Reg.). General habitat typically splits habitat requirements into up to 3 categories, Categories 1-3, where 1 indicates the greatest sensitivity to disturbances.

Note that a detailed evaluation of the project's potential to interact with these species or their habitat shall be discussed following site investigations in a separate deliverable. Any changes to species at risk and their protection will also be incorporated as needed.

In Table 3 below, the candidate SAR are listed along with their habitat needs. Where guidance is provided by the government, it is used to evaluate whether to bring the species forward for assessment. If no guidance is provided, the available literature is used to evaluate the suitability of the habitat on-Site for that species.

Note: The evaluation of presence in this report follows the existing ESA guidelines established prior to June 5, 2025, which are expected to exceed the interim ESA guidelines and the proposed SCA requirements. For informational purposes, the changes to the application of the ESA as a result of Bill 5 remain unclear at the time of this report. MECP provided Interim ESA advice in June 2025 confirming the following (MECP, 2025):

- Species protection continues to extend to individuals for killing and harming, but not for harassment.
- Habitat protection will be limited:
  - For animals: the dwelling place and immediate surrounding area;
  - For plants, the critical root zone and as per personal communications with MECP, this is currently 18x the maximum dbh of the species.
  - For all other species, the area on which any member of the species directly depends to carry out its life processes.

Table 3: List of Potential Endangered or Threatened Species Based on Desktop Screening

Common Name	Scientific Name	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status	Preferred Habitat / Guidelines	Preliminary Evaluation
BIRDS						
Least Bittern	*Ixobrychus exilis*	S4B	THR	THR	Freshwater marshes habitat with dense vegetation (Sandilands, 2005; COSEWIC, 2009). Nests are typically in cattail marshes, near edge or openings but they have been found in other emergents and occasionally in willow (Woodcliff, 2007), COSEWIC states that the species must have emergent marsh with open water areas and stable water levels and are usually found in those that are larger than 5 ha (COSEWIC, 2009). Provincially, this species receives only general habitat protection.	No suitable marsh habitat on the Property or near (within 120m). This species is considered absent.
Chimney Swift	*Chaetura pelagica*	S4B, S4N	THR	THR	Cities, towns, villages, rural, and wooded areas. This species rarely utilizes trees; they prefer trees greater than 50 cm in diameter and that are within 1 km of waterbodies (COSEWIC 2007). Provincially, this species' protected habitat consists of Category 1 habitat, which is a human-made nesting/roosting feature or natural nesting/roosting tree cavity, as well as the area within 90 m of the natural tree cavity (MECP, 2013). No Category 2 or 3 habitats are outlined for this species (MECP, 2013).	Candidate habitat is present on the property edges and adjacent lands, but not within the work area. Avoid impacting trees or conduct breeding bird surveys to determine presence/absence.
Red-headed Woodpecker	*Melanerpes erythrocephalus*	S4B	END	END	Open deciduous woodland, woodland edges, and sparsely treed habitats. (COSEWIC, 2007; MECP, 2022). The province does not currently have guidance for the general habitat of this species, though critical habitat is identified (both federally and provincially) as the suitable habitat within a 200 m radius around a nest observation OR the 600 m around confirmed or probable breeding OR two possible breeding records within 600 m and 7 days of each other (MECP, 2022). Observations must be from after 2021. Provincially, this species receives only general habitat protection.	Candidate habitat is present on the property edges and adjacent lands, but not within the work area; this species may occur. Avoid impacting trees or conduct breeding bird surveys to determine presence/absence.
Bank Swallow	*Riparia riparia*	S4B	THR	THR	This species nests within vertical banks, with a preference for sand-silt substrate. Nesting sites more likely near open upland habitats. (COSEWIC, 2013).	No suitable habitat or banks are anticipated; site investigations in 2025 will

Common Name	Scientific Name	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status	Preferred Habitat / Guidelines	Preliminary Evaluation
					Provincially, the species GHD includes the 50 m in front of a breeding colony's bank face and all suitable foraging habitat within 500 m (MECP, 2024).	confirm the presence/absence of suitable habitat.
Bobolink	*Dolichonyx oryzivorus*	S4B	THR	THR	Grasslands, wet meadows, hayfields, old fields, and pastures. This species is sensitive to edge effects, and prefers areas with few shrubs as well as a litter layer deeper than a couple of centimetres (COSEWIC, 2022). Provincially, the GHD for this species protects 60m from a nest and 300m of suitable habitat around a nesting site.	NHIC records indicate the presence of this species within the square containing the Property. Site investigations in 2025 will confirm the presence/absence of suitable habitat.
Eastern Meadowlark	*Sturnella magna*	S4B	THR	THR	This is a grassland breeding bird, typically requiring larger habitats but have been known to breed in habitats that were 1 ha in the United States. Usually, their defended territories are of 2.8-3.2 ha of uncut meadow or field (McCracken et al, 2013). Personal observations of successful nesting habitat for this species in Eastern Ontario has not found any successful nesting pairs in habitats that were less than 5 ha. (COSEWIC, 2011). Provincially. the GHD for this species protects 100m from a nest and 300m of suitable habitat around a nesting site.	NHIC records indicate the presence of this species within the square containing the Site. Site investigations in 2025 will confirm the presence/absence of suitable habitat.
MAMMALS						
Little Brown Myotis	*Myotis lucifugus*	S4	END	END	Females establish summer maternity colonies, often in buildings or large-diameter trees. Foraging occurs over water, along waterways, and forest edges. Overwinter in cold and humid hibernacula (caves/mines) (COSEWIC, 2013). Critical habitat has not yet been defined. Provincially, this hibernacula have a buffer of 200m. Buffers for maternity sites have not been established.	No rocky habitat suitable for any species hibernacula, or Eastern-small Footed Myotis appear present in imagery.
Northern Myotis	*Myotis septentrionalis*	S3	END	END	Older (late successional or primary forests) with large interior habitat and snags that are in the mid-stage of decay. They prefer intact interior habitat and are sensitive to edge habitats (Menzel et al., 2002; Broders et al., 2006). Critical habitat has not yet been defined. Provincially, this hibernacula have a buffer of 200m. Buffers for maternity sites have not been established.	Woodland bat maternity habitat and/or day-roosts may be present on the property edges and adjacent lands, but not

Common Name	Scientific Name	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status	Preferred Habitat / Guidelines	Preliminary Evaluation
Eastern Small-footed Myotis	*Myotis leibii*	S2S3	END	No Status	Roost in a variety of habitats, including in or under rocks, in rock outcrops, in buildings, under bridges, or in caves, mines, or hollow trees. The recovery strategy for the eastern small-footed myotis indicates that the preferred maternity habitat of this species consists of open rock habitats. In the winter, these bats hibernate, most often in caves and abandoned mines (Humphrey, 2017). Provincially, this hibernacula have a buffer of 200m. Buffers for maternity sites have not been established.	within the work area. Avoid impacting trees or conduct surveys to confirm presence / absence of suitable habitat for SAR bats.
Tri-colored Bat	*Perimyotis subflavus*	S3?	END	END	Females establish summer maternity colonies, often in buildings or large-diameter trees. Foraging occurs over water, along waterways, and forest edges. Overwinter in cold and humid hibernacula (caves/mines). (COSEWIC, 2013).	
Silver-haired Bat	*Lasionycteris noctivagans*	S4	END (as of 2025)	No Status	Critical habitat has not yet been defined. Provincially, these hibernacula have a buffer of 200m. Buffers for maternity sites have not been established.	
Eastern Red Bat	*Lasiurus borealis*	S4	END (as of 2025)	No Status	Roost in a variety of deciduous and coniferous forest types, usually in trees but occasionally shrubs. Trees used as maternity roosts by both species tend to be large diameter and tall (COSEWIC 2023). Both migrate south to hibernate in the southern US (COSEWIC 2023).	
Hoary Bat	*Lasiurus cinereus*	S4	END (as of 2025)	No Status		
VASCULAR PLANTS						
Butternut	*Juglans cinerea*	S2?	END	END	Can occur on a variety of sites, but grows best on well-drained fertile soils in shallow valleys and on gradual slopes (COSEWIC, 2003). Provincially, this species' habitat is described as up to 50 m from the stem (depending on the size and classification of the individual).	NHIC records for this species exist for the square containing the property. SAR flora surveys will be conducted.
Black Ash	*Fraxinus nigra*	S4	END	No Status	Swamps, bogs, and riparian areas, occasionally poorly drained upland areas (COSEWIC, 2018). Provincially, this species' habitat is described to include 30 m from the stem.	NHIC observations for this species exist for the square containing the property.

Common Name	Scientific Name	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status	Preferred Habitat / Guidelines	Preliminary Evaluation
						SAR flora surveys will be conducted.

Table Updated: May 2025

SRANK DEFINITIONS

S2 Imperiled, Imperiled in the nation or state/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 nation or state/province.
S3 Vulnerable, Vulnerable in the nation or state/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.
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).
? Inexact Numeric Rank—Denotes inexact numeric rank
S#B Breeding

SARO STATUS DEFINITIONS

END Endangered: A species facing imminent extinction or extirpation in Ontario which is a candidate for regulation under Ontario's ESA.
THR Threatened: A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed.
SC Special Concern: a species with characteristics that make it sensitive to human activities or natural events.

SARA STATUS DEFINITIONS

END Endangered, a wildlife species facing imminent extirpation or extinction.
THR Threatened, a wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.
SC Special Concern, a wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats.

6.1.2 Wetlands

Potential for unevaluated wetlands to be PSWs or LSW is based the *Ontario Wetland Evaluation System, Southern Manual 4th Edition* (OWES). Unless they contain a special feature or function, wetlands smaller than 0.5 ha are not delineated and wetlands are not evaluated when they are less than 2.0 ha.

There are two unevaluated wetlands identified by LIO, a small riverine wetland, and a larger wetland to the south of the existing lagoons. As per the OWES guidelines noted above, the first, at 0.6 ha, is much too small to trigger evaluation. Further it is situated on the opposite side of the existing access road. The second, does meet the minimum size requirement to trigger evaluation. This wetland appears to be a mixed treed swamp and is >200 m and to the south of the existing lagoons. As such, it is outside of the adjacent lands for the Work Area.

6.1.3 Significant Woodland

The woodlands extending into the property and adjacent lands were identified as significant on OP Schedule B2. They are situated to the east of the existing access road and are more than 50 m from the Work Area.

6.1.4 Significant Wildlife Habitat

Evaluation of wildlife habitat was informed by the vegetation communities identified on imagery; these were compared to the Significant Wildlife Habitat Technical Guide (MNR, 2019) and the Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E (OMNRF, 2015). Significant wildlife habitat (SWH) is divided into four categories:

1. Seasonal Concentration Areas
2. Rare Vegetation Communities or Specialised Habitats for Wildlife
3. Habitats of Species of Conservation Concern (excluding the habitats of Endangered and Threatened Species)
4. Animal Movement Corridors

There were no identified SWH on provincial databases or in the OP Schedules for this area. However, OP Section 5.5.5 indicates that SWH shall be assessed on a case-by-case basis. Using the Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E (OMNRF, 2015) the potential for candidate habitat to be present was assessed as a desktop review (Appendix C). Based on a desktop review of habitats that may be present, potential candidate habitats are noted in the table below. This will be fully assessed in the NHAR using the habitat description data collected in 2025

Table 4: Potential for Candidate Significant Wildlife Habitat

Significant Wildlife Habitat	Work Area	Property	Adjacent Lands to Property (120m)
Bat Maternity Colonies	No	No	Possible
Special Concern Species Habitat	Potential for meadow species such as Monarch, American Bumblebee, Yellow-banded Bumblebee		Potential for woodland species Eastern Wood-pewee and Wood Thrush
Reptile Hibernacula	Possible	Possible	Possible
Amphibian Breeding Habitat (Woodland)	No	No	Possible
Old Growth Forest	No	No	Possible
Other Rare Vegetation Communities	No	No	Possible
Woodland Raptor Nesting Habitat	No	No	Possible
Seeps and Springs	No	No	Possible
Amphibian Breeding Habitat (Woodland)	No	No	Possible
Amphibian Movement Corridor	No	No	Possible

6.1.5 Fish and Fish Habitat

The review of available imagery did not identify any potential fish habitat within the Work Area however, a ditch is seen running around the boundary of the Property. It is anticipated that this ditch flows into Moose Creek and is within 22 m of the Work Area. Moose Creek is known year-round, direct fish habitat. As such, the ditch is assumed to provide direct or indirect fish habitat. Site investigations can provide additional information as needed.

7. Conclusion and Next Steps

The proposed location of the Work Area has avoided direct impacts to many of the known natural heritage features (i.e., unevaluated wetland, significant woodland and fish habitat). Site investigations, carried out in 2025, will be used to provide additional information on the suitability of the Property and the Work Area, as well as the adjacent lands to provide habitat for endangered or threatened species, significant wildlife habitat, and fish habitat and will confirm whether additional surveys are required.

Based on the potential for natural heritage features within treed and wetland habitats, including individual trees (i.e., potential for bat habitat), it is recommended that no direct impacts occur to any trees and that a setback from nearby trees be established to protect their roots, where feasible.

The potential to impact SAR or their habitats will be further reviewed in the NHAR.

The unevaluated wetland situated within the adjacent lands is recommended to be treated as significant as it meets the minimum size requirements (2 ha) to trigger assessment, but is ≥200 m from the Work Area, and is south of the existing lagoons. As such, it is anticipated that impacts to the wetland and its functions can be avoided and mitigated (i.e., ensure that the water quality and quantity reaching the wetland is not impacted and avoid causing sensory impacts to wildlife within the wetland etc.). These will be elaborated in the NHAR.

Similarly, the Significant Woodland is significant based on the OP Schedules. It is also >50 m and on the other side of the existing access road from the proposed Work Area. No direct impacts are anticipated and indirect impacts can be avoided through traditional best management practices (i.e., minimize lighting and noise, ensure that drainage and dust does not affect habitat or its functions). These will be described in the NHAR.

Finally, the ditch can be treated as potential fish habitat. It is also outside of the Work Area and is 22 m away. No work is planned below the high-water mark. Indirect impacts can be avoided by ensuring that there is no impact to the water quality or quantity reaching the ditch. This will be further discussed in the NHAR.

Once the 2025 site investigations data is reviewed, these recommendations will be updated with that site specific data.

Note that the following site investigations have been completed within the Property in 2025:

- Vegetation community descriptions and wetland delineations
- Cavity tree survey and snag classification of the single tree situated near the Work Area
- Fish habitat assessment of the ditch

- Breeding Bird Surveys
- Species at risk flora survey

8. Study Limitations and Constraints

CIMA+ completed diligent and reasonable research in conducting this evaluation, with respect to recognized laws and standards of practice. The facts presented in this report are strictly limited to the period of investigation. Conclusions are based on available information and documents, observations made during Site investigations, and communications with various contacts. Interpretation is therefore limited to this data.

CIMA+ is not responsible for erroneous conclusions due to voluntary abstention or the non-availability of pertinent information. Any opinion expressed in relation to legal or regulatory conformity is technical and should not be, in any case, considered legal advice.

9. References

Broders, H., Forbes, G., Woodley, S. & Thompson, I. (2006). Range extent and stand selection for roosting and foraging in forest-dwelling northern long eared bats and little brown bats in the greater Fundy ecosystem, New Brunswick. Journal of Wildlife Management 70: 5.

Canadian Wildlife Federation (CWF). (2024). Canadian Aquatic Barriers Database.

COSEWIC (2018). COSEWIC assessment and status report on the Black Ash *Fraxinus nigra* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 95 pp.

COSEWIC. (2003). COSEWIC assessment and status report on the Butternut *Juglans cinerea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 32 pp.

COSEWIC. (2011). COSEWIC assessment and status report on the Eastern Meadowlark *Sturnella magna* on the Status of Endangered Wildlife in Canada. Ottawa. x + 40 pp.

COSEWIC. (2013). COSEWIC assessment and status report on the Little Brown Myotis *Myotis lucifugus*, Northern Myotis *Myotis septentrionalis* and Tri-colored Bat *Perimyotis subflavus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxiv + 93 pp

COSEWIC. (2023). COSEWIC assessment and status report on the Hoary Bat *Lasiurus cinereus*, Eastern Red Bat *Lasiurus borealis* and Silver-haired Bat, *Lasionycteris noctivagans*, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxi + 100 pp.

COSEWIC. (2022). COSEWIC assessment and status report on the Bobolink *Dolichonyx oryzivorus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 60 pp.

Dobbyn, J.S. (1994). Atlas of the Mammals of Ontario. Federation of Ontario Naturalists, Don Mills, Ontario. viii + 120 pp.

eBird. (2024). (Fink, D., T. Auer, A. Johnston, M. Strimas-Mackey, S. Ligocki, O. Robinson, W. Hochachka, L. Jaromczyk, C. Crowley, K. Dunham, A. Stillman, I. Davies, A. Rodewald, V. Ruiz-Gutierrez, C. Wood. 2023. eBird Status and Trends, Data Version: 2022; Released: 2023. Cornell Lab of Ornithology, Ithaca, New York. https://doi.org/10.2173/ebirdst.2022)

Eder, T. (2002). Mammals of Ontario. Lone Pine. Alberta, Canada.

Endangered Species Act, S.O. (2007). Government of Ontario.

Environment and Climate Change Canada (ECCC). (2018). Recovery Strategy for the Little Brown Myotis (*Myotis lucifugus*), the Northern Myotis (*Myotis septentrionalis*),and the Tri-colored Bat (*Perimyotis subflavus*) in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. ix + 172 pp.

Fisheries Act, (1985). Government of Canada

Global Biodiversity Information Facility (GBIF) (GBIF.org (2024). Occurrence Data. Available from: https://www.gbif.org)

Humphrey, C. (2017). Recovery Strategy for the Eastern Small-footed Myotis (Myotis leibii) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario. vii + 76 pp.

Important Bird and Biodiversity Areas (IBA) (Birdlife International). (No Date) Accessed from: https://www.ibacanada.ca/index.jsp?lang=en)

Jalava, J.V. and J.D. Ambrose. (2012). Recovery Strategy for the Drooping Trillium (*Trillium flexipes*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 20 pp.

Menzel. M, S. Owen, W. Edwards, P. Wood, B. Chapman & Miller, K. (2002). Roost tree selection by northern long-eared bat (*Myotis septentrionalis*) maternity colonies in an industrial forest of the central Appalachian Mountains. Forest Ecology and Management 155:107-114.

Migratory Birds Convention Act, (1994). Government of Canada

Ministry of the Environment, Conservation and Parks (MECP). (2022). Fern-leaved Yellow False Foxglove.

OMNR. (2000). Significant Wildlife Habitat Technical Guide. Fish and Wildlife Branch Wildlife Section. Science Development and Transfer Branch. Southcentral Sciences Section.

OMNR. (2010). Natural Heritage Reference Manual For Natural Heritage Policies of the Provincial Policy Statement, 2005. Second Edition. Toronto: Queen's Printer for Ontario. 248 pp.

OMNR. (2013). Recovery Strategy for the Dwarf Hackberry (*Celtis tenuifolia*) in Ontario. Ontario Recovery Strategy Series. Ontario Ministry of Natural Resources, Peterborough, Ontario. iii + 5 pp + Appendix vi + 43 pp. Adoption of Recovery Strategy for Dwarf Hackberry (*Celtis tenuifolia*) in Canada (Parks Canada Agency 2011).

OMNRF. (2016). Recovery Strategy for the Pink Milkwort (*Polygala incarnata*) in Ontario. Recovery Strategy Series. Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario. iv + 4 pp. + Appendix v + 18 pp. Adoption of Recovery Strategy for the Pink Milkwort (*Polygala incarnata*) in Canada (Environment Canada 2013).

OMNR. (2024). Land Information Ontario.

Ontario Nature. (2015). Ontario Reptile and Amphibian Atlas: a citizen science project to map the distribution of Ontario's reptiles and amphibians. Ontario Nature, Ontario. http://www.ontarionature.org/atlas

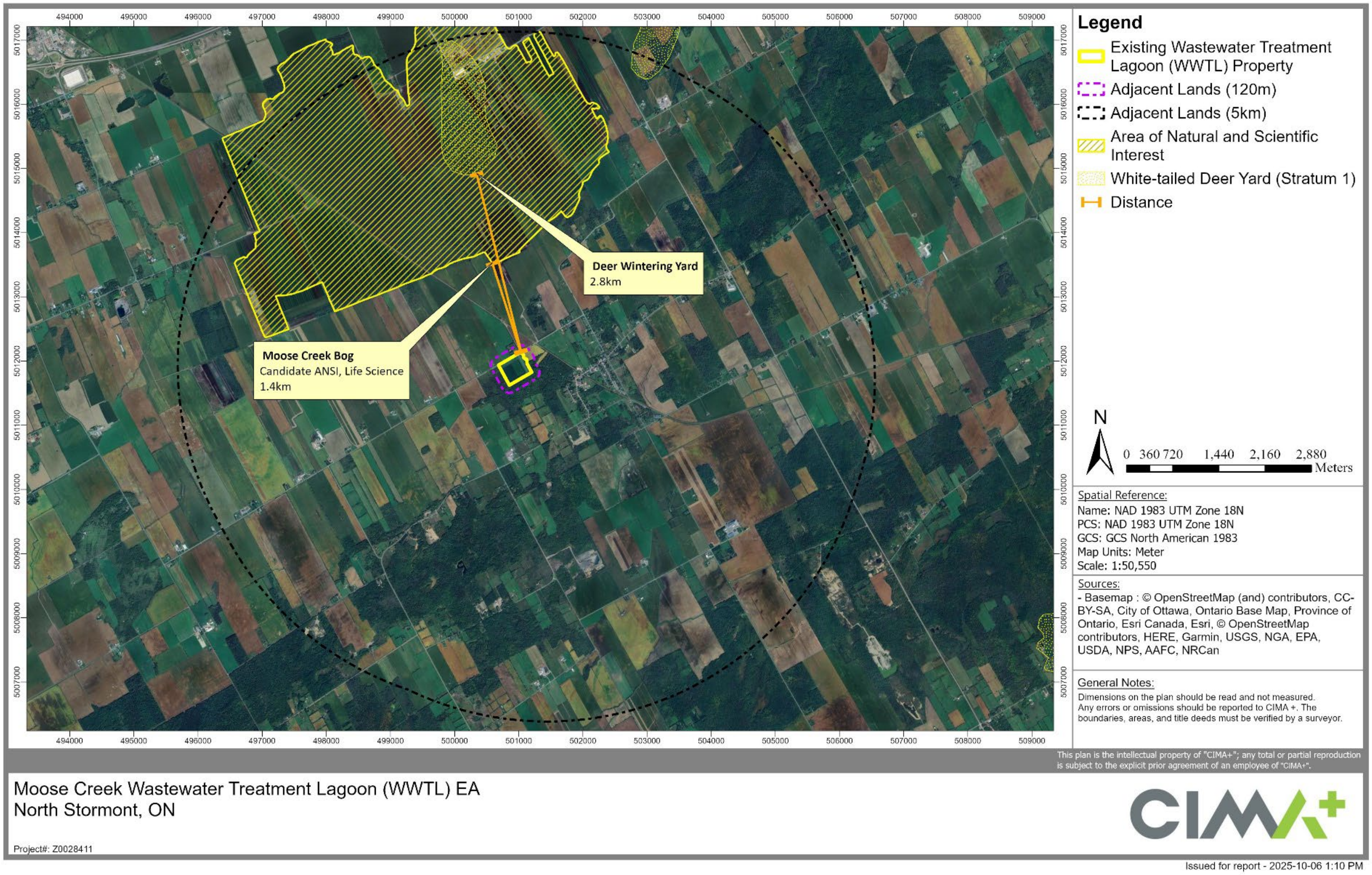
Ontario Regulation. 832/21. (2021): Habitat. filed December 9, 2021, under *Endangered Species Act*, 2007, S.O. 2007, c. 6

Peterson, R.T. (1980). A field guide to the birds: A completely new guide to all the birds of eastern and central North America. Houghton Mifflin Company, Boston.American White Pelican Recovery Team. (2011). Recovery Strategy for the American White Pelican (*Pelecanus erythrorhynchos*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 29 pp.

Zoladeski, C. and K. Hayes. (2013). Recovery Strategy for the Cherry Birch (*Betula lenta*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 12 pp.

A

Appendix A
Background Information on Terrestrial Environment



Background Information from Provincial Databases within 5 km of the Site

The Counties SDG Official Plan Schedules (April 2025)

Schedule A3c – Land Use Schedule – Township of North Stormont

Notes:

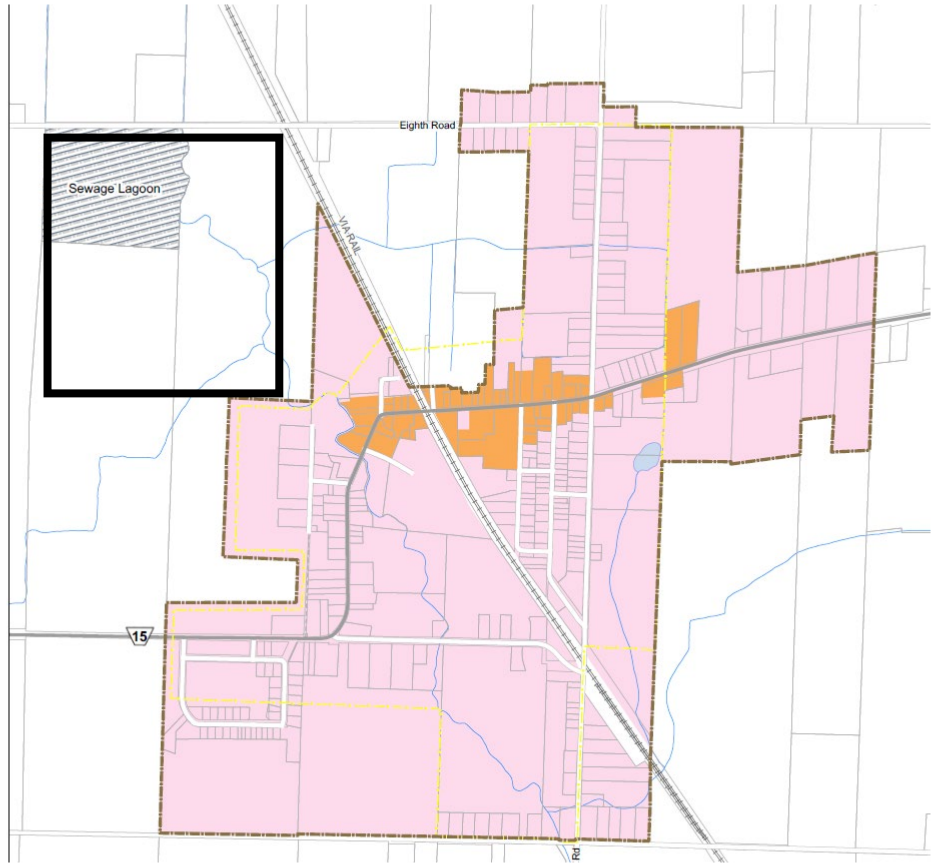
The Site is located within the black bounding box. Designations for the Laggoon Site as Sewage Lagoon, with both sites being outside of the Urban Settlement Aea

Legend

Boundaries (Land Use Designation)
- Urban Settlement Area
- Urban Service Limit

Settlement Areas (Land Use Designation)
- Residential District
- Commercial District

Infrastructure
- W Communal Well
- Sewage Sewage Lagoon



The Counties SDG Official Plan -Schedule A

The Counties SDG Official Plan Schedules (April 2025)

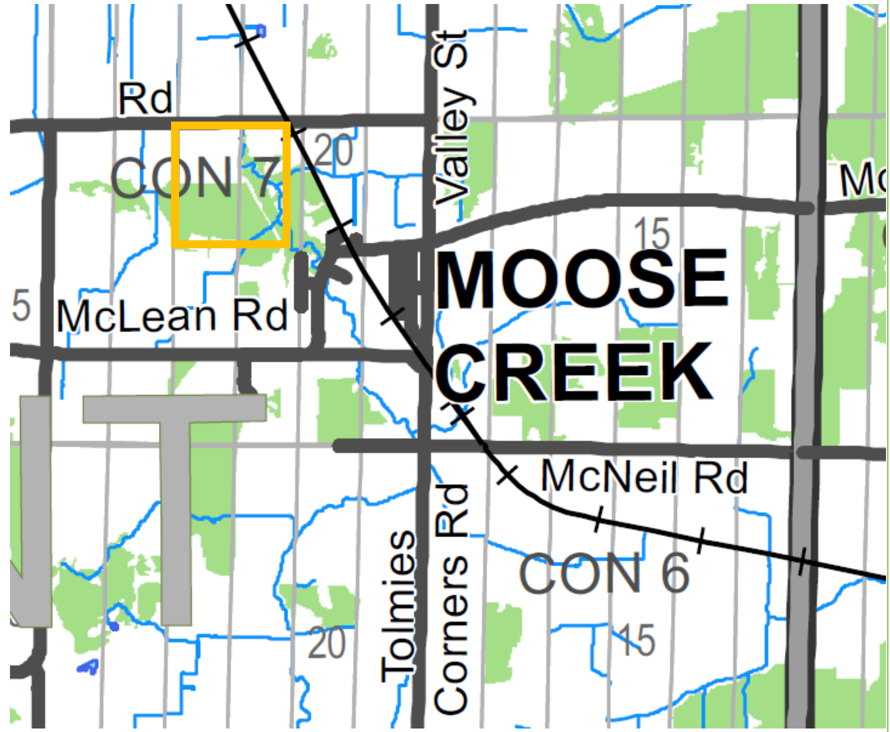
Schedule B3 Natural Heritage Systems (May 2022)

Notes:

The Site is located within the orange bounding box.

Designations are **Significant Woodlands**

Floodplain
Provincially Significant Wetlands
Locally Significant Wetlands (Verified, Significance Other)
Significant Woodlands
ANSI (Areas of Natural and Scientific Interest)

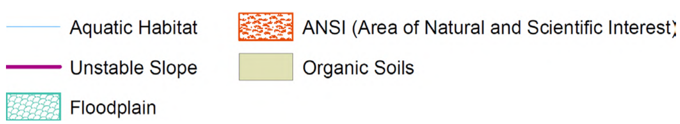


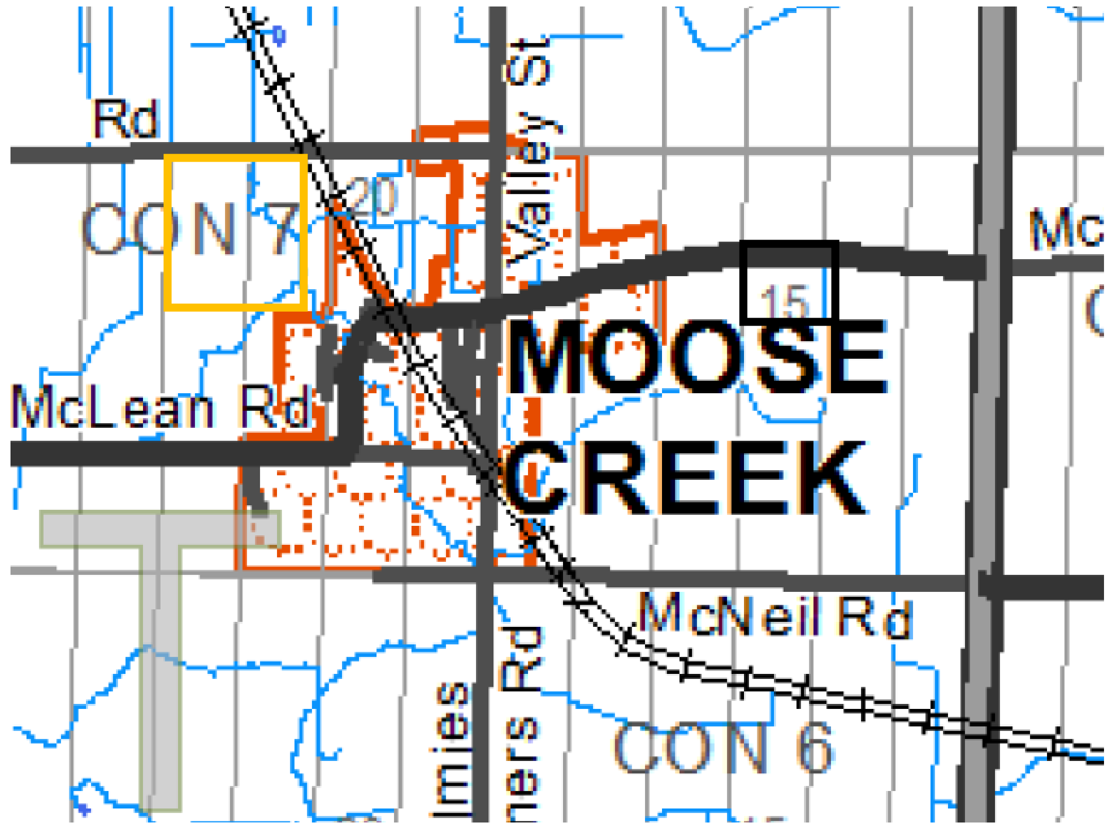
The Counties SDG Official Plan –Schedule B3

The Counties SDG Official Plan Schedules (April 2025)

Schedule B1 – Natural Hazards and Features(March 2016)

Notes: The Site is located within the light orange bounding box.
The dark orange on this map is not denoting an ANSI, it is the Settlement Area of Moose Creek as shown in Schedule A
Designations include **Aquatic Habitat**





Niagara official Plan – Schedule B

Atlas of Breeding Birds in Ontario

Common Name	Scientific Name	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status
Canada Goose	*Branta canadensis*	S5	No Status	No Status
Wood Duck	*Aix sponsa*	S5	No Status	No Status
Mallard	*Anas platyrhynchos*	S5	No Status	No Status
Gray Partridge	*Perdix perdix*	SNA	No Status	No Status
Ruffed Grouse	*Bonasa umbellus*	S4	No Status	No Status
Great Blue Heron	*Ardea herodias*	S4	No Status	No Status
Turkey Vulture	*Cathartes aura*	S5B	No Status	No Status
Northern Harrier	*Circus cyaneus*	S4B	No Status	No Status
Cooper's Hawk	*Accipiter cooperii*	S4	No Status	No Status
Red-tailed Hawk	*Buteo jamaicensis*	S5	No Status	No Status
American Kestrel	*Falco sparverius*	S4	No Status	No Status
Killdeer	*Charadrius vociferus*	S5B, S5N	No Status	No Status
Rock Dove	*Columba livia*	SNA	No Status	No Status
Upland Sandpiper	*Bartramia longicauda*	S4B	No Status	No Status
Ring-billed Gull	*Larus delawarensis*	S5B, S4N	No Status	No Status
Rock Pigeon	*Columba livia*	SNA	No Status	No Status
Mourning Dove	*Zenaida macroura*	S5	No Status	No Status
Ruby-throated Hummingbird	*Archilochus colubris*	S5B	No Status	No Status
Yellow-bellied Sapsucker	*Sphyrapicus varius*	S5B	No Status	No Status
Downy Woodpecker	*Picoides pubescens*	S5	No Status	No Status
Hairy Woodpecker	*Picoides villosus*	S5	No Status	No Status
Northern Flicker	*Colaptes auratus*	S5	No Status	No Status
Eastern Wood-Pewee	*Contopus virens*	S4B	SC	SC
Alder Flycatcher	*Empidonax alnorum*	S5B	No Status	No Status
Eastern Kingbird	*Tyrannus tyrannus*	S4B	No Status	No Status
Warbling Vireo	*Vireo gilvus*	S5B	No Status	No Status
Red-eyed Vireo	*Vireo olivaceus*	S5B	No Status	No Status
Blue Jay	*Cyanocitta cristata*	S5	No Status	No Status

Common Name	Scientific Name	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status
American Crow	*Corvus brachyrhynchos*	S5B	No Status	No Status
Horned Lark	*Eremophila alpestris*	S5B	No Status	No Status
Tree Swallow	*Tachycineta bicolor*	S4B	No Status	No Status
Bank Swallow	*Riparia riparia*	S4B	THR	THR
Barn Swallow	*Hirundo rustica*	S4B	SC	THR
Black-capped Chickadee	*Poecile atricapilla*	S5	No Status	No Status
White-breasted Nuthatch	*Sitta carolinensis*	S5	No Status	No Status
House Wren	*Troglodytes aedon*	S5B	No Status	No Status
Veery	*Catharus fuscescens*	S4B	No Status	No Status
American Robin	*Turdus migratorius*	S5B	No Status	No Status
Gray Catbird	*Dumetella carolinensis*	S5B,S3N	No Status	No Status
European Starling	*Sturnus vulgaris*	SNA	No Status	No Status
Cedar Waxwing	*Bombycilla cedrorum*	S5B	No Status	No Status
Nashville Warbler	*Vermivora ruficapilla*	S5B	No Status	No Status
Yellow Warbler	*Dendroica petechia*	S5B	No Status	No Status
Chestnut-sided Warbler	*Dendroica pensylvanica*	S5B	No Status	No Status
Black-and-white Warbler	*Mniotilta varia*	S5B	No Status	No Status
Ovenbird	*Seiurus aurocapillus*	S4B	No Status	No Status
Northern Waterthrush	*Seiurus noveboracensis*	S5B	No Status	No Status
Common Yellowthroat	*Geothlypis trichas*	S5B	No Status	No Status
Chipping Sparrow	*Spizella passerina*	S5B	No Status	No Status
Vesper Sparrow	*Pooecetes gramineus*	S4B	No Status	No Status
Savannah Sparrow	*Passerculus sandwichensis*	S4B	No Status	No Status
Song Sparrow	*Melospiza melodia*	S5B	No Status	No Status

Common Name	Scientific Name	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status
White-throated Sparrow	*Zonotrichia albicollis*	S5B	No Status	No Status
Northern Cardinal	*Cardinalis cardinalis*	S5	No Status	No Status
Indigo Bunting	*Passerina cyanea*	S4B	No Status	No Status
Bobolink	*Dolichonyx oryzivorus*	S4B	THR	THR
Red-winged Blackbird	*Agelaius phoeniceus*	S4	No Status	No Status
Eastern Meadowlark	*Sturnella magna*	S4B	THR	THR
Common Grackle	*Quiscalus quiscula*	S5B	No Status	No Status
Brown-headed Cowbird	*Molothrus ater*	S4B	No Status	No Status
Baltimore Oriole	*Icterus galbula*	S4B	No Status	No Status
House Finch	*Carpodacus mexicanus*	SNA	No Status	No Status
American Goldfinch	*Carduelis tristis*	S5B	No Status	No Status
House Sparrow	*Passer domesticus*	SNA	No Status	No Status

Table Updated May 2025

SRANK Definitions

S2 Imperiled, Imperiled in the nation or state/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 nation or state/province.

S3 Vulnerable, Vulnerable in the nation or state/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 nation or state/province.

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).

S#B Breeding

S#N Non-Breeding

SARO Status Definitions

SC Special Concern: A species with characteristics that make it sensitive to human activities or natural events.

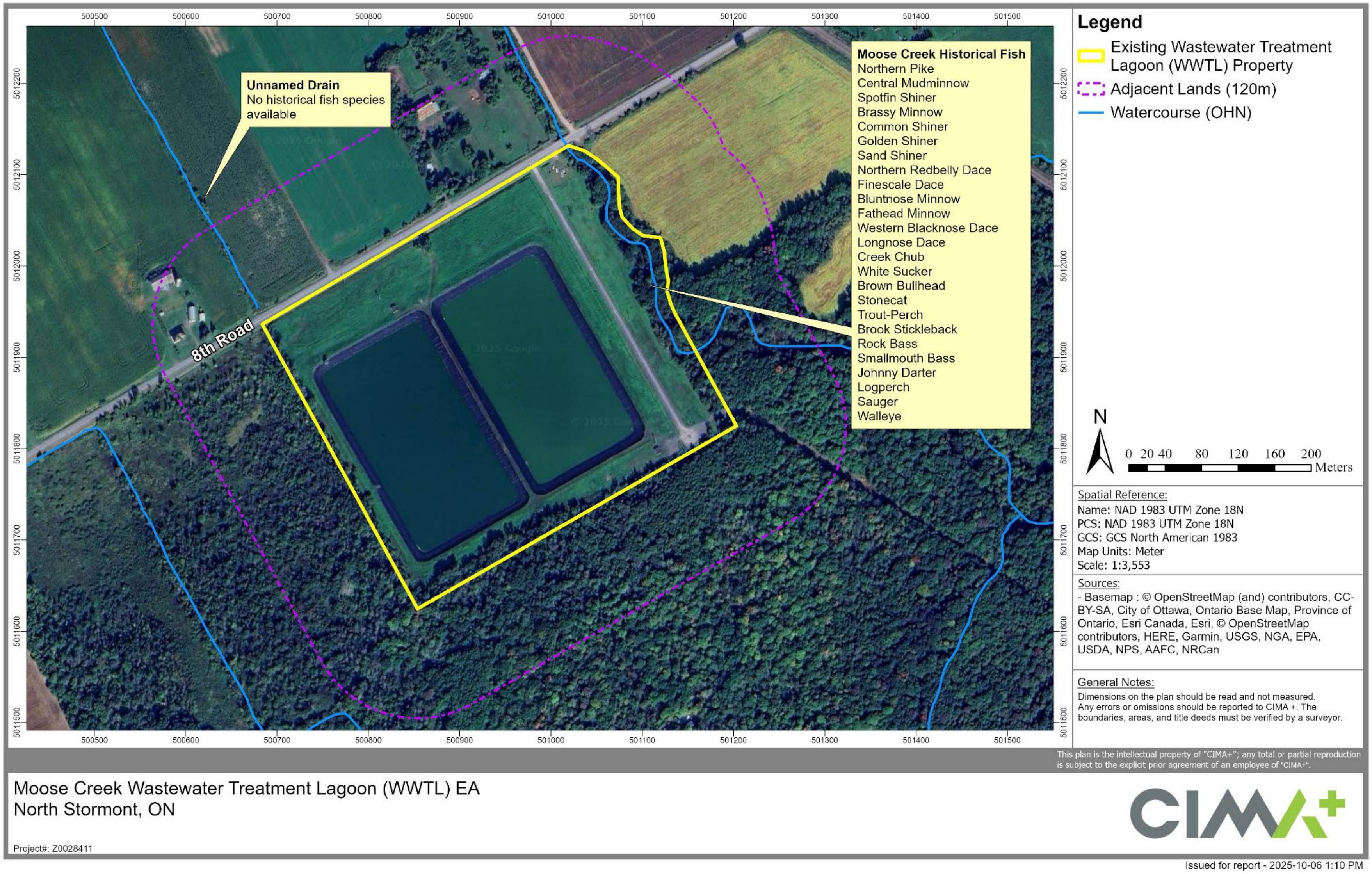
SARA Status Definitions

THR Threatened, a wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.

SC Special Concern, a wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats.

B

Appendix B
Background Information on Fish and Fish Habitat



Background Fish Community Information for Watercourses on-Site and the Adjacent Lands (120 m)

List of Fish Identified in Background Information in Moose Creek

Common Name	Scientific Name	Trophic Class*	Reproductive Guild	General Habitat (Adult)	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status	Source
Northern Pike	*Esox lucius*	carnivore	A.1.5 Non-guarder. Open substrate spawner. Obligate plant spawners. Scatters eggs onto submerged live or dead aquatic plants or recently flooded live terrestrial plants. Well developed embryonic respiratory structures.	Clear, slow moving water with dense aquatic vegetation. Preferred water temp 17-21°C.	S5	No status	No status	ARA Line
Central Mudminnow	*Umbra limi*	invertivore	A.1.5 Non-guarder. Open substrate spawner. Obligate plant spawners. Scatters eggs onto submerged live or dead aquatic plants or recently flooded live terrestrial plants. Well developed embryonic respiratory structures.	Ponds and pools with dense aquatic vegetation.	S5	No status	No status	ARA Line
Spotfin Shiner	*Cyprinella spiloptera*	invertivore/ herbivore	A.2.4 Non-guarder, brood hider. Cave spawners; Large eggs are adhesive and hide in crevices, extensive embryonic respiratory structures, large emerging larvae.	Creeks, medium to large rivers and lakes ofter found over sand and gravel.	S4	No status	No status	ARA Line
Brassy Minnow	*Hybognathus hankinsoni*	planktivore/ detritivore	A.1.4 Non-guarder. Open substrate spawner. Nonobligatory plant spawner. Adhesive eggs on submerged live or dead plants, late hatching, not photophobic, extremely well developed empryonic respiratory structures.	Pools of sluggish, clear creeks and small rivers with sand or gravel substrates, boggy lakes and shallow bays. Variety of habitats including streams and bog ponds.	S5	No status	No status	ARA Line
Common Shiner	*Luxilus cornutus*	invertivore	B.2.3 Guarder. Rock and gravel nesters (lithophils). Adhesive eggs.	Stream dweller, prefers pools located below faster water. Bottom velocities of 0.1-0.5 m/s.	S5	No status	No status	ARA Line

Common Name	Scientific Name	Trophic Class*	Reproductive Guild	General Habitat (Adult)	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status	Source
Golden Shiner	*Notemigonus crysoleucas*	invertivore/herbivore	A.1.5 Non-guarder. Open substrate spawner. Obligate plant spawners. Scatters eggs onto submerged live or dead aquatic plants or recently flooded live terrestrial plants. Well developed embryonic respiratory structures.	Clear water with aquatic vegetation and slow velocities. Preferred water temp. 17-24°C.	S5	No status	No status	ARA Line
Sand Shiner	*Notropis stramineus*	invertivore/detritivore	Categorized as A.1.6 in MTO 2006, however little is known of its spawning behaviour. It is assumed to spawn over sand. Non-guarder. Open substrate spawner. Adhesive eggs on submerged matter.	Sandy or gravel in runs and pools in rivers and creeks to sandy vegetated shallows in lakes.	S4	No status	No status	ARA Line
Northern Redbelly Dace	*Chrosomus eos*	invertivore/planktivore	A.1.4 Non-guarder. Open substrate spawner. Nonobligatory plant spawner. Adhesive eggs on submerged live or dead plants, late hatching, not photophobic, extremely well developed empryonic respiratory structures.	Quiet waters in ponds, lakes or streams. Can be found in bog lakes.	S5	No status	No status	ARA Line
Finescale Dace	*Chrosomus neogaeus*	invertivore/planktivore	A.1.4 Non-guarder. Open substrate spawner. Nonobligatory plant spawner. Adhesive eggs on submerged live or dead plants, late hatching, not photophobic, extremely well developed empryonic respiratory structures.	Prefers cool waters in ponds, lakes or streams. Can be found in bog lakes.	S5	No status	No status	ARA Line
Bluntnose Minnow	*Pimephales notatus*	detritivore	B.2.7 guarder. Nest spawner. Speleophils; Hole Nester. Either cavity roof top nester or bottom burrow nesters.	Variety of habitats. Prefers water temp of 29°C.	S5	NAR	No status	ARA Line

Common Name	Scientific Name	Trophic Class*	Reproductive Guild	General Habitat (Adult)	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status	Source
Fathead Minnow	*Pimephales promelas*	detritivore/ invertivore	B.2.7 guarder. Nest spawner. Speleophils; Hole Nester. Either cavity roof top nester or bottom burrow nesters.	Variety of quiet habitats.	S5	No status	No status	ARA Line
Western Blacknose Dace	*Rhinichthys obtusus*	invertivore	A.1.3 Non-guarder. Open substrate spawner. Lithophil; Rock and gravel spawners with benthic larvae. Early hatched embryo photophobic, hide under stones.	Tends to live in small to medium size watercoursess with gravel substrate and riffle/run habitat.	S5	No status	No status	ARA Line
Longnose Dace	*Rhinichthys cataractae*	invertivore	A.1.3 Non-guarder. Open substrate spawner. Lithophil; Rock and gravel spawners with benthic larvae. Early hatched embryo photophobic, hide under stones.	Fast flowing water with rocky substrate. Prefers depths <30 cm deep and surface velocities over 0.45 m/s. Prefers water temp. of 13-21°C.	S5	No status	No status	ARA Line
Creek Chub	*Semotilus atromaculatus*	invertivore/ carnivore	A.2.3 Non-guarder. Brood hiders. Lithphils. Buries eggs in gravel. Early hatch free embryos photophobic, large emerging alevins.	Variable habitats, typically found in small streams <12 m wide. Prefer velocities lower than 0.3 m/s but have been found in velocities up to 0.6 m/s.	S5	No status	No status	ARA Line
White Sucker	*Catostomus commersonii*	invertivore/ detritivore	A.1.3 Non-guarder. Open substrate spawner. Lithophil; Rock and gravel spawners with benthic larvae. Early hatched embryo photophobic, hide under stones.	Slow moving water, pools. Preferred water temp. 17-23°C.	S5	No status	No status	ARA Line
Brown Bullhead	*Ameiurus nebulosus*	invertivore/ herbivore/ carnivore	B.2.7 guarder. Nest spawner. Speleophils; Hole Nester. Either cavity roof top nester or bottom burrow nesters.	Shallow, slow moving water with abundant aquatic vegetation.	S5	No status	No status	ARA Line

Common Name	Scientific Name	Trophic Class*	Reproductive Guild	General Habitat (Adult)	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status	Source
Stonecat	*Noturus flavus*	invertivore/ carnivore	B.2.7 guarder. Nest spawner. Speleophils; Hole Nester. Either cavity roof top nester or bottom burrow nesters.	Cobble and boulder riffles and runs of creeks and small to large rivers, and gravel shoals of lakes. Riffle, run or rapids with large loose rocks as substrate.	S4	No status	No status	ARA Line
Trout-perch	*Percopsis omiscomaycus*	invertivore/ carnivore	A.1.3 Non-guarder. Open substrate spawner. Lithophil; Rock and gravel spawners with benthic larvae. Early hatched embryo photophobic, hide under stones.	Found in deeper habitats over sand and gravel substrates.	S5	No status	No status	ARA Line
Brook Stickleback	*Culaea inconstans*	planktivore/invertivore	B.2.4 Guarder. Ariadnophils; Gluemaking nesters. Males guard nest using a kidney secretion to bind together nest.	Clear, cold water with dense vegetation.	S5	No status	No status	ARA Line
Rock Bass	*Ambloplites rupestris*	invertivore/carnivore	B.2.3 Guarder. Rock and gravel nesters (lithophils). Adhesive eggs.	Rocky areas in lakes and streams. Prefers water temp of 25-29°C.	S5	No status	No status	ARA Line
Smallmouth Bass	*Micropterus dolomieu*	invertivore/ carnivore	B.2.3 Guarder. Rock and gravel nesters (lithophils). Adhesive eggs.	Clear water with rocky or sandy substrate. Prefers water temp. of 20-26°C.	S5	No status	No status	ARA Line
Johnny Darter	*Etheostoma nigrum*	invertivore	B.2.7 guarder. Nest spawner. Speleophils; Hole Nester. Either cavity roof top nester or bottom burrow nesters.	Variety of habitats but prefers areas with moderate to no current over sandy or mixed substrate. Prefers water temp. of 22.8°C.	S5	No status	No status	ARA Line
Logperch	*Percina caprodes*	invertivore	A.1.6. Non-guarders. Open substrate spawners. Psammophils; sand	Rocky or sandy habitats in lakes or streams.	S5	No status	No status	ARA Line

Common Name	Scientific Name	Trophic Class*	Reproductive Guild	General Habitat (Adult)	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status	Source
			spawners. Adhesive eggs in running water on sand or fine roots over sand. Phototropic. Poorly developed respiratory structures.					
Sauger	*Sander canadensis*	invertivore/ carnivore	A.1.3 Non-guarder. Open substrate spawner. Lithophil; Rock and gravel spawners with benthic larvae. Early hatched embryo photophobic, hide under stones.	Rivers and shallow turbid lakes in areas with sand or gravel runs or pools. Typically in less 6m of water. Preferred water temp. between 20-24°C.	S4	No status	No status	ARA Line
Walleye	*Sander vitreus*	invertivore/carn ivore	A.1.2. Non-guarders. Open substrate spawners. Lithopelagophil; Rock and gravel spawners with pelagic larvae. No photophobia. Limited embryonic respiratory structures.	Prefer shallow turbid lakes or deep rivers. Prefers water temp. of 19-23°C.	S5	No status	No status	ARA Line
Number of Species							**25**	

(Coker et al. 2001, DFO 2022, iNaturalist 2016-2023, LIO 2023, MTO 2006, OMNRF 2013, Page et al. 2013, ROM, 2024)

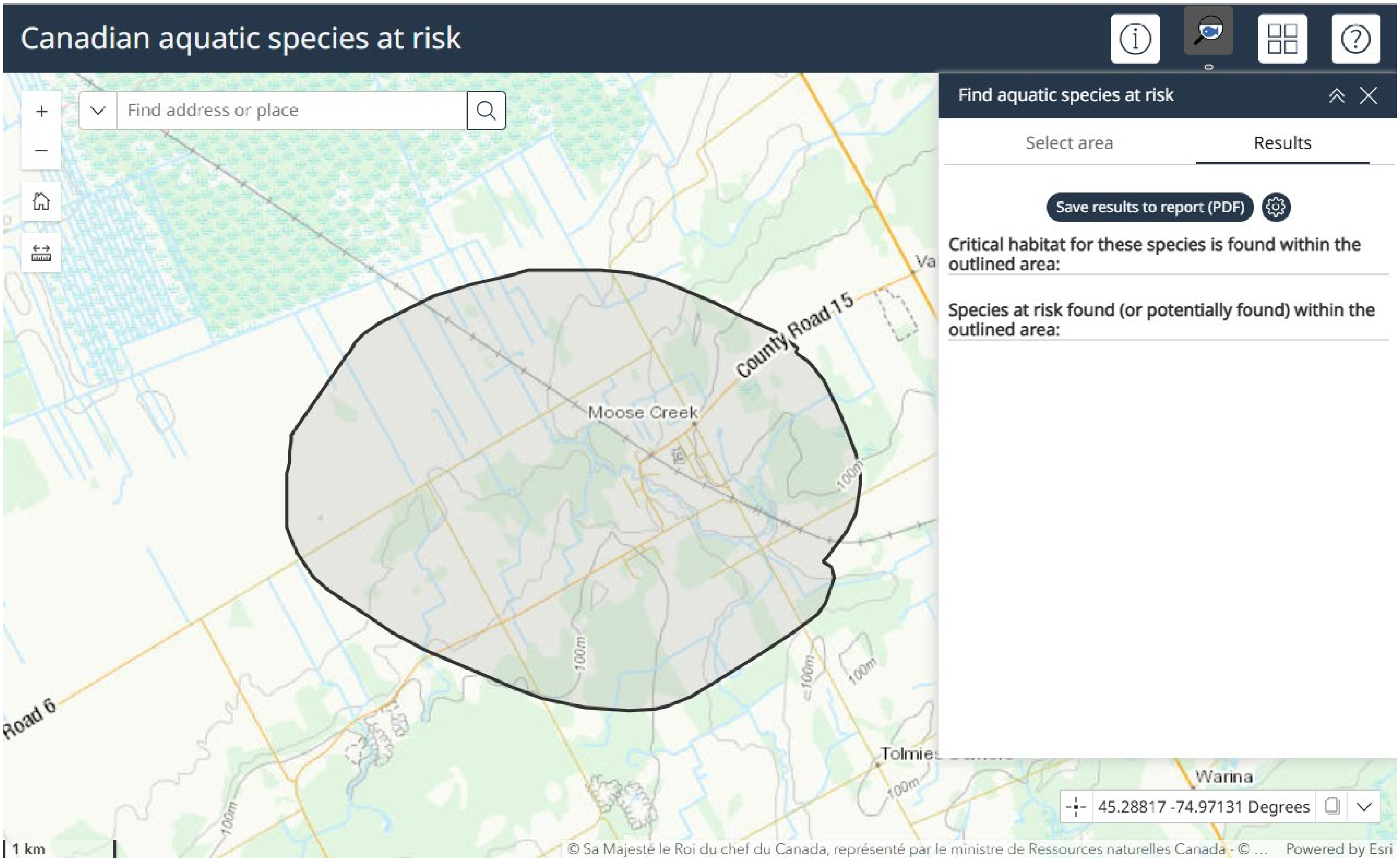
Table Updated: May 2025

SRANK Definitions

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 nation or state/province.

SNA Not Applicable, A conservation status rank is not applicable because the species is not a suitable target for conservation activities.



DFO CASAR Mapping (Accessed October 7, 2025)

C

Appendix C
Preliminary Significant Wildlife Habitat Assessment

Significant Wildlife Habitat	Candidate SWH Criteria (MNR, 2010)		Assessment of Candidacy		Results
	ELC Codes	Additional Criteria Summary	On Property	In Adjacent Lands to Property	
Seasonal Concentration Areas of Animals					
Waterfowl stopover and staging areas (terrestrial)	Certain cultural meadow or thicket Plus, evidence of annual spring flooding	Fields flooded from mid-March to May	There does not appear to be any spring flooding in the historical imagery.		Not Present; Not discussed further
Waterfowl stopover and staging areas (aquatic)	Specific aquatic habitat types (marsh, swamps)	Ponds, marshes, lakes, bays, coastal inlets, and watercourses used for migration. Stormwater and sewage management facilities are not included.	The artificial waterbody on site is not considered suitable aquatic habitat.		Not Present; Not discussed further
Shorebird migratory stopover area	Beach/Bar Sand Dunes Meadow marsh	Shorelines used in May to mid-June and early July to October. Stormwater and sewage management facilities are not included.	No suitable shoreline habitat present.		Not Present; Not discussed further
Raptor Wintering Area	Combination of ELC Community Series; need to have present one Community Series from each land class; Forest: Deciduous Forest, Mixed Forest, Coniferous Forest. Upland: Cultural Medow; Cultural Thicket; Cultural Savannah; Cultural Woodland.	The habitat provides a combination of fields and woodlands that provide roosting, foraging and resting habitats for wintering raptors. Raptor wintering sites (hawk/owl) need to be > 20 ha with a combination of forest and meadow. Least disturbed sites, idle/fallow or lightly grazed field/meadow (>15ha) with adjacent woodlands Field area of the habitat is to be wind swept with limited snow depth or accumulation. Eagle sites have open water, large trees and snags available for roosting	The surrounding forest is large enough but the field on site is too small to be considered candidate habitat.		Not present; not discussed further

Significant Wildlife Habitat	Candidate SWH Criteria (MNR, 2010)		Assessment of Candidacy		Results
	ELC Codes	Additional Criteria Summary	On Property	In Adjacent Lands to Property	
Bat hibernacula	Crevices and caves	Active mines are not to be included. Buildings are not included.	No rocky habitat appears in imagery.		Unlikely to be present; field work will confirm.
Bat maternity colonies	Deciduous, or mixed forests Deciduous or mixed Swamps (>5m tall)	>10/ha large diameter (>25 cm diameter at breast height) Snag trees in the decay classes 1-3 are preferred.	Potential to be present within the wooded habitat on and surrounding the property but none within the Work Area.		Possibly present, in Adjacent Lands.
Turtle wintering areas	Swamps, marshes, open water, shallow water, open fen, or open bog	Water that is deep enough not to freeze solid with soft bottoms. Must be permanent waterbody (or wetlands with adequate dissolved oxygen)	None within the Work Area; Ditch could provide habitat as well as existing lagoons. Watercourses within adjacent lands could also provide habitat.		Unlikely to be present; field work will confirm suitability of ditch
Reptile hibernaculum	Any habitat except very wet ones. Note that talus, rock barren, cave and alvar offer high potential.	The existence of features that go below frost line, such as rock piles or slopes, old stone fences, and abandoned crumbling foundations.	None of the higher potential habitats appear to be present.		Possibly present, additional habitat assessment completed in 2025 and will be reviewed in NHAR
Colonially – Nesting bird breeding habitat (Cliff Swallow)	Exposed sandy slopes of banks or piles. Cliff faces or structures (bridges, silos etc.…)	Does not include licensed aggregate areas. Does not include man-made structures or recently (within 2 years) disturbed soil	No suitable banks or cliff faces.		Not Present; Not discussed further
Colonially – Nesting bird breeding habitat (Trees/Shrubs)	Swamps – deciduous or mixed (trees >5m) Treed fen	Typically requires tall trees as nests are usually 11-15m from ground but shrubs and emergent vegetation could be used.	No potential in Work Area. No heronries identified by LIO, swamp looks quite densely treed.		Unlikely to be present; field work will confirm

Significant Wildlife Habitat	Candidate SWH Criteria (MNR, 2010)		Assessment of Candidacy		Results
	ELC Codes	Additional Criteria Summary	On Property	In Adjacent Lands to Property	
Colonially – Nesting bird breeding habitat (Ground)	Medow Marsh, Shallow Marsh, Cultural Meadow, Cultural Thicket, Cultural Savannah	Nesting colonies of gulls and terns are on islands or peninsulas associated with open water or in marshy areas. Brewers Blackbird colonies are found loosely on the ground in low bushes in close proximity to streams and irrigation ditches within farmlands.	Candidate habitat not present.		Not Present; Not discussed further
Migratory Butterfly Stopover Areas	Combination of ELC Community Series; need to have present one Community Series from each land class: Field: Cultural Meadow, Cultural Thicket, Cultural Savannah Forest: Deciduous Forest, Mixed Forest, Coniferous Forest, Cultural Coniferous Plantation	A butterfly stopover area will be a minimum of 10 ha in size with a combination of field and forest habitat present, and will be located within 5 km of Lake Ontario	Further than 10 km from the Great Lakes. Candidate habitat not present.		Not applicable
Landbird Migratory Stopover Areas	Deciduous Forest, Mixed Forest, Coniferous Forest, Coniferous Swamp, Mixed Swamp, Deciduous Swamp	Woodlots need to be >10 ha in size and within 5 km of Lake Ontario.	Further than 5 km from the Great Lakes. Candidate habitat not present.		Not applicable
Deer Yarding Areas	ELC Community Series providing a thermal cover component for a deer yard would include. Mixed Forest, Coniferous Forest, Mixed Swamp, Coniferous Swamp.	The Core of a deer yard (Stratum I) is located within the Stratum II area and is critical for deer survival in areas where winters become severe. It is primarily composed of coniferous trees (pine, hemlock, cedar, spruce)	None mapped by MNR. Candidate habitat not present.		Not applicable

Significant Wildlife Habitat	Candidate SWH Criteria (MNR, 2010)		Assessment of Candidacy		Results
	ELC Codes	Additional Criteria Summary	On Property	In Adjacent Lands to Property	
	Or Cultural Plantation, Cultural Thicket	with a canopy cover of more than 60% Woodlots with high densities of deer due to artificial feeding are not significant.			
Deer Winter Congregation Areas	Mixed Forest, Coniferous Forest, Deciduous Forest, Deciduous Swamp, Mixed Swamp, Coniferous Swamp. Conifer plantations much smaller than 50 ha may also be used.	Woodlots will typically be >100 ha in size. Woodlots <100ha may be considered as significant Large woodlots > 100ha and up to 1500 ha are known to be used annually by densities of deer that range from 0.1-1.5 deer/ha Woodlots with high densities of deer due to artificial feeding are not significant	None mapped by MNR. No candidate habitat present.		Not applicable
Rare Vegetation Communities or Specialized Habitat for Wildlife					
Cliffs and Talus Slopes	Near vertical face that is >3m in height (cliff or talus)		No candidate habitat present.		Not Present; Not discussed further
Sand Barren	Exposed sand, generally sparsely vegetated and caused by lack of moisture, periodic fires and erosion. A sand barren area >0.5ha in size Vegetation can vary from patchy and barren to tree covered, but less than 60%.		No candidate habitat present.		Not Present; Not discussed further
Alvar	An alvar is typically a level, mostly unfractured calcareous bedrock feature with a mosaic of rock pavements and bedrock overlain by a thin veneer of soil. An Alvar site > 0.5 ha in size Vegetation cover varies from patchy to barren with a less than 60% tree cover		No candidate habitat present.		Not Present; Not discussed further

<table>
<tr><th rowspan="2">Significant Wildlife Habitat</th><th colspan="2">Candidate SWH Criteria (MNR, 2010)</th><th colspan="2">Assessment of Candidacy</th><th rowspan="2">Results</th></tr>
<tr><th>ELC Codes</th><th>Additional Criteria Summary</th><th>On Property</th><th>In Adjacent Lands to Property</th></tr>
<tr><td>Old Growth Forest</td><td colspan="2">Woodland areas 30 ha or greater in size or with at least 10 ha interior habitat assuming 100 m buffer at edge of forest
If dominant trees species of the area >140 years old</td><td colspan="2">None within the Work Area or within 50 m of Work Area. Wooded area within adjacent lands meets size requirements.</td><td>Possible, field work required to confirm.</td></tr>
<tr><td>Savannah</td><td colspan="2">Tallgrass prairie habitat that has tree cover between 25 – 60%</td><td colspan="2">No candidate habitat present.</td><td>Not Present; Not discussed further</td></tr>
<tr><td>Tallgrass Prairie</td><td colspan="2">Ground cover dominated by prairie grasses. An open Tallgrass Prairie habitat has < 25% tree cover.</td><td colspan="2">No candidate habitat present.</td><td>Not Present; Not discussed further</td></tr>
<tr><td>Other Rare Vegetation Communities</td><td colspan="2">Provincially rare S1-S3 communities as described in Appendix M of the SWHTG</td><td colspan="2">None within Work Area. Possible on eastern edge of property and within adjacent lands.</td><td>Possible, field work required to confirm.</td></tr>
<tr><td colspan="6">Specialized Habitat for Wildlife</td></tr>
<tr><td>Waterfowl Nesting Area</td><td>Shallow marsh, meadow marsh, thicket swamp or deciduous (treed >5 m tall) swamps</td><td>Wetland must be 0.5 ha or consist of up to 3 smaller wetlands within 120 m of each other if known nesting is occurring.</td><td colspan="2">Insufficient standing water within the adjacent swamps in spring imagery.</td><td>Not Present; Not discussed further</td></tr>
<tr><td>Bald Eagle and Osprey Nesting, Foraging, and Perching Habitat</td><td>Any forest or swamp (trees >5m) type of habitat that is immediately next to rivers, lakes, ponds, or wetlands</td><td>Nests on man-made structures are not included.</td><td colspan="2">No sufficiently large waterbodies.</td><td>Not Present; Not discussed further</td></tr>
<tr><td>Woodland Raptor Nesting Habitat</td><td>Any forest habitat or treed swamp (>5m tall) or coniferous plantation</td><td>Stand must be > 30 ha with >4 ha of interior habitat (edge is 200 m)</td><td colspan="2">None within the Work Area; The woodland to the south meets the size criteria but is 50m away and across the access road.</td><td>Candidate habitat present and will be discussed in the NHAR.</td></tr>
<tr><td>Turtle Nesting Areas</td><td>Shallow marsh, shallow water, open bog</td><td>Close to water but away from roads.
Must provide sand and gravel that turtles can dig through and be in open sunny areas.</td><td colspan="2">No suitable exposed sandy or gravel substrates appear on imagery.</td><td>Unlikely based on imagery. Site investigations to confirm potential for habitat.</td></tr>
</table>

Significant Wildlife Habitat	Candidate SWH Criteria (MNR, 2010)		Assessment of Candidacy		Results
	ELC Codes	Additional Criteria Summary	On Property	In Adjacent Lands to Property	
		Areas on the sides of municipal or provincial roads are not included.			
Seeps and Springs	Any forested community could have a seep/spring	Forest area with <25% meadow/pasture in the headwaters of a stream.	Candidate habitat present 50m to the east, across the access road.		Possible, field work required to confirm.
Amphibian Breeding Habitat (Woodland)	Mixed Forest, Coniferous Forest, Deciduous Forest, Deciduous Swamp, Mixed Swamp, Coniferous Swamp	Presence of a wetland, pond or woodland pool (including vernal pools) >500m2 (about 25m diameter) within or adjacent (within 120m) to a woodland (no minimum size). Some small wetlands may not be mapped and may be important breeding pools for amphibians.	Candidate habitat present 50m to the east, across the access road.		Possible, field work required to confirm.
Amphibian Breeding Habitat (Wetlands)	Swamp, Marsh, Fen, Bog, Open Water, or Shallow Water Typically, isolated (>120m) from woodland ecosites	Wetlands>500m2 (about 25m diameter) supporting high species diversity are significant; some small or ephemeral habitats	All wetlands on-Site are evaluated under woodland breeding habitat due to their small size and proximity to woodlands.		Not Present; Not discussed further
Woodland Area – Sensitive Bird Breeding Habitat	Mixed Forest, Coniferous Forest, Deciduous Forest, Deciduous Swamp, Mixed Swamp, Coniferous Swamp	Habitats where interior forest breeding birds are breeding, typically large mature (>60 yrs old) forest stands or woodlots >30 ha Interior forest habitat is at least 200m from forest edge habitat.	None within the Work Area. Woodland in adjacent lands is less than 400 m across.		Not Present; Not discussed further
Habitat for Species of Conservation Concern (not including Endangered or Threatened Species)					
Marsh Bird Breeding Habitat	Meadow marsh, shallow water, fen, or open bog		No candidate habitat present.		Not Present; Not discussed further
Open Country Bird Breeding Habitat	Cultural meadows	Must be large grasslands (>30 ha)	No candidate habitat present.		Not Present; Not discussed further

Significant Wildlife Habitat	Candidate SWH Criteria (MNR, 2010)		Assessment of Candidacy		Results
	ELC Codes	Additional Criteria Summary	On Property	In Adjacent Lands to Property	
		Agricultural class 1 and 2 are not included Agricultural lands planted in row crop or intensive hay, or pastures (within past 5 years) not included.			
Shrub/Early Successional Bird Breeding Habitat	Cultural thickets or woodlands	Must be > 10 ha Agricultural class 1 and 2 are not included Agricultural lands planted in row crop or intensive hay, or pastures (within past 5 years) not included	No candidate habitat present.		Not Present; Not discussed further
Terrestrial Crayfish	Marsh, Deciduous Swamp, Mixed Swamp, Thicket Swamp	Wet meadow and edges of shallow marshes (no minimum size)	The Site is outside the species' range.		Not Present; Not discussed further.
Special Concern and Rare Wildlife Species	All special concern or species ranked as S1-S3, SH (plants or animals)	Habitat depends on the species.	Potentially present.		Possible, in field evaluation required.
Animal Movement Corridors					
Amphibian Movement Corridor	Any habitat, but amphibian breeding <u>wetland</u> habitat must be identified		Potentially present.		Possible, in field evaluation required.
Deer Movement Corridor	All forests but project must be in Stratum II Wintering Area has potential to contain corridors.		Not applicable – no Deer Wintering Areas or Habitat identified by MNR in the area.		Not applicable

G

Appendix G: Desktop Hydrogeological And Geotechnical Assessment

Ontario Clean Water Agency

Moose Creek Wastewater Treatment Lagoon Class EA

DESKTOP HYDROGEOLOGICAL AND GEOTECHNICAL ASSESSMENT

CIMA+ project number: Z0028411
30 September 2025

Ontario Clean Water Agency

Moose Creek Wastewater Treatment Lagoon Class EA

DESKTOP HYDROGEOLOGICAL AND GEOTECHNICAL ASSESSMENT

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CIMA+ project number: Z0028411
30 September 2025

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1. Introduction

CIMA Canada Inc. (CIMA+) was retained by the Ontario Clean Water Agency, (the 'Client') to complete a Desktop Hydrogeological and Geotechnical Assessment as part of a Municipal Class Environmental Assessment (MCEA) in support of upgrades to the existing Moose Creek Wastewater Treatment Lagoons (WWTL) in the Village of Moose Creek, United Counties of Stormont, Dundas, and Glengarry, Ontario (herein referred to as the 'Project').

1.1 Background

The Moose Creek WWTL facility is located along 8th Road approximately 1km to the west of the village of Moose Creek, Ontario. The Class EA Study Area includes the existing WWTL located along and an adjacent plot area, Eastward of the WWTL property, as shown on Figure 1 (Appendix A). The existing Moose Creek WWTL was constructed in 1994 and consists of the following components:

- Two facultative aerated lagoon cells
- Influent distribution chamber, with three inner chambers
- Aeration building with two positive displacement blowers
- Alum feed and metering building two positive displacement mild chemical diaphragm pumps
- Discharge and Metering chamber

The final effluent is discharged to Moose Creek, which flows along the eastern property boundary. As per the current ECA, the facility discharges effluent once a year, as an annual discharge. The discharge window is between March 15th to April 30th, with a maximum discharge flow rate of 11,040 m^3/d.

A Master Servicing Plan (MSP) was recently completed by R.V. Anderson Associates Ltd. (2024) on behalf of the Township of North Stormont, identifying the need for expansion of the existing Moose Creek WWTL to accommodate anticipated population growth. As per the ECA, the average day flow (ADF) for the Moose Creek WWTL is 302 m^3/day, and the total rated storage volume is 110,376 m3. Based on flow predictions in association with the population growth, the MSP predicted an ADF of 438 m^3/day in 2051 to meet the future population projections.

The objective of the MCEA is to evaluate detailed design concepts in terms of technical, environmental, social and economic considerations and arrive at the preferred wastewater treatment expansion path for the existing Moose Creek WWTL. The proposed alternatives under consideration include (1) a submerged aerated Growth reactor (SAGR) system consisting of two tanks, with one small building, or (2) a moving bed bioreactor (MBBR) consisting of a concrete tank that may be partially underground, and a small building.

The Desktop Hydrogeological and Geotechnical Assessment provided herein is being completed as part of the Environmental Study Report (ESR) for the Project, which describes the planning and decision-making process followed during the Schedule C Class EA study for the Moose Creek WWTL, and any environmental protective measures to protect the construction site and near neighborhoods.

1.2 Objective

The objective of the Desktop Hydrogeological and Geotechnical Assessment is to provide a preliminary characterization of baseline hydrogeological and geotechnical site conditions based on existing readily available information, and to evaluate the potential for significant constructability constraints or adverse impacts to soil and groundwater conditions on-Site and within the surrounding area.

The Class EA Study Area includes the existing WWTL and an adjacent plot area, Eastward of the WWTL property. For the purposes of the Desktop Hydrogeological and Geotechnical Assessment, the 'Site' will be limited to the area north of the existing lagoons along 8th Road as shown within **Figure 1** (**Appendix A**). The Study Area for the Desktop Hydrogeological and Geotechnical Assessment will consist of a 500m radius of the EA Study Area boundaries, as shown within **Figure 1** (**Appendix A**).

2. Methodology

The work plan for the Desktop Hydrogeological and Geotechnical Assessment included the review and compilation of existing readily available regional hydrogeological, and geotechnical site characterization information obtained from publicly available sources as supplemented by the review and compilation of existing Project and Site information from previous investigations where applicable.

3. Summary of Findings

3.1 Previous Environmental Investigations and Reports

Subsurface Investigation – 8th Conc. Rd. Bridge, Lot 22, Concession 7/8, Moose Creek, Ontario prepared by St. Lawrence Testing & Inspection Co. Ltd., December 2004.

St. Lawrence Testing & Inspection Co. Ltd. (SLT) was retained by the Township of North Stormont in 2004 to complete a subsurface investigation on a bridge over Moose Creek on Concession 8 Rd., Lot 22, Concession 7/8, which is located approximately 50 metres northeast of the current Study Area.

Two (2) boreholes were advanced on December 14, 2004 using standard penetration tests by split spoon sampler. To determine refusal, a penetration cone was driven below 5.18m to refusal, which was reached in each borehole at 8.35 and 8.08 metres (m) below ground surface (bgs). Subsurface conditions encountered at both boreholes consisted of approximately 50 mm of asphalt underlain by silty gray gravel fill to an average depth of 0.56 m bgs. Underlying the silty gravel fill is a brown, moist stiff silty clay, which becomes grey, very moist and firm from 2.8 to 3.0 m bgs then wet and soft between 3.8 to 4.5 m bgs. Glacial till (silty sand till) was encountered at each borehole at depths of 6.77 and 7.16 m bgs.

Geotechnical Feasibility Report - Proposed Landfill Expansion Lot 13, 14, 15, and 16, Concession Road 10, 17125 Lafleche Road Moose Creek, Ontario prepared by Terrapex Environmental Ltd., April 2021.

Terrapex Environmental Ltd. (Terrapex) was retained GFL Environmental Inc. to prepare a Geotechnical Feasibility Report in support of a proposed expansion of the Eastern Ontario Waste Handling Facility, located at 17125 Lafleche Road, which is approximately 4.2 km north of the current Study Area.

Eighteen (18) boreholes were advanced from January 21 to February 7, 2020 using mud rotary techniques to depths ranging from 4.0 to 25.3 m bgs. Standard penetration tests and in-situ vane shear tests were completed throughout the drilling program at regular intervals as needed. Seven (7) monitoring wells were installed in boreholes.

Subsurface conditions encountered during the drilling program generally consisted of topsoil form surface to depths ranging from 0.3 to 2.0 m bgs followed by cohesive soil deposits consisting of variable fractions of silt and clay to silty clay with traces of sand and gravel reported to depths ranging from 4.7 to 17.8 m bgs. In most of the boreholes, this deposit contained a weathered crust at the top, which was stiff to very stiff in consistency with varying thicknesses ranging between 0.2 to 2.0 m. In all the boreholes, below the weathered crust was an unweathered grey silty clay, which was typically firm to very soft in consistency. Underlying the silt and clay unit was a glacial till deposit consisting of variable fractions of predominantly sand and gravel, with a silt fraction ranging from trace to silty, and trace clay in the majority of borehole locations to depths ranging from approximately 5.8 to 19.2 m bgs, which correspond to elevations near 46.8 to 61.5 m above sea level (asl).

The bedrock surface was encountered at depths ranging from 5.8 to 19.2 m bgs underlying the silty clay and/or sand and gravel till. Bedrock was reported to consist of shale and limestone. The upper approximately 1.0 m of the bedrock was observed through coring at select borehole locations to be moderately to highly weathered and fractured, becoming competent and sound below this depth

Groundwater elevations taken at monitoring wells were reported in March 2020 and ranged from 64.85 m above sea level (asl) to 67.19 m asl, while in April 2020 groundwater elevations ranged from 44.54 m asl to 66.60 m asl.

Geotechnical Investigation - Proposed Residential Development 2161 Valley Street Moose Creek, Ontario prepared by Paterson Group, February 2023.

Paterson Group (Paterson) was retained by 809304 Ontario Inc. to complete a geotechnical investigation for a proposed residential development, located at 2161 Valley Street, which is approximately 1 km east of the current Study Area.

Ten (10) boreholes were advanced to a maximum depth of 6.8 m bgs using a track-mounted auger rig on January 20, 23, and 24, 2023. Soil sampling was completed directly from auger flights in addition to standard penetration tests by split spoon sampler. The thickness of the overburden was evaluated by dynamic cone penetration test (DCPT) at one selected borehole location. Two (2) groundwater monitoring wells were installed in selected locations, while standpipe piezometers were installed in all other boreholes.

Soil conditions encountered during the drilling program generally consisted of a thin layer of topsoil or fill at surface in most borehole locations. Where present, the fill material consisted of gravel, topsoil, and organics, with a thickness ranging from approximately 0.6 to 1.2 m. Underlying the topsoil/fill material, a compact to very dense deposit of glacial till was encountered at most borehole locations, consisting of silty sand with a variable amount of gravel, cobbles, and boulders. Practical refusal to DCPT was encountered at a depth of 12.6 m at the tested borehole location. The depth to bedrock was not further investigated as part of the drilling program.

Based on geological mapping and the results of the field investigation, Paterson inferred that overburden drift thickness ranged from approximately 6 to 15 m and was underlain by bedrock, consisting of shale and limestone of the Lindsay Formation.

Groundwater elevations taken at monitoring wells were reported in January 2023 and ranged from 87.07 m asl to 97.27 m asl.

3.2 Land Use and Servicing

The Site is located along 8th Road within the Township of North Stormont, approximately 1km west of the village of Moose Creek. The Study Area is primarily composed of agricultural land to the north, east, and west of the Site, and by vacant land to the south and southeast.

Based on the information presented in the United Counties of Stormont Dundas Glengarry of London Zoning By-law (2023), the Site is located within an Agricultural (AG) zone. No mapped Environmental Significant Areas (ESA) zones or railways are identified within a 250 m radius of the Project Area. A rail line is noted within the Study Area, located approximately 300 m northeast of the Site.

It is inferred herein that nearby properties within the Study Area are privately serviced by individual well and septic based on mapping information available from the Township of North Stormont's Open Data portal (accessed August 11, 2025).

3.3 Aerial Photography & Satellite Imagery

Current and historical aerial photographs obtained from the Land Information Ontario (LIO) interactive map tool and Google Earth Pro (accessed August 12, 2025) were used to conduct a preliminary desktop review of land usage in the immediate vicinity of the Project Area. The desktop review included inspection of available aerial imagery and "virtual" walkthrough from roadways to identify land use and evidence of current or historical sources of potential soil or groundwater contamination in relation to the Project. The associated findings generally corroborated land use of surrounding properties detailed in Section 3.2 and did not reveal any additional existing features or discernible constraints that may influence the Project. Historical aerial photographs are included herein as **Appendix B**.

3.4 Topography and Physiography

Review of regional topographic and drainage mapping information presented by the Ministry of Northern Development, Mines, Natural Resources and Forestry (MNRF) (accessed August 12, 2025) indicates that the Project Site is located within an area of low regional topographic relief, remaining relatively flat throughout. Ground surface elevation on-Site ranges from approximately 74 to 75 m asl across the Site. No notable surficial or topographic features are indicated on or in proximity to the Site or surrounding Study Area based on the available mapping information. Regional topography is shown in **Figure 2 (Appendix A)**.

The Site is located within the Winchester Clay Plain physiographic region of Ontario. Physiographic mapping information provided by Chapman and Putnam (2007) suggests that the Site is located within a clay plains physiographic unit, which also includes the northern and southwestern portion of the broader Study Area. The remaining portions of the Study Area is described to include discontinuous occurrences of beaches within a regionally extensive sand plains physiographic unit. Physiographic units are shown in **Figure 3** (**Appendix A**).

3.5 Geology and Hydrogeology

Surficial geology mapping presented by the Ontario Geological Survey (OGS, 2010) and reproduced within **Figure 4** (**Appendix A**) indicates that surficial geology within the Site and Study Area boundaries is dominated by foreshore-basinal deposits (fine-to medium-grained sand) of glaciomarine origin, with minor occurrences of stone-poor carbonate-derived silty to sandy till along the northeastern and southwestern limits of the Study Area.

As indicated within **Figure 5 (Appendix A)**, regional bedrock geology mapping information indicates that the bedrock underlying the overburden material within the Project Area has been characterized as a laterally extensive unit of limestone, dolostone, shale, arkose, and sandstone of the Ottawa Group (Armstrong and Dodge, 2007). Review of the available regional mapping of karst features presented by the OGS (2010) does not indicate the occurrence of any potential, inferred, or known karst features on or within a 1 km radius of the Project Site.

Based on the available information and watershed mapping, regional groundwater flow within the overburden and bedrock material is inferred to be oriented to the north/northwest following regional ground surface topography.

A search of the Water Well Information System (WWIS) indicated a total of four (4) water well records for locations within a 500-meter (m) radius of the Project Area boundary as illustrated within **Figure 6 (Attachment A)**. Review of the available records indicate that three of the four records (WWIS ID #5800984, 5801187, and 7331497) represent existing bedrock water supply wells, with the remaining record (5801195) being associated with a drilled well abandoned upon construction due to insufficient water encountered. Where information was available, records indicate total well depths ranging from 9 to 55 m, with static water levels reported between 3.06 m and 6.10 m below ground surface. Reported drilling observations for material encountered generally corroborate those described in the available regional mapping discussed above. Copies of each well record are provided herein as **Appendix C**.

Table A: Summary of MECP Well Records

MECP Well ID	Well Type	Distance to Site	Date of Construction	Total Well Depth	Overburden Thickness	Depth of Water Found	Depth of Static Water Level	Recommended Pumping Rate
		(m)	(MM/DD/YYY)	(m bgs)	(m)	(m bgs)	(m bgs)	(USGPM)
Records Within a 500 m Radius								
5800984	Bedrock Water Supply	205	20/01/1965	9.14	6.71	8.23	3.08	5
5801187	Bedrock Water Supply	903	24/02/1971	37.18	6.10	34.44	6.10	0
5801195	Abandoned - Dry	995	27/05/1971	54.86	5.18	-	-	-
7331497	Bedrock Water Supply	115	16/04/2019	12.2	-	-	3.06	-

3.6 Surface Water Features and Areas of Natural and Scientific Interest

The Site is located within the Horse Creek - South Nation River watershed within the South Nation Conservation Authority (SNC). Review of the Ontario Flow Assessment Tool (OFAT, accessed August 13, 2025) presented by the MNRF suggests that shallow groundwater within the Project Area likely discharges to Moose Creek, contributing to its baseflow.

Based on the SNC interactive online mapping tool, (accessed August 13, 2025), the Site does not fall within any SNC Regulation Areas. According to data available via the MNRF (2025) mapping information, seven (7) mapped unevaluated wetland features are identified within 500 m of the Site within the Study Area. However, there are no mapped Provincially Significant Wetland (PSW) areas or Areas of Natural and Scientific Interest (ANSI) identified within 500 m of the Project Area (MNRF, 2025). It is noted that a complimentary Natural Heritage Assessment is being completed concurrently, which will provide additional detail regarding natural heritage features as needed.

3.7 Source Water Protection

Based on the online interactive mapping information included within the Source Protection Information Atlas (MECP, accessed August 2025), the Study Area is not located within any Wellhead Protection Areas (WHPA), Highly Vulnerable Aquifer (HVA) areas, or Significant Groundwater Recharge Areas (SGRA). A portion of the Study Area, to the west of the Site, is located within a mapped Intake Protection Zone-3 (IPZ-3a) as illustrated within Figure 6 (Attachment A). In general terms, an IPZ-3 where present includes areas which have been assessed as having the potential of contributing contaminants towards an established surface water intake under an extreme event at a concentration which would result in a deterioration of the source water for the purpose of human consumption.

4. Geotechnical Considerations

Based on available information, the subsurface conditions are anticipated to consist of silty clay underlain by cohesionless glacial till. The upper few meters of the silty clay deposit are expected to comprise a stiff to very stiff weathered crust, underlain by a lower, unweathered, firm to very soft silty clay. The glacial till is expected to consist of silty sand and may contain cobbles and boulders. Bedrock is anticipated at approximately 6–7 m below ground surface.

The proposed alternatives for expansion, the Submerged Aerated Growth Reactor (SAGR) system or the Moving Bed Bioreactor (MBBR), are generally geotechnically feasible in the anticipated soil conditions. However, the presence of soft, moist silty clay may pose challenges for foundation design, requiring careful consideration of settlement and bearing capacity. Cobble- and boulder-rich glacial till could impede excavation and potentially cause construction delays.

The unweathered silty clay is firm to very soft and sensitive. Native clay may present trafficability issues during construction, and care will be required to protect the subgrade from disturbance.

To refine the design and construction planning, the following next steps are recommended:

- **Site-Specific Geotechnical Investigation**: Complete a site-specific geotechnical investigation at the proposed expansion location to confirm subsurface stratigraphy, obtain soil parameters (such as shear strength and compressibility), and determine the depth to bedrock/till refusal.
- **Foundation Design:** Based on the site-specific investigation, develop detailed recommendations for the foundation design of the new structures, specifically addressing anticipated settlement and required bearing capacity.

5. Hydrogeological Considerations

Review of the available regional geological and hydrogeological information within and in proximity to the Site and Study Area, reported an overburden thickness generally ranging from 5 to 7 m, with static water level elevations ranging from 3 to 6 m bgs. Seasonal and temporal fluctuation in local groundwater levels is anticipated in the overburden within the Study Area. Temporary local construction dewatering may be required to maintain dry excavation conditions to facilitate installation of subsurface structures. Dewatering requirements are expected to be low for excavations within the low-permeability silty clay but could be significant in the glacial till where encountered.

Based on the review of regional geology and hydrogeology in the study area, it is anticipated that the drawdown of water levels associated with dewatering would be limited in radius and any associated changes in groundwater flow direction would be at a local scale. The groundwater table and any temporary local fluctuations in groundwater flow direction would be anticipated to return to preconstruction conditions following the completion of dewatering and backfilling of the excavations.

Existing rural and agricultural properties within the Study Area are inferred to rely on private groundwater supply wells for potable water. A portion of the Study Area, to the west of the Site, is located within a mapped Intake Protection Zone-3 (IPZ-3a). The potential for adverse impact to these nearby receptors should be considered as part of the proposed facility design including planned construction and dewatering activities associated with the Project.

Should the need for construction dewatering be anticipated at a rate greater than 50,000 L/day, an Environmental Activity Sector Registry (EASR) will be required.

To refine the design and construction planning, the following next steps are recommended:

- **Site-Specific Hydrogeological Investigation**: Complete a site-specific hydrogeological investigation at the proposed expansion location to characterize the physical hydrogeological properties of subsurface materials anticipated to be intersected by planned construction activities, establish local groundwater elevations, estimate anticipated dewatering requirements, and evaluate potential groundwater and surface water receptors.

6. Closing

CIMA Canada Inc. (CIMA+) was retained by the Ontario Clean Water Agency, (the 'Client) to complete a hydrogeological and geotechnical assessment technical memorandum to inform hydrogeological and geotechnical conditions as part of the Schedule C Municipal Class Environmental Assessment (MCEA) in support of the planning and design process for the Moose Creek Wastewater Treatment Lagoon in Moose Creek, ON.

7. Limiting Conditions

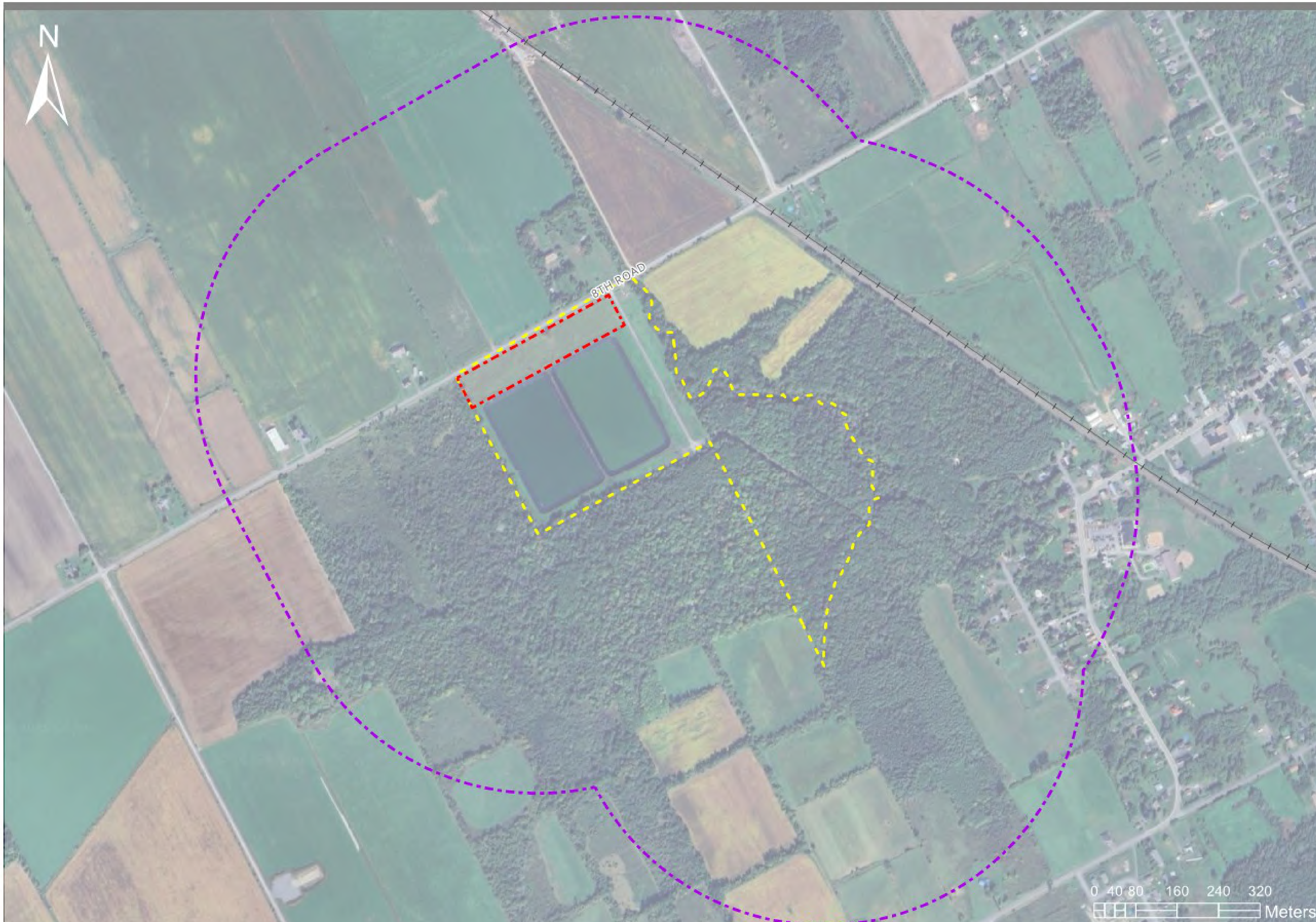
CIMA+ Completed diligent and reasonable research in the conduct of this evaluation, with respect to the recognized laws and standards of practice. The facts presented in this report are strictly limited to the period of investigation. The conclusions presented in this report are based on the available information and documents, the observations made during the Site visit, and the information obtained from communications with various contacts. The interpretation presented in this report is limited to this data.

CIMA+ is not responsible for erroneous conclusions due to voluntary abstention or the non-availability of pertinent information. Any opinion expressed in relation to legal or regulatory conformity is technical and should not be, in any case, considered as legal advice.

CIMA+ has prepared this report for the sole use of the client. Any use of this report by a third party, as any decision based on this report, is the singular responsibility of the third party. CIMA+ will not be held responsible for eventual damages towards a third party resulting from decisions taken, or based, on this report.

A

Appendix A
Figures



Site
Class EA Study Area
Study Area - 500 m
Railway

Spatial Reference:
Name: NAD 1983 CSRS MTM 8
GCS: GCS North American 1983 CSRS
Datum: North American 1983 CSRS
Map Units: Meter
Scale: 1:7,800

Sources:
- Railway, Road Labels, LIO, 2024
- Basemap : Google Earth Imagery, 2023

General Notes:
Dimensions on the plan should be read and not measured.
Any errors or omissions should be reported to CIMA+. The boundaries, areas, and title deeds must be verified by a surveyor.

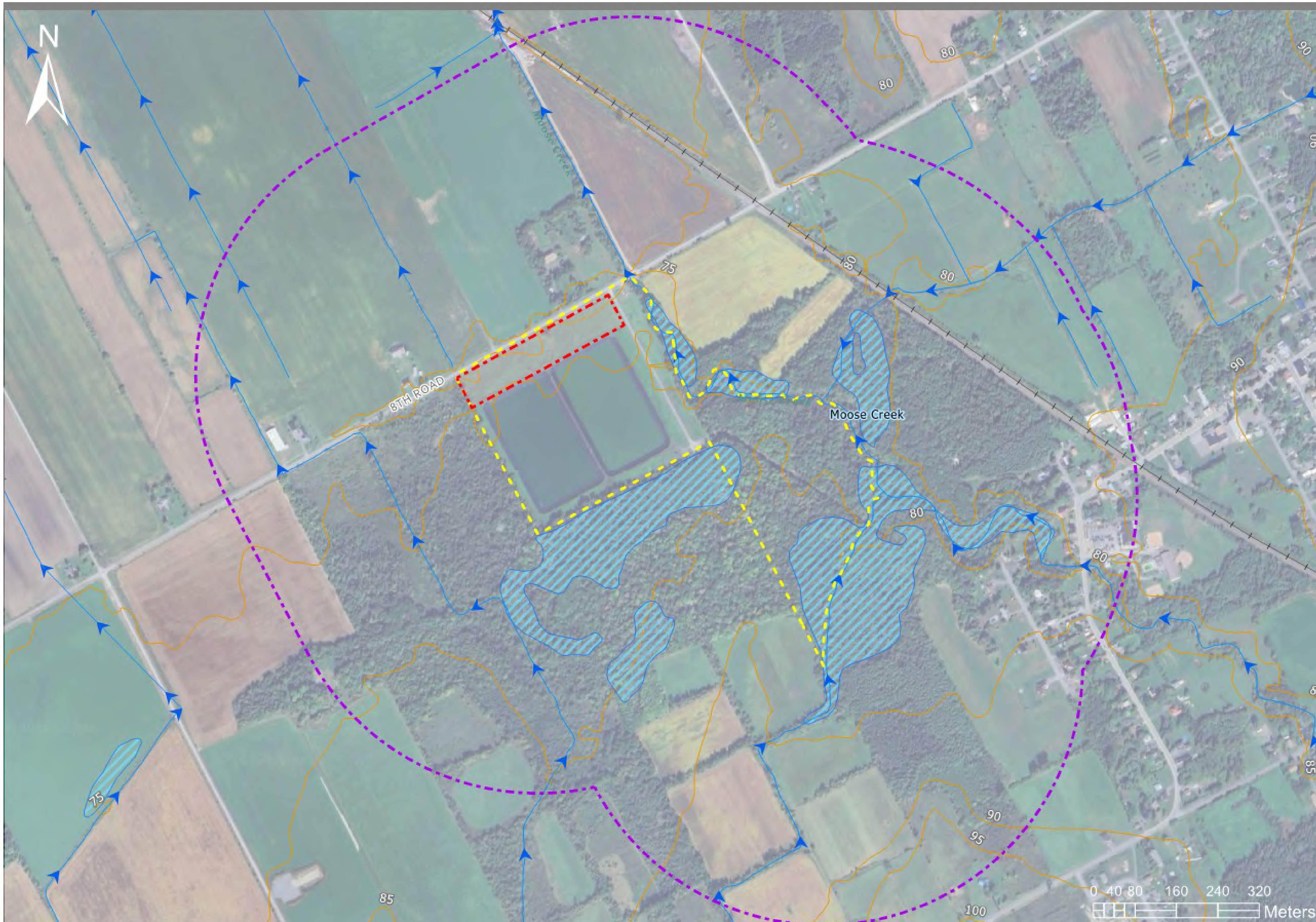
Figure 1 - Site Location Map

Desktop Hydrogeological and Geotechnical Assessment - Moose Creek Wastewater Treatment Lagoon Class EA
18T 5011986 N; 500847 E, Moose Creek, Ontario
OCWA

Survey by : -
Figure by : S. Scott
Concept by : S. Scott
Verified by : M. Klein

Ref # : Z0028411-500

Revision 00 - - Issued for report - September 23, 2025 1:50:37 PM



Site
Class EA Study Area
Study Area - 500 m
Unevaluated Wetland
Railway
Topographic Countours - 5 m
Watercourse

Spatial Reference:
Name: NAD 1983 CSRS MTM 8
GCS: GCS North American 1983 CSRS
Datum: North American 1983 CSRS
Map Units: Meter
Scale: 1:7,800

Sources:

- Railway, Road Labels, Topographic Contours, Unevaluated Wetlands, LIO, 2024
- Watercourses, OHN, 2024
- Basemap : Google Earth Imagery, 2023

General Notes:
Dimensions on the plan should be read and not measured.
Any errors or omissions should be reported to CIMA +. The boundaries, areas, and title deeds must be verified by a surveyor.

Figure 2 - Topography and Drainage Map

Desktop Hydrogeological and Geotechnical Assessment - Moose Creek Wastewater Treatment Lagoon Class EA
18T 5011986 N; 500847 E, Moose Creek, Ontario
OCWA

Survey by : -
Figure by : S. Scott
Concept by : S. Scott
Verified by : M. Klein

Ref # : Z0028411-500

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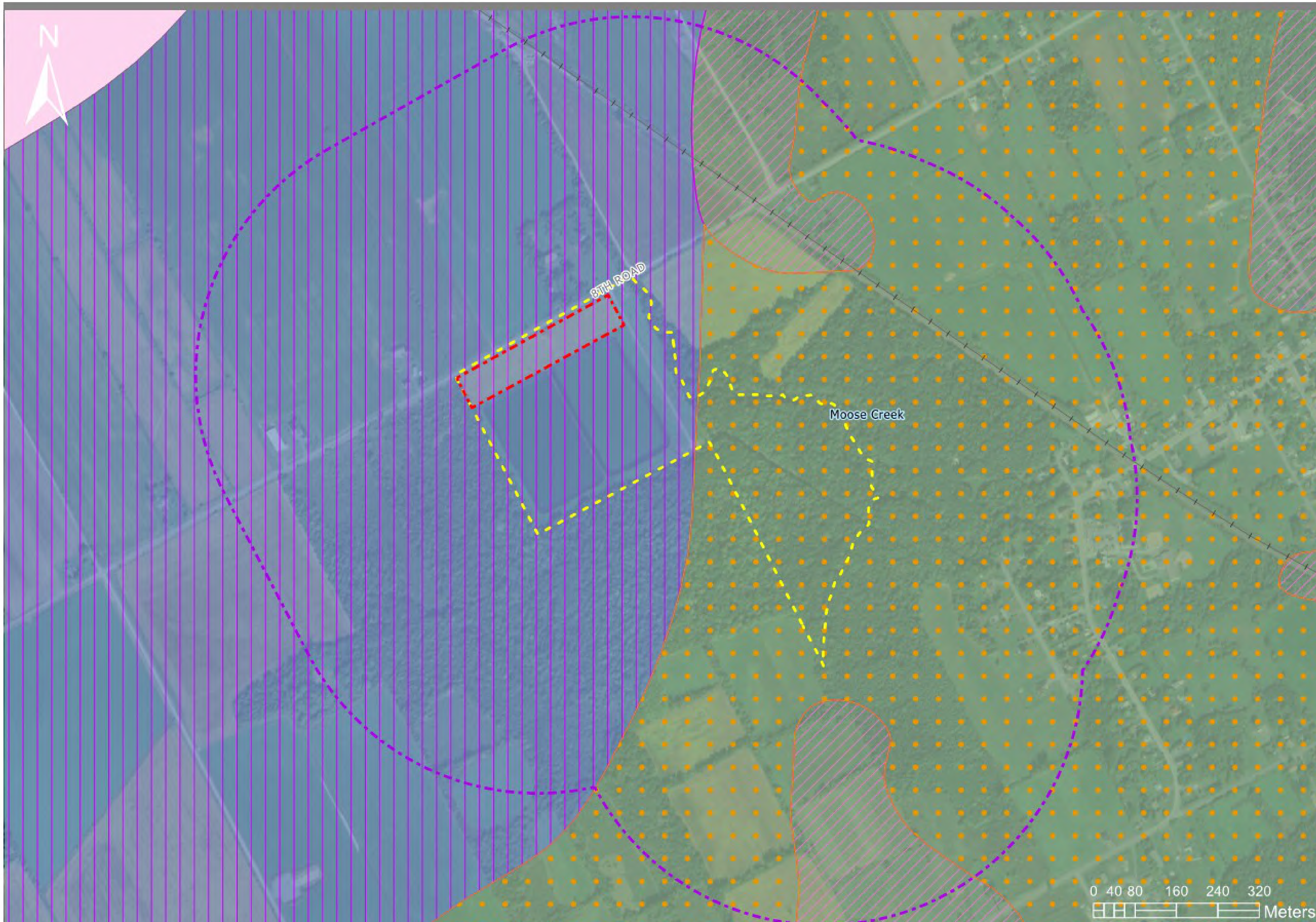

- Site
- Class EA Study Area
- Study Area - 500 m
- Railway

Physiographic Units

- Beaches
- Clay Plains
- Peat And Muck
- Sand Plains

Physiographic Regions

- Glengarry Till Plain
- Winchester Clay Plain

Spatial Reference:
Name: NAD 1983 CSRS MTM 8
GCS: GCS North American 1983 CSRS
Datum: North American 1983 CSRS
Map Units: Meter
Scale: 1:7,800

Sources:

- Chapman, L.J. and Putnam, D.F. 2007. Physiography of southern Ontario;
- Basemap : Google Earth Imagery, 2023

General Notes:
Dimensions on the plan should be read and not measured.
Any errors or omissions should be reported to CIMA +. The boundaries, areas, and title deeds must be verified by a surveyor.

Figure 3 - Physiography Map

Desktop Hydrogeological and Geotechnical Assessment - Moose Creek Wastewater Treatment Lagoon Class EA
18T 5011986 N; 500847 E, Moose Creek, Ontario
OCWA

Survey by : -
Figure by : S. Scott
Concept by : S. Scott
Verified by : M. Klein

Ref # : Z0028411-500

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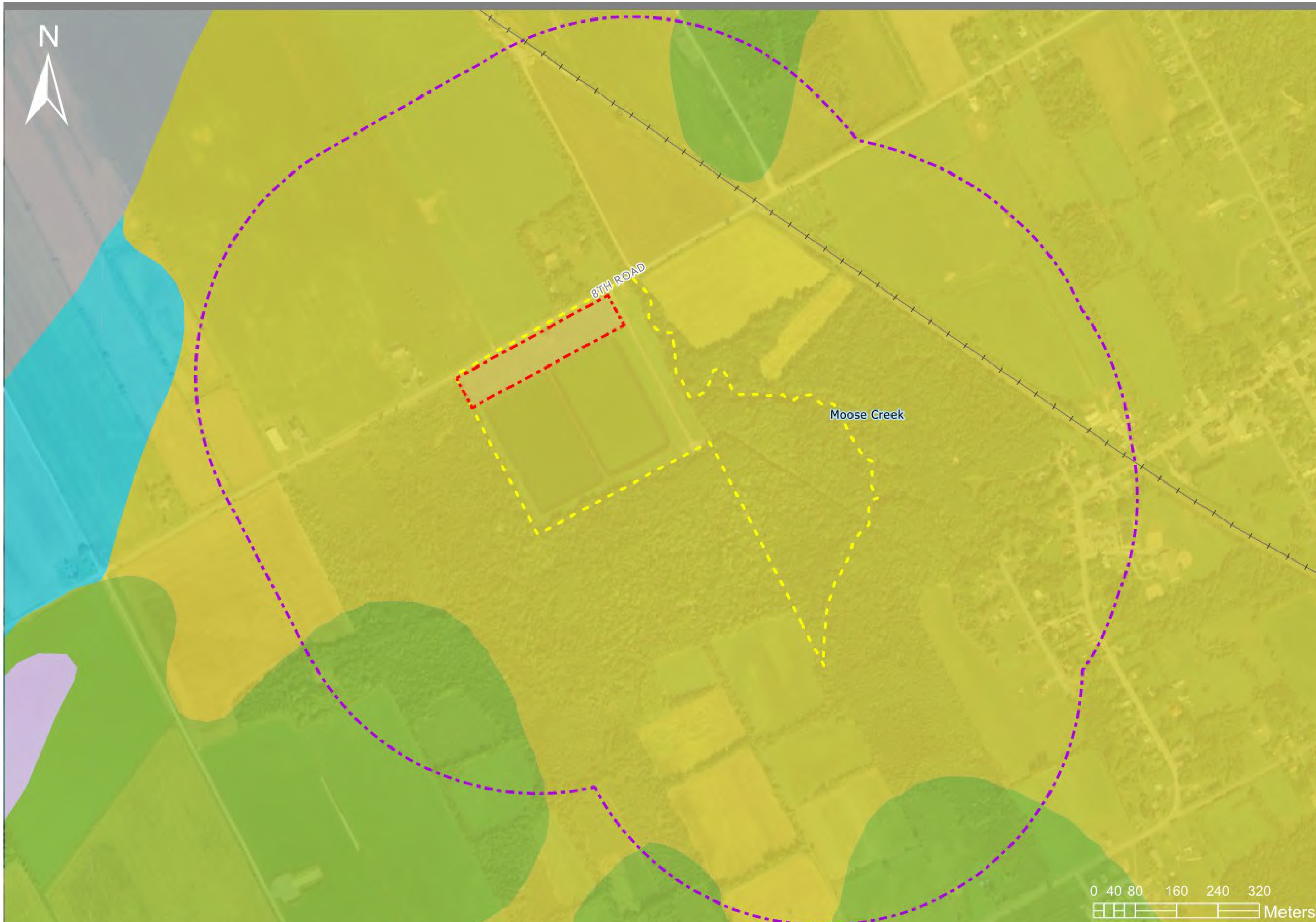

Site

Class EA Study Area

Study Area - 500 m

Railway

Surficial Geology

3: Paleozoic bedrock

5b: Stone-poor, carbonate-derived silty to sandy till

10a: Massive-well laminated

11c: Foreshore-basinal deposits

20: Organic deposits

Spatial Reference:
Name: NAD 1983 CSRS MTM 8
GCS: GCS North American 1983 CSRS
Datum: North American 1983 CSRS
Map Units: Meter
Scale: 1:7,800

Sources:
- Ontario Geological Survey 2010. Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release-Data 128 - Revised.
- Basemap : Google Earth Imagery, 2023

General Notes:
Dimensions on the plan should be read and not measured. Any errors or omissions should be reported to CIMA +. The boundaries, areas, and title deeds must be verified by a surveyor.

Figure 4 - Surficial Geology Map

Desktop Hydrogeological and Geotechnical Assessment - Moose Creek Wastewater Treatment Lagoon Class EA
18T 5011986 N; 500847 E, Moose Creek, Ontario
OCWA

Survey by : -
Figure by : S. Scott
Concept by : S. Scott
Verified by : M. Klein

Ref # : Z0028411-500

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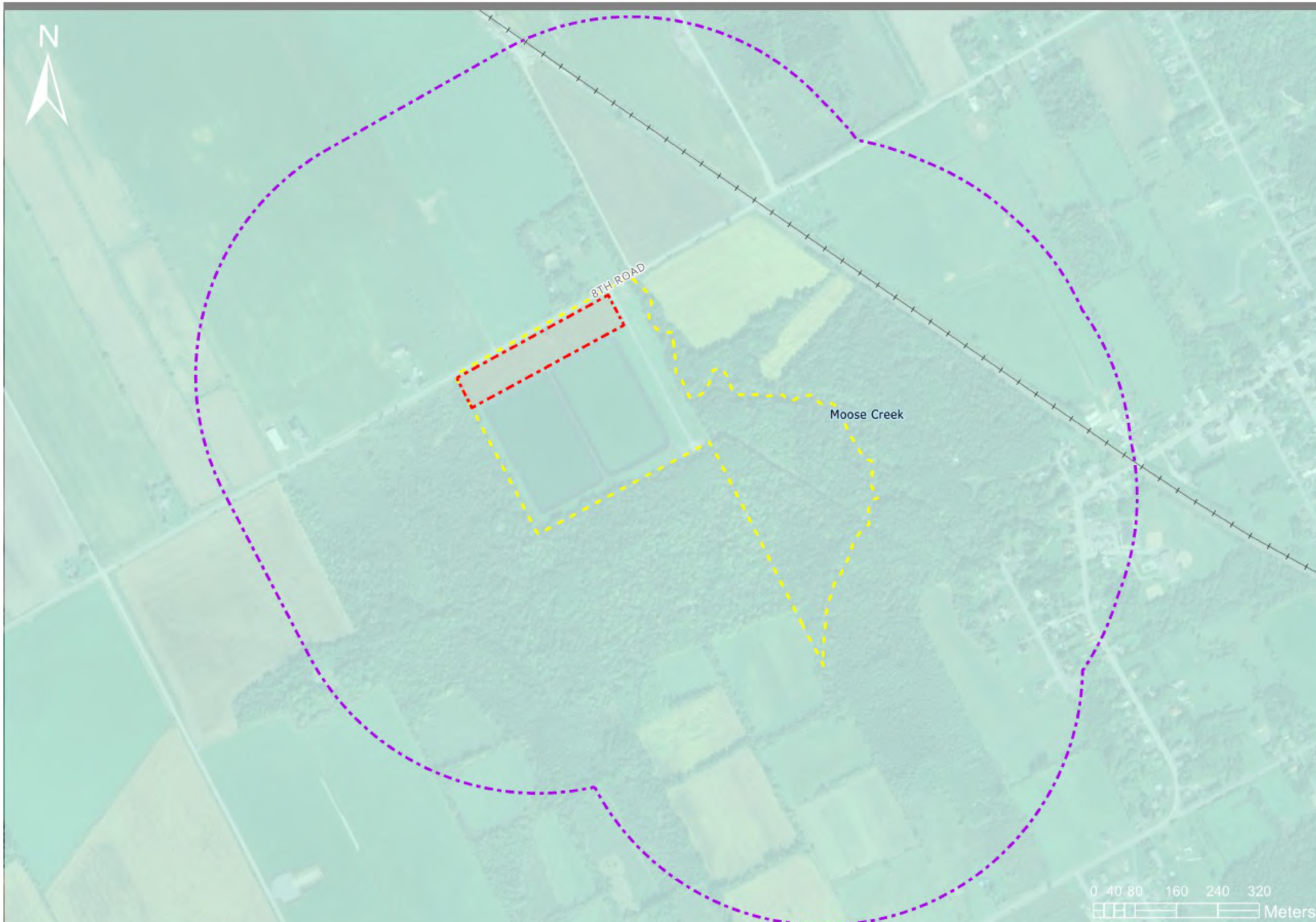

Site
Class EA Study Area
Study Area - 500 m
Railway

Bedrock Geology

54a,Limestone, dolostone, shale, arkose, sandstone

Spatial Reference:
Name: NAD 1983 CSRS MTM 8
GCS: GCS North American 1983 CSRS
Datum: North American 1983 CSRS
Map Units: Meter
Scale: 1:7,800

Sources:
- Ontario Geological Survey 2011. 1:25,000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Data 126 Release Rev 1.
- Basemap : Google Earth Imagery, 2023

General Notes:
Dimensions on the plan should be read and not measured.
Any errors or omissions should be reported to CIMA+. The boundaries, areas, and title deeds must be verified by a surveyor.

Figure 5 - Bedrock Geology Map

Desktop Hydrogeological and Geotechnical Assessment - Moose Creek Wastewater Treatment Lagoon Class EA
18T 5011986 N; 500847 E, Moose Creek, Ontario
OCWA

Survey by : -
Figure by : S. Scott
Concept by : S. Scott
Verified by : M. Klein

Ref # : Z0028411-500

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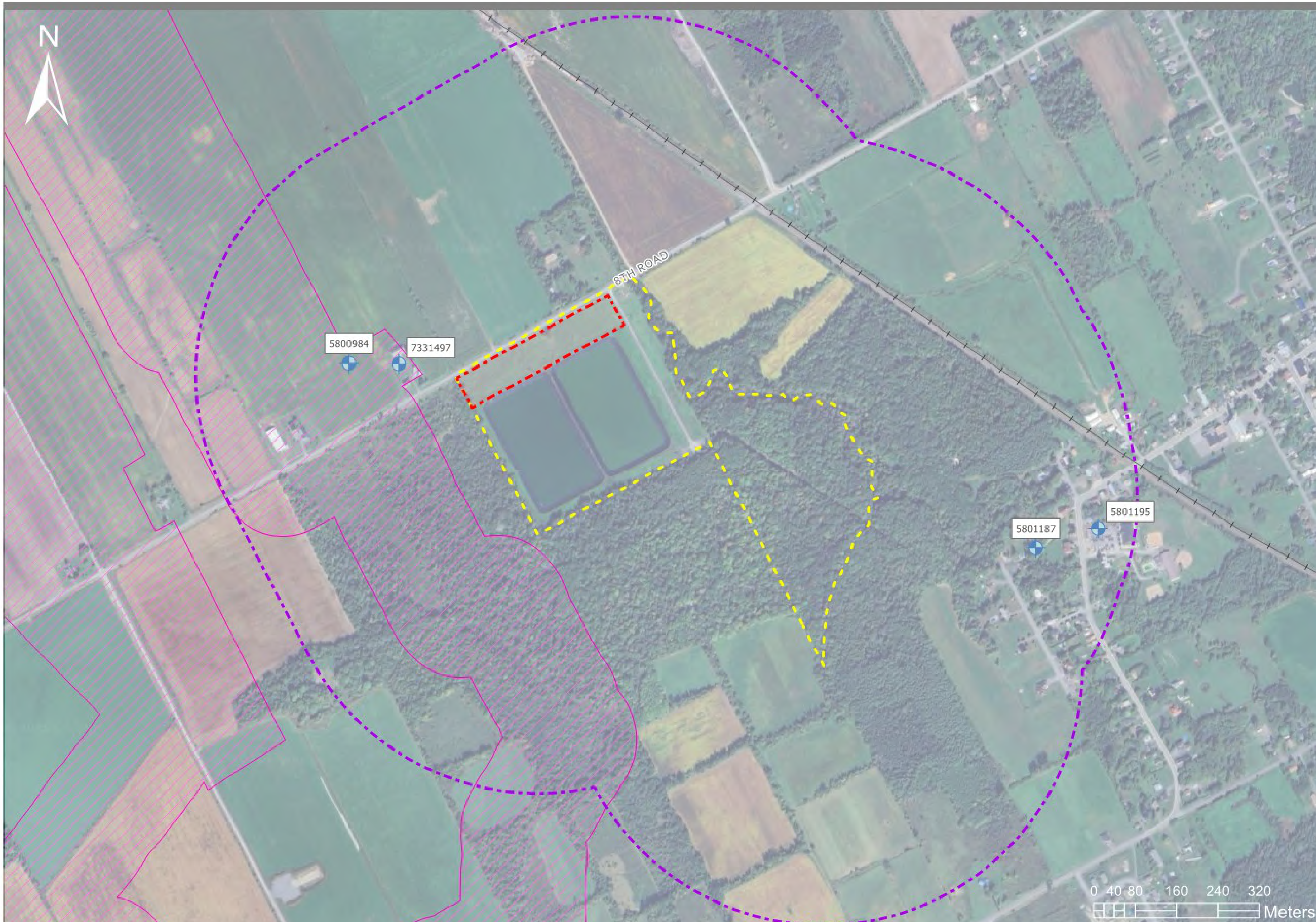


Site
Class EA Study Area
Study Area - 500 m
Railway
MECP Well Records

Source Water Protection Features

Intake Protection Zone

IPZ-3a

Spatial Reference:
Name: NAD 1983 CSRS MTM 8
GCS: GCS North American 1983 CSRS
Datum: North American 1983 CSRS
Map Units: Meter
Scale: 1:7,800

Sources:
- IPZ, SNCA, 2025
- Well Records, MECP, 2025
- Railway, Road Labels, LIO, 2024
- Basemap : Google Earth Imagery, 2023

General Notes:
Dimensions on the plan should be read and not measured.
Any errors or omissions should be reported to CIMA+. The boundaries, areas, and title deeds must be verified by a surveyor.

Figure 6 - MECP Well Record Locations & Source Water Protection Features

Desktop Hydrogeological and Geotechnical Assessment - Moose Creek Wastewater Treatment Lagoon Class EA
18T 5011986 N; 500847 E, Moose Creek, Ontario
OCWA

Survey by : -
Figure by : S. Scott
Concept by : S. Scott
Verified by : M. Klein

Ref # : Z0028411-500

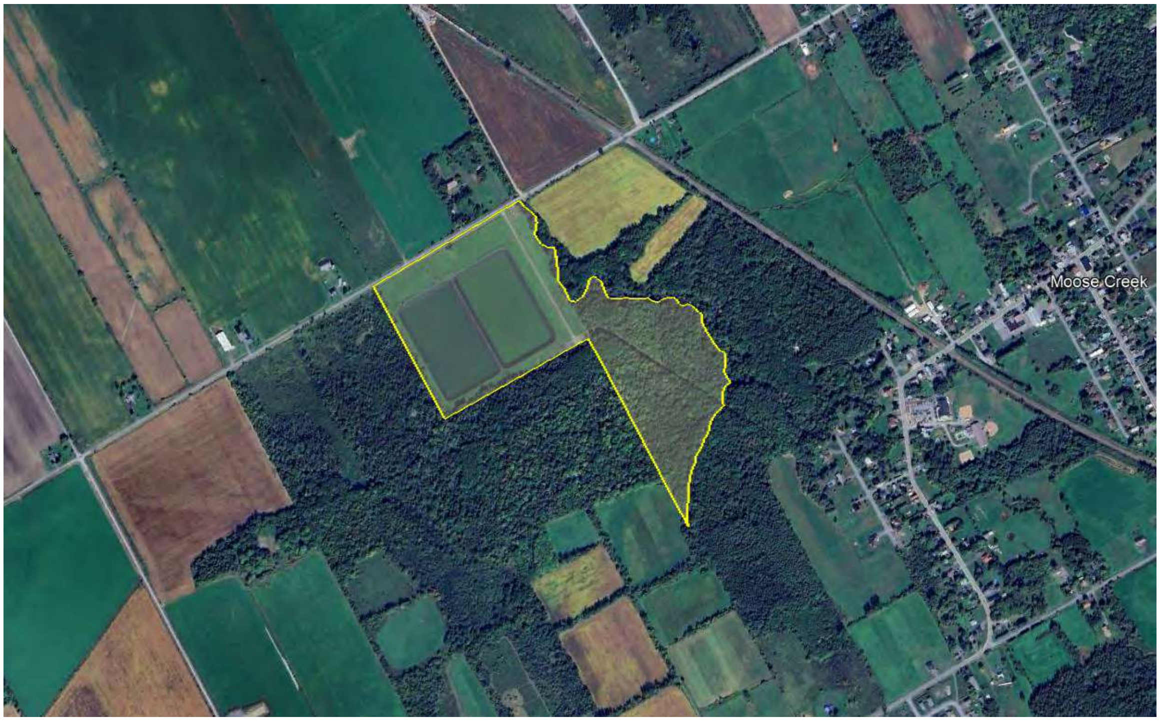
Revision 00 - - Issued for report - September 23, 2025 4:38:00 PM

B

Appendix B
Air Photos

Aerial Photograph – Google Earth
Moose Creek WWTP, 8th Road and surrounding area
2009
Moose Creek (Ontario)

Aerial Photograph – Google Earth
Moose Creek WWTP, 8th Road and surrounding area
2015
Moose Creek (Ontario)



Aerial Photograph – Google Earth
Moose Creek WWTP, 8th Road and surrounding area
2023
Moose Creek (Ontario)

C

Appendix C
Well Records

m)

UTM 18 Z 5004500 E

Con VIII R 5011725 N 316/7W

Lot 5 R 232401

Elev.

Basin 25 1 | Stormont

The Ontario Water Resources Commission Act

WATER RESOURCES DIVISION
JAN 20 1965
ONTARIO WATER RESOURCES COMMISSION

No. 58 ~~84~~

WATER WELL RECORD

County or District Stormont Township, Village, Town or City Roxborough

Con. 8 Lot 23 W Date completed 21 (day) nov. (month) 1964 (year)

[redacted]dress Moose creek Ont

Casing and Screen Record	
Inside diameter of casing	5"
Total length of casing	22'
Type of screen	
Length of screen	
Depth to top of screen	
Diameter of finished hole	5"

Pumping Test	
Static level	10 feet from the top
Test-pumping rate	5 G.P.M.
Pumping level	15 feet from top
Duration of test pumping	1 hour
Water clear or cloudy at end of test	clear
Recommended pumping rate	5 G.P.M.
with pump setting of	25 feet below ground surface

Well Log / **Water Record**

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Red clay	0	10	27	fresh
Hard pan	10	18		
Gravel	18	22		
Grey rock	22	30		

For what purpose(s) is the water to be used? for a farm

Is well on upland, in valley, or on hillside? valley

Drilling or Boring Firm Gilles Bourgeois

Address St albert Ont

Licence Number 1304

Name of Driller or Borer same

Address same

Date 21 nov. 64

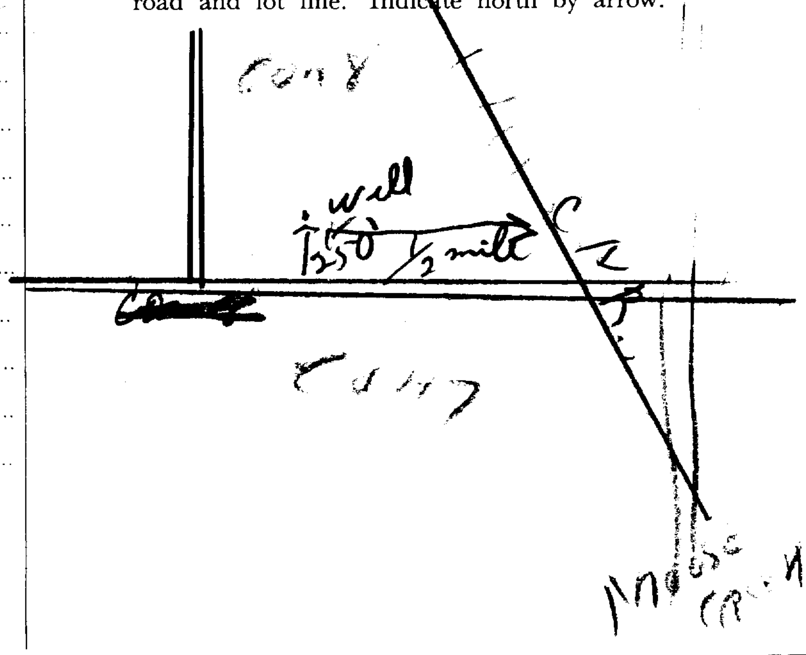
Gilles Bourgeois
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



31G/74

The Ontario Water Resources Commission Act

WATER WELL RECORD

Water management in Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5801187 | MUNICIP. 58004 | CON. CON 07

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
Stormont	Roxborough.	7	~~19~~ 20 / 020

[redacted]S ... oose Creek, Ontario. — DATE COMPLETED: DAY 01. MO ~~Oct.~~ 10 YR 70.

[redacted]THING 011140d | RC. 4 | ELEVATION 0275 | RC. 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	TO
Brown.		Sand.		0	20
Brown.		Limestone Rock.		20	122.

31 | 0020409 | 0122615

32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0113	☒ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	TO
06.	☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	.188	0	0030 (~~30~~)
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☒ OPEN HOLE			0122
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: ☐ PUMP ☒ BAILER

PUMPING RATE: 0000 — ~~150 Gal. every 12 hrs.~~

DURATION OF PUMPING: HOURS / MINS.

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
020 FEET	122 FEET	122 FEET	122 FEET	122 FEET	122 FEET

WATER LEVELS DURING: ☒ PUMPING ☐ RECOVERY

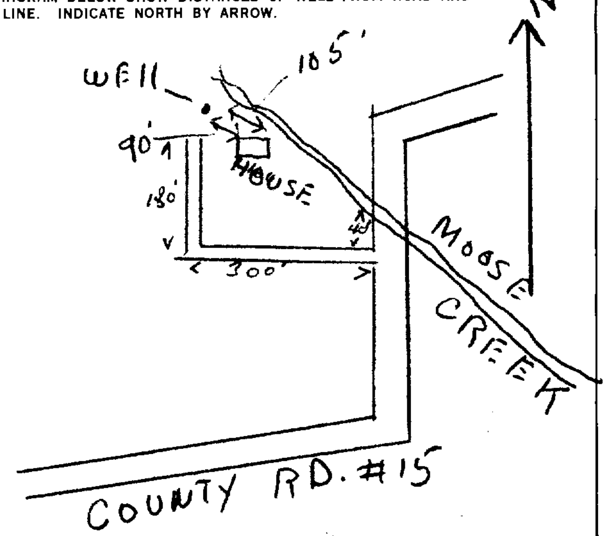
IF FLOWING, GIVE RATE: GPM. | PUMP INTAKE SET AT: FEET | WATER AT END OF TEST: ☒ CLEAR ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP | RECOMMENDED PUMP SETTING: FEET | RECOMMENDED PUMPING RATE: GPM.

000.0 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS:

FINAL STATUS OF WELL

☒ WATER SUPPLY ☐ OBSERVATION WELL ☐ TEST HOLE ☐ RECHARGE WELL ☐ ABANDONED, INSUFFICIENT SUPPLY ☐ ABANDONED, POOR QUALITY ☐ UNFINISHED

WATER USE 01

☒ DOMESTIC ☐ STOCK ☐ IRRIGATION ☐ INDUSTRIAL ☐ OTHER ☐ COMMERCIAL ☐ MUNICIPAL ☐ PUBLIC SUPPLY ☐ COOLING OR AIR CONDITIONING ☐ NOT USED

METHOD OF DRILLING

☒ CABLE TOOL ☐ ROTARY (CONVENTIONAL) ☐ ROTARY (REVERSE) ☐ ROTARY (AIR) ☐ AIR PERCUSSION ☐ BORING ☐ DIAMOND ☐ JETTING ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: Ramon H. Casselman — LICENCE NUMBER: 1505.

ADDRESS: Williamsburg, Ontario.

NAME OF DRILLER OR BORER: Lorne Barkley. — LICENCE NUMBER:

SIGNATURE OF CONTRACTOR: Ramon H Casselman — SUBMISSION DATE: DAY 1. MO Oct. YR 70.

OFFICE USE ONLY

DATA SOURCE: 1 | CONTRACTOR: 1505 | DATE RECEIVED: 240271

DATE OF INSPECTION: | INSPECTOR: Hun. Elm.

REMARKS:

OWRC COPY

The Ontario Water Resources Commission Act

WATER WELL RECORD

31-9 7 W

Water management in Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5801195 | MUNICIP. 58094 | CON. CON | 07

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
Stormont	Roxborough	St Patrick (7) St. BR	019

[redacted] ...ose Creek

DATE COMPLETED: DAY 22 MO. 05 YR. 71

11450 | RC. 4 | ELEVATION 0275 | RC. 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	TO
Brown		sandy gravel		0	10
				10	17
Gray	Rock	Limestone		17	180

Dry

31 | 0010099 | 0017 11 | 0180215
32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

N/A

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	TO
	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	188'	0	0017
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE			0180
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☐ BAILER | PUMPING RATE GPM. | DURATION OF PUMPING HOURS MINS.

STATIC LEVEL FEET | WATER LEVEL END OF PUMPING FEET | WATER LEVELS DURING: 1 ☐ PUMPING 2 ☐ RECOVERY — 15 MINUTES FEET, 30 MINUTES FEET, 45 MINUTES FEET, 60 MINUTES FEET

IF FLOWING, GIVE RATE GPM | PUMP INTAKE SET AT FEET | WATER AT END OF TEST: 1 ☐ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☐ DEEP | RECOMMENDED PUMP SETTING FEET | RECOMMENDED PUMPING RATE GPM.

GPM./FT. SPECIFIC CAPACITY

N/A

FINAL STATUS OF WELL

1 ☐ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☒ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE

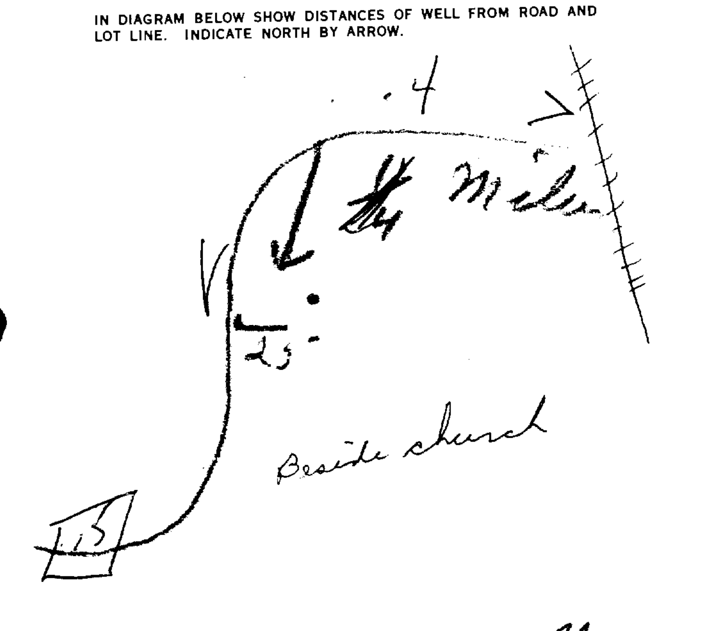
1 ☐ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☒ NOT USED

METHOD OF DRILLING

1 ☒ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS: Moose-Creek Village

CONTRACTOR

NAME OF WELL CONTRACTOR: Cayer Well driller | LICENCE NUMBER: 1517

ADDRESS:

NAME OF DRILLER OR BORER: Claude Cayer | LICENCE NUMBER: 1517

SIGNATURE OF CONTRACTOR: Maurice Cayer | SUBMISSION DATE: DAY 22 MO. 5 YR. 71

OFFICE USE ONLY

DATA SOURCE: 1 | CONTRACTOR: 1517 | DATE RECEIVED: 270571

DATE OF INSPECTION: | INSPECTOR: Km.

REMARKS: | P | WI

OWRC COPY

Ontario — Ministry of the Environment and Climate Change

Well Tag No.: A236254 — Tag#: A236254

Well Record

Regulation 903 Ontario Water Resources Act

Page ___ of ___

Measurements recorded in: ☒ Metric ☐ Imperial

[redacted]

Address of Well Location (Street Number/Name)	16605 Eight Road, Cty Rd6
Township	
Lot	26
Concession	8
County/District/Municipality	
City/Town/Village	Moose Creek
Province	Ontario
Postal Code	K0C1W0
UTM Coordinates Zone / Easting / Northing	NAD 83 18 500574 5011940
Municipal Plan and Sublot Number	
Other	

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	To
	well previously	Drill	from	1	12.2
	Extand casing	and	Re-Instal pamp		
	at 10m Deep				

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	1	Bentonyte	

Method of Construction

☐ Cable Tool ☐ Diamond ☐ Rotary (Conventional) ☐ Jetting ☐ Rotary (Reverse) ☐ Driving ☐ Boring ☐ Digging ☐ Air percussion ☐ Other, specify

Well Use

☐ Public ☐ Commercial ☐ Not used ☐ Domestic ☐ Municipal ☐ Dewatering ☐ Livestock ☐ Test Hole ☐ Monitoring ☐ Irrigation ☐ Cooling & Air Conditioning ☐ Industrial ☐ Other, specify

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
15.55	Steel	.48	+6	7.6
15.55	Open Hole		7.6	12.2

Status of Well

☐ Water Supply ☐ Replacement Well ☐ Test Hole ☐ Recharge Well ☐ Dewatering Well ☐ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☐ Abandoned, other, specify ☐ Other, specify

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To

Results of Well Yield Testing

After test of well yield, water was: ☐ Clear and sand free ☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ___ hrs + ___ min

Final water level end of pumping (m/ft)

If flowing give rate (l/min / GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min / GPM)

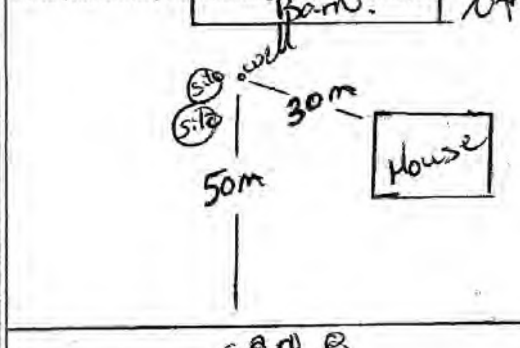
Well production (l/min / GPM)

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level	3.06		
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Map of Well Location

Please provide a map below following instructions on the back.



Water Details

Water found at Depth ___ Kind of Water: ☐ Fresh ☐ Untested (m/ft) ☐ Gas ☐ Other, specify

Water found at Depth ___ Kind of Water: ☐ Fresh ☐ Untested (m/ft) ☐ Gas ☐ Other, specify

Water found at Depth ___ Kind of Water: ☐ Fresh ☐ Untested (m/ft) ☐ Gas ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	12.2	15.55

Well Contractor and Well Technician Information

Business Name of Well Contractor	Bourgeois Well Drilling Ltd.
Well Contractor's Licence No.	7417
Business Address (Street Number/Name)	4245 Conc. 10-11
Municipality	Crysler
Province	On
Postal Code	K0A1R0
Business E-mail Address	N/A
Bus. Telephone No. (inc. area code)	6139875291
Name of Well Technician (Last Name, First Name)	GENIER, MICHAEL
Well Technician's Licence No.	3493
Signature of Technician and/or Contractor	[signature]
Date Submitted	20180418

Comments:

Well owner's information package delivered	Date Package Delivered	Ministry Use Only
☒ Yes ☐ No	20180419	Audit No. Z284952
	Date Work Completed: 20180419	Received: APR 16 2019

0506E (2014/11) — Ministry's Copy

H

Appendix H: Stage 1 Archaeological Assessment Report and MCM submission correspondence

ORIGINAL REPORT

Stage 1 Archaeological Assessment

Moose Creek Wastewater Treatment Lagoon, 16810 8th Road, Part of Lot 21 and 22, Concession 7, Geographic Township of Roxborough, now the Township of North Stormont, United Counties of Stormont, Dundas and Glengarry

Archaeological Licensee: Randy Hahn (P1107)

PIF Number: P1107-0087-2025

Submitted to:

CIMA+
600 – 1400 Blair Towers Place
Ottawa, Ontario
K1J 9B8

Submitted by:

True North Archaeological Services Inc.
220 Terence Mattews Crescent, Unit 2D, Ottawa K2M 0E2

TNAS Project Number: 2025034

30 July 2025

Distribution List

1 e-copy – CIMA+

1 e-copy – True North Archaeological Services Inc.

1 e-copy – Ministry of Citizenship and Multiculturalism

Project Personnel

Client Contact:	Bradley Young, PhD, PEng
Project Manager:	Bradley Drouin, MA (P311)
Licensed Archaeologist:	Randy Hahn, PhD (P1107)
Field Director:	Randy Hahn, PhD (P1107)
Report Preparation:	Randy Hahn, PhD (P1107)
	Gabryell Kurtzrock Belyea, MA (R1195)
Spatial IM:	Gabryell Kurtzrock Belyea, MA (R1195)
Senior Technical Review:	Aaron Mior, M.MA (P1077)

Report Abbreviations

TNAS	True North Archaeological Services Inc.
MCM	Ministry of Citizenship and Multiculturalism
PIF	Project Information Form issued by the MCM
ASDB	Archaeological Sites Database maintained by the MCM
CHVI	Cultural Heritage Value or Interest
BP	Years Before Present
ha	Hectare
km	Kilometre
m	Metre

Executive Summary

The Executive Summary highlights key points from the report only; for complete information and findings, as well as the limitations, the reader should examine the complete report.

True North Archaeological Services Inc. (TNAS) was retained by CIMA+ to undertake a Stage 1 archaeological assessment to support upgrades to the Moose Creek Wastewater Treatment Lagoon, situated within 16810 8th Road, Part of Lot 21 and 22, Concession 7, Geographic Township of Roxborough, now the Township of North Stormont, United Counties of Stormont, Dundas and Glengarry (Maps 1 and 2). The study area measures approximately 22.3 ha in area and is located on the existing site and to the east of the Moose Creek Wastewater Treatment Lagoon.

The primary objectives of this Stage 1 archaeological assessment were to identify known archaeological resources within and in the vicinity of the study area, to provide information on previous archaeological investigations conducted in the area, to assess the archaeological potential of the study area and to provide recommendations as to whether any additional archaeological investigations are required to comply with the *Standards and Guidelines for Consultant Archaeologists* issued by the Ministry of Citizenship and Multiculturalism (MCM 2011).

Background research indicates an Indigenous land use within the United Counties of Stormont, Dundas and Glengarry from at least as early as the Paleo Period. The crown patent for Lots 21 and 22, Concession 7 of Roxborough Township was first granted to Euro-Canadian settlers in 1858 and 1876 respectively. By 1878 several homesteads are depicted along County Road 15 and 8th Road with the community of Moose Creek located east of the study area. The navigable waterway of Moose Creek forms the eastern border of the study area. Two large man-made reservoirs associated with the existing Moose Creek Wastewater Treatment Lagoon are located within the western portion of the study area. No previously recorded archaeological sites are known within 1 km of the study area (MCM 2025).

A visual property inspection was completed on 6 June 2025 under PIF P1107-0087-2025. The majority of the study area retains archaeological potential due to its proximity to Moose Creek, seven 19th century homesteads depicted on historical plans (Map 3), and two historical transportation corridors; 8th Road, and Moose Creek. Portions of the study area have been disturbed by the construction of the existing Moose Creek Wastewater Lagoons, a gravel road and parking lot, and deep ditching along 8th Road.

The results of the Stage 1 archaeological assessment documented within this report formed the basis for the following recommendations:

1) The portions of the study area identified as retaining archaeological potential in Map 9 are recommended for Stage 2 archaeological assessment by a licensed archaeologist prior to development impacts. The Stage 2 archaeological assessment should be a test pit survey involving the hand excavation of test pits at 5 m intervals following the standards outlined in Section 2.1.2 of the MCM's (2011) *Standards and Guidelines for Consultant Archaeologists.*
2) The portions of the study area identified as disturbed in Map 9 are recommended for no additional archaeological assessment.
3) Should ground disturbance extend beyond the area shown in Map 9, additional archaeological assessment may be required.

This report is submitted to the Ministry of Citizenship and Multiculturalism as a condition of licensing obligations in accordance with Part VI of the Ontario Heritage Act, R.S.O. 1990, c. 0.18. The report is

reviewed to ensure that the licensed consultant archaeologist has met the terms and conditions of their archaeological license, and that the archaeological field work and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario.

Table of Contents

1.0 Project Context

1.1 Development Context

True North Archaeological Services Inc. (TNAS) was retained by CIMA+ to undertake a Stage 1 archaeological assessment to support upgrades to the Moose Creek Wastewater Treatment Lagoon, situated within 16810 8th Road, Part of Lot 21 and 22, Concession 7, Geographic Township of Roxborough, now the Township of North Stormont, United Counties of Stormont, Dundas and Glengarry (Maps 1 and 2). The study area measures approximately 22.3 ha in area and is located on the existing site and to the east of the Moose Creek Wastewater Treatment Lagoon.

This archaeological assessment was triggered by the requirements of the Planning Act, 1990, in accordance with the Ontario Heritage Act, 1990. The assessment was carried out in accordance with the Ministry of Citizenship and Multiculturalism's (MCM) *Standards and Guidelines for Consultant Archaeologists* (MCM 2011).

Permission to access the study area was provided by CIMA+ with no limitations or restrictions.

1.2 Objectives

This Stage 1 archaeological assessment was completed to identify known archaeological resources on, or in the vicinity of, the project area as well as to assess the archaeological potential of the study area. The objectives of a Stage 1 archaeological assessment are based on principals outlined in the *Ontario Heritage Act* (consolidated 2007) and the MCM's *Standards and Guidelines for Consultant Archaeologists* (2011). More specifically, this Stage 1 archaeological assessment was completed with the following objectives:

- To provide information about the study area's geography, environment, cultural history, previous archaeological fieldwork and current land condition.
- To evaluate in detail the study area's archaeological potential, which will support recommendations for Stage 2 survey for all or parts of the property.
- To recommend appropriate strategies for Stage 2 field survey.

1.3 Historical Context

1.3.1 Regional Indigenous Context

The following historical narrative is intended to provide a general overview of the interpreted land use during the "Pre-Contact and Post-Contact Periods" within the vicinity of the current study area. This historical overview generally reflects inferences and interpretations based on archaeological and historical interpretations primarily made by non-Indigenous representatives.

This section is intended to provide a general historical overview that can be referenced when determining the potential for archaeological resources within the current project study area. The text and comments below, including the cited references, may reflect archaeological literature within general publications, but may not represent the opinions of those Indigenous communities whose history it is purported to reflect.

Paleo Period (11,000 – 9,000 BP)

The Paleo Period represents a temporal classification developed by archaeologists and may not necessarily reflect the current world view of Indigenous peoples. Based on archaeological research, human occupation of eastern Ontario dates back approximately 11,000 years before present (BP) depending on the sources that are reviewed. This time period is commonly referred to by archaeologists as the Paleo Period. Following the period of deglaciation, much of eastern Ontario was inundated by the Champlain Sea, which is interpreted to have extended from Rideau Lakes in the south, along the Ottawa Valley and St. Lawrence areas and terminating around Petawawa in the west (Watson 1999). The exact western boundary is undetermined as current elevation levels reflect the isostatic adjustment of the land following the melting of the glaciers and cannot be used to determine the exact location of the Champlain Sea at the time of its existence (Chapman and Putnam 1984). The eastern portion of the sea extended into the Atlantic Ocean.

During the Early and Middle Paleo Periods (13,000 – 9,500 BP) the study area would have remained inundated by the Champlain Sea, although as the Champlain Sea receded during the Late Paleo Period (9,500 – 9,000 BP) it is likely that people migrated along the changing waterfront landscape where vegetation was being re-established (Watson 1999). The ridges and old shorelines of the Champlain Sea and early Ottawa River channels reflect areas most likely to contain evidence of Paleo Period land use in the region. Archaeological and geological investigations in the Ottawa Valley have indicated these early sites may be identified within the 550 ft (167.6 m) or higher contour topography, although additional research may be required to confidently assess this correlation (Kennedy 1976). As the majority of the material remains collected from Paleo sites are typically manufactured from stone, representative diagnostic materials include finely crafted lanceolate type projectile points that typically exhibit parallel flake scars and as well as flutes for easier hafting (Ellis and Deller 1997).

By the Late Paleo Period (9,500 - 9,000 BP), enclosed coniferous forests with some minor deciduous elements became established in eastern Ontario, with contemporary populations traversing large territories in response to seasonal resource fluctuations. The transition to the Late Paleo Period also included projectile points comprised of smaller unfluted projectiles along with lanceolate parallel flaked stemmed and non-stemmed Plano points, while hunting strategies may have transitioned from communal groups to more individualized pursuits (Ellis and Deller 1997). Isolated finds of the distinctive, parallel-flaked Paleo Indigenous Period spear points have been recorded in the Rideau Lakes area and north of Kingston (Watson 1982). Given the paucity of sites within Ontario compared to later Periods, and the lack of organic remains, minimal tangible materials have been recovered to provide insights into past human practices during this period. However, it is suggested contemporary populations were highly mobile hunters and gatherers relying on caribou, small game, fish and wild plants found in the sub-arctic environment (Ellis and Deller 1997; Ellis 2013).

There is one registered archaeological site in the United Counties of Stormont, Dundas and Glengarry with a potential Paleo Period component. The Francis Island site (BgFp-15), located along the St. Lawrence River east of Cornwall, represents the remains of an Indigenous campsite with occupations dating from the Paleo to Woodland periods (MCM 2025).

Archaic Period (9,000 – 2,950 BP)

During the Early Archaic Period (9,000 – 8,000 BP), a gradual increase in atmospheric humidity in conjunction with warmer summers influenced the environmental landscape within the general study area vicinity. Fossil pollen and spore identification from sedimentation cores lifted from Lovesick Lake provided evidence of climate change, with jack pine forests becoming dominant during the beginning of the Early Archaic Period (Teichroeb 2007).

Concurrent with the environmental evolution were notable diagnostic technological changes including the appearance of side and corner-notched projectile points used for hunting. Other significant innovations included the introduction of ground stone tools such as celts and axes, which may reflect an emerging woodworking industry.

As more land became accessible following the retreat of the glacial lakes and the warming climate, Archaic Period populations continued as hunter-gatherers; however, they appear to have focused more on local food resources, abandoning the highly mobile lifestyle of their predecessors. It is during the Archaic Period that there is also a distinct shift in technology with Archaic Peoples beginning to grind stones such as slate, granite, schist and limestone (Ellis 2013). In addition, the fine craftsmanship observed on Paleo Period projectile points is no longer as prevalent and is replaced by smaller projectile points that were either stemmed or corner notched. This technological transition observed in the projectile point styles is related to a shift from using spears as a primary hunting tool to atlatls (Ellis et al 1990). Although Paleo Period workmanship of stone tools had transitioned by the Archaic Period, the overall tool kit became more diversified, reflecting the change to a temperate forest environment. Ground stone tools such as adzes and gouges first appeared and may indicate the construction of dug-out canoes or other heavy wood working activities.

Trade connections across vast territories continued through the Archaic Period, with Late Archaic Period sites documented in greater numbers compared to Early and Middle Archaic Period sites, suggesting the local population was rapidly expanding (Laliberté 1998; Bursey et al. 2013).

There are six Archaic Period archaeological sites registered within the United Counties of Stormont, Dundas and Glengarry (MCM 2025). The closest to the study area is the Adams site (BgFr-8), a Middle Archaic Period campsite located approximately 25 km to the south.

Woodland Period (2,950 – 500 BP)

The Early Woodland Period (2,950 – 2,200 BP) is distinguished from the Late Archaic Period primarily by the introduction of ceramic technology. The first pots were thick walled and friable, suggesting they may have been primarily used in the processing of nut oils by boiling crushed nut fragments in water and skimming off the oil (Spence et al. 1990). These early vessels were not easily portable, and their fragile nature suggests they may have required regular replacement. There have also been numerous Early Woodland Period sites identified where ceramics were absent from the recovered assemblage, suggesting ceramic vessels may not have been completely integrated within the daily lives of Early Woodland Period populations.

Besides the addition of ceramic technology, the cultural affinity of Early Woodland Period inhabitants shows a great deal of continuity with the preceding Late Archaic Period. For instance, birdstones continued to be manufactured, although the Early Woodland Period varieties have "pop-eyes" that protrude from the sides of their heads (Spence et al. 1990). Another example of general continuity from the terminal segment of the Archaic Period is represented by the thin, well-made projectile points, although the Early Woodland Period variants were side-notched rather than corner-notched, giving them a slightly altered and distinctive appearance (Spence et al. 1990).

The Early Woodland Period can be further sub-divided into the Meadowood and Middlesex complexes. Meadowood sites are typically found in southern Ontario while Middlesex complex sites are generally found within eastern Ontario. During the Early Woodland Period groups continued to live primarily as hunters, gatherers and fishers in much the same way as the earlier Archaic Period populations had done with the exception of what appears to be more complex ceremonial and burial practices (Spence et al. 1990). Extensive trade networks are evidenced by the inclusion of funerary objects made from exotic and non-local materials. Specifically, for the Middlesex complex in Ontario, it appears that they were heavily influenced by groups to the south, particularly the Adena people of the Ohio Valley as well as Early Woodland populations within modern-day New York State. Significant Middlesex complex sites within eastern Ontario include the Morrison's Island-2 site located on Morrison's Island in the Ottawa River, the Long Sault Island Mounds in the St. Lawrence River, and the Mound Site located on Tremont Park Island in the St. Lawrence River (Spence et al. 1990).

There is one registered Early Woodland Period archaeological site within the United Counties of Stormont, Dundas and Glengarry. The Glengarry Cairn site (BgFo-1) is campsite, burial ground, and cairn located along the St. Lawrence River with components dating from the Late Archaic Period to the Late Woodland Period.

The transition from the Early to Middle Woodland Period (*ca*. 2,400 to 1,100 BP) is not well defined but can be characterized by an overall increase in decorative styles found on ceramic pots. It is also during this period that regional variants slowly begin to become more evident with three distinct complexes. Within southern Ontario, the Saugeen and Couture complexes are predominant while in eastern and south-central Ontario, Point Peninsula is the predominant complex. Sites associated with the Point Peninsula complex are typically found between the Algonquin Park area east to the St. Lawrence River (Spence et al. 1990).

Due to an increase in overall sites documented within eastern and south-central Ontario, archaeologists have developed a better understanding of how Woodland Period inhabitants utilized the land, which generally reflected more seasonal rounds of hunting and gathering exploiting local flora and fauna within defined territories. During the late fall and winter, small groups would utilize inland "family" hunting areas while in the spring, these dispersed families would congregate at specific lakeshore sites to fish and hunt in the surrounding forest, and socialize. This gathering would last through to the late summer when large quantities of food would be stored for the approaching winter. Within the archaeological record, there's an overall increase in the number of archaeological sites dating to the Middle Woodland Period compared to the Archaic and Early Woodland Periods (Spence et al. 1990). This increase has been attributed to an overall expansion in the Middle Woodland Period population.

There are several Middle Woodland Period sites documented in the South Nation Drainage Basin near Casselman and further south near Winchester and along the Ottawa and St. Lawrence Rivers including the northwest end of Ottawa at Marshall's and Sawdust Bays (Daechsel 1980; Daechsel 1981), as well as at Lac Leamy (Laliberté 1995). Within the United Counties of Stormont, Dundas and Glengarry, 11 Middle Woodland Period archaeological sites have been registered (MCM 2025).

Food sources such as tree nuts and a proliferation of plant greens and seeds were also utilized during the Middle Woodland Period. The seasonal variety and relative dependability of these foods encouraged population growth in many areas. The land use patterns reflected from archaeological investigations of Middle Woodland Period sites generally reflect densely occupied locations that appear on the valley floor of major rivers, often producing sites with significant artifact deposits. Unlike earlier seasonally utilized locations, many Middle Woodland Period sites appear to have functioned as base camps, occupied periodically over the course of the year and situated to take advantage of the greatest number of resources. There are also numerous small upland Middle Woodland Period sites, many of which can be interpreted as special purpose camps where localized natural resources were exploited (MCR 1981).

Ceramics within the Point Peninsula Complex are commonly associated with the Vinette 2 series and are constructed with conoidal or sub-conoidal bases, with slightly flaring rims. Exterior surfaces tend to be smoothed or brushed while the interiors are combed. There is also evidence of modified bone and antler tools consisting of harpoons, combs, fish hooks, and various other tools. Typical lithic assemblages during this complex consist of scrapers, axes, adzes, as well as corner and side notched projectile points, as well as un-notched points (Spence et al. 1990).

The transition from the Middle to Late Woodland Period is marked by the introduction of triangular projectile point styles and cord-wrapped stick decorated ceramics, which are associated with the Princess Point Complex (Martin 2004; Crawford et al. 1997; Bursey 1995; Ferris and Spence 1995; Spence et al. 1990; Williamson 1990; Ritchie 1971), although these attributes may not always reflect diagnostic components of specific Nations as many interacted and shared cultural traits.

Many of the villages maintained by Indigenous People who established agricultural economies during the Late Woodland Period included palisades that enclosed community longhouses (Fox 1990; Smith 1990; Williamson 1990), with the villages often surrounded by gardens and field crops, which were worked by the clan families of the village (Hill 2017).

There are 13 registered Late Woodland Period archaeological sites within the United Counties of Stormont, Dundas and Glengarry (MCM 2025). The closest is the Chesterville 2 site (BgFt-6), located approximately 25 km to the west.

Early contact with European explorers at the end of the Late Woodland Period resulted in changes to the traditional lifestyles of many Indigenous populations, influencing settlement size, population distribution, and material culture. The introduction of European-borne diseases also significantly increased mortality rates, resulting in a drastic decrease in population size (Warrick 2000).

1.3.2 European Contact and Post-Contact Period

During the terminal Late Woodland Period and at the point of contact with Europeans, portions of eastern Ontario along the St. Lawrance River and sections of the South Nation River, were inhabited by the St. Lawrence Iroquois. The first oral accounts of the St. Lawrence Iroquois were recorded in 1534 when Jaques Cartier, accompanied by early settlers encountered two villages of Iroquoian speaking peoples along the Gaspé Peninsula. Encounters with additional Iroquoian speaking peoples continued in 1535 when Jacques Cartier continued to travel up the St. Lawrence River to present day Quebec City (Jamieson 1990).

Material culture associated with the St. Lawrence Iroquois is similar to that of Iroquoian people of the Late Woodland Period. However, some of the key differences include finely manufactured and decorated ceramics with punctates, chevron designs, high collars and pinched bases to collars. Additionally, there is a paucity of flaked stone tools and a higher frequency of bone and antler tools, which are generally considered representative of a typical horticultural society (Jamieson 1990).

In terms of settlement patterns, two general site types have been archaeologically documented within the study area vicinity: small special purpose sites located along the St. Lawrence River (e.g. fishing sites) and larger village type sites located further in-land. Typical features of the larger village sites include multi-row palisades for defense, large longhouses with complex interior features as well as various other features present within the village (Jameison 1990). There is a cluster of Late Woodland Period St. Lawrence Iroquoian sites within close proximity to Spencerville including the Roebuck site, which represents one of the earliest systematically excavated sites in Canada having been investigated by W.J. Wintemberg in 1912 and again in 1914 (Wintermberg 1936).

North of the South Nation River and at times into the St. Lawrence Valley, as well as north-central and the remainder of eastern Ontario, is commonly associated with Anishinaabe Peoples. Samuel de Champlain met with Algonquin representatives in 1603 shortly after he established the first permanent French settlement on the St. Lawrence River at Tadoussac (AOO 2013), with Étienne Brûlé generally acknowledged as the first European to pass through what is now the Ottawa Valley area when he portaged at the Rideau Falls in 1610 and with the aid of Algonquin guides explored the interior of Canada (AOO 2013).

Another French expedition led by Nicholas de Vignau traveled along the Ottawa River through the Ottawa Valley area in 1611 (Pendergast 1999), followed by Samuel de Champlain in 1613 who led the French voyageurs from Montreal, passing the mouth of the Madawaska River, to Morrison Island along the Ottawa River (Croft 2006), which was commonly known as the Grand River (Kichi Sibi in Algonquin) or the River of the Algoumequin (Pilon 2005). Champlain again encountered Algonquins in the Ottawa Valley area in 1615, with many living in regional groups around the Madawaska River, Muskrat Lake, along the Ottawa River above and below Morrison Island, and also along the Mattawa River to Lake Nipissing (AOO 2023).

The French established a relationship with the Algonquin communities around the Ottawa Valley that provided an opportunity to monopolize the early fur trade as the two groups developed close relations throughout the 17th century (Trigger and Day 1994). The colonial economic wealth stimulated by the French fur trade in the early 17th century promoted the rapid expansion northward, with the Ottawa River providing the opportunity to transport goods to the western trading posts on the lakes by canoe, which could not be accomplished by the larger sailing vessels operating on Lake Ontario (Adney and Chapelle 2014).

Competition for furs increased existing tensions between the Algonquin communities and their Indigenous neighbours including the Haudenosaunee Nations, residing to the south around the St. Lawrence River and Lake Ontario areas. The 17th century saw a long period of conflict known as the Beaver Wars between the Algonquin and the Haudenosaunee communities that resulted in the significant disruption of trade. Mohawk raids against Algonquin villages in the Upper Ottawa and St. Lawrence Valleys resulted in the abandonment or destruction of many Algonquin villages (Trigger and Day 1994). Some Algonquin's found refuge in French settlements such as Trois-Rivieres, Quebec City, Sillery, and Montreal while others may have relocated to interior locations along the Ottawa River's tributaries (Holmes 1993). At the end of the 17th century, the Haudenosaunee were driven out of much of southern Ontario by the Mississauga though they continued to occupy areas within eastern Ontario on a seasonal basis.

In 1701, representatives from the Haudenosaunee and more than 20 Anishinaabeg Nations assembled in Montreal to participate in the Great Peace negotiations, sponsored by the French Governor Calliere (Johnston 2006; Johnston 2004). A peace treaty between the Anishinaabeg and the Kanien'kehá:ka (Mohawk) was agreed to once again share in the bounty of the territory as partners (One Dish, One Spoon), although this partnership was strained by the "Great Imbalance" represented by the fur trade with European capitalists (Monague 2022).

The resulting treaty document signed at Montreal was not the only record made of the Peace between the Anishinaabeg and the Haudenosaunee. At a council held at Lake Superior, the Haudenosaunee secured peace by delivering a wampum belt to the Anishinaabeg. This belt was carried by successive generations of leaders who were charged with remembering the meaning of symbols worked upon the shell beads and each generation had a responsibility to renew the peace forged by their ancestors (Johnston 2006).

Between 1712-1716, Algonquin communities continued to utilize the Ottawa Valley and were also observed along the Gatineau River with the primary Haudenosaunee occupation located south of the St. Lawrence River (Holmes 1993).

Following the Seven Years' War in the mid-18th century, the defeat of the French, Algonquin, and their allies by the British and the Haudenosaunee resulted in the further loss of Algonquin hunting territories in southern Quebec and eastern Ontario as the British seized former French colonies. Shortly after the French abandonment around the Great Lakes, English merchant Alexander Henry ventured into the Great Lakes area where he communicated with Anishinaabeg leader Minavanana in September 1761. Henry was informed that the English would suffer retaliation for Anishinaabeg war losses unless the English King made peace with them, with many of the former French forts in the Great Lakes region within Anishinaabeg control. In response, King George III issued a Royal Proclamation on 7 October 1763 acknowledging that Indigenous Nations residing on all lands outside the boundaries of the settled colonies "*not having been ceded to or purchased by Us, are reserved to them, or any of them, as their Hunting Grounds*" (Reimer 2019). The territory reserved for Indigenous Nations encompassed the entire Great Lakes region and peace was secured following discussions between the British and more than 1,500 Anishinaabeg leaders at Niagara Falls in July 1764 where the alliance was sealed by two magnificent wampum belts (Johnston 2006).

Land Treaties

Britain's colonial policy differed from the French, with the British much more interested in securing land surrenders from the Indigenous populations for settlement by Europeans rather than establishing communal relationships. The Royal Proclamation of 1763 issued by King George III enabled the Crown to monopolize the purchase of Indigenous lands west of Quebec and although the proclamation recognized Indigenous rights to their land and hunting grounds, it also included stipulations where these rights could be taken away (Surtees 1994).

The study area is situated within the lands associated the Crawford Purchase, which extends from the north shore of Lake Ontario, east along the St. Lawrence River to the Quebec border (Surtees 1994). On October 9, 1783, through negotiations led by Captain William Crawford with both the Algonquin and Iroquois Nations, the Crawford Agreement was signed. The purchase of the land within the Crawford Agreement was to make available lands for the incoming Loyalist settlers who had fought on behalf of the British during the American revolutionary war.

Land cession agreements between Indigenous groups and the Crown increased following the War of 1812 as a new wave of settlers arrived in Upper Canada primarily from Britain. The British implemented annuity systems in the purchase of lands from Indigenous peoples where the interest payments of settlers on the land were intended to cover the cost of the annuity rather than pay a one-time lump sum.

1.3.3 Post-Contact Period – Township of Roxborough History

The Township of Roxborough was originally named Roxboroughshire and saw its first permanent European settlers in the early 19th century (Mika and Mika 1983). Settlement was slow until after the War of 1812 and the construction of the Canada Atlantic Railway in 1882 and Canada Pacific Railway in 1887 opened the township to further growth.

The village of Moose Creek developed from a settlement of Scottish immigrants that grew to include two general stores and a sawmill (Mika and Mika 1981). The name comes from the nearby creek which contained a small waterfall that rarely froze over and attracted moose in the winter as a watering location. During the late 19th century, much of the village's men worked seasonally on farms and spent their winters at nearby lumber camps. The creation of the Ottawa to Montreal Railway in 1881, which passed through the village, contributed to its growth into the early 20th century. The Townships of Roxborough and Finch were amalgamated in 1998 to form the Township of North Stormont.

1.3.4 Contextual Study Area History

Lot 21, Concession 7

Land registry records indicate the Crown Patent for Lot 21, Concession 7 of the Township of Roxborough was issued in 1858 to Donald Grant, who is listed in the 1861 Canada Census records as a 54 year old farmer from Scotland residing within a 1 and a half storey log house. He was married to Mary Grant (age 37) and the couple had six children aged 13 to 21. Their oldest daughter's occupation was listed as a school teacher.

Portions of the remainder of the land registry records for the 19th century are illegible, so the following summary is based on the available inferred information. In 1862, Grant sold portions of the east half of the lot to William Fovids and William McKillican. James McIntosh purchased a portion of Fovids' land on the east half of the lot in 1864. The community of Moose Creek appears to have expanded into Lot 21, Concession 7 by the 1870s with small portions of the east half of the lot being purchased for individual homes. Many of the names, dates, and locations of these entries are unfortunately illegible.

The west half of the lot was sold to John Stewart in 1868 and then sold to Alexander McRae in 1869. McRae appears to have owned the west half of Lot 21 until 1900 when it was sold to John Stewart and then Daniel Grant.

An 1878 plan of the Township of Roxborough shows several structures in the eastern and southern portions of Lot 21, Concession 7 along County Road 15 (Map 3). The community of Moose Creek is located along County Road 15 where it intersects with Moose Creek. The 1878 map depicts two general stores, a tannery, a church, and a schoolhouse to the east of the study area. The name A. McRae is associated with the west half of the lot and W. McKillican with the east half of the lot. Three structures in the east central portion of the lot are located closest to the study area and are likely the small house lots listed in the land registry for this period.

A. McRae is likely Alexander McRae from the land registry records. The 1881 Canada Census Records list him as a 54 year old farmer born in Scotland and married to Annie McRae, also aged 54 and from Scotland. The couple were living with an elderly relative, Christina McRae (age 76) and had seven children including Annie (age 24), Finlay (age 22), Christy (age 19), Mary Ann (age 18), Anabella (age 14), Duncan Alexander (age 2), and Maggie (age 2 months).

William McKillican could not be found in the census records, but he appears to have served as postmaster for Moose Creek from 1865 to 1876 (LAC 2025).

A topographic map from 1909 shows the study area during the early 20th century (Map 4). The study area is depicted as woodlot with no structures. An aerial image taken in 1954 confirms that the study area had largely remained a woodlot, which continues to the present day (Map 5).

Lot 22, Concession 7

Land registry records indicate the Crown Patent for Lot 22, Concession 7 of the Township of Roxborough was issued in 1843 to the McRae family. In 1876, Daniel McRae granted the east half of the lot to John McRae. The east half of the lot remained with the McRae family until 1911 when John McRae sold the property to Daniel McCowan.

The land registry records for the west half of the lot indicates the Crown Patent was first issued to John McRae in 1810. In 1865, a Michael McRae is listed as selling the entire west half to John McRae, likely a different person than the one first granted the Crown Patent. The lot remained within the McRae family until 1911 when John sold the lot to Daniel McCowan.

The 1851 census lists John McRae as the head of a large Scottish family whose mother appears to have already passed. Mathew McRae lives with John's family, which consists of Duncan (18), John (16), Faryuos (14), Donald (12), John (11), Neil (9), Alexander (7), Catherine (4), and Nancy (2). The 17 year old Matilda Byron lives with the family as a servant.

An 1878 plan of the Township of Roxborough depicts one homestead along County Road 15 at the south end of the lot (Map 3). The homestead is occupied by the McRae family, however the first name is not listed.

An aerial image taken in 1954 depicts the study area as an open agricultural field with a small woodlot along its southern border (Map 5). Recent aerial imagery shows a large area of disturbance at the center of the study area due to the presence of two man made reservoirs (Map 2). There is a paved driveway which connects a farmer's laneway on Lot 21 to County Road 15 and a building along the southern border of the study area. A small area of piled soils can be seen northeast of the paved driveway. Another unpaved roadway connects a small building north of the reservoir to County Road 15.

1.4 Archaeological Context

1.4.1 Study Area Environment and Landscape

The study area is located along the northern boundary of the Glengarry till plain, which represents an area of low relief between the St. Lawrences and Ottawa River basins characterized by stony till and undulating topography (Chapman and Putnam 1984). Physiographic mapping indicates that portions of the study area located on Lot 21, Concession 7 are situated on a sand plain and the portion of the study area located on Lot 22, Concession 7 is located on a clay plain (Map 6). The surficial geology (Map 7) primarily consists of fine to medium grained sand reflecting glaciomarine deposits.

The soils within the west half of the study area consist entirely of Osgoode loam, which is a poorly draining gleisolic soil. The west half of the study area consists of Achigan sandy loam in the south and Cheney sand in the north. Achigan sandy loam is an imperfectly draining podzol soil and Cheney sand is a poorly draining gleisolic soil. Eroded channel soils surround Moose Creek which bisects the study area at the northern border of the study area and the southwest and southeast border of the study area (Map 8).

The study area is located within the Great Lakes – St. Lawrence Forest Region. Prior to European agricultural practices and the removal of woodlots for agricultural purposes, the forest cover would have consisted of white and red pines, eastern hemlock and yellow birch, as well as sugar and red maples, beech, red oaks, basswood and white elms (Eckenwalder et al. 2023).

The nearest water source in Moose Creek, which forms the northeastern boundary of the study area.

1.4.2 Previously Completed Archaeological Assessments Within 50 Metres of Study Area

The primary source of information regarding previously completed archaeological studies is the MCM Past Portal database, which was accessed on 4 June 2025 (MCM 2025). No previously completed archaeological assessments are known to have been completed within 50 m of the study area.

1.4.3 Registered Archaeological Sites Within One Kilometre of Study Area

The primary source of information regarding previously registered archaeological sites within the Province of Ontario is the MCM archaeological sites database (ASDB), which designates archaeological sites registered according to the Borden system. Under the Borden system, Canada is divided into grid blocks based on latitude and longitude. A Borden Block is approximately 13 km east to west and approximately 18.5 km north to south. Each Borden Block is referenced by a four-letter designator and sites within a block are numbered sequentially as they are found.

The ASDB was accessed on 4 June 2025 and a 1 km buffer was applied to the general limits of the Stage 1 study area. The search of the ASDB indicated no archaeological sites have been registered within 1 km of the Stage 1 study area. The nearest registered archaeological site is the BhFs-5 site located over 10 km to the northwest. No additional information on the BhFs-5 site was available in the database.

2.0 Field Methods

2.1 Property Inspection

A property inspection was completed on 6 June 2025 by Randy Hahn, PhD (P1107) under PIF P1107-0078-2024 issued by the MCM. The site inspection was conducted following the standards outlined in Section 1.2 of the MCM's (2011) *Standards and Guidelines for Consultant Archaeologists.* The weather was cloudy with a high of 26° Celsius. At no time were the weather or lighting conditions detrimental to the assessment of features representing archaeological potential. Permission to access the study area was provided by CIMA+ with no limitations or restrictions.

The existing Moose Creek Wastewater Lagoon consists of two large lagoons surrounded by berms (Images 1 to 5, pp. 19-21). The topography around the lagoons is with no evidence of previous landscape disturbance visible from the surface inspection (Images 6 to 8, pp. 21-22). The right-of-way along 8th Road at the north end of the study area is deeply ditched and disturbed below the natural topsoil stratum (Images 9 and 10, p. 23).

The area for the proposed Wastewater expansion is located to the east and southeast of the existing lagoons and currently consists of woodlot and a pedestrian trail accessed via a road and parking lot beside the eastern entrance to the existing lagoon. Portions of the study area have been disturbed by the gravel road and parking lot (Images 11 and 12, p. 24). The topography within the eastern portion of the study area is undulating with the formation of Moose Creek having carved steep slopes along its banks (Images 13 to 22, pp. 25-29). No areas of significant disturbance were identified in the eastern portion of the study area. The eastern boundary of the study area largely follows Moose Creek and a branching creek with a small setback. The pedestrian trail passing through the center of the eastern portion of the study area consists of gravel and a wood bridge passing over Moose Creek (Images 23 and 24, p. 30).

3.0 Analysis and Conclusions

Several factors are employed when assessing archaeological potential within a particular area. In addition to the proximity to known archaeological sites, factors for determining archaeological potential for Indigenous and Euro-Canadian historical resources include watershed area (primary and secondary watercourses), distance from water, drainage patterns, identification of historical water sources (e.g. beach ridges, river beds, relic creeks, ancient shorelines, etc.), elevated topography, identification of significant physiological and geological features (e.g. knolls, drumlins, eskers, plateaus, etc.), soil geomorphology, distinctive land formations (e.g. mounds, caverns, waterfalls, peninsulas, etc.), known burials sites and cemeteries, ecological features (e.g. distribution of food and animal resources before European colonization), features identifying early Euro-Canadian settlements (e.g. monuments, structures, etc.), historical transportation routes (e.g. historical roads, trails, portages, rail corridors, etc.) and properties designated and/or listed under the *Ontario Heritage Act.* Local knowledge from Indigenous communities and heritage organizations, as well as consultation of available historical and archaeological literature and cartographic resources, aids in the identification of features denoting archaeological potential. These criteria are based on the MCM's *Standards and Guidelines for Consultant Archaeologists* (2011) and were used to assess the potential for archaeological resources within the Study Area.

Specifically in relation to archaeological potential triggers for the Moose Creek Wastewater Treatment Lagoon project, all undisturbed lands within 300 m of the seven historic homesteads recorded as being located within or directly adjacent to the study area as early as 1878 (Map 3) is considered to possess archaeological potential. Additionally, the presence of two historic transportation corridors which form the study area's northern and eastern boundary; 8th Road and Moose Creek, are triggers denoting archaeological potential for all undisturbed land within 100 m of these historical throughfares. All land within 300 m of water sources, including Moose Creek is also considered to possess archaeological potential in accordance with the MCM Standards.

Areas where the potential for archaeological resources has been negated due to visible landscape disturbances below the natural topsoil stratum include land impacted by construction associated with the existing wastewater treatment lagoons, the gravel road and parking lot, and deep ditching along County Road 8.

4.0 Recommendations

The results of the Stage 1 archaeological assessment documented within this report formed the basis for the following recommendations:

1) The portions of the study area identified as retaining archaeological potential in Map 9 are recommended for Stage 2 archaeological assessment by a licensed archaeologist prior to development impacts. The Stage 2 archaeological assessment should be a test pit survey involving the hand excavation of test pits at 5 m intervals following the standards outlined in Section 2.1.2 of the MCM's (2011) *Standards and Guidelines for Consultant Archaeologists.*

2) The portions of the study area identified as disturbed in Map 9 are recommended for no additional archaeological assessment.
3) Should ground disturbance extend beyond the area shown in Map 9, additional archaeological assessment may be required.

5.0 Advice on Compliance with Legislation

This report is submitted to the Ministry of Citizenship and Multiculturalism as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Citizenship and Multiculturalism, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.

It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest, and the report has been filed in the Ontario Public Register of Archaeology Reports referred to in Section 65.1 of the *Ontario Heritage Act*.

Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48 (1) of the *Ontario Heritage Act*.

The *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33, (when proclaimed in force) require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Public and Business Service Delivery and Procurement.

Archaeological sites recommended for further archaeological fieldwork or protection remain subject to Section 48(1) of the *Ontario Heritage Act* and may not be altered, or have artifacts removed from them, except by a person holding an archaeological licence.

6.0 Important Information and Limitations of this Report

This report has been prepared for the specific site, development objective, and purpose as requested by the client and outlined in the original proposal, and subsequent agreed changes, for this project. The specific results, factual data, interpretations, and recommendations, outlined in this report are for the sole use of the client, and applicable only to this project and site location. No other warranty, expressed or implied, is made. No other party may rely on all, or portions, of this report without True North Archaeological Services Inc.'s express written consent. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of True North Archaeological Services Inc. The Client acknowledges the electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can only rely upon the electronic media versions of this True North Archaeological Services Inc. report or other work products at their discretion.

True North Archaeological Services Inc. prepared this report in a manner consistent with the level of care and skill ordinarily exercised by other members of the archaeological consulting community currently practicing within the Province of Ontario, in accordance with the *Ontario Heritage Act* the Ministry of Citizenship and Multiculturalism's (MCM) 2011 *Standards and Guidelines for Consultant Archaeologists*, and all the subsequent MCM bulletins.

There are special risks whenever an archaeological assessment is completed, whether they be solely desktop assessments or in-field assessments, and even a thorough background study, comprehensive field investigation or sampling and testing program may fail to detect all archaeological resources present within the project area. The desktop review, field strategies and subsequent interpretations utilized for this report comply with the Ministry of Citizenship and Multiculturalism's (MCM) 2011 *Standards and Guidelines for Consultant Archaeologists*, and all the subsequent MCM bulletins.

All artifacts collected as part of this archaeological assessment, when applicable, will be housed and curated by True North Archaeological Services Inc. until such time that the collection may be transferred to an appropriate MCM approved repository or repatriated to an appropriate First Nation. As part of Licensing obligations, this report, along with pertinent written information will be uploaded to the MCM Past Portal website and reviewed for compliance with the 2011 *Standards and Guidelines for Consultant Archaeologists*.

7.0 References

Adney, Edwin Tappan and Chapelle, Howard

2014 **Bark Canoes and Skin Boats of North America**. New York.

Algonquins of Ontario (AOO)

2013 **Our Proud History**. Accessed from <https://www.tanakiwin.com/algonquins-of-ontario/our-proud-history/> [30 March 2025].

Archaeological Services Inc. (ASI) and Geomatics International Inc. (GII)

1999 **The Archaeological Resource Potential Mapping Study of the Regional Municipality of Ottawa-Carleton: Planning Report**. Archaeological Master Plan study prepared for the Regional Municipality of Ottawa-Carleton.

Bursey, Jeffrey

1995 *The Transition from the Middle to Late Woodland Periods: A Re-Evaluation*. **Origins of the People of the Longhouse: Proceedings of the 21st Annual Symposium of the Ontario Archaeology Society**. A. Bekerman and G. Warrick (eds), Ontario Archaeology Society, pp. 43-54.

Bursey, Jeffrey, Daechsel, H., Hinshelwood, A. and Murphy, C.

2013 **Summary of Ontario Archaeology.** < https://ontarioarchaeology.org/resources/summary-of-ontario-archaeology/ > [Accessed 11 March 2025].

Chapman, L.J. and D.F. Putnam

1984 **The Physiography of Southern Ontario***.* Ontario Geological Survey Special Volume 2, Ontario.

Crawford, Gary, Smith, David and Bowyer, Vandy

1997 *Dating the entry of corn (Zea mays) into the Lower Great Lakes region*. **American Antiquity**, 62(1): 112-119.

Croft, David J.A.

2006 *Champlain's Portage from Muskrat Lake to the Ottawa River*. **Ontario Archaeology**, 81/82:3-12.

Daechsel, Hugh J.

1980 **An Archaeological Evaluation of the South Nation River Basin**. A report prepared for the South Nation River Conservation Authority, Berwick, Ontario.

1981 **Sawdust Bay-2. The Identification of Middle Woodland Site in the Ottawa Valley.** M.A. Thesis, Department of Anthropology, McMaster University.

Eckenwalder, James E., Deborah Metsger, Timothy Dickinson, and Sarah Hodges

2023 **A Field Guide to Trees of Ontario**. Royal Ontario Museum, Ontario.

Ellis, C.J.

2013 *Before Pottery: Paleoindian and Archaic Hunter-Gathers.* **Before Ontario: The Archaeology of a Province**., eds. Marit K. Munson and Susan M. Jamieson. Library and Archives of Canada Publishing.

Ellis, Christopher and Deller, Brian D.

1997 *Variability in the Archaeological Record of Northeastern Early Paleoindians: A View from Southern Ontario*, **Archaeology of Eastern North America**, 25: 1-30.

Ellis, Chris J., Kenyon, Ian T. and Spence, Michael W.
1990 *The Archaic*. **The Archaeology of Southern Ontario to A.D. 1650**, C.J. Ellis and N. Ferris (eds), Ontario Archaeology Society, p. 65-124.

Ferris, Neal and Spence, Michael
1995 *The Woodland Traditions in Southern Ontario.* **Revista de Arqueologia Americana** 9: 83-138.

Fox, William A.
1990 *The Middle Woodland and Late Woodland Transition*. **The Archaeology of Southern Ontario to A.D. 1650**. C.J. Ellis and N. Ferris (eds), Ontario Archaeology Society, p. 171-188.

Gemtec
2023 **Environmental Impact Statement Proposed Plan of Subdivision, Part of Lots 39 and 40m Concession 4, Ottawa, Ontario.**

Hember, Ian
2009 **Stage 1 Archaeological Assessment, Lots 39, 40, 41, Concession IV, City of Ottawa (Former Township of North Gower, Regional Municipality of Ottawa-Carleton).** Consultant's report submitted to the MCM under PIF P154-001-2009.

Hill, Susan M.
2017 **The Clay We are Made of: Haudenosaunee Land Tenure on the Grand River**. Winnipeg, University of Manitoba Press.

Holmes, Joan & Associates Inc. (Holmes)
1993 **Report on the Algonquins of Golden Lake Claim.**

Jamieson, James B.
1990 *The Archaeology of the St. Lawrence Iroquoians.* **The Archaeology of Southern Ontario to A.D.**, edited by C.J. Ellis and N. Ferris. Ontario Archaeology Society, Occasion Paper No. 5.

Johnston, Darlene
2006 **Connecting People to Place: Great Lakes Aboriginal History in Cultural Context**. Ipperwash Inquiry.

Johnston, Louise
2004 **The Covenant Chain of Peace: Metaphor and Religious Thought in Seventeenth Century Haudenosaunee Council Oratory**, Montreal, McGill University Press.

Kennedy, Clyde C.
1976 *Champlain Sea and Early Ottawa River Shoreline Studies, 1975.* **Arch Notes**, 76-7:18-23.

Laliberté, M.
1995 **Inventaire Archéologique du Parc du Lac Leamy, 1995.** Report Submitted to the National Capital Commission and Ministere de la Culture et des Communications du Quebec.

1998 **Archaeological Resource Potential, Federal Lands in the National Capital Region, Volumes 1 and 2.** Report on file with the NCC.

Library and Archives Canada (LAC)

2025 **Moose Creek.** <http://central.bac-lac.gc.ca/.redirect?app=posoffposmas&id=5892&lang=eng>[30 April 2025].

Martin, Scott

2004 *Lower Great Lakes Region Maize and Enrichment in the First Millennium AD*. **Ontario Archaeology**, 77/78: 135-159.

Mika, Nick and Helma Mika

1981 **Places in Ontario: Their Name Origins and History, Part II F– M.** Mika Publishing Company, Belleville.

1983 **Places in Ontario: Their Name Origins and History, Part III N – Z.** Mika Publishing Company, Belleville.

Ministry of Citizenship and Multiculturalism (MCM)

2011 **Standards and Guidelines for Consulting Archaeologists**. Queens Printer, Ontario.

2024 **Search of Past Portal Database for Registered Archaeological Sites and Previous Archaeological Assessments within 50 metres of Study Area**, 12 September2024.

Ministry of Culture and Recreation (MCR)

1981 **Heritage Studies on the Rideau-Quinte-Trent-Severn Waterway**. Historical Planning and Research Branch, Toronto.

Monague, Jeff

2022 *Area's Indigenous Roots Ignored in History Books*. **Orillia Matters**. Accessed from <https://www.orilliamatters.com/local-news/column-areas-indigenous-roots-ignored-in-history-books-5994672> [27 October 2022].

Pendergast, James F.

1999 *The Ottawa River Algonquin Bands in a St. Lawrence Iroquoian Context*. **Canadian Journal of Archaeology**, 23: 63-136.

Pilon, Jean-Luc

2005 *Ancient History of the Lower Ottawa River Valley*. **A Background Study for Nomination of the Ottawa River Under the Canadian Heritage River System**. QLF Canada, p. 12-17.

Reimer, Gwen

2019 *British-Canada's Land Purchases, 1783-1788: A Strategic Perspective*. **Ontario History**, 111(1): 36-72.

Ritchie, William

1971 *A Typology and Nomenclature for New York Projectile Points, Revised Edition*. **New York State Museum and Science Service, Bulletin Number 384**. The University of the State of New York, The State Education Department, Albany, New York.

Schut, LW and Wilson, EA

1987 **The Soils of the Regional Municipality of Ottawa-Carleton.** Report No. 58 of the Ontario Institute of Pedology. Agriculture Canada.

Spence, Michael W., Pihl, Robert H., and Murphy, Carl

1990 *Cultural Complexes of the Early and Middle Woodland Periods* in **The Archaeology of Southern Ontario to A.D. 1650**, C.J. Ellis and N. Ferris (eds), Ontario Archaeology Society, p. 125-169.

Smith, David G.

1990 *Iroquoian Societies in Southern Ontario: Introduction and Historic Overview*. **The Archaeology of Southern Ontario to A.D. 1650**. C.J. Ellis and N. Ferris (eds), Ontario Archaeological Society, p. 279-290.

Surtees, Robert J.

1994 *Land Cessions, 1763-1830*. In In E.S. Rogers and D.B. Smith (eds) **Aboriginal Ontario: Historical Perspectives on the First Nations**. Dundurn Press, Toronto, p. 92-121.

Teichroeb, Janet

2007 **The Archaic Lithic Assemblage from West Burleigh Bay, Ontario**. M.A. Thesis Submitted to Trent University.

Trigger, Bruce G. and Day, Gordon M.

1994 *Southern Algonquin Middlemen: Algonquin, Nipissing and Ottawa, 1550-1780*. In E.S. Rogers and D.B. Smith (eds) **Aboriginal Ontario: Historical Perspectives on the First Nations**. Dundurn Press, Toronto, p. 64-77.

Warrick, Gary

2000 *The Precontact Iroquoian Occupation of Southern Ontario*. **Journal of World Prehistory**, 14(4): 415-456.

Watson, Gordon

1982 *Prehistoric Peoples in the Rideau Waterway*, **Archaeological Historical Symposium, Rideau Ferry, Ontario**, F.C.L. Wyght, Lombardy, Ontario, pp. 24-55.

1999 *The Paleo-Indian Period in the Ottawa Valley*. In **Ottawa Valley Prehistory**, edited by J. L. Pilon. Imprimerie Gauvin, Hull, Quebec, p. 28-41.

Williamson, Ronald F.

1990 *The Early Iroquoian Period of Southern Ontario*. **The Archaeology of Southern Ontario to A.D. 1650**.C.J. Ellis and N. Ferris (eds), Ontario Archaeology Society, p. 291-320.

Wintemberg, W.J.

1936 **Roebuck Prehistoric Village Site, Grenville County, Ontario.** In Anthropological Series, No. 19, Bulletin No. 83. National Museum of Canada, Ottawa.

8.0 Images

Image 1: View northwest of eastern wastewater treatment lagoon.

Image 2*:* View northeast of western wastewater treatment lagoon.

Image 3: Built up area on the south side of the lagoons. Rushing water was audible indicating the mound likely covers water pipes, view southwest.

Image 4: View northwest showing berm on the right side and the natural topography on the left.

Image 5: North side of wastewater lagoons showing pump house, view west.

Image 6: View northeast of the north end of the study area from the northern berm of the lagoons.

Image 7: View east of the northern portion of the study area.

Image 8: View west from the northeast corner of the existing wastewater treatment lagoon property.

Image 9: Steeply ditched right-of-way along 8th Road, view west.

Image 10: View west of ditched right-of-way of 8th Road.

Image 11: View northwest showing gravel road and east side of study area before woodlot.

Image 12: Gravel parking lot, view northeast.

Image 13: Slope down to Moose Creek in the northeastern corner of the study area, view southeast.

Image 14: View southeast of conditions within the northeast corner of the study area.

Image 15: View northeast conditions within woodlot.

Image 16: View east of Moose Creek.

Image 17: View south showing representative field conditions within the eastern portion of the study area.

Image 18: Low lying area next to small slope leading down to Moose Creek, view west.

Image 19: Creek located along the eastern boundary of the study area, view south.

Image 20: View northeast of the unnamed dirt road along the southern boundary of the study area. The right-of-way is ditched.

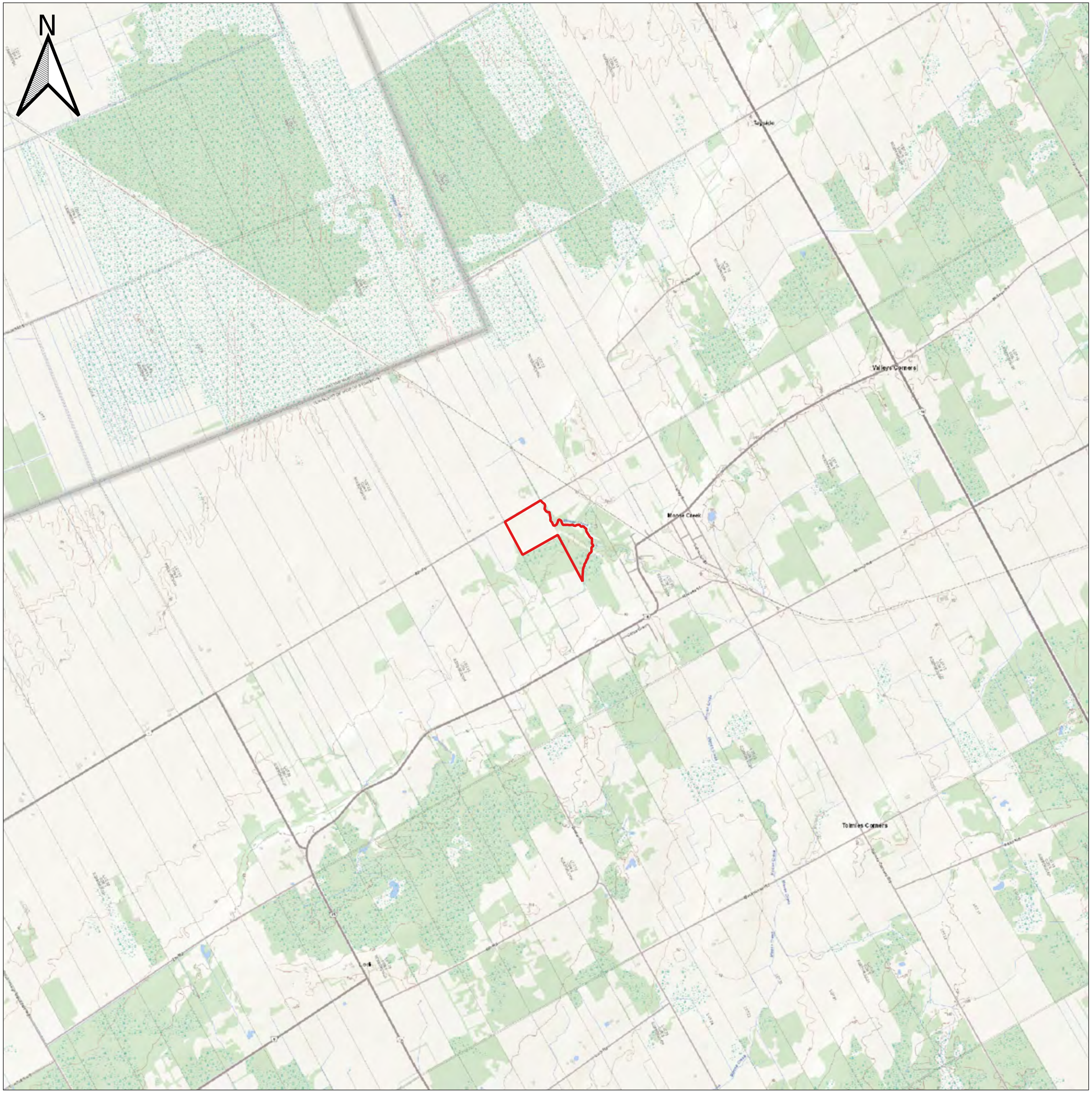
Image 21: View north from southern most portion of the study area.

Image 22: View east of field conditions within the southern portion of the study area.

Image 23: View southeast of gravel pedestrian path passing through study area.

Image 24: View southeast of pedestrian bridge over Moose Creek.

9.0 Maps



LEGEND

Study Area

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83. COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

2. BASE PLANs: LIO TOPOGRAPHIC MAP

0.5 0 0.5 1 1.5 km

SCALE 1:50,000

CLIENT

CIMA+

PROJECT

STAGE 1 ARCHAEOLOGICAL ASSESSMENT, MOOSE CREEK WASTEWATER TREATMENT LAGOON, PART OF LOT 21, CONCESSION 7, GEOGRAPHIC TOWNSHIP OF ROXBOROUGH, NOW THE TOWNSHIP OF NORTH STORMONT, UNITED COUNTIES OF STORMONT, DUNDAS AND GLENGARRY

TITLE

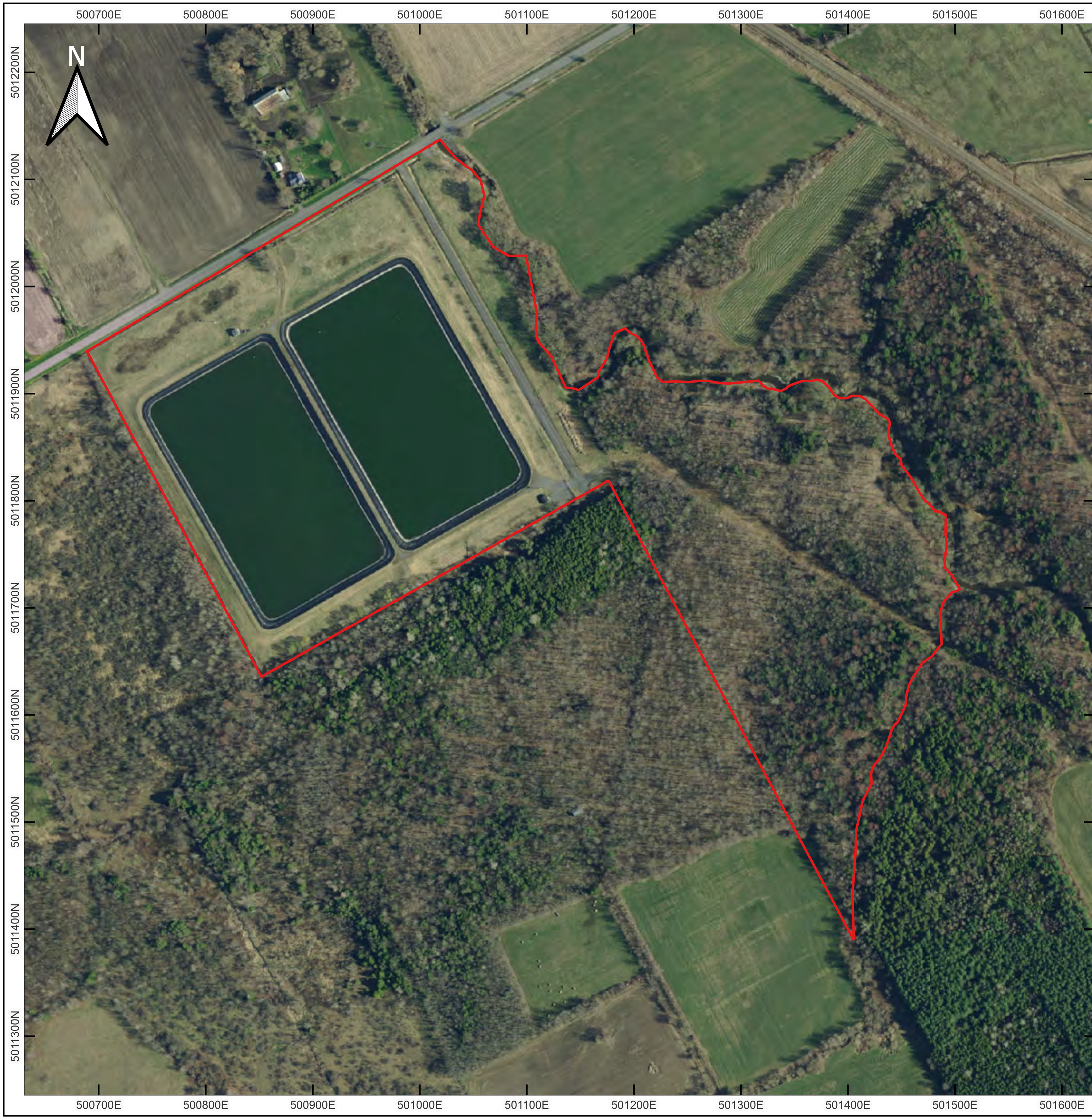
KEY PLAN

CONSULTANT

TRUE NORTH ARCHAEOLOGICAL SERVICES

YYYY-MM-DD	2025-07-30
PREPARED	GKB
REVIEWED	BD
APPROVED	BD

PROJECT NO.	REV.	MAP
2025034	001	1



KEY MAP

SCALE 1:100,000

LEGEND

Study Area

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83. COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

2. BASE PLANS: LAND INFORMATION ONTARIO (LIO) OPEN DATA DRAPE 2014 AND LIO TOPOGRAPHIC MAP

50 0 50 100 150 m

SCALE 1:5,000

CLIENT

CIMA+

PROJECT

STAGE 1 ARCHAEOLOGICAL ASSESSMENT, MOOSE CREEK WASTEWATER TREATMENT LAGOON, PART OF LOT 21, CONCESSION 7, GEOGRAPHIC TOWNSHIP OF ROXBOROUGH, NOW THE TOWNSHIP OF NORTH STORMONT, UNITED COUNTIES OF STORMONT, DUNDAS AND GLENGARRY

TITLE

SITE PLAN

CONSULTANT

TRUE NORTH ARCHAEOLOGICAL SERVICES

YYYY-MM-DD	2025-07-30
PREPARED	GKB
REVIEWED	BD
APPROVED	BD

PROJECT NO.	REV.	MAP
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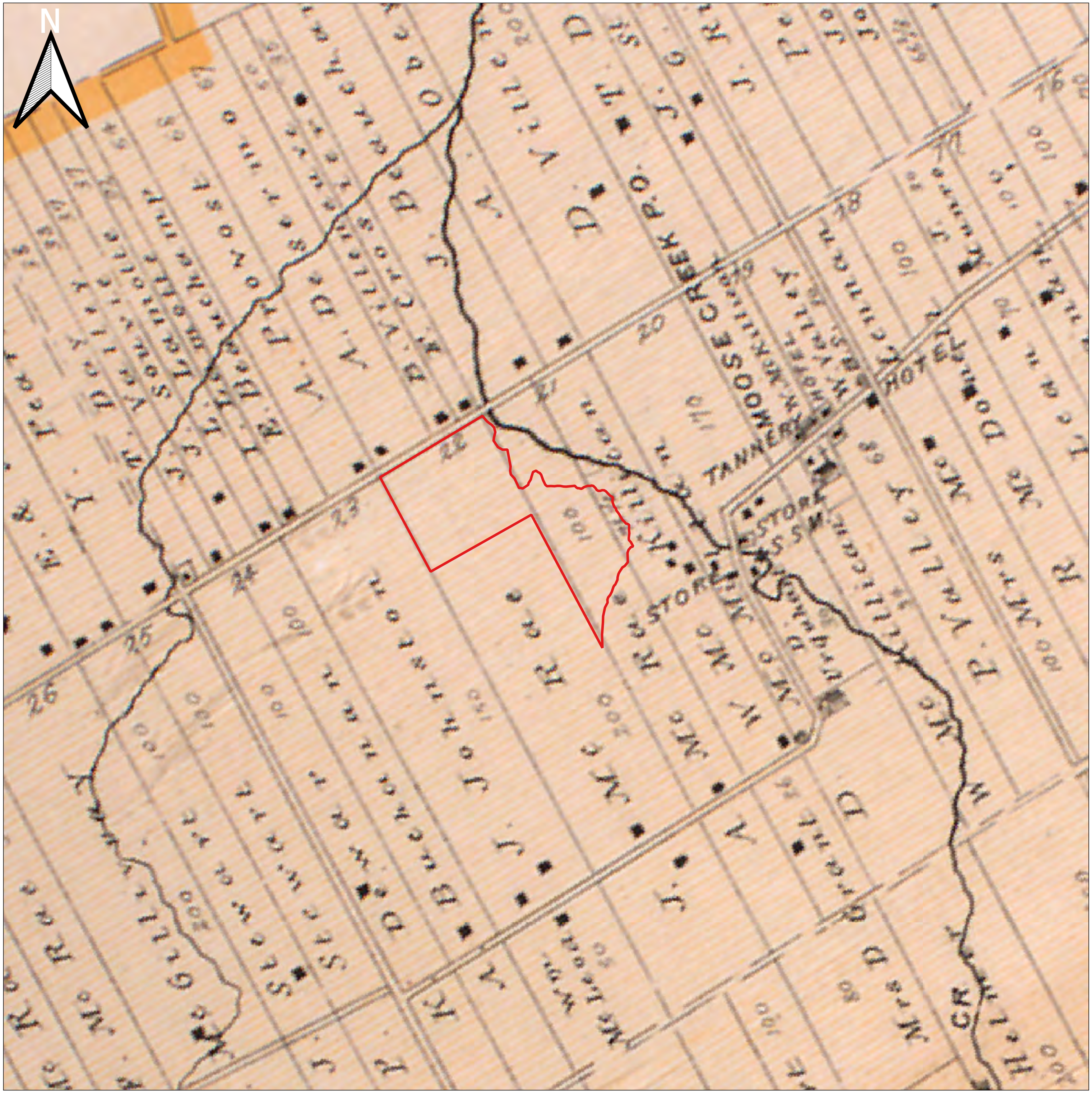

LEGEND

Study Area

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83. COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

2. COPY OF SURVEY PLAN PREPARED BY H. BELDEN, 1878

150 0 150 300 450 600 m

SCALE 1:17,500

CLIENT

CIMA+

PROJECT

STAGE 1 ARCHAEOLOGICAL ASSESSMENT, MOOSE CREEK WASTEWATER TREATMENT LAGOON, PART OF LOT 21, CONCESSION 7, GEOGRAPHIC TOWNSHIP OF ROXBOROUGH, NOW THE TOWNSHIP OF NORTH STORMONT, UNITED COUNTIES OF STORMONT, DUNDAS AND GLENGARRY

TITLE

1878 ROXBOROUGH TOWNSHIP SURVEY PLAN

CONSULTANT

TRUE NORTH ARCHAEOLOGICAL SERVICES

YYYY-MM-DD	2025-05-26
PREPARED	GKB
REVIEWED	BD
APPROVED	BD

PROJECT NO.	REV.	MAP
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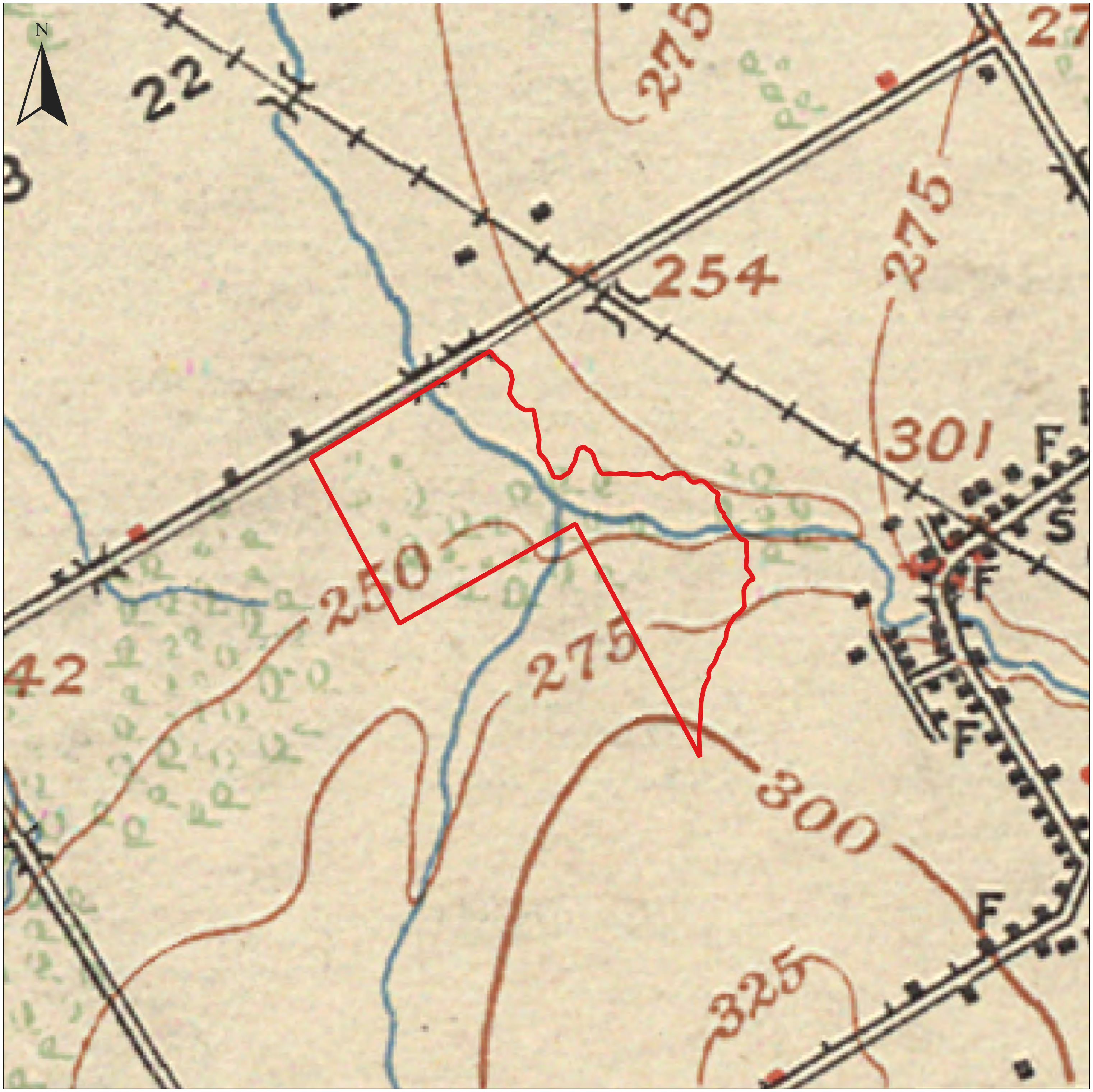

LEGEND

Study Area

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83. COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

2. BASE PLAN: SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MILITIA AND DEFENCE, 1909

100 0 100 200 300 m

SCALE 1:10,000

CLIENT

CIMA+

PROJECT

STAGE 1 ARCHAEOLOGICAL ASSESSMENT, MOOSE CREEK WASTEWATER TREATMENT LAGOON, PART OF LOT 21, CONCESSION 7, GEOGRAPHIC TOWNSHIP OF ROXBOROUGH, NOW THE TOWNSHIP OF NORTH STORMONT, UNITED COUNTIES OF STORMONT, DUNDAS AND GLENGARRY

TITLE

1909 TOPOGRAPHIC PLAN

CONSULTANT

TRUE NORTH ARCHAEOLOGICAL SERVICES

YYYY-MM-DD	2025-07-30
PREPARED	GKB
REVIEWED	BD
APPROVED	BD

PROJECT NO.	REV.	MAP
2025034	001	4

LEGEND

Study Area

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83.
COORDINATE SYSTEM: UTM ZONE 17, VERTICAL DATUM: CGVD28

2. 1954 AIR PHOTOS OF SOUTHERN ONTARIO, PHOTO NO. 432802, ONTARIO. DEPARTMENT OF LANDS AND FORESTS

200 0 200 400 600 m

SCALE 1:15,000

CLIENT

CIMA+

PROJECT

STAGE 1 ARCHAEOLOGICAL ASSESSMENT, MOOSE CREEK WASTEWATER TREATMENT LAGOON, PART OF LOT 21, CONCESSION 7, GEOGRAPHIC TOWNSHIP OF ROXBOROUGH, NOW THE TOWNSHIP OF NORTH STORMONT, UNITED COUNTIES OF STORMONT, DUNDAS AND GLENGARRY

TITLE

1954 AERIAL PHOTOGRAPH

CONSULTANT	YYYY-MM-DD	2025-07-30
TRUE NORTH ARCHAEOLOGICAL SERVICES	PREPARED	GKB
	REVIEWED	BD
	APPROVED	BD

PROJECT NO.	REV.	MAP
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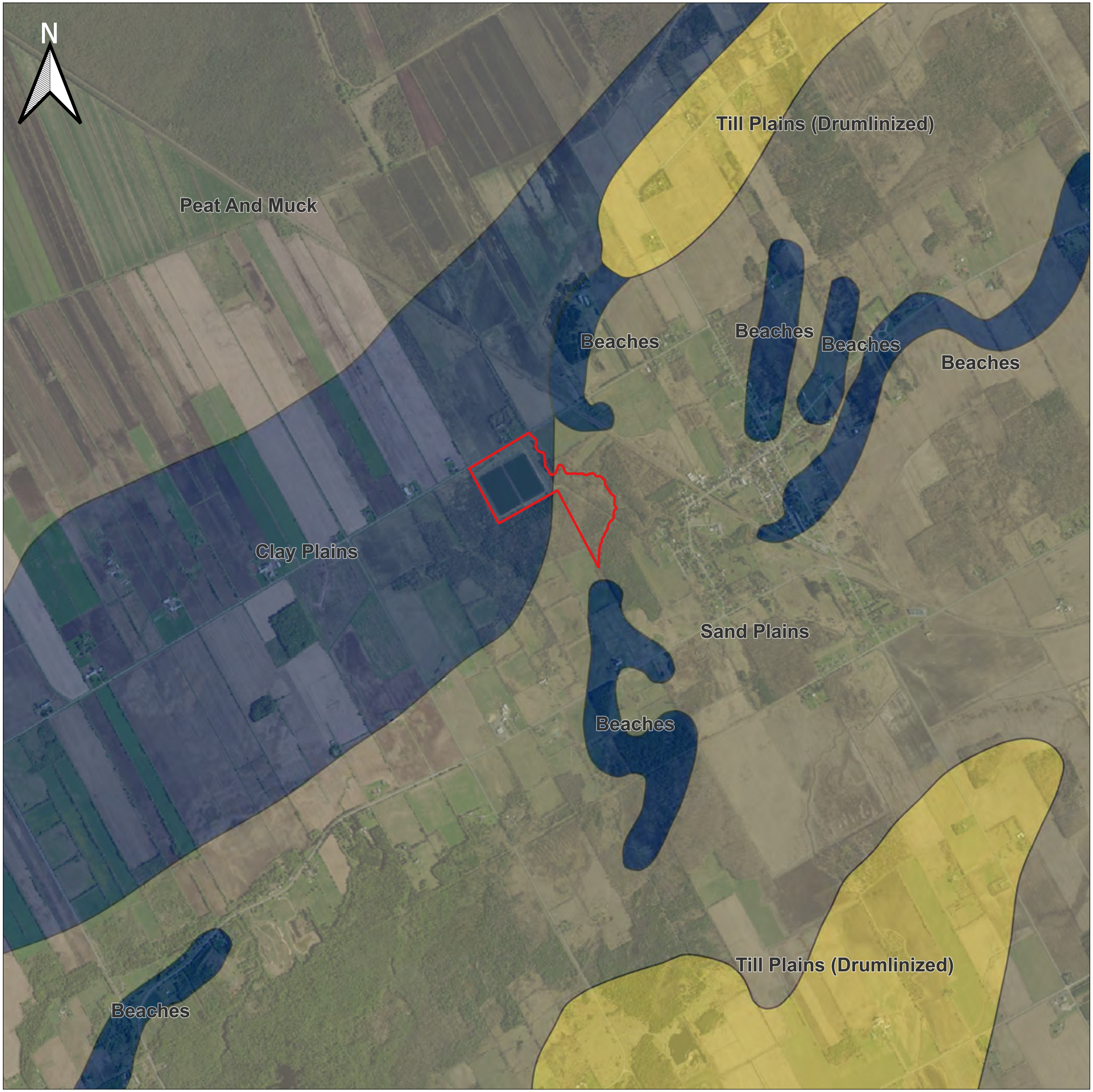

LEGEND

Study Area

Physiographic Feature

Beaches

Clay Plains

Peat And Muck

Sand Plains

Till Plains (Drumlinized)

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83. COORDINATE SYSTEM: UTM ZONE 17, VERTICAL DATUM: CGVD28

2. CHAPMAN, L.J. AND PUTNAM, D.F. 2007. PHYSIOGRAPHY OF SOUTHERN ONTARIO; ONTARIO GEOLOGICAL SURVEY, MISCELLANEOUS RELEASE-DATA 2008

250 0 250 500 750 1,000 m

SCALE 1:30,000

CLIENT

CIMA+

PROJECT

STAGE 1 ARCHAEOLOGICAL ASSESSMENT, MOOSE CREEK WASTEWATER TREATMENT LAGOON, PART OF LOT 21, CONCESSION 7, GEOGRAPHIC TOWNSHIP OF ROXBOROUGH, NOW THE TOWNSHIP OF NORTH STORMONT, UNITED COUNTIES OF STORMONT, DUNDAS AND GLENGARRY

TITLE

PHYSIOGRAPHY

CONSULTANT	YYYY-MM-DD	2025-07-30
TRUE NORTH ARCHAEOLOGICAL SERVICES	PREPARED	GKB
	REVIEWED	BD
	APPROVED	BD

PROJECT NO.	REV.	MAP
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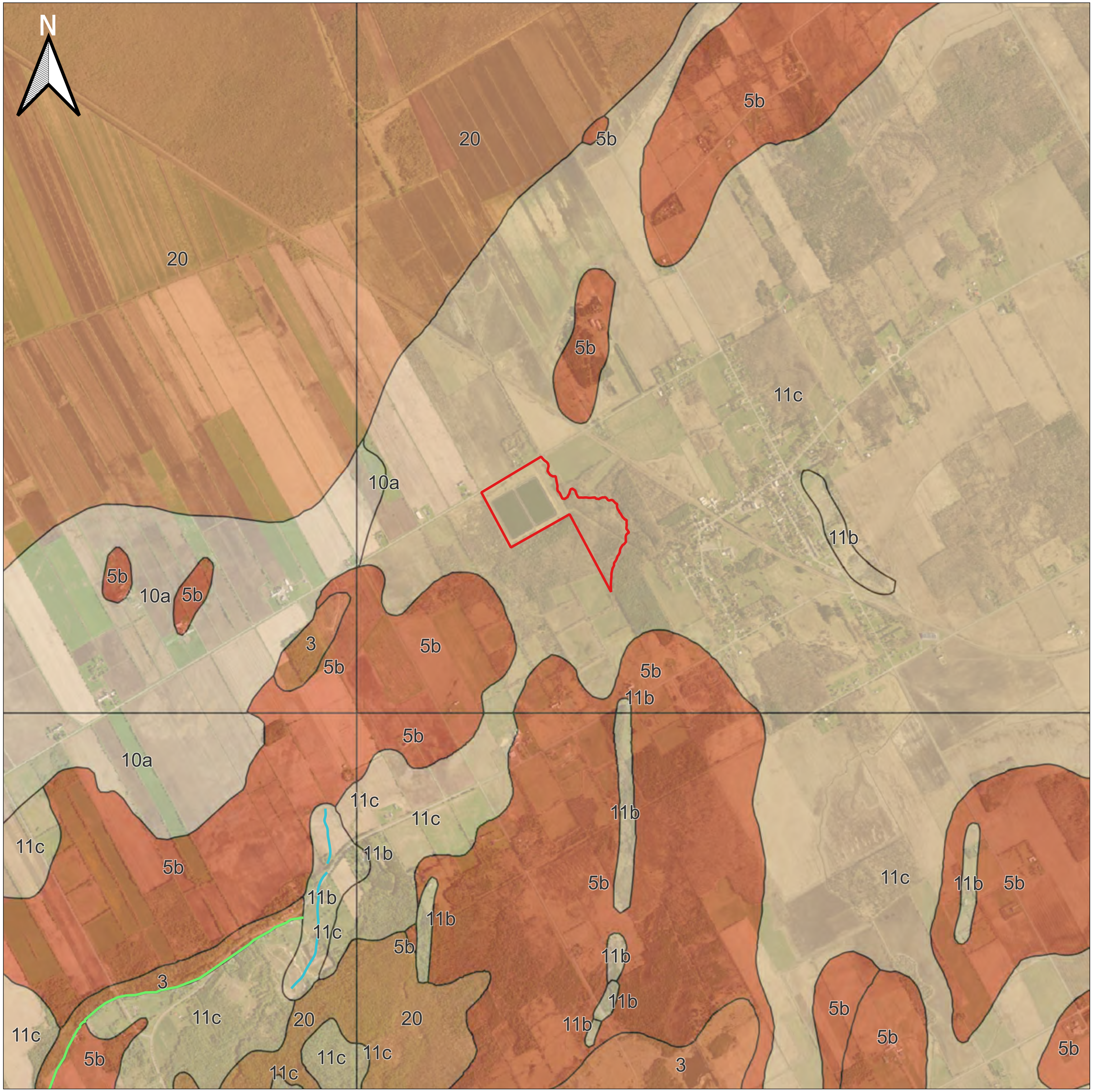

LEGEND

Study Area

Surficial Geology

10a	Glaciomarine Offshore Marne Despoits: clay, silty clay and silt
11b	Glaciomarine Nearshore Sediments: gravel, sand and boulders
11c	Glaciomarine Nearshore Sediments: sand
20	Organic Deposits: muck and peat in bogs, fens, swamps and poorly drained areas
3	Paleozoic Bedrock
5b	Glacial Till: sand silty compact diamicton

Surficial Geology Feature

Beach Ridge

Escarpment

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83. COORDINATE SYSTEM: UTM ZONE 17, VERTICAL DATUM: CGVD28

2. ONTARIO GEOLOGICAL SURVEY 2010. SURFICIAL GEOLOGY OF SOUTHERN ONTARIO; ONTARIO GEOLOGICAL SURVEY, MISCELLANEOUS RELEASE-DATA 128-REV

250 0 250 500 750 1,000 m

SCALE 1:30,000

CLIENT

CIMA+

PROJECT

STAGE 1 ARCHAEOLOGICAL ASSESSMENT, MOOSE CREEK WASTEWATER TREATMENT LAGOON, PART OF LOT 21, CONCESSION 7, GEOGRAPHIC TOWNSHIP OF ROXBOROUGH, NOW THE TOWNSHIP OF NORTH STORMONT, UNITED COUNTIES OF STORMONT, DUNDAS AND GLENGARRY

TITLE

SURFICIAL GEOLOGY

CONSULTANT

TRUE NORTH ARCHAEOLOGICAL SERVICES

YYYY-MM-DD	2025-07-30
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REVIEWED	BD
APPROVED	BD

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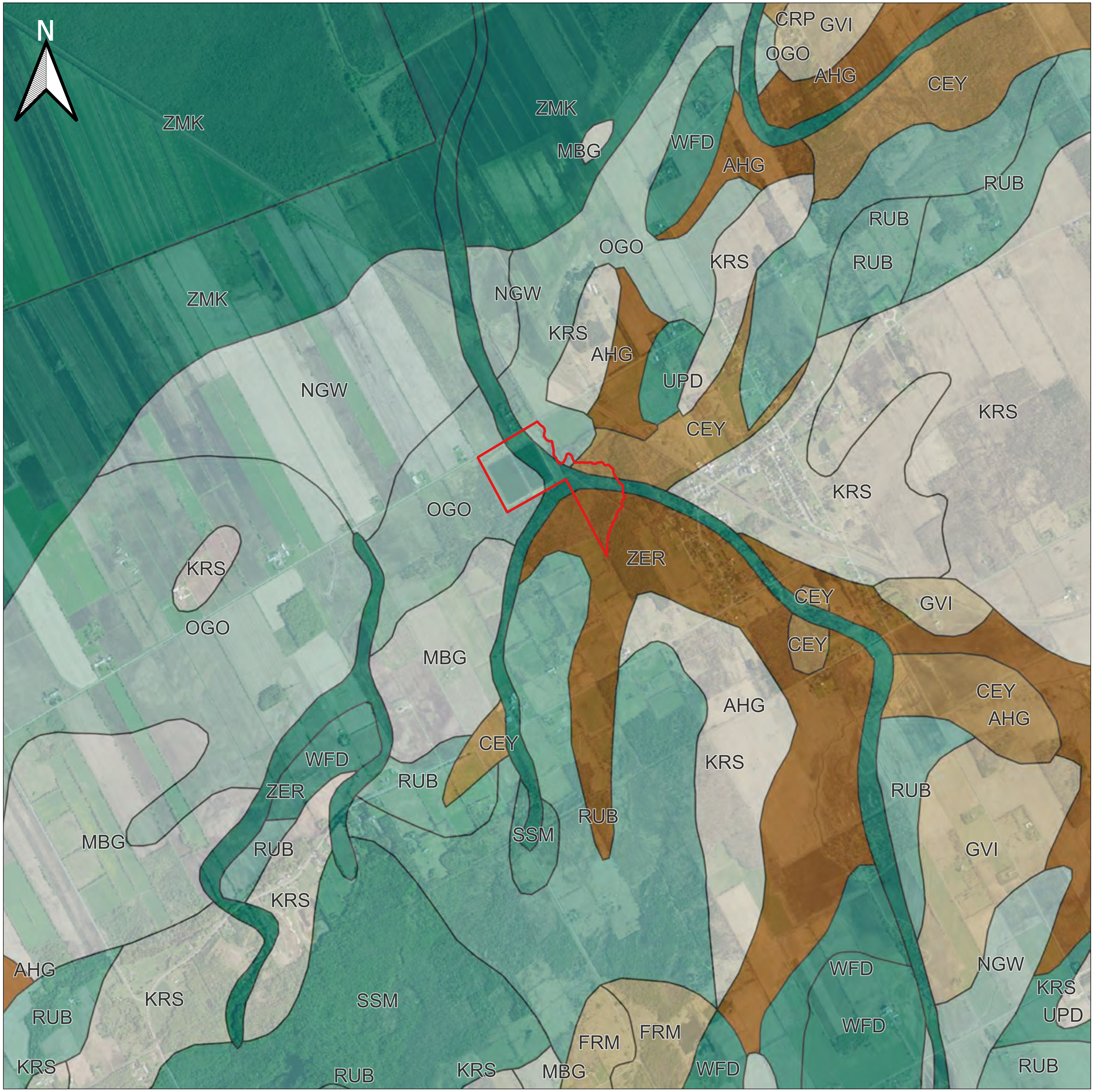

LEGEND

Study Area

Soil Survey Complex

AHG	Achigan Sand
CEY	Cheney Sand
CRP	Carp Clay
FRM	Farmington Loam
GVI	Grenville Loam
KRS	Kars Gravelly Sandy Loam
MBG	Morrisburg Clay
NGW	North Gower Clay
OGO	Osgoode Loam
RUB	Rubicon Sand
SSM	St-Samuel Sand
UPD	Uplands Sand
WFD	Wolford Clay
ZER	Eroded Channel
ZMK	Muck

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83. COORDINATE SYSTEM: UTM ZONE 17, VERTICAL DATUM: CGVD28

2. SOIL SURVEY COMPLEX, ONTARIO MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS, 2019-11-06

400 0 400 800 1,200 m

SCALE 1:30,000

CLIENT

CIMA+

PROJECT

STAGE 1 ARCHAEOLOGICAL ASSESSMENT, MOOSE CREEK WASTEWATER TREATMENT LAGOON, PART OF LOT 21, CONCESSION 7, GEOGRAPHIC TOWNSHIP OF ROXBOROUGH, NOW THE TOWNSHIP OF NORTH STORMONT, UNITED COUNTIES OF STORMONT, DUNDAS AND GLENGARRY

TITLE

SOIL SURVEY COMPLEX

CONSULTANT		
TRUE NORTH ARCHAEOLOGICAL SERVICES	YYYY-MM-DD	2025-07-30
	PREPARED	GKB
	REVIEWED	BD
	APPROVED	BD

PROJECT NO.	REV.	MAP
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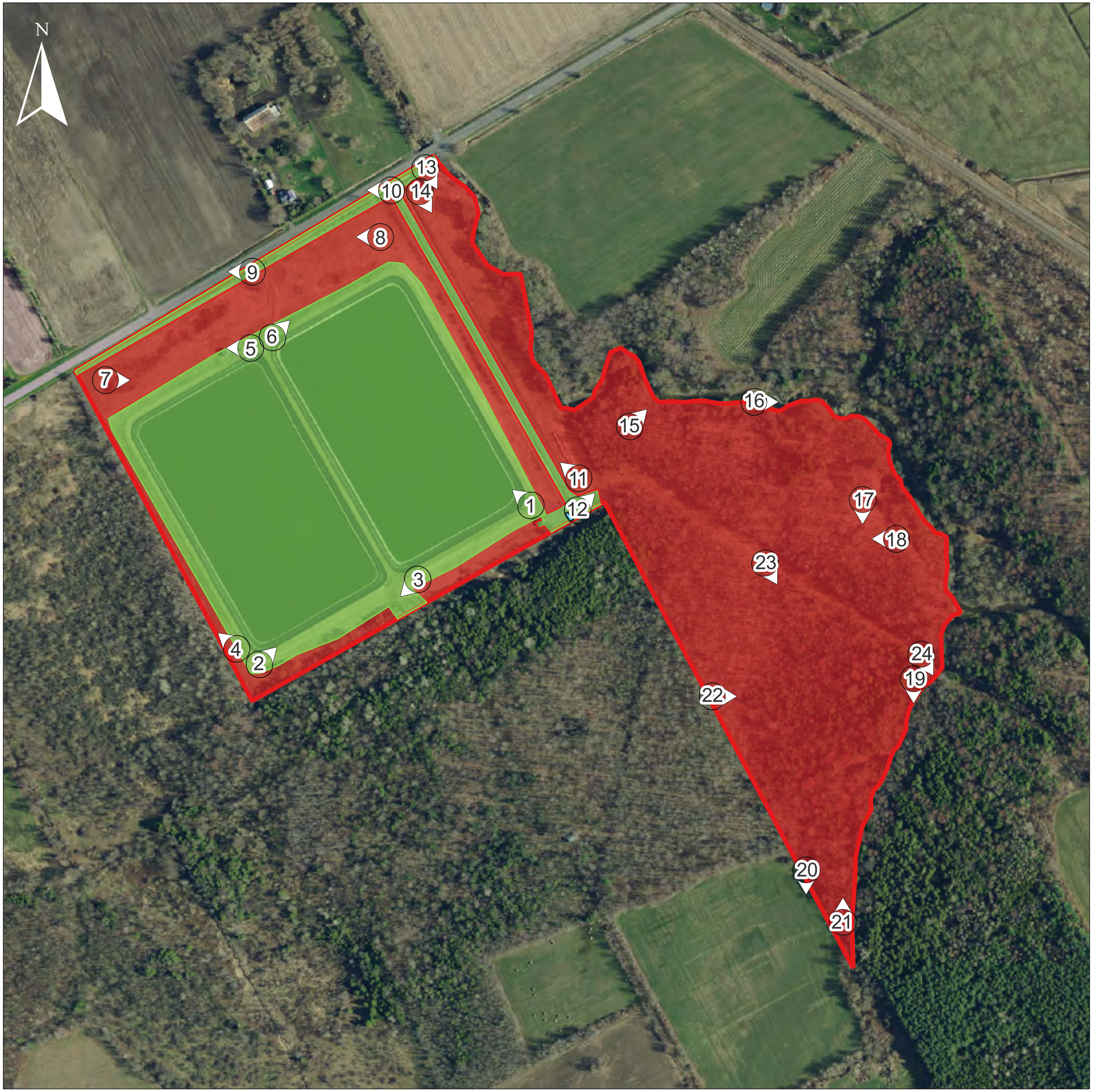

LEGEND

Study Area

Image Locations

Recommendations

Archaeologicla Potential - Test Pit Survey at 5 m Intervals

Disturbed - No Furher Archaeology

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83. COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

2. BASE PLAN: LAND INFORMATION ONTARIO (LIO) OPEN DATA DRAPE 2014

50 0 50 100 150 m

SCALE 1:5,000

CLIENT

CIMA+

PROJECT

STAGE 1 ARCHAEOLOGICAL ASSESSMENT, MOOSE CREEK WASTEWATER TREATMENT LAGOON, PART OF LOT 21, CONCESSION 7, GEOGRAPHIC TOWNSHIP OF ROXBOROUGH, NOW THE TOWNSHIP OF NORTH STORMONT, UNITED COUNTIES OF STORMONT, DUNDAS AND GLENGARRY

TITLE

RECOMMENDATIONS AND IMAGE LOCATIONS

CONSULTANT

TRUE NORTH ARCHAEOLOGICAL SERVICES

YYYY-MM-DD	2025-07-30
PREPARED	GKB
REVIEWED	BD
APPROVED	BD

PROJECT NO.	REV.	MAP
2025034	001	9

10.0 Signature Page

We trust that this report meets with your current needs. If you have any questions, or if we may be of further assistances, please contact either of the undersigned.

TRUE NORTH ARCHAEOLOGICAL SERVICES INC.

Randy Hahn, PhD
Project Archaeologist

Aaron Mior, MMA
Principal, Senior Archaeologist

Gmail

Randy Hahn <randy.m.hahn@gmail.com>

Your report package is being screened for completeness - P1107-0087-2025 / *

1 message

pastport <pastport@ontario.ca> Wed, Jul 30, 2025 at 8:40 AM
To: randy.m.hahn@gmail.com
Cc: PastPort@ontario.ca

Dear Randy Hahn,

The ministry has received your project report package associated with PIF number P1107-0087-2025 submitted on Jul 30, 2025.

We are screening the report package to make sure it is complete and accurate. Please allow for up to 10 business days.

If the report package does not pass screening before the report due date, the report will become overdue and you will not be eligible to begin new fieldwork projects (submit new PIFs).

When the report passes screening, the report will be considered 'filed'. Once this happens, you will receive an email notifying you that the report has been added to our review queue or entered into the *Ontario Public Register of Archaeological Reports* without technical review.

Please do not reply to this e-mail. The message will be undeliverable, and we are unable to respond from this address.

If you have any questions about this message, email us at: Archaeology@ontario.ca

Gmail

Randy Hahn <randy.m.hahn@gmail.com>

Expedited Report Review Request Granted / *

1 message

pastport <pastport@ontario.ca> Fri, Sep 5, 2025 at 3:15 PM
To: randy.m.hahn@gmail.com
Cc: PastPort@ontario.ca

Dear Randy Hahn,

Your request for an expedited review of report number 68778 submitted under Project Information Form P1107-0087-2025 on Sep 4, 2025 has been granted and the report has been assigned for review.

Please do not reply to this e-mail. The message will be undeliverable, and we are unable to respond from this address.

If you have any questions about this message, email us at: Archaeology@ontario.ca

I

Appendix I: Design Basis for the Moose Creek WWTL expansion

Moose Creek Wastewater Treatment Lagoons Class EA (Z0028411)
Design Basis for Expanded WWTL
12-Jun-25

Prepared by MJ
Reviewed by BY

CIMA+

Population projections - Basis: 2024 Master Service Plan for the Township (2024, RVA)

Year	Population (persons)	
2021	580	(2021 census population)
2051	1080	(from 2024 MSP)

Maintaining population growth rates specified in the 2024 MSP, population projections for the last 5 years are shown below and were used for per capita generation evaluation:

2020	568	
2021	580	
2022	592	
2023	604	
2024	617	
2025	630	
2051	1080	(from 2024 MSP)

Existing flow summary (Jan 2020-April 2025)

Parameter	Value	Unit	
ADF	**255.37**	m^3/d	(Jan 2020-Apr 2025)
Population	580	persons	(2021 census population)
Avg per Cap. Generation	397.93	L/c/d	(Jan 2020-Apr 2025)
PDF	849.27	m^3/d	(Jan 2020-Apr 2025)
PDF Factor	3.43	_	(Jan 2020-Apr 2025)

Existing Loadings (Jan 2020-April 2025)

Parameter	Avg. Concentration		Avg. Loading		Per Capita generation		Max Month Loadings		P.F.
BOD	170.97	mg/L	39.66	kg/d	65.79	g/p/d	121.63	kg/d	1.90
TSS	197.67	mg/L	45.32	kg/d	75.42	g/p/d	216.00	kg/d	2.10
TKN	58.73	mg/L	13.14	kg/d	21.93	g/p/d	28.63	kg/d	1.65
TP	6.02	mg/L	1.36	kg/d	2.27	g/p/d	3.11	kg/d	1.67

Flow Increases from:

2021 to 2051	162.88	m^3/d

Future flow summary (2051)

Parameter	Value	Unit	
ADF	**438.0**	m^3/d	(from 2024 MSP)
Population	1080	persons	(from 2024 MSP)
Avg per Cap. Generation	405.56	L/c/d	
PDF	1397.15	m^3/d	
PDF Factor	3.00	—	

Future loadings (2051)

Parameter	Concentration		Avg. Loading Future Total		Typical Per Capita generation (New Development)		Max Month Future Total		P.F. New Develop ment
BOD	176.35	mg/L	77.24	kg/d	75	g/p/d	177.99	kg/d	1.5
TSS	206.42	mg/L	90.41	kg/d	90	g/p/d	283.64	kg/d	1.5
TKN	45.22	mg/L	19.81	kg/d	13.3	g/p/d	38.63	kg/d	1.5
TP	5.51	mg/L	2.41	kg/d	2.1	g/p/d	4.69	kg/d	1.5

J

Appendix J: Assimilative Capacity Study

Hutchinson
Environmental Sciences Ltd.

Moose Creek
Wastewater Treatment Lagoon
Assimilative Capacity Study

Prepared for: CIMA+
Job #: 250054

September 11, 2025

FINAL REPORT

93 Kimberley Avenue, Bracebridge ON P1L 1Z8 | 705-645-0021

Hutchinson
Environmental Sciences Ltd.

93 Kimberley Avenue, Bracebridge, ON P1L 1Z8 │705-645-0021
www.environmentalsciences.ca

September 11, 2025 Project No. 250054

Bradley Young, Ph.D., P.Eng.
Associate Partner/Director – Infrastructure
CIMA+
600-1400 Blair Towers Place
Ottawa, ON, K1J 9B8

Dear Dr. Young:

Re: Moose Creek Wastewater Treatment Lagoon Assimilative Capacity Study

We are pleased to provide this ACS in support of the Class Environmental Assessment for the expansion of the Moose Creek Wastewater Treatment Lagoons from the current rated capacity of 302 m^3/d (spring discharge) to 438 m^3/d (spring and fall discharges). The report includes a background characterization and modelling to predict the influence of the lagoon effluent on the receiving watercourse.

Based on our assessment, we recommend the following effluent limits for the lagoons at expanded capacity: 20 mg/L for carbonaceous biochemical oxygen demand (5-day) and total suspended solids, 0.5 mg/L for total phosphorus, 3 mg/L for total ammonia nitrogen, and 0.12 mg/L for hydrogen sulphide.

Thank you for providing us the opportunity to complete another interesting project for CIMA+.

Sincerely,
Per. Hutchinson Environmental Sciences Ltd.

Joel Harrison, Ph.D.
Senior Aquatic Scientist
joel.harrison@environmentalsciences.ca

Signatures

Report Prepared by:

Joel Harrison, Ph.D.
Senior Aquatic Scientist

Report Reviewed by:

Deborah Sinclair, M.A.Sc.
Senior Aquatic Scientist

Executive Summary

The Ontario Clean Water Agency (OCWA) requires an Assimilative Capacity Study (ACS) in support of the expansion of the Moose Creek Wastewater Treatment Lagoon (WWTL) from a rated capacity of 302 m^3/d to 438 m^3/d to support future population growth. The WWTL is a 2-cell facultative aerated lagoon system located ~60 km southeast of Ottawa, in the Village of Moose Creek. The total area of the lagoons is approximately 5.6 ha, with a maximum operating liquid depth of 2 m, and a storage volume of approximately 110,000 m^3 (MOEE 1994a). Waste is treated via mechanical aeration and alum.

Daily average effluent flows have ranged from 486 to 12,195 m^3/d during the period 2015–2025, with an average daily outflow of 5,886 m^3/d. During this period, the effluent discharge rate was in excess of the Certificate of Approval (CoA) limit of 11,040 m^3/d on 9 of 126 dates (6% exceedance). Total annual discharge ranged from 43,523 to 117,487 m^3/y (avg. = 77,054 m^3/y) during 2015–2025. Discharge has been lower in recent years than it was between 2015 and 2020.

The 3-day average total suspended solids (TSS) concentration exceeded the limit of 30 mg/L at least once in 2018, 2020, 2021, 2022, 2023, and 2024. Total ammonia nitrogen (TAN) exceeded its limit of 15 mg/L in 2016 and 2025 and hydrogen sulphide (H_2S) was above 0.17 mg/L once, in 2024. There were no instances of non-compliance with CoA loading limits with the exception of TSS in 2018.

Measured flow data for Moose Creek are limited. 7Q20 flows for Moose Creek were therefore estimated based on scaling flows from a nearby proxy gauge (Payne River near Berwick; Water Survey of Canada gauge 02LB022). Based on this approach, the 7Q20 flow of Moose Creek during the existing spring lagoon-discharge period (15 Mar – 30 Apr) was estimated to be 0.0488 m^3/s, with 7Q20 estimates of 0.0104 m^3/s and 0.0164 m^3/s for the proposed future extended spring discharge window (1 Mar to 31 May) and (additional) fall lagoon-discharge period (1 Nov – 15 Dec), respectively.

Monitoring by OCWA shows that the lagoon effluent is an enriching influence on *E. coli,* TAN, total Kjeldahl nitrogen (TKN), and total phosphorus (TP) concentrations during lagoon discharge periods. Year-round data collected by GFL shows that the receiver is Policy 2 for nitrate and TP while concentrations of CBOD5, TSS, and ammonia are relatively low. The limited fisheries data available reflect a predominantly cool-water fish community dominated by small fish such as minnows and darters.

Mass-balance modelling was used to estimate concentrations of TP, TSS, and ammonia in Moose Creek, downstream of the lagoon outfall, during lagoon-discharge periods. Dissolved oxygen (DO) concentrations were estimated using the Streeter-Phelps model. Modelling for future scenarios was based on effluent concentrations limits that would not increase total annual loadings, as recommended by the Ministry of Environment, Conservation and Parks (MECP) during pre-consultation.

Under the future WWTL discharge scenario, downstream TP is predicted to exceed the provincial water quality objective (PWQO) but be lower than under the existing discharge scenario, as is the case for TSS and nitrate in the spring. TSS is predicted to be below the federal guideline in the fall under the future scenario. Downstream unionized ammonia is predicted to exceed PWQO at the current effluent limit and rated capacity and under the future scenario, although concentrations are lower under the future scenario. DO concentration was predicted to meet the PWQO for cold-water biota under all scenarios modelled.

Based on the modelling, recommended effluent concentration limits for the increased rated capacity of 438 m^3/d are 20 mg/L for cBOD5 and TSS, 0.5 mg/L for TP, 3 mg/L for TAN, and 0.12 mg/L for H_2S. These concentration limits entail no increase in total annual loadings, as discussed with the MECP during pre-consultation. No change to the total annual loading limits specified in the CoA is recommended.

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1. Background

1.1 Project Context

In the Province of Ontario, the discharge of treated effluent to a surface water receiver requires an Assimilative Capacity Study (ACS) to determine suitable effluent-quality limits and to assess the effects of effluent discharge on downstream water quality. The Ontario Clean Water Agency (OCWA) requires an ACS in support of the expansion of the Moose Creek Wastewater Treatment Lagoon (WWTL) from 302 m^3/d (3.5 L/s) to 438 m^3/d (5.1 L/s) to support future population growth. The Moose Creek WWTL discharges to the Moose Creek Lower Municipal Drain (hereafter, "Moose Creek") and flows approximately 22 km before discharging into the South Nation River in Lemieux (Figure 1). The South Nation River flows in a north-easterly direction for 45 km before discharging into the Ottawa River.

1.2 MECP Consultation

A work plan for the ACS was developed by HESL and was refined based on feedback from a pre-consultation meeting with the Ministry of Environment, Conservation and Parks (MECP) on 8 July 2025. The minutes from the pre-consultation meeting are provided as Appendix A. The key outcomes from the discussion were:

- the MECP recommended that a high level of detail be provided regarding the method for estimating monthly 7Q20 flows
- it was agreed that future effluent-concentration limits that maintain existing loading would be an acceptable approach
- the MECP indicated the possibility of an extended spring discharge and additional fall discharge period if sufficient supporting flow data are provided

1.3 Watersheds

Land cover in the Moose Creek watershed is predominantly agricultural/undifferentiated rural land use (64%), with some swamp and marshland (14%), treed areas (11%), and plantations (6%) according to the provincial classification scheme (MNR 2025). The total watershed area drained by Moose Creek (i.e., upstream of its confluence with the South Nation River) is 140 km^2, with a drainage area of 29 km^2 upstream of the Moose Creek WWTL (MNR 2025).

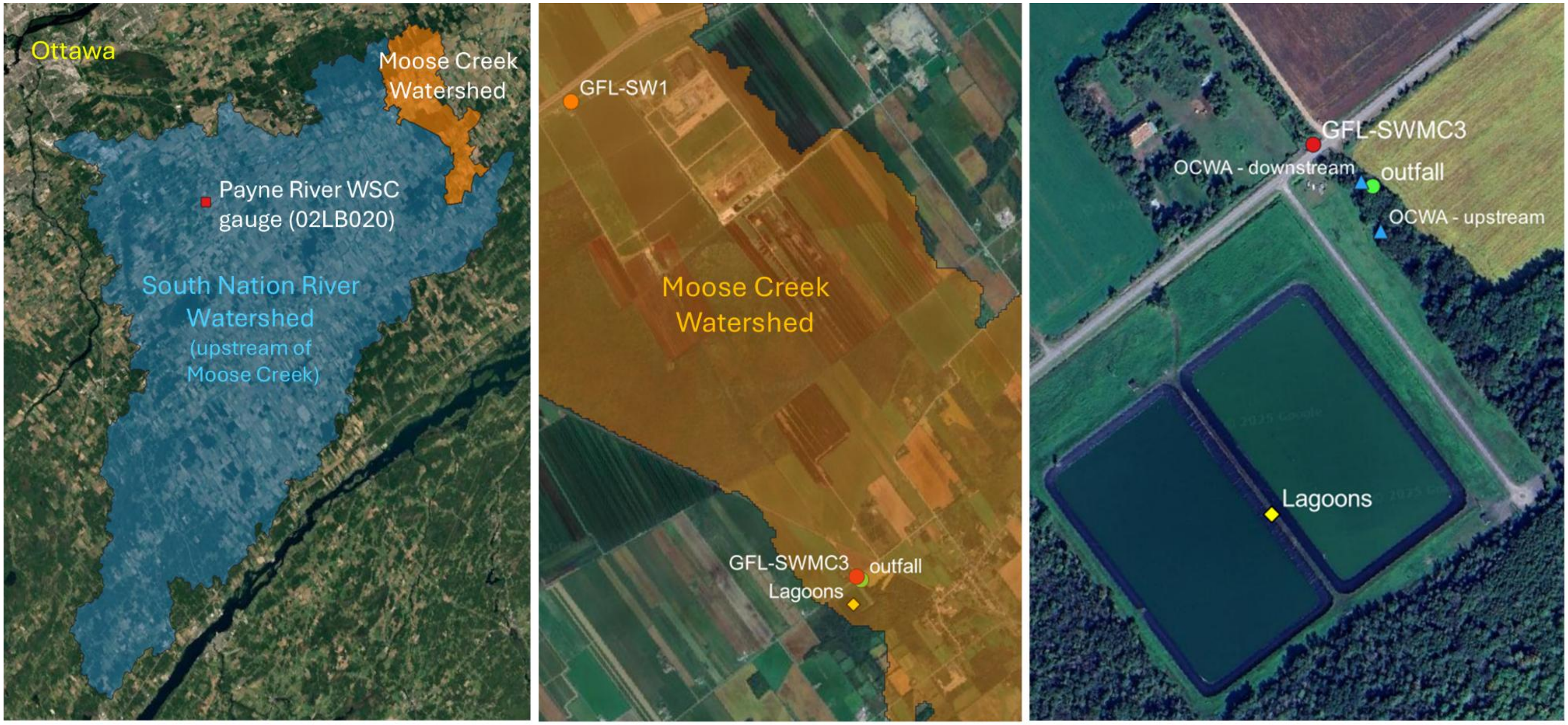

Figure 1. Watersheds of the study area, the Moose Creek WWTL, and the monitoring locations from which the data used for this study were obtained.

2. WWTP Characterization

2.1 Description

The Moose Creek WWTL is a 2-cell facultative aerated lagoon system operated by OCWA. The WWTL is located approximately 60 km southeast of Ottawa, in the Village of Moose Creek, south of 8th Rd. between Valley St. and Dewar Rd. (45.26°, -74.99°). According to the Certificate of Approval (CoA; MOEE 1994a), the total area of the lagoons is approximately 5.6 ha, with a maximum operating liquid depth of 2 m, and a storage volume of approximately 110,000 m^3. Waste is treated via both mechanical aeration and the addition of aluminum sulphate (alum).

The sewage works have been designed and approved for an average daily inflow of 302 m^3/d. The CoA stipulates that the lagoons be discharged annually between March 15 and April 30. The discharge period may be up to 20 days, with a maximum outflow rate of up to 11,040 m^3/d. The effluent limits and objectives, as listed in the existing CoA, are provided below (Table 1). The concentration and loading limits for 5-day carbonaceous biochemical oxygen demand (cBOD5), total suspended solids (TSS), and total phosphorus (TP) are based on the average of 3 consecutive grab samples whereas the limits for total ammonia nitrogen (TAN) and hydrogen sulphide (H_2S) are based on single samples/dates.

Table 1. Moose Creek Effluent Objectives and Limits (MOEE 1994a).

Parameter Name	Short Name	Concentration (mg/L) Objective	Concentration (mg/L) Limit	Loading (kg/d) Objective	Loading (kg/d) Limit
Ammonia Nitrogen, Total	TAN	-	15	-	166
Biochemical O_2 Demand, 5-d, Carbonaceous	cBOD5	15	30	166	331
Hydrogen Sulfide	H_2S	"Absent"	0.17	-	1.9
Phosphorus, Total	TP	<0.5	1	<5.5	11
Solids, Total Suspended	TSS	20	30	121	331

2.2 Effluent Flows

Daily average effluent flows (Figure 2) have ranged from 486 to 12,195 m^3/d during the period 2015–2025, with an average daily outflow of 5,886 m^3/d. During this period, the effluent discharge rate was in excess of the CoA limit of 11,040 m^3/d on 9 of 126 dates (6% exceedance). Total annual discharge ranged from 43,523 to 117,487 m^3/y (avg. = 77,054 m^3/y) during 2015–2025. Discharge has been lower in recent years than it was between 2015 and 2020 (Figure 2).

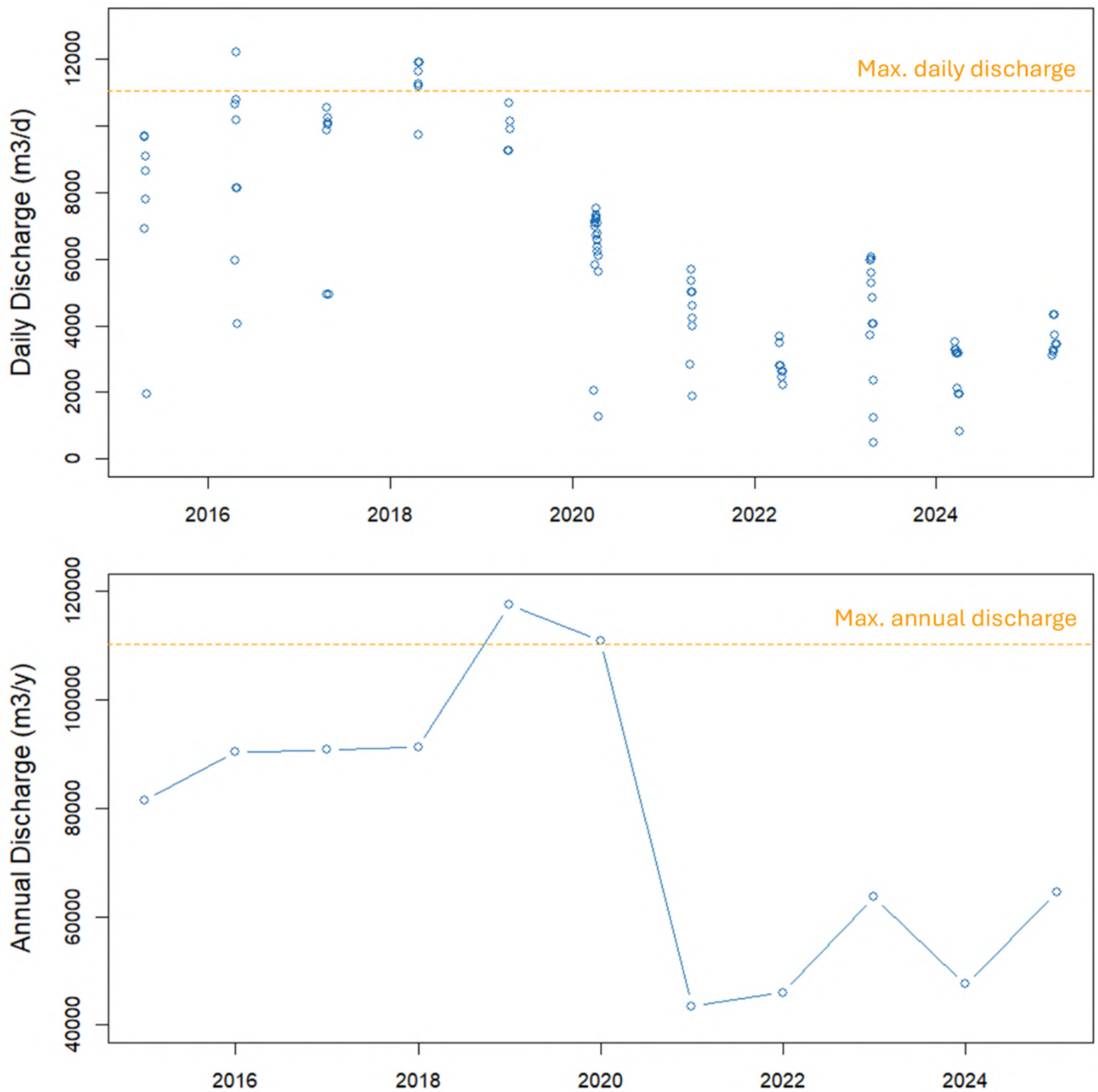

Figure 2. Daily (top) and total annual (bottom) effluent discharges from lagoons to Moose Creek (2015–2025).

2.3 Effluent Quality & Loading

A summary of effluent quality for all monitored parameters during the past 11 years is provided below (Table 2). For parameters regulated by the CoA (Figure 3), compliance for cBOD5, TP, and TSS is based on 3-day average concentrations whereas compliance for H_2S and TAN is based on single-sample results. The 3-day average TSS concentration exceeded the limit of 30 mg/L at least once in 2018, 2020, 2021, 2022, 2023, and 2024. TAN exceeded its limit of 15 mg/L in 2016 and 2025 and H_2S was above 0.17 mg/L once, in 2024. There were no instances of non-compliance with CoA loading limits with the exception of TSS in 2018 (Figure 4).

Table 2. Wastewater quality (2015–2025), as determined by OCWA monitoring.

Parameter Name	Short Name	Min.	Median	75th Percentile	Max.	# data
Ammonia Nitrogen, Total	TAN	0.3	8.7	11.1	19.4	55
Ammonia Nitrogen, Unionized	UAN	<0.01	0.24	0.86	10.90	55
Biochemical Oxygen Demand, Carbonaceous	cBOD5	1.5	6.0	8.5	30	55
Conductivity	Cond	550	760	890	1000	51
Escherichia coli bacteria	*E. coli*	5	400	1255	8800	55
H_2S, undissociated	–	0.00	0.00	0.02	0.12	37
Hydrogen Sulphide	H_2S	0.002	<0.10	<0.10	0.20	55
Kjeldahl Nitrogen, Total	TKN	1.4	13.6	16.3	24.9	55
Nitrate Nitrogen	NO_3-N	0.05	0.27	1.13	7.12	55
Nitrite Nitrogen	NO_2-N	<0.05	<0.10	<0.10	0.32	55
pH	pH	6.50	8.12	8.49	9.10	55
Phosphorus, Total	TP	0.17	0.34	0.49	1.13	55
Suspended Solids, Total	TSS	9	22	35	70	55
Temperature	Temp	6.1	9.0	10.8	14.7	55

Note: units are mg/L except for Cond (µS/cm), *E. coli* (CFU/100 mL), pH (pH units), and Temp (°C).

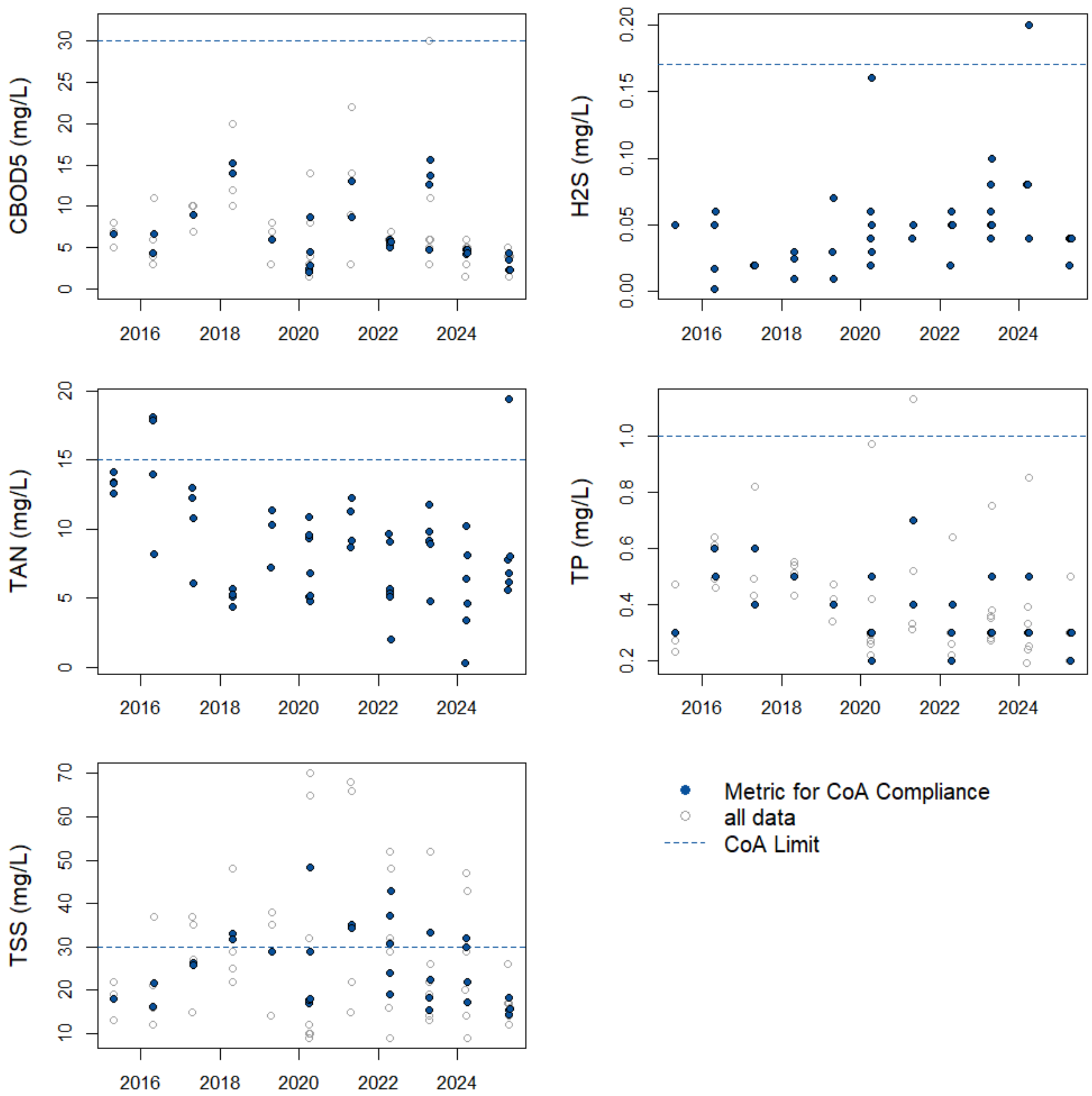

Figure 3. Effluent quality compared to CoA limits.

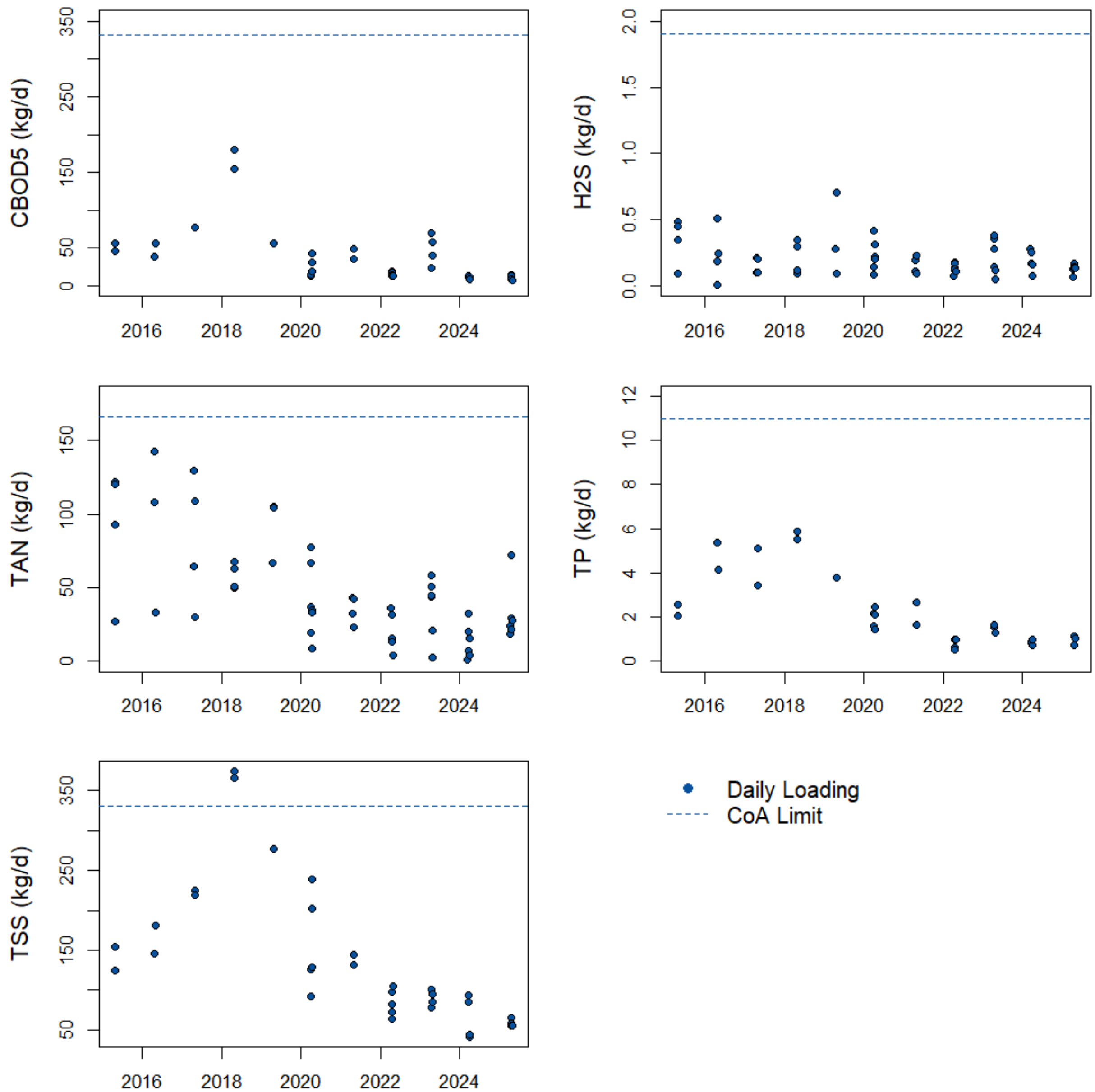

Figure 4. Effluent loading compared to CoA limits.

3. Receiver Characterization

3.1 Receiver Flows

Available flow data for Moose Creek are, to our knowledge, limited to information obtained by CanDetec Inc. for GFL Environmental for an Environmental Assessment for the Eastern Ontario Waste Handling Facility (CanDetec Inc. 2022) and associated ongoing monitoring (Greg van Loenen, Personal Communication); the majority of the relevant data has been collected at their sites “SW1” (45.3158 -75.0197) and “SWMC3” (45.2628 -74.9871; Figure 1, Table 3). Site SWMC3 is immediately downstream of the lagoons, whereas site SWMC3 is approximately 6.5-km north of the lagoons (linear distance), and drains a much larger area (57 km^2) than does the creek at the lagoons (29 km^2).

Table 3. Summary of Moose Creek flows (m^3/s) based on data provided by GFL Environmental.

			Percentiles							
Site	Avg.	Range	5th	25th	50th	75th	95th	*n*	Period	Description
SW1	0.372	0.000–1.977	0.006	0.062	0.254	0.520	1.317	74	2013-2025	Conc. Rd. 7 (S of Hwy 417)
SWMC3	0.340	0.010–2.042	0.019	0.097	0.184	0.493	1.045	55	2019-2024	8th Rd. (downstream of lagoons)

GFL reported flows for Moose Creek in the range of 0–2 m^3/s, with considerable variability apparent within and among years (Figure 5). They estimated a 7Q20 flow of 0.0018 m^3/s (95% Confidence Limit = +/-0.0010 m^3/s) for Moose Creek at their SW1 site (based on data available up to 2021); their 7Q20 estimates were made using HEC-SSP, based on simulated (“synthetic”) flows derived from establishing a linear relationship with data from WSC station 02LB020 (“Payne River near Berwick”). CanDetec (2022) also reported a 7Q20 estimate for SW1 of 0.06 m^3/s, based on analysis using the Ontario Flow Assessment Tool[1]; they noted that this 7Q20 was likely an overestimate, which is consistent with the measured data that they presented (i.e., the 25th percentile flow was 0.062 m^3/s at SW1 (Table 3) which suggests that a 7Q20 of 0.06 m^3/s is much too high).

Following the “synthetic flows” approach used by GFL/CanDetec, HESL established the relationship between the average daily flow of the Payne River and flows at SWMC3 via simple linear regression analysis (forced y-intercept = 0) in order to estimate 7Q20 flows of Moose Creek at the lagoons (Figure 7). The slope of the regression line was used to estimate SWMC3 flows from Payne River flows. 7Q20 flows were estimated for the Payne River near Berwick by fitting various theoretical distributions (Gamma, Generalized Extreme Value, Gumbel, Inverse-Gamma, Lognormal, Weibull) to 7-day rolling-average flows for each proposed discharge period (spring and fall) based on daily-average flows reported by WSC for the period 1995–2024 (i.e., most recent 30 years of data available). The best-fitting distribution for each month was determined based on minimization of the Akaike Information Criterion (AIC), and the monthly 7Q20 for the Payne River was calculated as the 5th-percentile of the fitted distribution. The root mean squared error (RMSE) was also calculated as a supplementary measure of model fit. The 7Q20 estimates for the Payne

[1] MNR replaced the Ontario Flow Assessment Tool with the Ontario Watershed Information Tool; the latter does not feature a tool for flow estimation.

River were then scaled by 0.1583 (see Figure 7) to estimate 7Q20 flows for Moose Creek at the lagoons (Table 4).

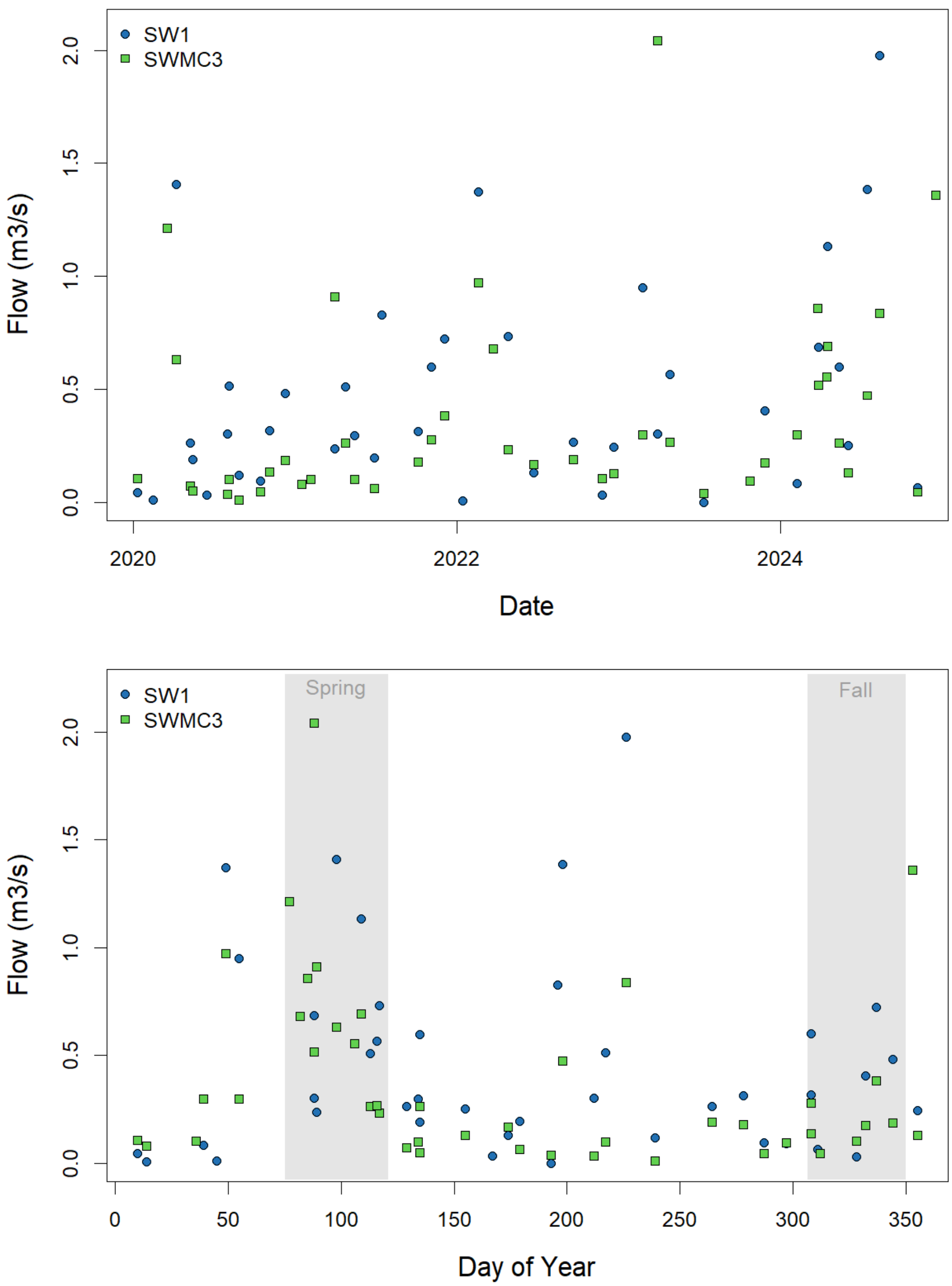

Figure 5. Flow of Moose Creek based on spot measurements (data from GFL Environmental). The gray areas represent the existing spring discharge window and the proposed (additional) fall discharge period.

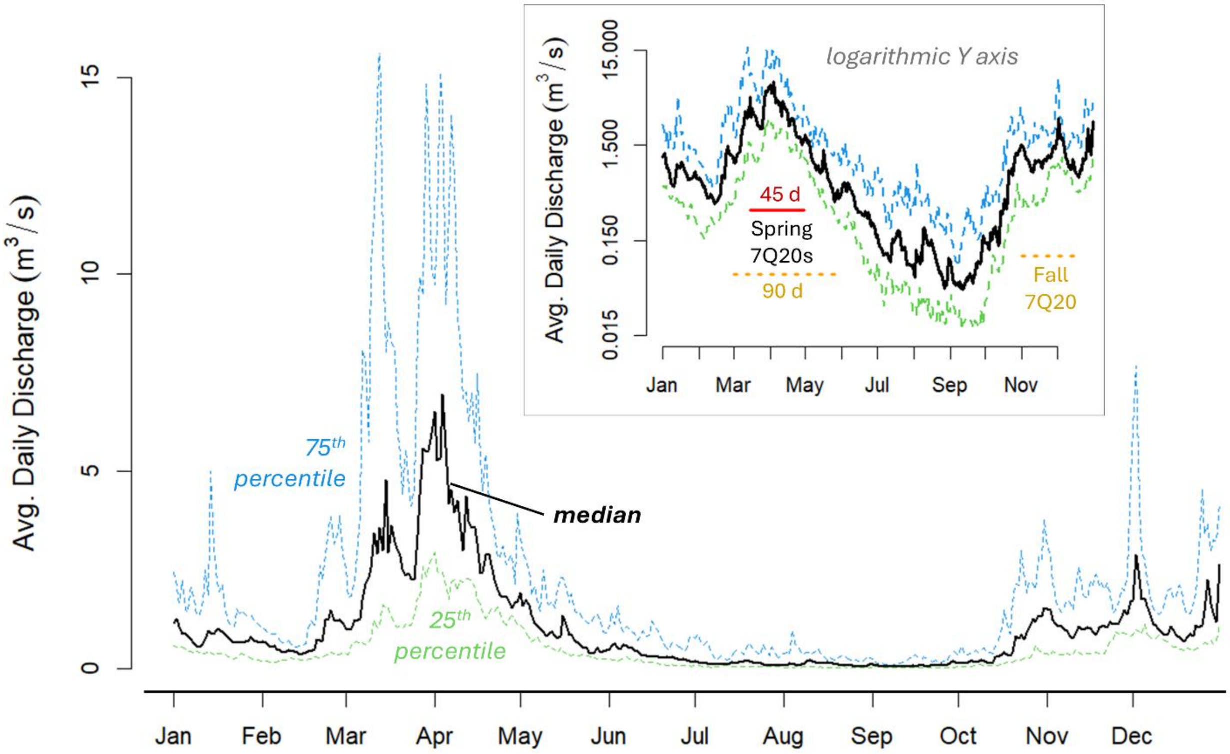

Figure 6. Seasonal hydrograph of the Payne River near Berwick (WSC-02LB022; 1995–2024).

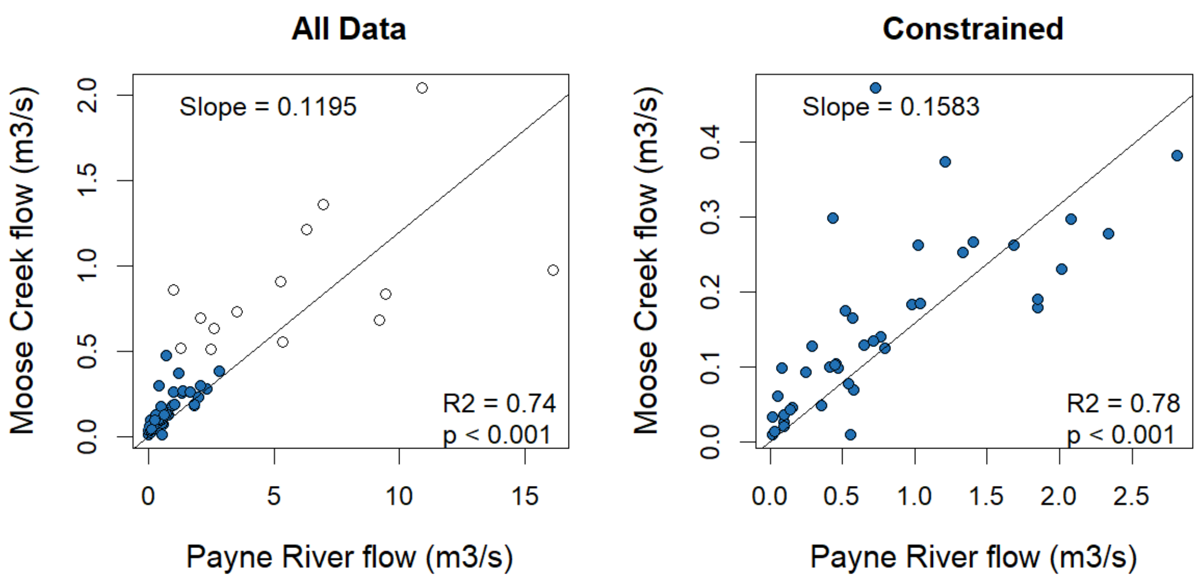

Figure 7. Relationship between the flow of Moose Creek (GFL-SWMC3) and the Payne River (WSC-02LB022) based on all common dates (2019–2024; n = 55). The plot on the right ("Constrained") excludes paired data for which Payne River flows were above the 75th percentile (open circles in "All Data") to reduce the influence of high flows on the linear regression model.

Table 4. Estimates of seasonal 7Q20 flows and corresponding 5th-percentiles of annual 7-d minimum flows.

Season	Period	Moose Ck. 7Q20 (m^3/s)	Payne R. 7Q20 (m^3/s)	5th percentile	Distribution Function	RMSE	AIC
Spring	15 Mar – 30 Apr	0.0488	0.309	0.367	Gamma	0.27	43.0
	1 Mar – 31 May	0.0104	0.066	0.067	Log-normal	0.40	-4.24
Fall	1 Nov – 15 Dec	0.0164	0.104	0.125	Gamma	0.21	16.9

The 7Q20 flow of the Payne River near Berwick was estimated to be 0.309 m^3/s during the existing spring lagoon-discharge period, which corresponds to an estimated 0.0488 m^3/s flow of Moose Creek (Table 4) based on the empirically determined ratio of 0.1583 for Moose Creek vs. Payne River flows (Figure 7Figure 5). The 7Q20 flow of Moose Creek was estimated to be much lower (0.0104 m^3/s) for the proposed future extended spring discharge window (1 Mar to 31 May). The 7Q20 flow of the Payne River near Berwick was estimated to be 0.104 m^3/s during the proposed (additional) fall lagoon-discharge period, which corresponds to an estimated 0.0164 m^3/s flow of Moose Creek.

3.2 Receiver Water Quality

Water quality data were assessed against applicable Provincial Water Quality Objectives (PWQOs; MOEE 1994b) to determine the policy status of Moose Creek to receive treated effluent in accordance with MECP policies and guidelines (MOEE 1994c):

- Policy 1 - In areas which have water quality better than the PWQO, water quality shall be maintained at or above the objectives;

- Policy 2 - Water quality which presently does not meet the PWQO shall not be degraded further, and all practical measures shall be taken to upgrade the water quality to the objectives.

Comparisons were made against the Canadian Water Quality Guidelines for the Protection of Aquatic Life (CWQG) for nitrate (NO_3-N; CCME 2012), nitrite (NO_2-N, CCREM 1987) and total suspended solids (TSS; CCME 2002) because PWQOs are not available for these parameters.

The water quality of Moose Creek has been monitored by OCWA during lagoon discharges (Table 5) and by GFL on a year-round basis (Table 6). The OCWA dataset shows that the lagoon effluent is an enriching influence on *E. coli,* TAN, TKN, and TP (and, less consistently, TSS) concentrations during lagoon discharge periods. The year-round dataset collected by GFL shows that the receiver is Policy 2 for NO_3-N and TP while concentrations of CBOD5, TSS, and ammonia (TAN and UAN) are relatively low. Summary statistics based on the GFL dataset did not differ appreciably when data collected in April (i.e., during lagoon discharge) were excluded (Table 6), suggesting a limited influence of the effluent on the water quality of Moose Creek at the SWMC3 site; this location is further (~50 m) downstream of the outfall than the (downstream) OCWA site, which is only ~10 m downstream of the outfall.

Table 5. The water quality of Moose Creek upstream ("up") and downstream ("down") of the lagoon outfall during the discharge period (late-Mar and Apr), based on monitoring by the OCWA (2015–2025; *n* = 55).

Parameter	Location	Min.	Median	75th percentile	Max.	# NDs*
CBOD (mg/L)	up	<1	<3	<3	6	50
	down	<1	<3	<3	26	35
Cond. (µS/cm)	up	325	810	895	1000	0
	down	270	800	900	1000	0
E. coli (CFU/100mL)	up	<10	30	75	790	9
	down	<10	160	470	2300	4
H_2S (mg/L)	up	<0.01	<0.04	<0.04	1.0	35
	down	<0.01	<0.04	<0.04	0.2	22
NO_2-N (mg/L)	up	<0.05	<0.10	<0.10	<0.10	55
	down	<0.05	<0.10	<0.10	0.28	54
NO_3-N (mg/L)	up	<0.10	3.81	4.80	7.13	1
	down	0.10	3.41	4.32	7.13	0
pH (pH units)	up	6.85	8.02	8.28	9.47	0
	down	6.80	8.00	8.28	9.47	0
TAN (mg/L)	up	<0.01	0.07	0.14	3.51	11
	down	<0.01	1.47	3.37	6.16	3
Temp. (°C)	up	5.5	8.0	9.7	12.5	0
	down	5.6	8.0	9.9	12.7	0
TKN (mg/L)	up	0.1	0.8	1.0	6.1	3
	down	0.6	3.0	4.6	14.6	2
TP (mg/L)	up	<0.01	0.04	0.05	0.31	5
	down	0.01	0.11	0.16	0.73	1
TSS (mg/L)	up	<2	7	12	58	9
	down	<2	12	18	48	2

** number of observations below the laboratory detection limit (“non-detects”); where detection limits differed, statistics are expressed based on the higher of the detection limits for the upstream and downstream locations for a more direct comparison between locations (e.g., where one location has a limit of 1 mg/L and the other 2 mg/L both values are expressed as “<2” for consistency).*

Table 6. The water quality of Moose Creek at GFL site SWMC3 (downstream of the lagoon outfall), based on available data (Jan 2022 – Apr 2025) for all months of the year and excluding data from the month of April, when the lagoons are discharged.

Parameter	Period	Min.	Median	*75th percentile	Max.	*n*	# NDs
CBOD5 (mg/L)	Jan–Dec	<1	<1	2.00	3.00	25	13
	Excl. Apr	*<1*	*<1*	*1.00*	*3.00*	*21*	*11*
Cond. (µS/cm)	Jan–Dec	5	317	372	621	24	-
	Excl. Apr	*5*	*312*	*390*	*621*	*20*	-
DO (mg/L)	Jan–Dec	6.0	12.3	10.5*	21.6	24	-
	Excl. Apr	*6.0*	*12.3*	10.4*	*21.6*	*20*	-
NO_3-N (mg/L)	Jan–Dec	0.22	4.23	6.03	11.70	25	0
	Excl. Apr	*0.22*	*4.41*	*6.27*	*11.70*	*21*	*0*
pH (pH units)	Jan–Dec	7.36	7.97	8.17	8.94	24	-
	Excl. Apr	*7.36*	*8.06*	*8.18*	*8.94*	*20*	-
TAN (mg/L)	Jan–Dec	<0.02	0.04	0.11	1.77	25	4
	Excl. Apr	*<0.02*	*0.05*	*0.11*	*1.77*	*21*	*4*

Parameter	Period	Min.	Median	*75th percentile	Max.	*n*	# NDs
TDP (mg/L)	Jan–Dec	0.004	0.019	0.041	0.151	25	0
	Excl. Apr	*0.004*	*0.022*	*0.042*	*0.151*	*21*	*0*
Temp (°C)	Jan–Dec	-1.2	6.5	14.1	22.0	24	-
	Excl. Apr	*-1.2*	*3.1*	*16.5*	*22.0*	*20*	*-*
TP (mg/L)	Jan–Dec	0.011	0.036	0.051	0.164	25	0
	Excl. Apr	*0.011*	*0.049*	*0.054*	*0.164*	*21*	*0*
TSS (mg/L)	Jan–Dec	<2	3	7	47	25	7
	Excl. Apr	*<2*	*3*	*6*	*47*	*21*	*7*
UAN (mg/L)	Jan–Dec	0.00008	0.00051	0.00202	0.03436	21	**
	Excl. Apr	*0.00008*	*0.00070*	*0.00202*	*0.03436*	*17*	**

**25th percentiles for DO; ** UAN calculated by GFL (their TAN non-detect conversion method was not specified).*

3.3 Fish

The fish community composition of Moose Creek, upstream of the lagoons, was assessed by South Nation Conservation (SNC) in 2008–2009 using the Ontario Stream Assessment Protocol; the data shared by SNC are provided below (Table 7). The limited available data reflect a predominantly cool-water fish community dominated by small fish such as minnows and darters.

Table 7. Fish abundances in Moose Creek, as observed by SNC in 2008–2009.

Common Name	Scientific Name	DEWMC (45.2138°, -74.9661°)	ISMC (45.2545°, -74.9702°)	STEELMC (45.1950°, -74.9918°)	Habitat Preference*
Central Mudminnow	*Umbra limi*	1	2	6	cool water
Bluntnose Minnow	*Pimephales notatus*	1	78		warm water
Northern Redbelly Dace	*Chrosomus eos*	7	8	76	cool water
Creek Chub	*Semotilus atromaculatus*	11	82	76	cool water
Brook Stickleback	*Culaea inconstans*	20	15	98	cool water
White Sucker	*Catostomus commersonii*	21	80	4	cool water
Darters	*Etheostoma* spp.	50	236	0	"most … prefer warmer waters"
Brassy Minnow	*Hybognathus hankinsoni*	0	21	0	cool water
Common Shiner	*Luxilus cornutus*	0	12	0	cool water
Mimic Shiner	*Notropis volucellus*	0	27	0	"vegetated areas of lakes and slow moving streams"
Central Stoneroller	*Campostoma anomalum*	0	3	0	warm water
Hornyhead Chub	*Nocomis biguttatus*	0	1	0	cool water
Blacknose Dace	*Rhinichthys atratulus*	0	5	2	cool water
Longnose Dace	*Rhinichthys cataractae*	0	3	0	cool water
Finescale Dace	*Chrosomus neogaeus*	0	0	1	cool water

**Habitat preference based on Holm et al. (2009).*

4. Mass-balance Modelling

4.1 Methodology

4.1.1 Mass-balance Approach

Mass-balance modelling was used to estimate concentrations of TP, TSS, and TAN/UAN in Moose Creek, downstream of the lagoon outfall, during lagoon discharge periods. The existing scenario and multiple future discharge scenarios were modelled. The form of the mass-balance equation is

$$C = \frac{Q_e \times C_e + Q_s \times C_s}{Q_e + Q_s}$$

where

C is the concentration of the parameter of interest downstream of the lagoon discharge,
Q_e is the flow of effluent,
C_e is the concentration of the parameter of interest in the effluent,
Q_s is the flow of Moose Creek, and
C_s is the ambient concentration of the parameter of interest in Moose Creek.

4.1.2 Unionized Ammonia

Downstream UAN was estimated from downstream TAN based on ambient 75th percentiles for water temperature (temp, in °C) and pH. The fraction of TAN present as UAN was calculated as

$$f = (10^{pKa-pH} + 1)^{-1}$$

where

$$pKa = 0.09018 + (2729.92) \times (temp + 273.16)^{-1})$$

as described by MOEE (1994b).

4.1.3 Dissolved Oxygen and CBOD5

The Streeter-Phelps model was used to estimate DO concentrations as a function of time and distance downstream of the outfall based on equations and coefficients provided by Chapra (2008). An effluent CBOD5 concentration of 20.7 mg/L (i.e., no change in loading relative to existing CoA) was modelled and predicted DO was compared to the PWQO for protection of cold-water biota (MOEE 1994b).

According to the Streeter-Phelps model, the change in DO with time (i.e., distance downstream) can be modelled as

$$D = D_0 e^{-k_a t} + \frac{k_d L_0}{k_a - k_r}\left(e^{-k_r t} - e^{-k_a t}\right)$$

where

> D is the oxygen deficit (mg/L) at time, t (days),
> D_0 is the initial oxygen deficit (mg/L),
> L_0 is the initial BOD concentration (mg/L),
> k_a is the aeration rate (per day),
> k_d is the BOD decomposition rate (per day),
> k_r is the BOD removal rate (per day) = k_d + k_s, and
> k_s is the BOD settling rate (per day).

The total ("ultimate") BOD was estimated as 3.2 times the 5-day BOD (BOD5) based on the ratio described by Chapra (2008) as typical for effluent from a plant with activated sludge treatment. The effluent was assumed to be 70% saturated with DO (no data available). The aeration rate (/d) was calculated based on stream depth (H; m) and velocity (U; m/s) according to the Owens-Gibbs formula, which, according to Chapra (2008), "is used for shallower systems".

$$k_a = 5.32\frac{U^{0.67}}{H^{1.85}}$$

k_a was temperature-corrected according to the relationship:

$$k_{a,T} = k_{a,20} \times 1.024^{T-20}$$

Cross-sectional average watercourse depth (H) was estimated to be 0.3 m based on rating-curve data reported by CanDetec for their downstream site SW1 (0.5–1.0 m; CanDetec Inc. 2022) that drains a much larger area (i.e., is downstream of the confluence with Fraser drain) and based on a photograph of the creek taken immediately downstream of the lagoons (Photograph 7 of CanDetec Inc. 2022).

Velocity was calculated for spring and fall based on the respective 7Q20 flows and a stream (wetted) width of 5 m (estimated based on inspection of satellite imagery and Photograph 7 of CanDetec Inc. 2022).

As recommended by Chapra (2008) for shallow (≤2.4-m) streams, the BOD-decomposition rate was estimated as

$$k_{d,20} = 0.3\left(\frac{H}{2.4}\right)^{-0.434}$$

The BOD decomposition rate was then temperature-corrected according to the relationship:

$$k_{d,T} = k_{d,20} \times 1.047^{T-20}$$

The settling rate (/d) was calculated as

$$k_s = \frac{v_s}{H}$$

A settling velocity (v_s) value of 0.3 m/d, the midpoint of the range of 0.1–0.5 m/d described by Chapra (2008) as “typical”, was used for the modelling.

4.1.4 Effluent Flow

Modelling was based on average daily effluent outflows during the discharge period for the existing WWTP and a preferred future scenario, the latter comprising a fall and spring discharge period. The preferred future discharge scenario was selected from 8 options provided by CIMA; the preferred scenario (6.1) has the lowest average daily flow (ADF) during the fall period, during which there currently is no lagoon discharge (Table 8).

Table 8. Potential lagoon-discharge scenarios provided by CIMA.

Scenario	Season	Days	7Q20 (m^3/s)	Total Seasonal Discharge (m^3)	Daily Discharge (m^3/d)	ADF during discharge	
						(m^3/s)	(% total)*
CoA	Spring	20	0.0488	110,306	5,515	0.0638	57%
1.0	Spring	15	0.0488	72,708	4,847	0.0561	53%
1.0	Fall	15	0.0164	87,162	5,811	0.0673	80%
2.0	Spring	30	0.0488	72,708	2,424	0.0281	36%
2.0	Fall	30	0.0164	87,162	2,905	0.0336	67%
3.0	Spring	45	0.0488	72,927	1,621	0.0188	28%
3.0	Fall	45	0.0164	86,943	1,932	0.0224	58%
4.2	Spring	30	0.0488	26,718	891	0.0103	17%
4.2	Winter	90	0.0092	133,152	1,479	0.0171	65%
4.3	Spring	45	0.0488	33,507	745	0.0086	15%
4.3	Winter	90	0.0092	126,363	1,404	0.0163	64%
5.2	Spring	45	0.0488	106,434	2,365	0.0274	36%
5.2	Fall	45	0.0164	53,436	1,187	0.0137	46%
5.3	Spring	90	0.0104	126,582	1,406	0.0163	61%
5.3	Fall	45	0.0164	33,288	740	0.0086	34%
**6.1	Spring	90	0.0104	139,722	1,552	0.0180	63%
**6.1	Fall	45	0.0164	20,148	448	0.0052	24%

**Effluent flow (ADF) as percent of total stream flow (ambient + effluent) at 7Q20 ambient flow.*
***Preferred scenario (modelled).*

4.1.5 Modelled Effluent Concentrations

Modelling for each effluent flow scenario was based on CoA limits (MOEE 1994a) for the existing scenarios and concentrations that maintain existing CoA load limits (as per MECP pre-consultation) for the future scenarios (Table 9).

Table 9. Effluent concentrations modelled under existing and proposed future effluent discharge rates.

	Rated Capacity (m^3/d)	CBOD5 (mg/L)	H_2S (mg/L)	TAN (mg/L)	TP (mg/L)	TSS (mg/L)
Existing	302	30.0	0.17	15.0	1.00	30.0
Future	438	20.7	0.12	10.3	0.69	20.7

4.1.6 Ambient Flow

Mass-balance modelling was based on the 7Q20 flow of Moose Creek as determined for the existing 45-d discharge window of 15 Mar–30 Apr (0.0488 m^3/s) and for the future potential discharge periods, comprising 1 Mar – 31 May (0.0104 m^3/s) and 1 Nov–15 Dec (0.0164 m^3/s); details are provided in Section 3.1.

4.1.7 Ambient Concentrations

As per Policy B-1-5 (MOEE 1994c), the mass-balance modelling exercise used the 75th-percentiles of historical ambient water-quality data to represent the ambient conditions in Moose Creek (Table 10)[2]. The percentiles were calculated separately for the spring and fall periods. The spring calculations were based on the pooled available data from OCWA (upstream site) and GFL (SWMC3) for the months of March and April. Fall ambient concentrations were based on the available data from GFL for site SWMC3 (only) as OCWA monitoring has been restricted to the current (spring) discharge period.

Table 10. Ambient water quality used for mass-balance modelling. Concentrations are in mg/L. The number of available data is represented by *n*.

Spring	CBOD5	DO	H_2S	NO_3-N	TAN	TP	TSS
75th percentile	1.5*	12.06**	0.02	4.85	0.14	0.05	12
OCWA-upstream (2015–2025); *n*	55	0	55	55	55	55	55
GFL-SWMC3 (2022–2024); *n*	8	8	0	8	8	8	8
Fall	**CBOD5**	**DO**	**H_2S**	**NO_3-N**	**TAN**	**TP**	**TSS**
75th percentile	1	10.55**	-	4.82	0.042	0.021	2
OCWA (2015–2025); *n*	0	0	0	0	0	0	0
GFL-SWMC3 (2022–2024); *n*	5	5	0	5	5	5	5

**Half the method detection limit was substituted for the CBOD5 75th percentile because it was below detection (<3.0 mg/L).*
***Summary statistic for DO is the 25th percentile.*

[2] *Background DO was based on the 25th-percentile because the PWQO for DO is based on maintaining a minimum concentration.*

5. Results

Under the future discharge scenario, spring concentrations of TP downstream of the lagoons are predicted to be above PWQO but lower than concentrations under the existing discharge scenario, as is the case for TSS (Table 11). TSS is predicted to be below the CWQG (background +5-mg/L) in the fall under the future scenario of maintained loading and at the recommended future limit of 20 mg/L (Table 12). Based on the assumption of no change in effluent NO_3-N concentrations, future NO_3-N concentrations downstream of the WWTP are predicted to be lower than upstream concentrations in both fall and spring, thus meeting the guideline under Policy 2.

Table 11. Predicted downstream concentrations of TP, TSS, and NO_3-N under fully mixed conditions based on no change in annual loading relative to existing CoA limits.

Parameter	Season	Existing	Future	
		Spring	Spring	Fall
Flow	Discharge Period	15 Mar–30 Apr	1 Mar–31 May	1 Nov–15 Dec
	ADF (m^3/s)	0.0638	0.0180	0.0052
	7Q20 (m^3/s)	0.0488	0.0104	0.0164
TP Concentration (mg/L)	Effluent	1.000	0.689	0.689
	Upstream	0.050*	0.050*	0.021
	Downstream	0.588	0.455	0.182
	PWQO	0.030	0.030	0.030
TSS Concentration (mg/L)	Effluent	30.0	20.7	20.7
	Upstream	12.0	12.0	2.0
	Downstream	22.2	17.5	6.5
	CWQG	17.0	17.0	7.0
NO_3-N (mg/L)	Effluent**	1.13	1.13	1.13
	Upstream	4.85*	4.85*	4.82
	Downstream	2.74	2.49	3.93
	CWQG	3.0	3.0	3.0

**Policy 2 (i.e., ambient (upstream) concentration exceeds PWQO/CWQG).*

***No effluent limit for NO_3; 75^{th}-percentile historical effluent concentration was modelled (see Table 2).*

Downstream UAN concentrations are predicted to be well above the PWQO at the current effluent limit and rated capacity and under the future scenario which assumes no change in loading, although concentrations are lower under the future scenario; TAN effluent limits of 0.89, 0.81, and 5.47 mg/L would be needed to meet the PWQO under the existing, future-spring, and future-fall scenarios, respectively (Table 13). At the recommended future TAN limit of 3 mg/L, downstream concentrations of TAN and UAN are predicted to be much lower than under the existing scenario (effluent limit of 15 mg/L) and UAN is predicted to be well below PWQO in the fall.

Table 12. Predicted downstream concentrations of TP and TSS under fully mixed conditions based on recommended effluent limits.

Parameter	Season	Existing Spring	Future Spring	Future Fall
Flow	Discharge Period	15 Mar–30 Apr	1 Mar–31 May	1 Nov–15 Dec
	ADF (m^3/s)	0.0638	0.0180	0.0052
	7Q20 (m^3/s)	0.0488	0.0104	0.0164
TP Concentration (mg/L)	Effluent	1.000	0.500	0.500
	Upstream	0.050*	0.050*	0.021
	Downstream	0.588	0.335	0.136
	PWQO	0.030	0.030	0.030
TSS Concentration (mg/L)	Effluent	30.0	20.0	20.0
	Upstream	12.0	12.0	2.0
	Downstream	22.2	17.1	6.3
	CWQG	17.0	17.0	7.0

**Policy 2 (i.e., ambient (upstream) concentration exceeds PWQO/CWQG).*

Table 13. Predicted downstream concentrations of TAN and UAN under fully mixed conditions based on no change in annual loading relative to existing CoA limits.

	Season	Existing Spring	Future Spring	Future Fall
	ADF (m^3/s)	0.0638	0.0180	0.0052
	7Q20 (m^3/s)	0.0488	0.0104	0.0164
	Ambient TAN (mg/L)	0.140	0.140	0.042
	Ambient pH	8.23	8.23	8.06
	Ambient Temperature (°C)	9.45	9.45	3.20
	pKa	9.7	9.7	10.0
	f (fraction)	0.029	0.029	0.012
Loading Maintained	Effluent TAN (mg/L)	15.00	10.34	10.34
	Downstream TAN (mg/L)	8.56	6.61	2.52
	Downstream UAN (mg/L)	0.2482	0.1915	0.0307
Meet PWQO	Effluent TAN (mg/L)	0.89	0.81	5.47
	Downstream TAN (mg/L)	0.57	0.57	1.34
	Downstream UAN (mg/L)	0.0164	0.0164	0.0164
Recommended Limit	Effluent TAN (mg/L)	–	3.0	3.0
	Downstream TAN (mg/L)	–	1.95	0.75
	Downstream UAN (mg/L)	–	0.0566	0.0092

DO concentration was predicted to meet the PWQO for cold-water biota under all scenarios modelled, with a steeper initial rate of decline and nearer “sag-point” under the future spring scenario than the existing scenario due to the greatly reduced 7Q20 estimated for the extended future spring discharge window (Figure 8).

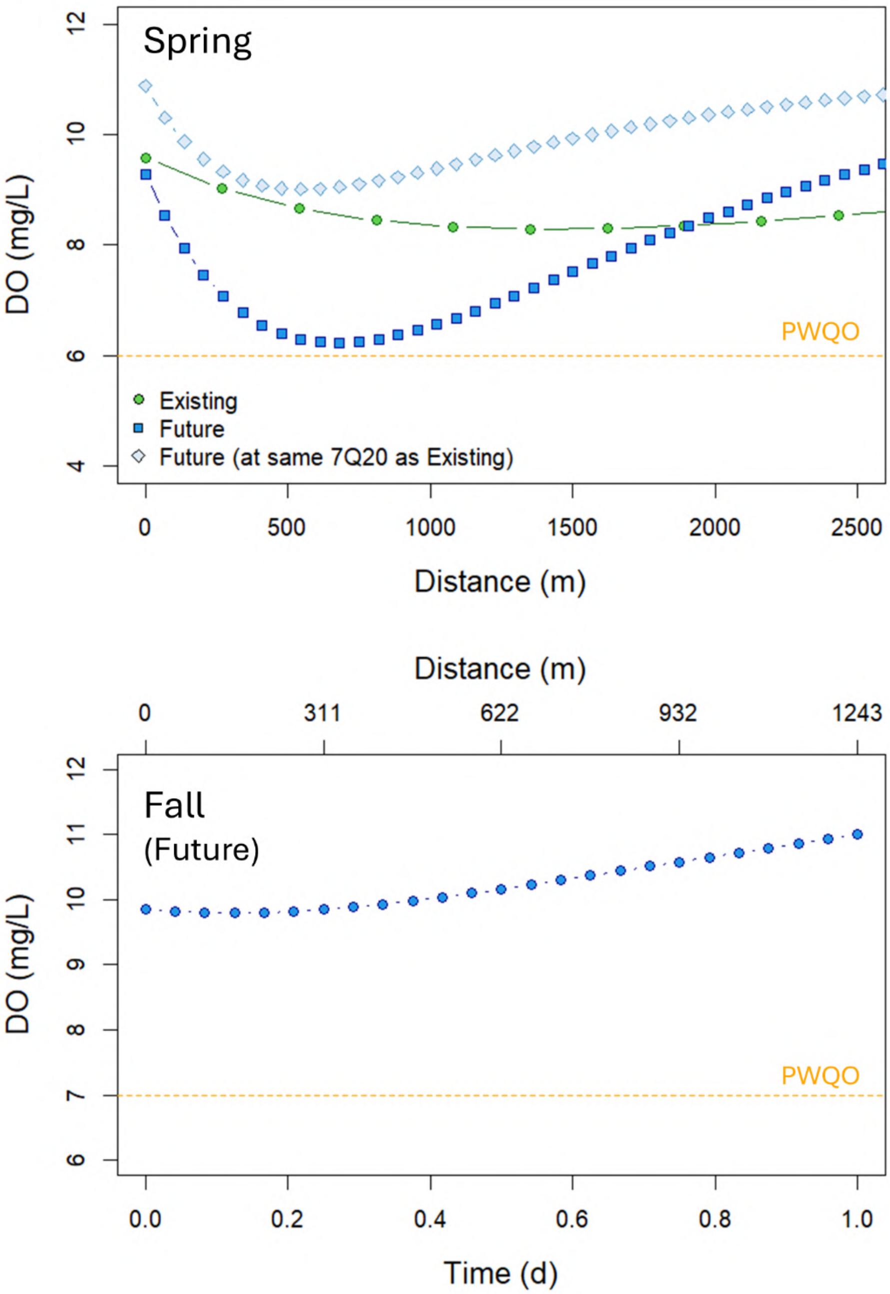

Figure 8. Predicted DO downstream of the WWTP outfall at effluent CBOD5 of 30 mg/L (CoA limit; “Existing”) and 20.7 mg/L (“Future”; effluent BOD at new rated capacity and no change in loading) during 7Q20 flow conditions, based on the Streeter-Phelps model. The dashed horizontal line represents the PWQO for DO recommended to protect cold-water biota (MOEE 1994b).

6. Recommendations

Based on the available data and the modelling performed, the following effluent concentration limits are recommended for the Moose Creek WWTLP at an increased future rated capacity of 438 m^3/d (Table 14). No change to the total annual loading limits specified in the CoA is recommended.

Table 14. Recommended effluent limits for the Moose Creek WWTP at increased rated capacity.

Parameter	Recommended Effluent Limit	Rationale
CBOD5	20 mg/L	Streeter-Phelps model predictions indicate that limit will allow downstream DO to meet the PWQO for protection of cold-water biota.
H_2S	0.12 mg/L	Entails no change to loading based on limit in existing CoA (no ambient H_2S data are available for mass-balance modelling).
NO_3-N	no limit	Consistent with existing CoA; modelling indicates dilution of high ambient concentrations by effluent discharge.
TAN	3 mg/L	Entails a large decrease in annual TAN loading. Downstream UAN predicted to be lower than with existing limit and to meet PWQO during fall discharge period.
TP	0.5 mg/L	Represents a decrease in total annual loading; PWQO is not currently being met under existing CoA effluent limit. Predicted TP concentrations in spring are lower for future scenario than under existing conditions.
TSS	20 mg/L	Downstream concentrations will decrease relative to under existing CoA limit with slight exceedance of CWQG in spring (less so than under existing limit) and CWQG will be met during fall discharge.

7. References

Canadian Council of Ministers of the Environment (CCME). 2012. Canadian water quality guidelines for the protection of aquatic life: Nitrate. In: Canadian environmental quality guidelines, Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Council of Ministers of the Environment (CCME). 2002. Canadian water quality guidelines for the protection of aquatic life: Total particulate matter. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg

Canadian Council of Resource and Environment Ministers (CCREM). 1987. Canadian water quality guidelines. Prepared by the Task Force on Water Quality Guidelines.

CanDetec Inc. 2022. Supporting Document 1-4: Surface Water Quality Existing Conditions Report – Eastern Ontario Waste Handling Facility Future Development Environmental Assessment – GFL Environmental Inc. Moose Creek, Ontario. October 11, 2022.

Chapra, S.C. 2008. Surface Water-Quality Modeling. Waveland Press Inc., Long Grove (IL).

Holm, E., Mandrak, N.E., Burridge, M.E. 2009. The ROM field guide to freshwater fishes of Ontario. Royal Ontario Museum. Friesens Printers, Altona, MB.

National Research Council Canada (NRC). 2022. Low Flow Characteristics of Ontario Streams. Report No.: NRC-OCRE-2022-TR-026. Author: M.N. Khaliq. Ocean, Coastal and River Engineering Research Center.

Ontario Ministry of Environment and Energy (MOEE) 1994a. Amendment to Certificate of Approval. Sewage. Number 3-1555-91-936.

Ontario Ministry of Environment and Energy (MOEE). 1994b. Water management policies guidelines and water quality objectives of the Ministry of Environment and Energy, July 1994. ISBN 0-7778-8473-9 rev.

Ontario Ministry of the Environment (MOEE). 1994c. Deriving receiving water based point source effluent requirements for Ontario waters. PI

Ontario Ministry of Natural Resources (MNR). 2025. Ontario Watershed Information Tool. https://www.lioapplications.lrc.gov.on.ca/OWIT/Index.html?viewer=OWIT.OWIT&locale=en-ca. Accessed: 2025-09-05.

Appendix A. Minutes of MECP Pre-consult Meeting

Minutes of Meeting

Project Name		Project Number	Meeting no.
Moose Creek WWTL Class EA Project		Z0028411	MECP-01
Title	**Date of meeting**	**Location**	**Time**
MECP Pre-consult for ACS	July 08, 2025	Online	01:00 pm CST

Attendees:	Affiliation	Role	Email
Lauren Forrester (LF)	MECP	Surface Water Specialist	lauren.forrester@ontario.ca
Melissa Forget (MF)	MECP	Water Compliance Officer	melissa.forget@ontario.ca
Jon K. Orpana (JO)	MECP	Regional Environmental Planner	jon.orpana@ontario.ca
Deborah Sinclair (DS)	HESL	Senior Aquatic Scientist	deborah.sinclair@environmentalsciences.ca
Joel Harrison (JH)	HESL	Senior Aquatic Scientist	joel.harrison@environmentalsciences.ca
Natalie Colantonio (NC)	OCWA	Project Engineer	ncolantonio@ocwa.com
Bradley Young (BY)	CIMA+	Project Manager	bradley.young@cima.ca
Mary Jislin (MJ)	CIMA+	Project coordinator, EIT	mary.jislin@cima.ca

Note: If you believe that these minutes are lacking in accuracy, please inform the author who will make the necessary changes within 10 days following distribution of the document. After that delay, the minutes will be deemed official and binding for all those involved.

Discussion Topics		Action by
Purpose of the meeting: Project introduction, summary of existing information, work plan review, and discussion on any questions or concerns with the approach.		
1.0	**Introduction** Team introductions were carried out.	
2.0	**Project Background & Historical flows** BY provided brief project introduction and background. ▪ The project was initiated by the Township of North Stormont primarily due to future growth and storage volume considerations. Facility is currently at 85% of the rated capacity of 302 m^3/d, also necessitating additional capacity. ▪ A Master Servicing Plan report (MSP) was undertaken by the Township in 2024, for Phase 1 and Phase 2 of the Class EA process. Notice of Commencement has been sent out last month for this Project (Phases 3 and 4 of the Class EA Process). Flow projections from the MSP have been maintained. ▪ The study area consists of the existing property, and an adjacent plot to the East. Due to the large forest cover, this new land is not preferred for use, unless a third lagoon is required in the future. ▪ BY also noted that due to funding criteria, the project is on a very tight schedule to meet construction deadlines, for completion expected in 2027. Hence, the aim is to be efficient and streamlined with the ACS to save as much time as possible.	Info
3.0	**Summary of Existing approach** JH provided background on the current ECA concentration and loading limits. ▪ 10 years of quality data (effluent and upstream & downstream of the outfall) were provided by OCWA. Over the data period, only minor exceedances have occurred for the controlled parameters. o Additionally, monitoring data (2019-2024) from GFL's recent expansion study has been shared by GFL with CIMA. From this, one monitoring location (SWMC3) is approximately 50m downstream from the lagoon outfall and its data is highly relevant to this study. ▪ Two approaches to derive the (monthly) 7Q20s were presented. o Approach 01 is similar to that used by GFL in their ACS, employing 'synthetic flows'. Flow data will be used to arrive at 7Q20s for the Payne River and the relevant scaling factor will be applied to derive 7Q20s for Moose Creek.	

Discussion Topics		Action by
	o Approach 02 will use median data from surrounding Water Survey Canada gauges, followed by conversion to runoff, based on the watershed area. Finally, (monthly) 7Q20s for Moose Creek will be derived using the area upstream of the Lagoons.	
	■ Moose Creek flows North into the South Nation River. Quality data comparison between both the water bodies was presented. Nitrates were slightly higher in Moose Creek, while the other parameters (BOD5, TAN, TP, TSS) were higher in the South Nation.	
4.0	**Confirmation of ACS Approach**	
	■ JH queried if either of the two approaches for deriving the 7Q20s was preferred by the MECP or if there were any concerns associated with them.	Info
	■ LF advised that the MECP is open to both approaches for 7Q20 derivation and noted that should Approach 01 be used, the MECP would require a high level of detail.	Info
	o LF also added that the GFL report referenced here seems to be an older version. A significant amount of additional supporting information was required by the MECP from GFL, to support their ACS approach. If the final GFL ACS study is a public document, the MECP can provide the document to CIMA for reference, to understand the relevant 7Q20s and the level of detail required by the MECP for Approach 01.	Info
	■ DS asked whether GFL utilised the monthly or annual 7Q20s. LF confirmed that it was monthly. o LF also noted that for GFL, the discharge conditions are complex with almost continuous discharge, while maintaining a set volume of discharge, and varying discharge flows based on the relevant Creek flow. o DS asked if this project could also utilise a similar method, essentially for a longer discharge period. LF noted that if the effluent limits are met, and sufficient supporting information is provided, the MECP would not be opposed to this method.	Info
	■ DS noted that the current strategy for this project, in terms of approaching re-rating, is maintaining existing loading limits and increasing flow quantities, hence, decreasing concentration limits. o LF noted that based on this preliminary information, maintaining loadings would be an acceptable approach. However, the MECP may impose varying discharge rates through the year, to prevent high loadings from flowing downstream of the lagoons.	Info

Discussion Topics		Action by
	- DS clarified that the project is not aiming for a year-round discharge. The current discharge period is once a year, for 20 days within a 45-day window. The goal is to extend this Spring discharge period and include a Fall discharge. o BY added that since Moose Creek has low flows in the Summer months, year-round discharging has been ruled out. However, since the adjacent property presents several complications for usage, constructing only on the existing plot is the team's preferred preliminary solution. An extended Spring discharge window with a Fall discharge would aid in this, and also greatly reduce the capital costs and construction time period, serving in meeting the funding deadlines for this project. o LF confirmed that if sufficient supporting flow data is provided, the MECP would be open to discussing an extended discharge window and a fall discharge.	Info
	- JH enquired about the reporting needs, if a significant amount of background data for the South Nation River would be required, or if the report needs to be more focused on Moose Creek. o LF confirmed that Moose Creek is more of a concern for the MECP, due to the existing downstream loading by GFL. The MECP would like to avoid major loading impacts that can alter GFL's loading limits, due to recent approvals. o BY noted that CIMA has consulted with GFL during the data sourcing and provided them with project background, and GFL had expressed similar concerns which were noted.	Info
	- DS asked when the GFL ACS study was completed and if they received their new ECA. If available, the ECA will provide limits that can be referenced for consideration in this project. o LF noted that the GFL ACS was completed within the past year, their ECA was recently issued and can be provided to CIMA for reference.	Info / MECP
5.0	**Other points of discussion**	
	- J.O asked to be cc'ed on all ACS related emails, incoming from CIMA+ and outgoing from the MECP, since the ACS relates to the ongoing Class EA process.	CIMA+ / MECP

Prepared by: Mary Jislin, M.Eng.

K

Appendix K: Alternative Design Concepts – Cost Breakdown

Moose Creek Wastewater Treatment Lagoons Class EA (Z0028411)
Preliminary Class 'D' Level Cost Estimates
08-Oct-25
Alternative 01: SAGR retofit

Prepared by MJ
Reviewed by BY

CIMA+

Component Description	Quantity	Unit	Total Cost, Including installation
Site Works & Structural / Architectual			**$ 1,080,000**
General Civil Work	1	LS	$ 300,000
SAGR Excavation/Disposal	3,536	m3	$ 176,788
SAGR Clean Rock Media	2,240	m3	$ 280,000
SAGR Insulating Wood Chips	210	m3	$ 8,400
SAGR HDPE Liner (60 mil)	1440	m2	$ 100,800
Non-Woven Geotextile	2290	m3	$ 10,992
Wall Framing and Sheeting	180	m	$ 16,200
Backfill and Berm Construction	1086	m	$ 65,145
Blower Building	39	m2	$ 117,000
Process & Equipment			**$ 3,100,000**
Intermediate Pump Station	1	LS	$ 650,000
SAGR and related Process Units	1	LS	$ 1,770,000
Influent flow splitter structure	1	LS	$ 24,000
Piping, fitting, valve splitter to SAGR	1	LS	$ 72,000
Effluent level control manholes	2	LS	$ 24,000
Piping	527	m	$ 237,330
Valving	1	LS	$ 100,000
Miscellaneous	1	LS	$ 200,000
HVAC & Plumbing	1	LS	$ 27,322
Instrumentation and Controls	1	LS	$ 75,000
Electrical	1	LS	$ 410,000
Sub-Total: Alternative 6			**$ 4,700,000**
Sub-Total Costs (A)			**$ 4,700,000**
General Contractor's Overhead & Profit, Mob., bond	% of A	15.0%	$ 710,000
Sub-Total Costs (B)			**$ 5,400,000**
Construction Contingency	% of B	25.0%	$ 1,350,000
Engineering	% of B	15.0%	$ 810,000
Total Estimated Construction Costs (C) - Excluding Escalation, GST & Engineering			**$ 7,600,000**

Moose Creek Wastewater Treatment Lagoons Class EA (Z0028411)
Preliminary Class 'D' Level Cost Estimates
08-Oct-25
Alternative 02: MBBR retofit

Prepared by MJ
Reviewed by BY

Component Description	Quantity	Unit	Total Cost, Including installation
Site Works & Structural / Architectual			**$ 980,000**
General Civil Work	1	LS	$ 250,000
MBBR Tanks - Concrete	197	m3	$ 393,936
MBBR Tanks - Excavation	676	m3	$ 33,792
Blower / DAF Building	100	m2	$ 300,000
Process & Equipment			**$ 3,700,000**
Intermediate Pump Station	1	LS	$ 650,000
Additional Aeration Lines	1	LS	$ 150,000
MBBR Supply and Lagoon Aeration, with DAF	1	LS	$ 2,340,000
Influent Flow Split Structure	1	LS	$ 15,000
Effluent Control manholes	2	LS	$ 20,000
Piping	527	m	$ 237,300
Valving	1	LS	$ 100,000
Miscellaneous	1	LS	$ 200,000
HVAC & Plumbing	1	LS	$ 50,069
Instrumentation and Controls	1	LS	$ 195,150
Electrical	1	LS	$ 737,750
Sub-Total: Alternative 5a			**$ 5,700,000**
Sub-Total Costs (A)			**$ 5,700,000**
General Contractor's Overhead & Profit, Mob., bond	% of A	15.0%	$ 860,000
Sub-Total Costs (B)			**$ 6,600,000**
Construction Contingency	% of B	25.0%	$ 1,650,000
Engineering	% of B	15.0%	$ 990,000
Total Estimated Construction Costs (C) - Excluding Escalation, GST & Engineering			**$ 9,200,000**

L

Appendix L: Climate Change Information Report

Township of North Stormont

Moose Creek Wastewater Treatment Lagoons Expansion Project

Climate Change Information Report

Monday, August 25, 2025

Z0028411

CIMA+

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Township of North Stormont

Climate Change Information Report

Moose Creek Wastewater Treatment Lagoons Expansion Project

Project no. Z0028411

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List of Abbreviations

ACS	Assimilative Capacity Study
ADF	Average Day Flow
CDM	Canadian Drought Monitor
CH_4	Methane
CNFDB	Canadian National Fire Database
CWFIS	Canadian Wildland Fire Information System
EA	Environmental Assessment
ECCC	Environment and Climate Change Canada
GHG	Greenhouse Gas
HDPE	High-Density Polyethylene
I&I	Inflow And Infiltration
L/p/d	Liters per person per day
m^3/d	cubic meter per day
MBBR	Moving Bed Biofilm Reactor
MECP	Ministry of the Environment, Conservation and Parks
MNRF	Ministry of Natural Resources and Forestry
MSP	Master Servicing Plan
N_2O	Nitrous oxide
SAGR	Submerged Attached Growth Reactor
TN	Total Nitrogen
WWTL	Wastewater Treatment Lagoon

1. Introduction

The Village of Moose Creek is situated in the Township of North Stormont (the Township), and is located approximately 70 km South-East of Ottawa and 9 km South-East of Casselman. Wastewater treatment and servicing for the community is currently provided by the Moose Creek Wastewater Treatment Lagoons (WWTL), which were constructed in 1994.

The Township is expecting considerable planned growth in the next 25-30 years. This, coupled with population projections that forecast an 86% population increase for Moose Creek by the year 2051, point to a need to increase the treatment capacity of the existing Moose Creek WWTL.

A Master Servicing Plan (MSP) Study was previously undertaken for the Township and completed in 2024 (by R.V. Anderson Associates Ltd). The MSP completed Phase 1 (Problem Definition) and Phase 2 (Alternative Solutions) of the Class Environmental Assessment (EA) process and included future waster and wastewater servicing evaluations for the communities of Finch, Crysler and Moose Creek.

CIMA Canada Inc. (CIMA+) has been retained by the Township to complete the Class EA Phase 3 (Alternative Design Concepts for the Preferred Solution) and Phase 4 (Environmental Study Report).

The objective of this report is to present a summary of the current conditions as well as describe likely future impacts from climate change, to mitigate against existing and future adverse climate change trends as much as reasonably possible, to increase resiliency where possible and better protect assets and the environment.

1.1 Need for the current project

As mentioned above, the Township is anticipating significant planned and future growth over the next 25 to 30 years. According to the 2024 MSP, the population of Moose Creek is expected to increase from 580 people in 2021 to 1,080 people by 2051.

As per the ECA, the average day flow (ADF) for the Moose Creek WWTL is 302 m^3/day, and the total rated storage volume is 110,376 m^3. Based on flow predictions in association with the population growth, the MSP predicted an ADF of 438 m^3/day in 2051 to meet the future population projections.

The 2024 MSP also noted a need for increased storage capacity at the lagoons, and opportunities to increase the treatment efficiency at the facility. The MSP flow projections depicted that the rated capacity (storage volume) of 110,376 m^3 of the Moose Creek WWTL would be exceed by the year 2033.

The facility is currently operating at approximately 85% of this rated capacity of 110,376 m^3. Due to this approaching proximity to the rated capacity, there is a further need to increase the plant capacity through upgrades or an expansion in the short-term.

1.2 Background of the Moose Creek WWTL & components

The existing Moose Creek WWTL was constructed in 1994 and operates under the ECA approval no. 3-1555-91-936, dated January 19, 1993. The facility consists of the following components:

- Two facultative aerated lagoon cells
- Influent distribution chamber, with three inner chambers
- Aeration building with two positive displacement blowers
- Alum feed and metering building two positive displacement mild chemical diaphragm pumps
- Discharge and Metering chamber

The final effluent is discharged to Moose Creek, which flows along the eastern property boundary. As per the current ECA, the facility discharges effluent once a year, as an annual discharge. The discharge window is between March 15th to April 30th, with a maximum discharge flow rate of 11,040 m^3/d.

Figure 1-1 presents the site layout of the existing Moose Creek WWTL.

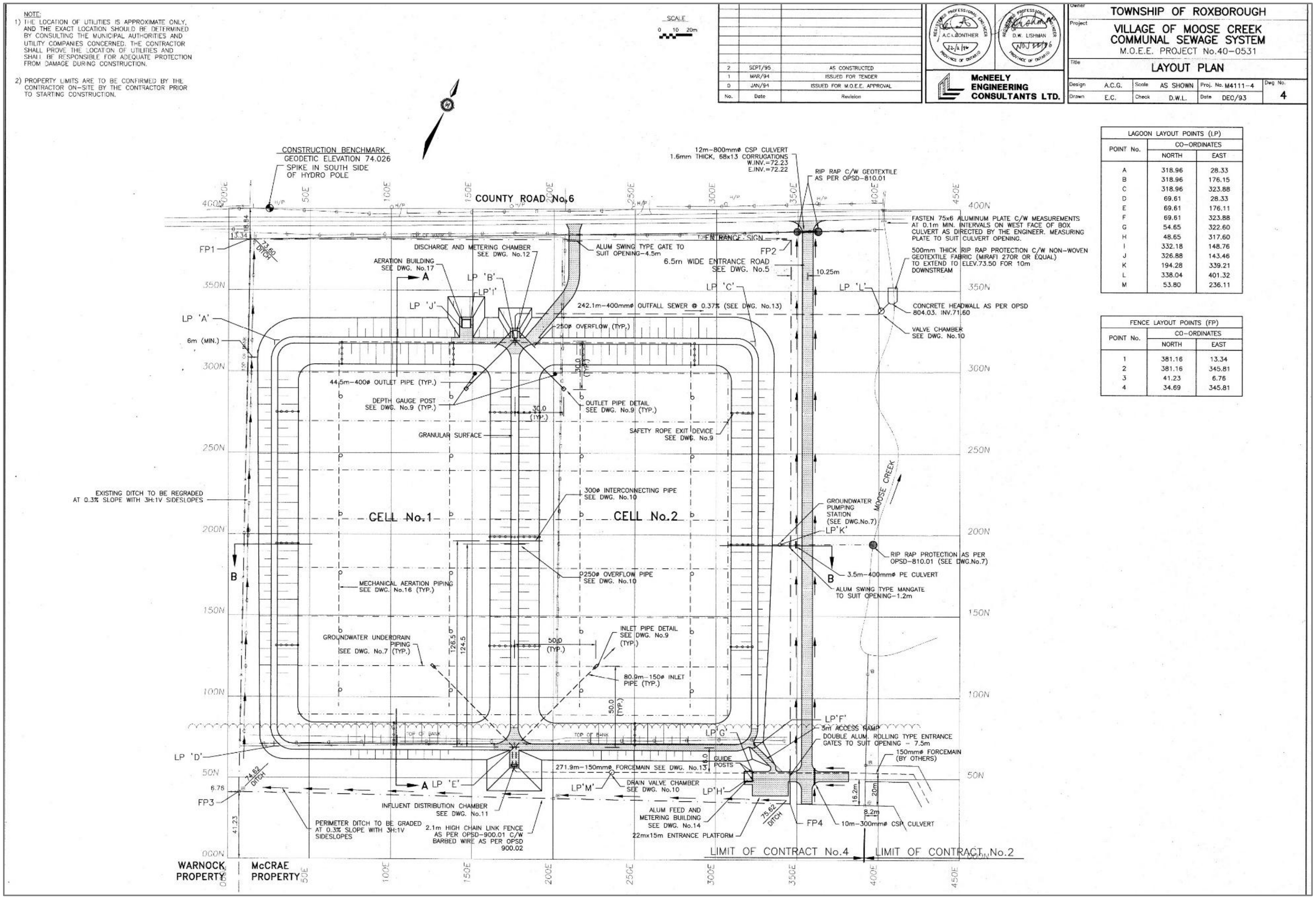

Figure 1-1 Site layout of the existing Moose Creek WWTL

2. Project descriptors

2.1 Study Area Location and Site Features

The Study Area for this Class EA Study includes the existing WWTL and a plot area adjacent to the lagoon property. The location of the existing Moose Creek WWTL is approximately 1 km away from the Village of Moose Creek, on Lot 22, Concession 07. Including the existing plot and the adjacent plot to the south-east, the study area consists of a total area of approximately 23 ha. The extent of the study area is presented in Figure 2-1.

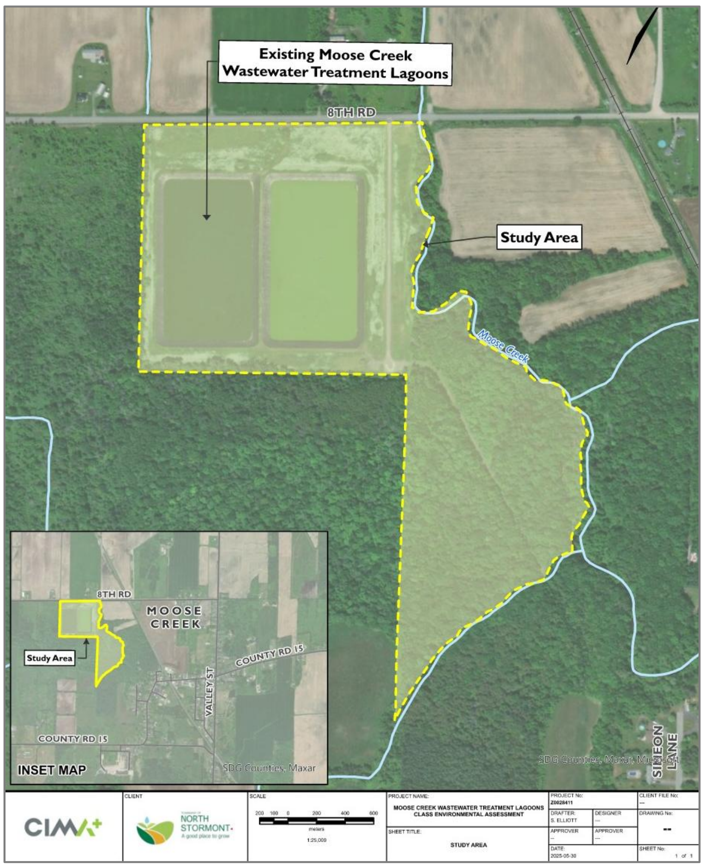

Figure 2-1: Moose Creek WWTL Class EA Study Area

2.2 Proposed Upgrades to the Moose Creek WWTL

The proposed upgrades to the Moose Creek Lagoons will enable the system to be appropriately sized for future flows, with efficient treatment. Out of the long-list of alternatives considered during the MSP, the preferred alternative was to expand the lagoon capacity through Treatment Optimization via Technology.

The preferred alternative will be chosen based on the technical, socio-cultural, natural environmental and economic impacts, as well as the permitted discharge limits and windows, in accordance with the findings of the Assimilative Capacity Study (ACS) and inputs from the Ministry of the Environment, Conservation and Parks (MECP). The ACS for this Class EA is currently underway, as of July 2025.

In line with the MSP recommendation, and based on preliminary design at the current stage of the Class EA project, the following two technology alternatives are being considered for implementation and are described in the following subsections.

2.2.1 Submerged Attached Growth Reactor (SAGR)

The Submerged Attached Growth Reactor (SAGR) is a technology trademarked by Nexom®, and is primarily used to aid in pollutant control for effluents wastewater treatment plants.

The technology is particularly efficient in nitrification. Nitrification is the process by which harmful nitrogen polluters such as ammonia, are neutralised by conversion to less harmful and simpler compounds such as nitrates.

The SAGR is also known to function well in cold climates at about 1°C. Typically, in conventional biological wastewater treatment technologies, the Nitrifying bacteria, which are bacteria responsible for the nitrification process, are impeded by cold temperatures. This leads to reduced bacterial growth and rate of treatment which causes sub-optimal nitrification. The SAGR technology, owing to its set up and installation, effectively prevents the loss of performance of these nitrifiers, even in cold weather.

The reactor build consists of rock aggregates that act as the media for biofilm growth, and uses an impermeable HDPE liner. The top of the reactor is covered in insulating material such as mulch. The bottom of the reactor is well-aerated through diffuser grids that ensure efficient aeration as the water flows across the reactor in a lateral manner. As biofilm grows on the rock surfaces, the nitrifying bacteria convert ammonia into simpler nitrates. The treated effluent then flows out of the reactor via gravity. The closed vessel and stable rock surfaces provide the bacteria with adequate protection from high flows and low temperatures, thus producing a high treatment capacity.

The SAGR technology has seen increasing use in wastewater treatment plants and in lagoon systems over the past decade. Though the degree of treatment is dependent on the quality of the influent and the flow, and requires aeration, the SAGR provides a highly efficient and compact method of treatment (Nexom, n.d.). Figure 2-2 depicts the schematic of a typical SAGR unit.

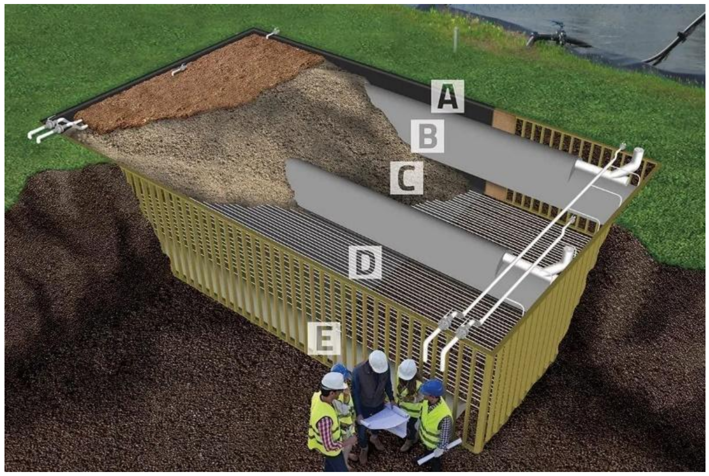

Figure 2-2 Schematic of a typical SAGR unit during installation (Courtesy of Nexom)

2.2.2 Moving Bed Biofilm Reactor (MBBR)

The Moving Bed Biofilm Reactor (MBBR) is another biofilm based technology that is gainly popularity in the wastewater industry in recent years. The technology was first developed in the 1980s in Norway and is also aimed at nitrification treatment in cold weather conditions. The MBBR works on the principle of biofilm growth on the surfaces of a large quantity of plastic media. It should be noted that while the plastic media move within the tank, the biofilm itself remains fixed onto the media, giving rise to the MBBR's name.

The plastic media is typically made of durable polymer such as HDPE, and comes in varying sizes, shapes and configurations. Air is supplied from the bottom of the tank. Scouring, the process by which intense bursts of air are used to control biofilm growth, is typically not required for the MBBR. This is due to the fact that the constant motion of the media aids in a passive control of the biofilm growth, as they brush against each other, which helps to maintain optimum biofilm thickness levels. Figure 2-3 depicts examples of biofilm media with and without the biofilm growth.

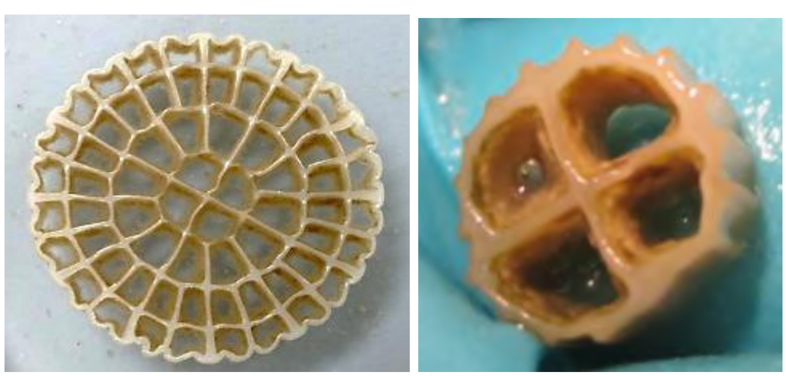

Figure 2-3 Example of media used for MBBR, with and without biofilm growth (Courtesy of Veolia)

There are several MBBR installations all over Ontario, and it has widely been implemented across the world. The technology offers several advantages. Due to the lack of filtration seen in other biofilm technologies, the MBBR does not exhibit clogging issues. The stable surface also prevents the “washout” or loss of microorganisms, during high-flow events which increases the overall resiliency of the facility. Additionally, if increase in the treatment capacity is required, the amount of MBBR media used can be increased, which provides a simple and swift method to increase treatment capacity.

The MBBR requires a higher amount of aeration to function effectively, and although media typically have long lifespans, they require replacement at the end of life. Overall, it offers several benefits and its compact size and high treatment efficiency make it a good fit for retrofitting the Moose Creek WWTL.

2.3 Project Timeline

The timeline for this Class EA, as well as the expected construction timeline are detailed below:

- The Notice of Commencement for the Moose Creek WWTL Class EA (Phase 03 and Phase 04) was sent out on June 06th 2025.
- The Class EA project is expected to reach completion during Fall 2025, with subsequent detailed design.
- Construction is expected to start in 2026, with a completion goal of mid-2027.

3. Watershed for Moose Creek

Moose Creek is located in the watershed of the South Nation River – Lower Ottawa River. Moose Creek flows northward and enters the South Nation River near the Town of Lemieux. The South Nation then flows eastward and subsequently drains into the Ottawa River at Plantagenet, as shown in Figure 3-1. The project site is shaded and marked in blue.

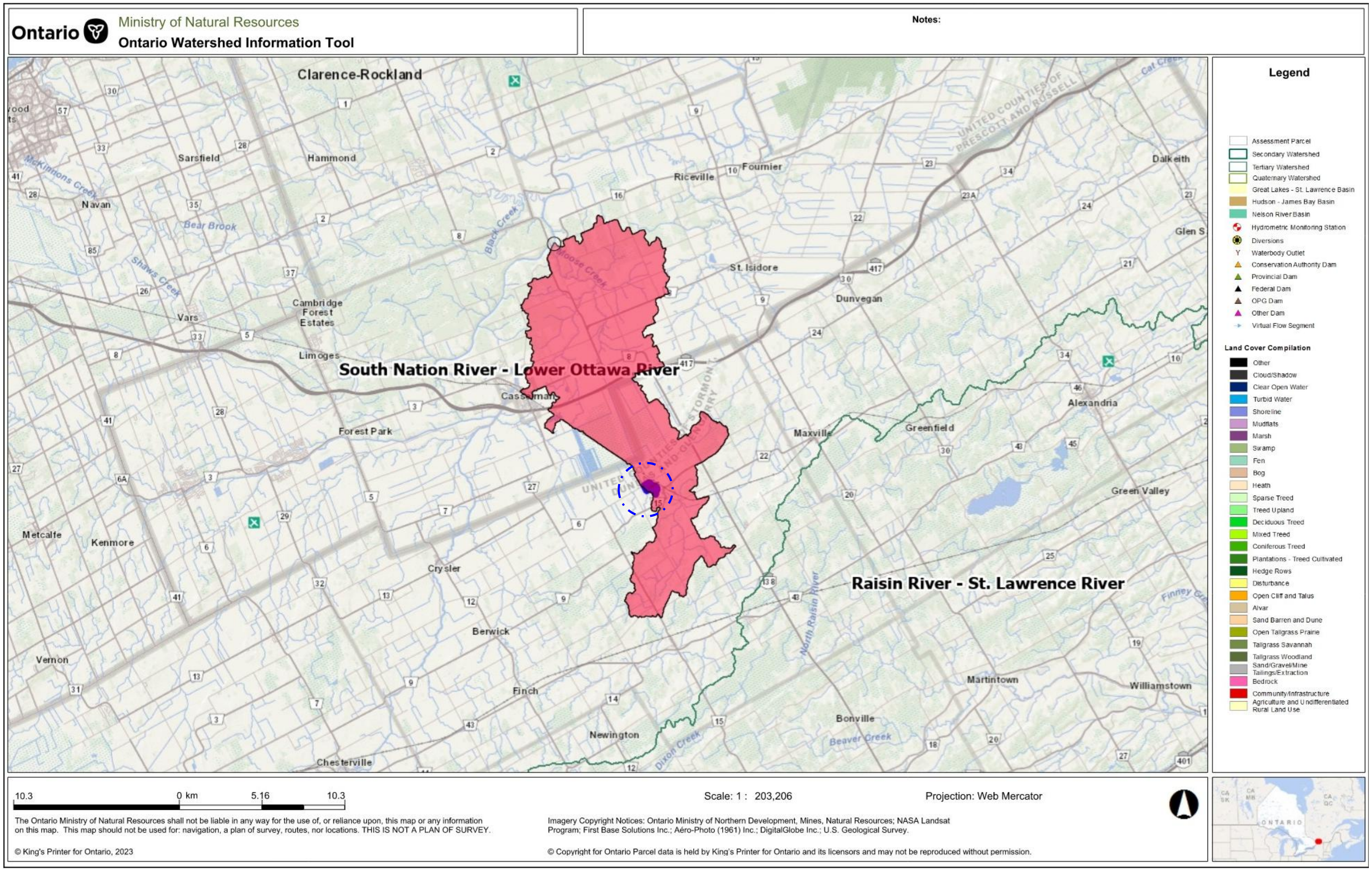

Figure 3-1 Project Site on the South Nation River – Lower Ottawa River watershed (Courtesy of Ontario Watershed Information Tool)

The region of this watershed has moderate temperatures and is not an arid region. In terms of rainfall, the watershed experiences moderate rainfall.

The South Nation River is the largest waterbody in this watershed. When verifying flows in the South Nation River with rainfall for the past year, a correlation was observed between rainfall and increased flow levels in the river. Flows (in m³/s) and rainfall received (in mm) for the South Nation River are presented in Figure 3-2, for the time period of Jan 2024 – June 2025.

In addition to rainfall, historical data also shows increased flows in the South Nation River during periods of snow melt in the spring. Overall, seasonal variations were observed in the flow, with higher flows during the spring and lower flows during summer and winter, typical of other water bodies in the region. The same trend is expected of Moose Creek and is further elaborated in Section 4.3.1.

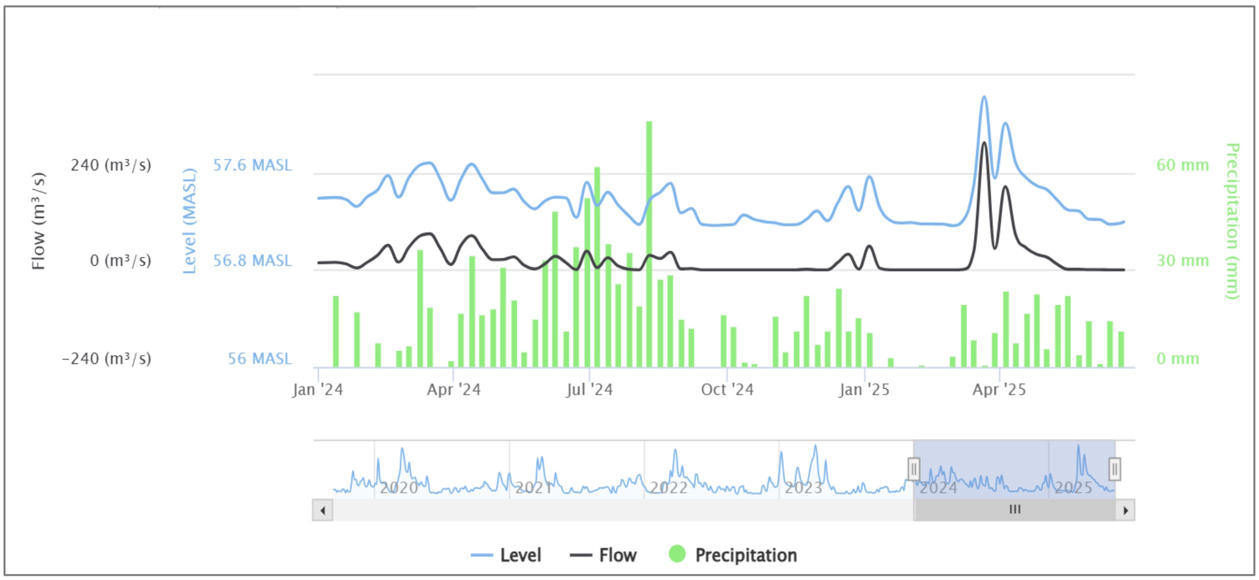

Figure 3-2 Flows for the South Nation River and regional rainfall, monitored at Casselman (Courtesy of the South Nation Conservation Authority)

4. Climate Change Considerations

4.1 Overview of Canadian climate regions, trends and projections

4.1.1 Canadian Climate Regions

Canada experiences diverse and varying climate regions, with differences largely influenced by the geographic location of each province, proximity to oceans, wind patterns, and so on. These factors closely relate to the ecosystem, diversity of wildlife, regional climate, etc.

Figure 4-1 depicts the climate regions found in Canada according to Environment and Climate Change Canada (ECCC). Ontario is seen to primarily fall under the Northeastern Forest, which experiences a Boreal Forest climate region.

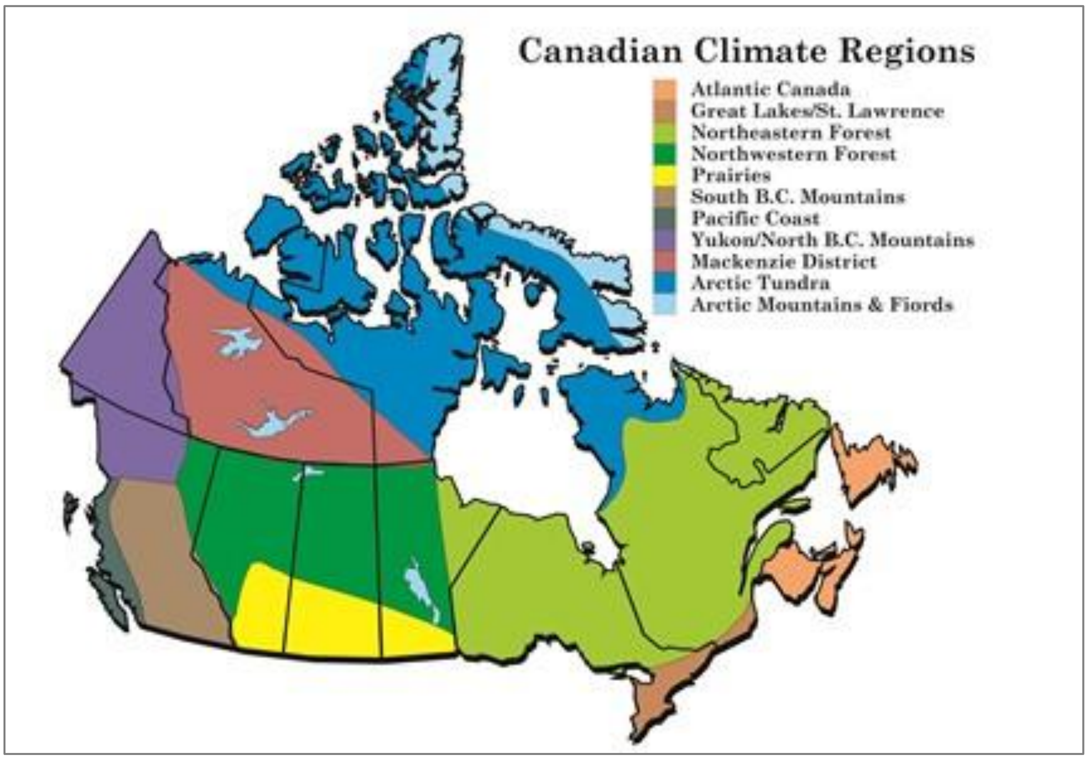

Figure 4-1 Climate Regions of Canada(Courtesy of ECCC)

4.1.2 Canadian Climate Trends

In line with global increases seen in temperature rises over the past decade, Canada has also experienced increased average temperatures.

According to the ECCC, based on preliminary data, it was observed that the national average temperature for 2023 winter (December 2023 to January 2024) has significantly increased from 1961–1990 baseline average, by 5.2°C. Figure 4-2 depicts this increased temperature change.

This marks the 2023 winter as the warmest winter on record across the country since 1948 (ECCC, 2024).

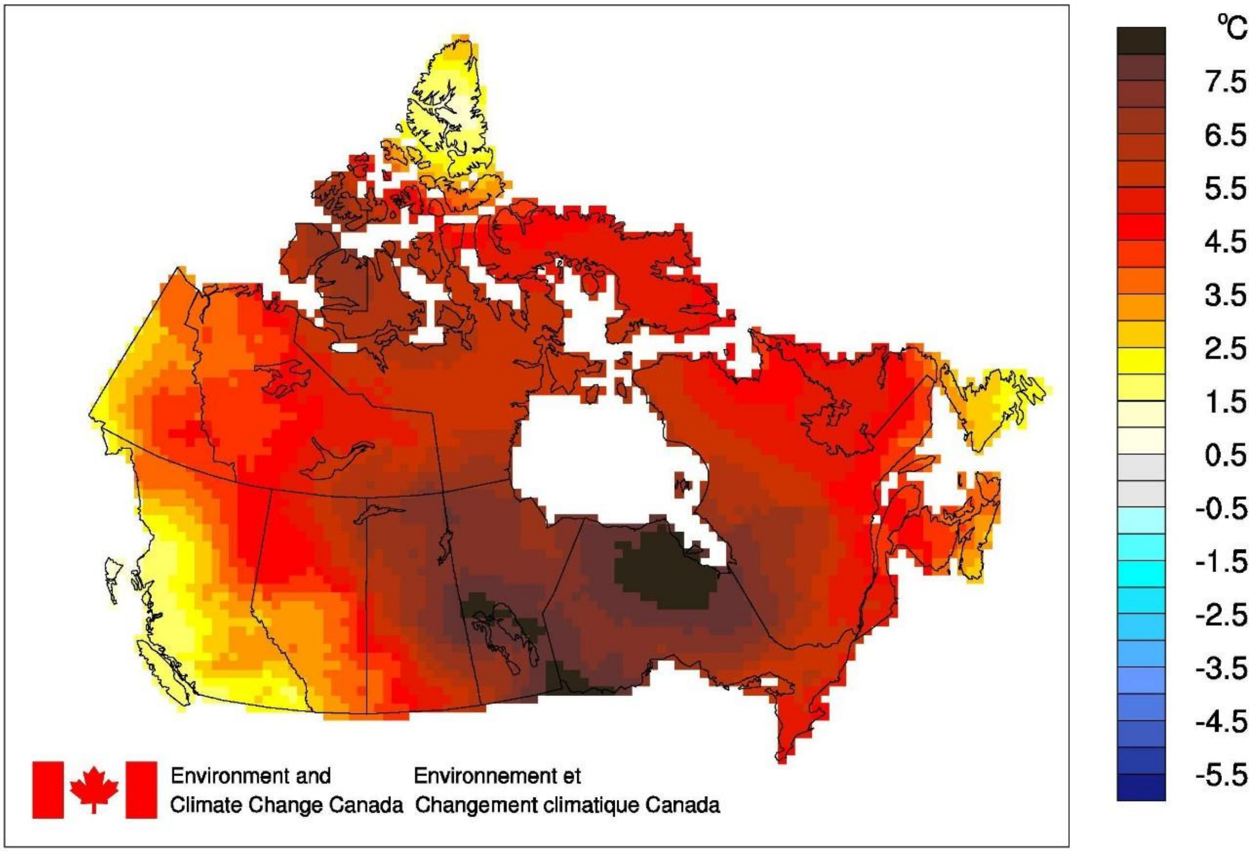

Figure 4-2 Temperature departures from the 1961–1990 average – Winter 2023/2024 (Courtesy of ECCC)

Increasing national temperature departures for winters have also been depicted in Figure 4-3 for the period of 1948 to 2024, showing the rising long-term trend as well as the increases from one winter to the next. Overall, winter temperature increases for the nation have increased on average by 3.6°C, for this 77-year time period (ECCC, 2024).

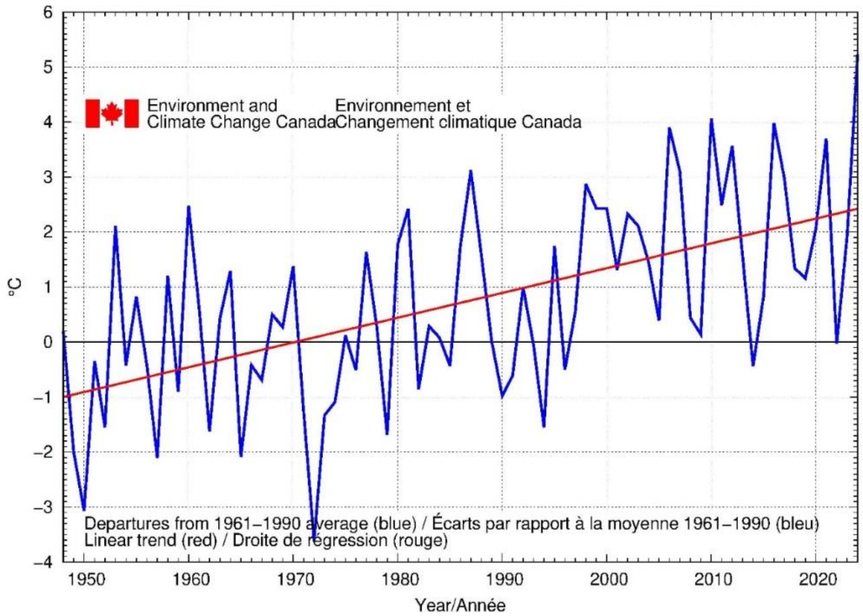

Figure 4-3 Winter national temperature departures and long-term trend, 1948–2024 (Courtesy of ECCC)

4.1.3 Regional considerations

Given the vast area and varying geography for Canada, not all regions experience the same climate events or with the same intensity.

Heat waves: For Ontario, based on historical data(1948 to 2023), the number of days experiencing extreme heat or 'heat waves' was seen to increase in trend (ECCC, 2025), as shown in Figure 4-4.

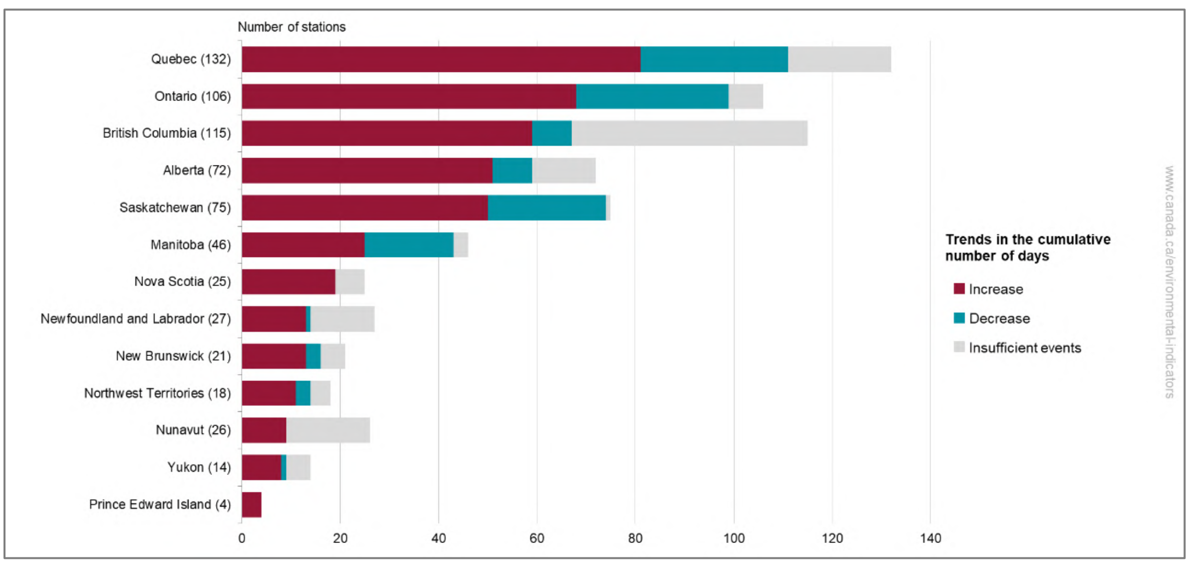

Figure 4-4 Trends in the cumulative number of days under extreme heat conditions by province and territory, Canada, 1948 to 2023 (Courtesy of ECCC)

Precipitation: According to a climate change study by York University, which utilised mean data from 1986-2005, Eastern and Southern Ontario have historically experienced the highest amounts of precipitation (Climate Change Team at LAMPS, York University, n.d.).

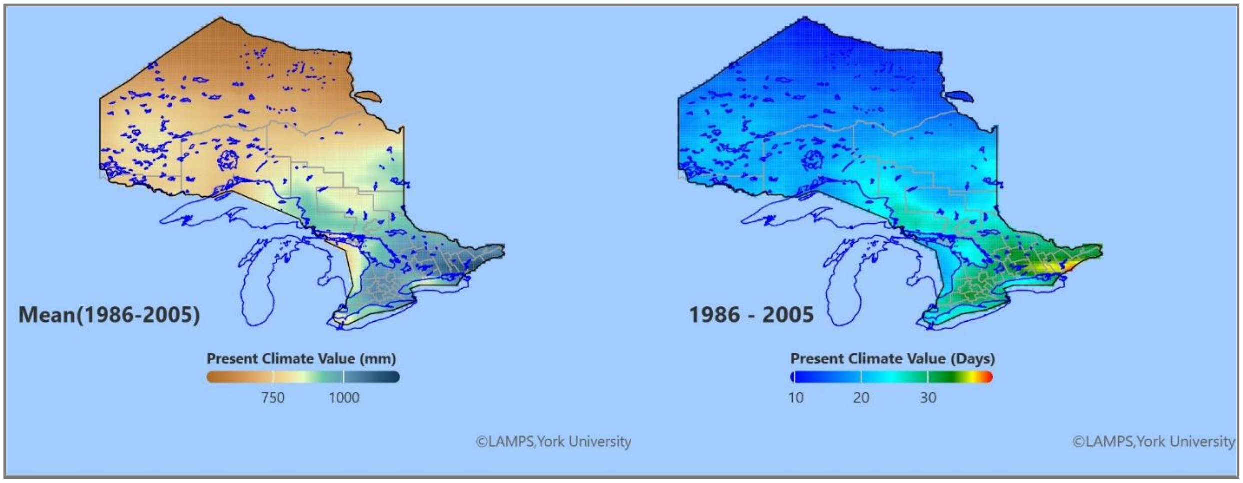

Figure 4-5 Historical Heavy Precipitation in Ontario (left) in mm and (right) in Days (Courtesy of LAMPS, York University)

Future projections, for the worst case emissions scenario RCP8.5 (which would result in the highest impacts from climate change) are shown in the graph in Figure 4-6. The reference period is 1986-2005, and the trend in the graph predicts the number of days of heavy precipitation (where precipitation is greater than or equal to 10 mm of rainfall) to steadily increase in future years.

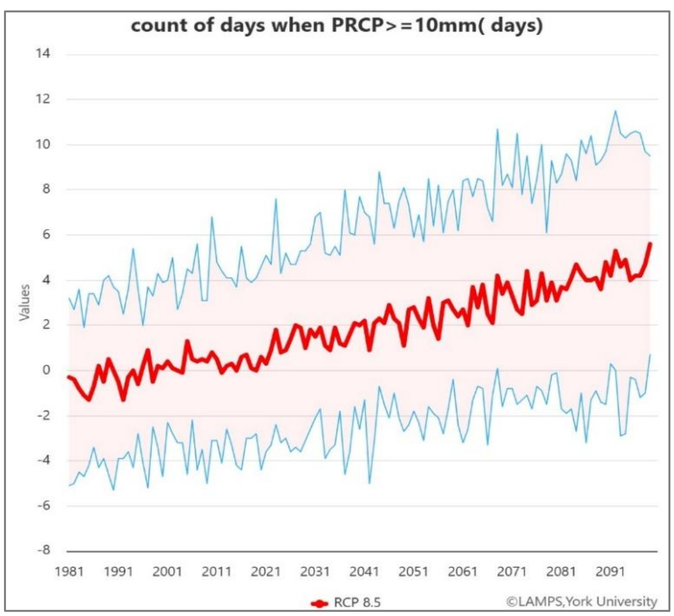

Figure 4-6 Number of days under extreme precipitation (Courtesy of LAMPS, York University)

This is in-line with findings from the Climate Resiliency Strategy for the City of Ottawa, which found that under the high-emission (worst-case) scenario, by 2050 the total amount of precipitation is expected to increase by 8%, for the winter, spring and fall. The amount of precipitation annually is also expected to increase, leading to higher precipitation that will subsequently be concentrated in shorter time-periods. Essentially, wet days are expected to be more severe in magnitude (City of Ottawa, n.d.).

Overall, it is clear that Ontario, much like the rest of Canada is expected to face increased climate change impacts. According to Conservation Ontario, the consequences of climate change include, but are not limited to the following:

- Changing climate patterns
- Increased temperatures
- Increased precipitation and severe weather events (ice storms, floods, etc.)
- Changes in surface water flows
- Degradation of biodiversity

The primary reason for climate change impacts being at the forefront of discussions toward future planning, is due to their far-reaching effects and risks. The associated repercussions on the environment, infrastructure, human communities and human health have led to a vital need for good planning practices during early Projects stages. The aim is to better understand these climate change impacts and to best-tailor works in order to improve environmental resiliency and limit associated risks .

4.2 Natural Hazard Risk Assessment

Owing to the geographical location of the Project site, only two major risks were identified: Drought and flooding. Their impacts, pertaining to the project location, are discussed below.

4.2.1 Drought Considerations

Historically, the area of Moose Creek has been affected by warnings for Low water levels, according to the Ontario Low Water Program (Ministry of Natural Resources, n.d.). The program defines warning levels as follows :

- **Low Water Level 1**: early indication of a potential drought condition
- **Low Water Level 2**: increased likelihood of drought conditions

The website has information until February 2021. The relevant recent warning for Moose Creek was a “Low Level 2” warning in June 2020, as shown in Figure 4-7. The region appears to experience Low water warnings during the summer and fall months. It is otherwise not classified as a drought-prone region.

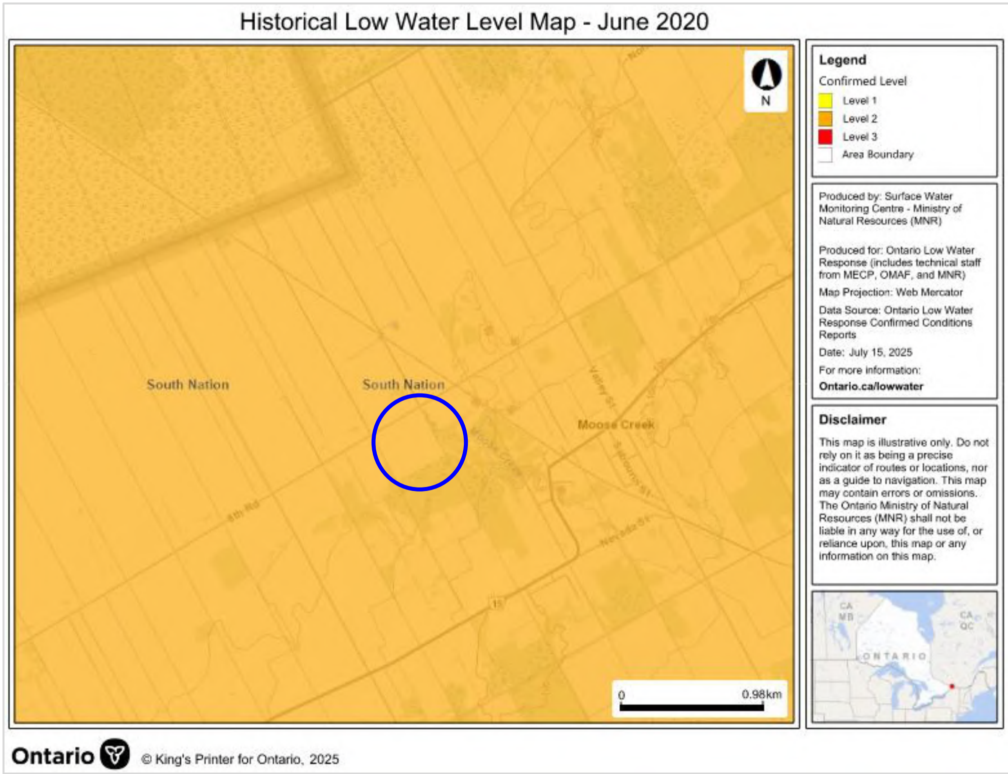

Figure 4-7 Example of Low Water Level 2 for Moose Creek during June 2020 (Courtesy of Ontario Low Water Program)

The Canadian Drought Monitor (CDM) is a Federal resource that also provides notices and historical information on drought related risks for Canada. According to the CDM, the classification for drought is as follows, for Monthly areas of drought in Canada :

- D0 - Abnormally dry
- D1 - Moderate drought
- D2 - Severe drought
- D3 - Extreme drought
- D4 - Exceptional drought
- Drought not analyzed

On reviewing the past 10 years of drought intensity for Moose Creek, it was seen that the region generally experiences periods of 'D0- Abnormally dry' during the summer and late fall months.

Two instances of 'D2- severe drought' were noted during July 2016 and July 2020. The years of 2016, 2021 and 2024 also experienced periods of 'D1 -Moderate drought' during the late fall (Agriculture and Agri-Food Canada, 2025). An image of the D2 warning from July 2020 is shown in Figure 4-8, with the project location demarcated in blue.

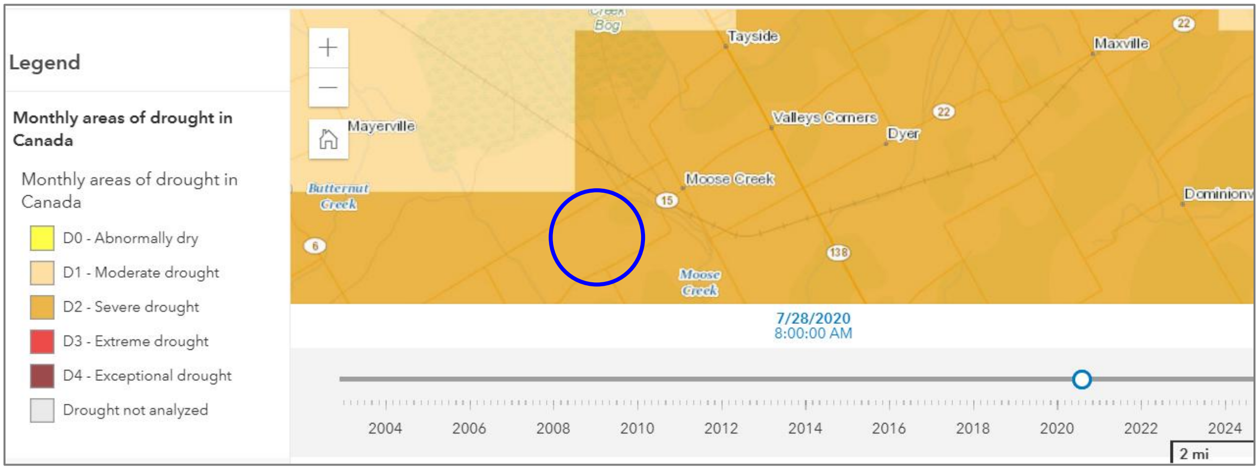

Figure 4-8 Example of Severe drought for Moose Creek, July 2020 (Courtesy of Ontario Low Water Program)

Historical trends point to increasing heat intensity, frequency and their associated impacts. According to the Climate change viewer, projected temperature changes of +3.9°C (in the range +3.2°C to +5.6°C) are expected in the immediate vicinity of Moose Creek by the year 2071-2100 (Canadian Climate Institute, n.d.).

In the context of this project's drought considerations a possibility of increased evaporation from the lagoons exists, in cases of increased and prolonged heat. However, due to the large size and volume of the lagoons, the resulting water loss is expected to be negligible.

As detailed above, based on recent historical data (Agriculture and Agri-Food Canada, 2025), it was also noted that the primary cases of D2 droughts in Moose Creek were observed in the summer months (June to August) with corresponding low flows in the Creek. The Moose Creek Lagoons currently store water during the summer months and will continue to do so, with no significant modifications proposed through this project for the summer storage. Hence, the direct impact of low flows in the summer is expected to be minor.

However, due to the predicted increasing intensity and duration of heat waves, there is a possibility of heat waves extending into the spring and fall months, in addition to their significance during the summer months. This phenomenon has the potential of resulting in low surface flows in the Spring and Fall.

For the Spring period, potential low flows are expected to be moderately offset by snow melt, and hence, have a minor probability of occurrence. On the other hand, there is a higher possibility of low flows in the Fall due to associated impacts from the summer heat.

The effluent discharge criteria is to be determined through the outcome of the ongoing Class EA for the Moose Creek WWTL Expansion. However, limitations on the discharge volume and windows may arise for the Municipality in the future, if Creek flows prove to be insufficient or incapable of assimilating the lagoon effluent due to changing climate trends. This was evaluated in terms of the lagoon's storage needs since it directly influences the effluent discharge.

Based on the scenarios being considered in the ongoing Class EA, twice-a-year lagoon discharges (once each in the Spring and Fall) are proposed. This approach was seen to provide a buffer for operating the overall lagoon capacity of 110,376 m^3. Essentially, the lagoons may not need to utilise their full storage capacity, thus enabling discharges within a shorter duration, if needed. For instance, if only 70% of the lagoon volume is required to be filled prior to one of the twice-a-year discharges, these flows can be released in a shorter duration when compared to releasing flows that are 100% of the lagoon storage volume.

Hence, even in the event that the number of discharge days are restricted in the Fall due to low flows from droughts, a moderate level of inherent mitigation is expected to exist from the twice-a-year discharge, subject to final permitted discharge windows from the Class EA outcome.

Overall, the probable impacts of increasing heat waves remain an important factor to be considered for the Creek flows and the lagoon's discharge windows, especially in light of changing climate trends.

4.2.2 Flood Risks

The location of the Moose Creek WWTL is away from major waterways, lakes or coastlines. The nearest major waterway is the South Nation River, located approximately 10.5 km to the East. The key factor influencing flood risks in this region, hence, arises from increased precipitation. As shown above in Figure 3-2, the South Nation River experiences peak flows during rainfall and snow melt events with low flows in the summer.

Moose Creek is known to exhibit similar behaviour, with low flows in the summer and higher flows during the spring snow melt as shown in Figure 4-9. Due to a lack of continuous monitoring data for the Creek, historical data for cumulative flows has been utilised to demonstrate past flows in Figure 4-9.

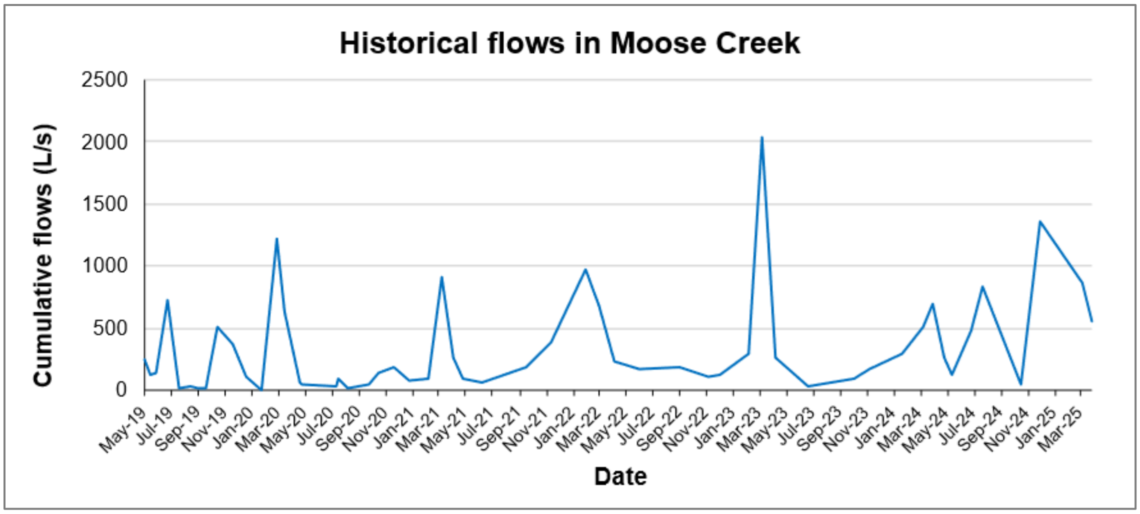

Figure 4-9 Historical flows in Moose Creek (May 2019- Mar 2025)(Courtesy of GFL)

Flood forecasting is issued by the Ontario Flood Forecasting and Warning Program, through the Ministry of Natural Resources and Forestry (MNRF) in partnership with Conservation Authorities and Environment Canada. Based on the recent warnings from the program, the region of Moose Creek experiences warnings for 'watershed conditions statements': which entails early notice, based on heavy rain, snow melt etc., for the potential for flooding.

An example of this 'watershed conditions statements' warning for Moose Creek, during a heavy precipitation event, is shown below in Figure 4-10 as seen in the Ontario Flood Forecasting and Warning Program .

Outside this typical warning, no major continued flood risks were observed for Moose Creek on reviewing historical data from the Climate data Viewer (Government of Canada, n.d.). The most recent major event necessitating a Water Safety Statement was seen in March 2023, where snow melt and high rainfall of about 10 mm increased local river flows significantly (Township of North Stormont, 2023). Further impacts related to increased precipitation are discussed in Section 4.3.1 below.

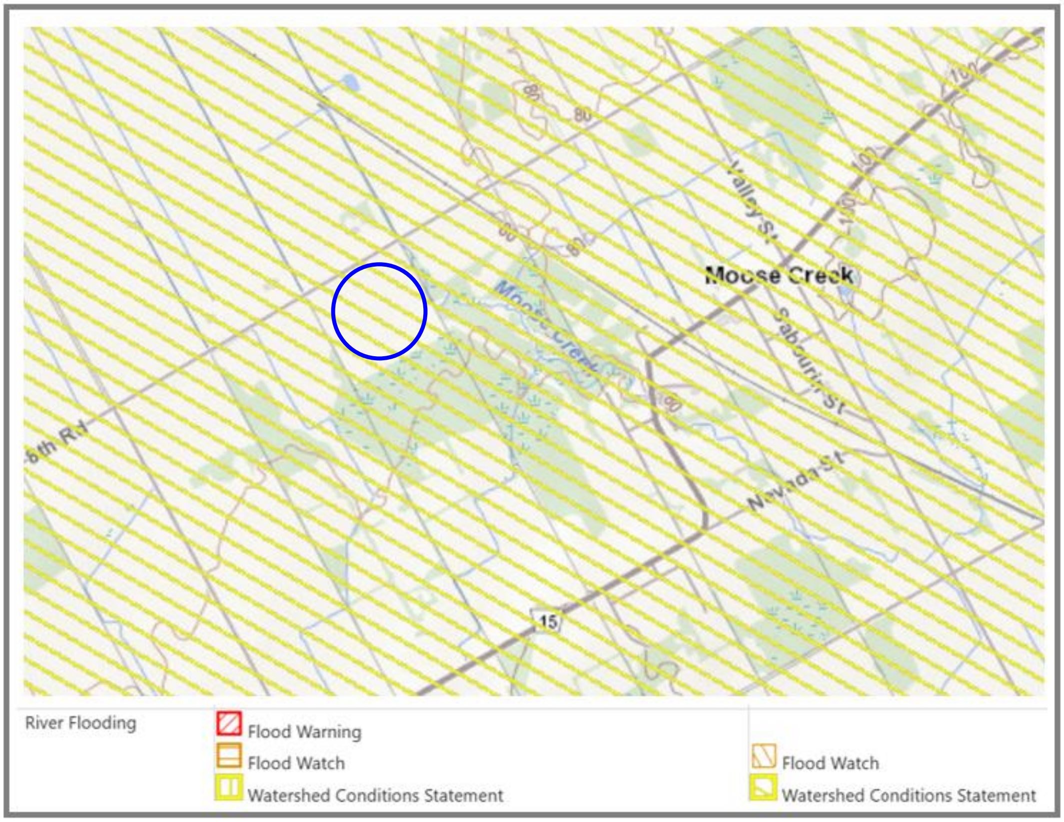

Figure 4-10 Example of watershed conditions statement for Moose Creek (Courtesy of Ontario Flood Forecasting and Warning Program)

4.2.3 Forest Fires

Public Safety Canada provides information on provincial and territorial wildfires as well as area classifications, in terms of Forest Fire Danger Ratings and provides a Forest Fire Info Map by the MNR (MNR, n.d.). The map provides danger ratings for forest fires and as per the map's classification for Ontario's Fire Regions, the area of Moose Creek is considered 'Outside the Fire Region', and is depicted in Figure 4-11.

The Canadian Wildland Fire Information System (CWFIS) also provides extensive fire maps and data. The CWFIS displays the Canadian National Fire Database (CNFDB), and based on mapping for 1980-2024, no forest fires have been reported in the Village of Moose Creek (Natural Resources Canada, n.d.).

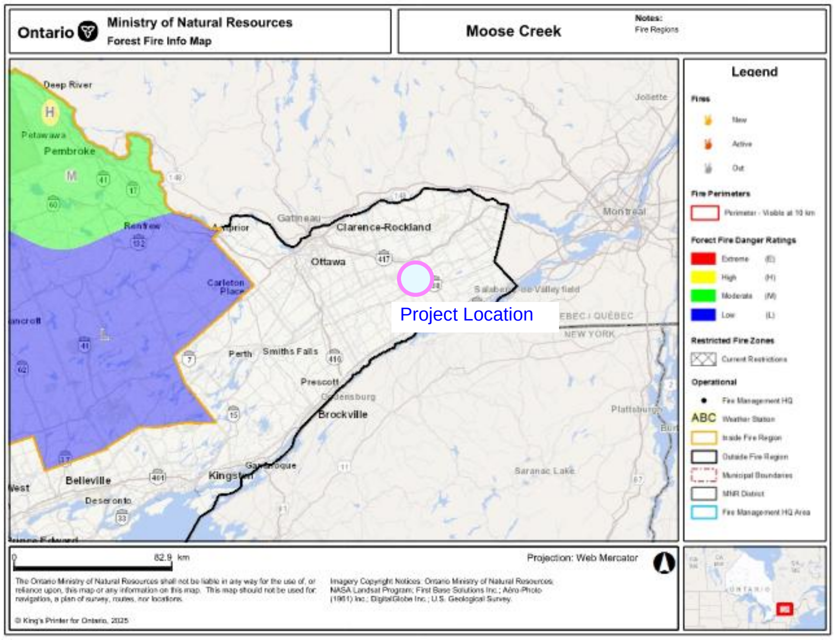

Figure 4-11 Forest Fire Mapping, Moose Creek (Courtesy of MNR)

CWFIS also hosts Historical Fire Weather, from 1981 to 2010, and the fire weather index on a monthly basis (Natural Resources Canada, n.d.). It portrays a general index of fire danger in forested areas, and uses a numeric rating from zero (low) to > 30 (high). For Moose Creek, it was seen that the months of April-August had a low rating of 5-10, while the other months were rated lower at 0-5 or none.

Hence, based on above data, it can be determined that the Village of Moose Creek is not a high fire-risk region. An example image of the CWFIS rating for the month of July is provided in Figure 4-12. The project location is marked in white.

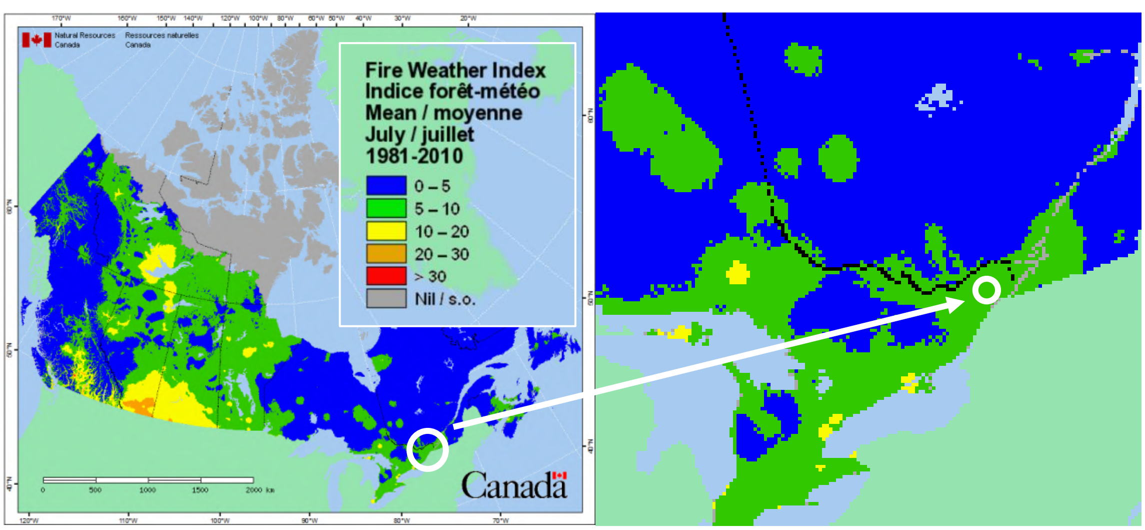

Figure 4-12 Historical fire weather index for Moose Creek for July (Courtesy of CWFIS)

Additional considerations include the surrounding tree cover on the adjacent lands to the South, East and West of the project site. The tree cover has the potential to act as fuel, should there be an ignition source in the vicinity such as lightning (natural) or from man-made causes. Additionally, extreme dry weather can increase the associated risk of forest fires.

While the possibility of forest-fires in Moose Creek cannot be completely ruled-out, based on historical and current fire mapping, it can be determined that the Village of Moose Creek has low potential for forest fires. Periodic mitigation measures, such as fire bans during extremely dry weather, can be adopted to reduce forest fire risks in the Village.

4.3 Climate Change Impacts

According to the IPCC report on *Understanding Global Warming of 1.5°C*, an increase in intensity and frequency of climate and extreme weather events have been observed during time spans where an increase as small as 0.5°C of global warming has occurred (IPCC, 2018).

Hence, given the current rising global temperature, evaluating and understanding the impacts of climate change is vital to mitigate impacts, but also to protect infrastructure assets and the environment, as much as reasonably possible.

This section discusses likely climate change impacts in the region based on their applicability on a more project-specific context. This measure aids in understanding the resiliency of the lagoons, to identify potential physical vulnerabilities, and to recognize opportunities to increase system resiliency against climate change.

4.3.1 Precipitation and Snow melt

Climate change is leading to deviations in typical global weather patterns. One associated factor is that the hydrological cycle, by which rainwater is generated and dissipated globally, is expected to experience an increase due to global warming. This can in turn lead to an increased amount of water vapor atmospherically, contributing to increased precipitation.

Canada experiences substantial amounts of winter snow, and as much as 85% of the country is covered in snow during the winter months, according to data for the period 1976-2019 (ECCC, 2024). As mentioned in Section 3, snow melt has notable effects on natural waters.

This is especially relevant in the current project context, since snow melt is a key parameter leading to inflow and infiltration (I&I) into wastewater treatment plants, thereby increasing their influent flows significantly. An increase in rainfall also typically results in high I&I into wastewater treatment plants.

For the Moose Creek WWTL, a comparison of the plant's inflow data against the local precipitation, for the period Jan 2020 to May 2025, is shown in Figure 4-13. The local precipitation data is from the weather monitoring station at the Moose Creek Wells, located approximately 2 km South-East of the Moose Creek WWTL (Government of Canada, 2025).

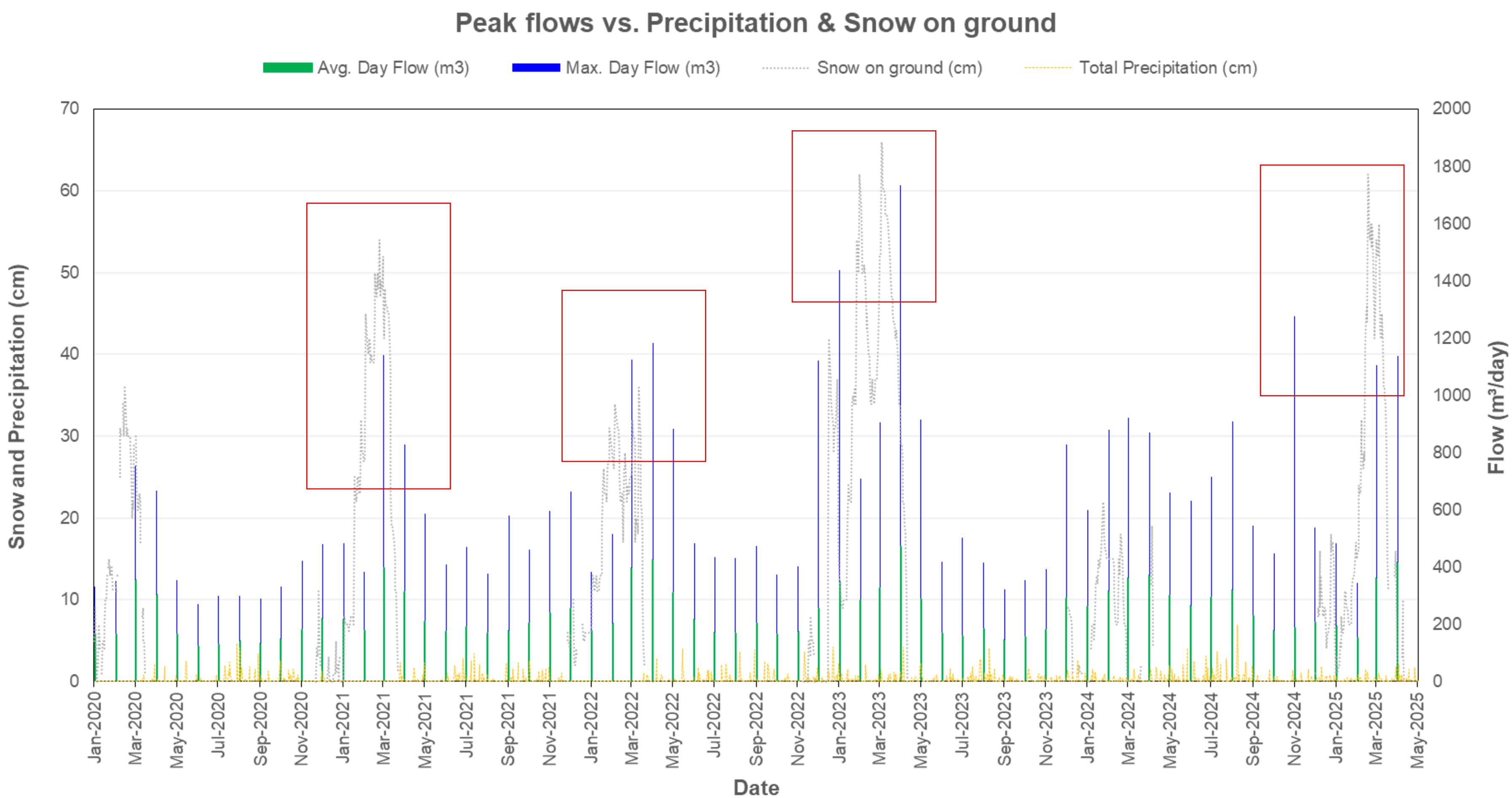

Figure 4-13 Peak flows at the Moose Creek WWTL vs. precipitation and snow on ground

From Figure 4-13 above, it is evident that peaks in the snow melt coincide with the extreme peaks observed for peak inflows to the plant (maximum day flows). Four major instances have been demarcated in red on Figure 4-13. Increases in the rainfall also show overall increases in plant flows for the respective months.

Hence, precipitation and snow melt are seen to have a direct impact on the Moose Creek WWTL. This is particularly important in the context of storage volume for the lagoons, since they are only capable of storing a fixed volume of water which steadily decreases until their subsequent effluent discharge period.

This further correlates to the vast surface area of the existing lagoons. Owing to their significant surface area of 5.6 ha., the lagoons hold high potential to act as catchment basins that can additionally capture any rainwater from direct overhead precipitation. A sensitivity analysis was performed to verify this rainfall volume and the lagoon’s associated resiliency in the following sub-section.

4.3.1.1 Sensitivity analysis

As detailed in Section 4.1.2, the likelihood of intense rainfall events has increased due to climate change. For instance, a 1 in 100-year rainfall event that brings significant rainfall typically has a 1 per cent chance of occurring in any given year. However, due to the effects of climate change, the probability and scale of these occurrences have become harder to predict and have seen a rise in frequency (City of Ottawa, n.d.).

The intensity and duration of these events have also been predicted to increase. Hence, it is essential to quantify the amount of storage volume available for normal operations amid such extreme weather events. A sensitivity analysis was verified, to check the resiliency of the system in the face of these potential increased flows.

4.3.1.1.1 I&I flows

I&I during the high precipitation event, can further reduce the amount of storage volume available, owing to the increased inflows entering the facility. Hence, amount of I&I was quantified based on average monthly historical dry and wet weather flows, and was found to be 131.33 m^3/d. On normalising the flows in terms of the current population of 580 persons, the I&I rate was found to be 227 L/p/d.

On extrapolating this for the future population of 1080 persons in 2051, the increased I&I flows were rated at 245 m^3/d, which needs to be accounted for any prolonged periods of high precipitation.

4.3.1.1.2 Capacity until mandated freeboard

The freeboard for wastewater treatment lagoons, as mandated, by the MECP is 0.9 m (MECP, 2024).

Hence, based on the existing freeboard of 1.1 m at the lagoons, an allowance of 0.2 m is currently present. This allowance may be used for emergency storage capacity during severe storm events until the mandated freeboard of 0.9 m is reached. This additional emergency storage capacity was verified and the freeboard volume was calculated using the freeboard height of 0.2 m. Calculations are summarized below:

- A 1-in-100 was chosen to verify extreme amounts of rainfall.
- For predicting the quantity of intense rainfall, it was assumed that a 1-in-100 year storm leads to 140-150 mm of rainfall for 24 hours, based on the Climate Data Extraction Tool provided by the ECCC (ECCC, n.d.). For this exercise, the higher value of 150 mm was chosen conservatively.
- The total surface area of the existing lagoons is 56,000 m^2
- Converting rainfall depth to volume of rainfall using the lagoon surface area and rainfall depth: Volume of Rainfall = 8,400 m^3/d
- Freeboard height is 0.2 m at the lagoons. Hence,
- Available freeboard volume = surface area x freeboard height = 11,200 m^3
- Applying a typical contingency of 10%, the available freeboard = 10,080 m^3
- Considering the average day inflows of 438 m^3/d for 2051 and average amounts from I&I (as 245 m^3/d) a volume of 683 m^3 would be required for 1 day, leaving a freeboard volume of 9397 m^3
- This implies that the lagoons can withstand 1 day (or 26 hrs) of continuous rainfall during a 1-in-100 year event, until they meet the MECP mandated limit of 0.9 m freeboard.

The current calculations in this section are primarily to verify the resiliency of the system in terms of storage capacity, in the extreme possibility that severe rainfall occurs when the lagoons are at full capacity. From design freeboard to the minimum allowable MECP freeboard, it was seen that the lagoons can accommodate a 1 in 100 year rain event.

As discussed in Section 4.2.1, various discharge scenarios are currently being reviewed for the ongoing Class EA. These scenarios depict the lagoons to be more resilient against intense precipitation when flexible/lengthened discharge windows are employed. It is to be noted that the final discharge windows are subject to outcome of the ongoing Class EA for the Moose Creek WWTL Expansion (ACS findings are pending).

All the discharge scenarios being considered for this Class EA project the maximum lagoon storage volume to be less than the design freeboard, hence, accounting for a 1 in 100 year rain event per the above calculations. An additional amount of storage volume in the lagoons may also be expected, depending on the final permitted discharge criteria and the associated degree of utilising the total lagoon storage volume. In essence, if the lagoons utilise 75% of their total volume prior to each discharge, an additional 10% can safely serve as an emergency storage volume in extreme cases of precipitation, which can further the resilience of the Moose Creek WWTL.

Similar to the findings in Section 4.2.1, although there is a possibility that droughts may detrimentally affect the duration of the Fall discharge window, the proposed twice-a-year discharge scenario coupled with the potential available storage volume in the lagoons, are expected to offset a moderate degree of impacts from high precipitation events related to climate change.

4.3.2 Other considerations

In addition to the increase in overhead rainfall, and inflows from I&I, severe precipitation also has associated impacts such as soil erosion from run-off. The MECP recommends that run-off around lagoons be diverted in order to safeguard embankments, as needed (MECP, 2024).

Based on existing and historical conditions at site, no issues of erosion and embankment loss have been reported at the Moose Creek WWTL. However, to support proactiveness and preparedness, it is recommended that periodic inspections be carried out to ascertain the conditions of the lagoon embankments and to verify stormflow patterns around the site. Stormwater diversions and fortifications on the project site are to be updated as necessary.

Additionally, the existing lagoons are located above ground with the top of the lagoon berm at a height of 3.1m above ground. This elevation thus reduces the risk of run-off from directly flowing into the lagoons from surrounding ground surfaces. This also reduces risk of flooding into the lagoons, thus enhancing resiliency of the system.

4.3.2.1 Electrical power & associated impacts of ice storms

In terms of electrical power, the lagoons can be run without electricity for the most part. This adds to the resiliency of the system, especially possible during power outages arising from heavy rain, winter storms etc.

However, an important factor that needs to be noted is the lack of effluent monitoring that will exist during a power outage. Consequently, a cessation in the effluent discharge can be anticipated, in the event that the power outage occurs during the effluent release period, i.e., a late winter storm that may impact the spring discharge window.

The resiliency of the Moose Creek WWTL in such events can be compared to that discussed for drought considerations and the associated possible impacts on the Fall discharge window, as seen in Section 4.2.1. A moderate level of inherent mitigation is expected to exist from the twice-a-year discharge, subject to final permitted discharge windows from the Class EA outcome.

Additionally, measures such as a Back-up diesel generator sufficient for monitoring and other discharge activities can be considered by the Township, if the need arises.

4.4 Climate Change Resiliency

This project is aimed at implementing efficient methods to meet the increase treatment capacity, while utilising sustainable methods and promoting environmentally responsible construction practices. The positive impacts and resiliency to climate change from both technology alternatives and the overall project implementation are detailed below:

- Both the MBBR and SAGR technologies exhibit an increased resistance to washout events during high flows. This adds to improvement in the capacity of the WWTP to respond to adverse climatic events such as high flows caused by significant storms.

In terms of technology-specific advantages for sustainability:

- For the **SAGR** alternative, the rock aggregates will be sourced locally. This will aid in lowering emissions from truck and/or air transportation as compared to aggregates that would otherwise be sourced internationally or from other provinces.
    - Overall environmental impacts associated with the transportation of materials is also expected to decrease with this decrease in greenhouse gas emissions. Additionally, local sourcing supports the regional economy while maintaining efficiency throughout the project lifecycle.
- The **MBBR** alternative will utilise high quality plastic such as HDPE, as well as recycled plastic where possible. The impacts associated with the production of new plastics will hence be reduced. Higher quality plastics will result in a longer lifespan of the media and reduced breakage, which will also lead to lower media replacement needs. This will also reduce the amount and frequency of plastic entering the environment when the plastic media become obsolete.

Biodiversity conservation: Based on the final discharge window that will be approved for this lagoon upgrades project, if either the SAGR or the MBBR is chosen, the construction impacts are expected to be minimal.

- Both technologies are designed to be highly compact. If chosen, the SAGR will be build on the northern most portion of the existing site, while the MBBR media will be added to smaller external tanks. Any additional facilities such as blower or chemical buildings will also be built on the existing lagoon site.
- Hence, the adjacent plot of land with significant forest cover and wildlife is not anticipated to be impacted by this alternative. Impacts from all alternatives do not deviate beyond the status quo.
- In terms of effluent water temperature, the fall discharge for this Class EA is proposed to occur approximately during the October-November months, when there is less impact on and generally cooler waters in Moose Creek, mitigating the associated potential for negative impacts such as algae.

4.5 Green House Gas Emissions

4.5.1 Process Emissions

The process greenhouse gas (GHG) emissions are often described in terms of the Methane (CH_4) and Nitrous oxide (N_2O) emissions resulting from the process. These emissions often have 'emission factors' from correlations in similar processes or from measured values.

These emissions are then quantified by relating the emission factors to the Global Warming Potential (GWP), which is a measure of how much heat a greenhouse gas is trapped in the atmosphere over a specific time period, relative to carbon dioxide (CO_2).

Detailed GHG emissions calculations will be performed in the Class EA Final Report, using various tools, once the ACS is completed and relevant equipment and tank sizing are finalised. This section provides a brief description of emissions information for the two technologies currently being considered for this project.

A variety of factors, such as the scale, type of influent, treatment degree, oxygen, etc. can influence these emissions (Zhou, et al., 2022). In general, for domestic wastewater systems, the IPCC 2006 Guidelines provide reference emission factors as follows (Eggleston, Buendia, Miwa, Ngara, & K. Tanabe, 2006):

- CH_4: 0.6 kg CH_4/kg BOD removed (for aerobic systems)
- N_2O from nitrification/denitrification: 0.005 kg N_2O-N/kg TN removed

For biofilm based processes, in particular, further complexity arises for GHG emissions estimation. For instance, the composition of microbes, the biofilm thickness, types of operations, type of reactor, etc. have all been seen to impact emissions such as N_2O emissions. Owing to the high complexity and intricate relationship between individual factors, it is often difficult to quantify and predict emissions from full-scale systems (Sabba & et al, 2018).

4.5.1.1 SAGR

Studies that quantify GHG emissions specifically for SAGRs are limited. Measured data from existing SAGR plants for GHG emissions is also lacking. However, several key factors significantly affecting emissions in SAGR systems have been identified. Based on a study quantifying ammonia removal of SAGRs, it was found that the Ammonia oxidation efficiency highly influenced the N_2O emissions. The degree of microbial activity in the biofilm, also highly influenced both CH_4 and N_2O production (Mattson, Wildman, & Just, 2018).

This is in-line with studies for similar systems such as biological aerated filters (BAFs). A study by J. Fiat that investigated N_2O emissions for full-scale BAFs found that key influencers for N_2O emissions were the applied NH4+ load, the oxygenation level and the influent temperature. Overall, the N_2O emissions factor was seen to decrease with increase in oxygen supply , and increase with increase in NH4+ concentration, which was congruent with other similar full-scale studies. The temperature was also seen to have some influence on the N_2O emissions but a specific effect was not established .

SAGRs area known to posses high-aeration efficiencies due to the design of the reactors Overall, it is expected that higher oxygen supply efficiencies will aid in reducing associated N_2O emissions.

4.5.1.2 MBBR

Similar to SAGR, a wide variety of factor can influence GHG emissions from MBBRs. Though studies are limited, some quantification data has been found and is discussed below.

One study by Ribeiro et. al investigated the N_2O emissions from MBBRs in the context of the effect of aeration intensity and total nitrogen (TN) loading on emission levels. The study found that that N_2O emissions from the MBBR system were influenced by the oxygen availability and the biofilm's nitrifying processes. The average N_2O emissions ranged between approximately 0.0011% and 0.068% of the influent total nitrogen, in terms of g N- N_2O /g TN (Ribeiro, Kligerman, & Oliveira, 2024).

Studies also mention that thinner biofilms have a higher chance of releasing more N_2O emissions due to incomplete biological treatment. However, MBBRs are generally known for their robust biofilm growth, and hence, it is expected that the resulting efficient biological treatment will aid in preventing such associated emissions.

As mentioned above in Section, 4.5.1.1 oxygen transfer is another parameter that can impact GHG emissions. Due to the free-floating media and new lagoon diffuser grids that would be needed for this technology, a high degree of oxygenation is expected. Hence, associated N_2O emissions are expected to be lower for the MBBR.

Overall, it is to be noted that N_2O emissions are dependent on a variety of factors and are hence, highly variable.

4.5.1.3 Coagulant

GHG impacts of the coagulant use will be verified as part of the Class EA Final Report, once the preferred treatment alternative has been finalised.

5. Conclusion & Recommendations

This report evaluates the impacts of climate change on a regional and project-specific context, to quantify system resiliency as much as reasonably possible.
The findings are summarized below:

- No major continued flood risks were observed and risk of forest fires was found to be low. Periodic mitigation such as fire bans are recommended where appropriate.
- Drought: Increased heat waves in the summer may stretch into the Fall, causing low flows in Moose Creek. This has the potential to affect Fall discharge window's duration (window may be shortened).
- High precipitation: Risk of reduction in lagoon storage volume. In the worst-case event (a 1 in 100 year storm when lagoons are at full capacity), system was found to be capable of accommodating rainfall, from the design freeboard to the minimum allowable MECP freeboard.
- Lagoon height, coupled with electrical power independence, adds to system resilience. However, Spring discharge window can be adversely impacted during power outages from extreme winter storms. Backup generator may be considered by the Township to increase resiliency.
- WWTL can demonstrate a moderate degree of resiliency towards potential reduced discharges owing to:
    - Proposed twice-a-year discharge scenario, and
    - Resulting potential storage volume in the lagoons (subject to the final permitted discharge and the outcome of the ongoing Class EA).
- Erosion Management: recommendations for periodic inspections and stormwater management measures, as needed.
- Proposed technologies: SAGR and MBBR are robust, efficient and anticipated to use sustainable material sourcing.
- Biodiversity Conservation: supported by the project's aim to avoid construction within the adjacent forested area.
- GHG emissions: limited information available for SAGR and MBBR but both technologies are expected to have lower N_2O emissions.
    - Detailed GHG emission calculations: in the Class EA Final Report, once ACS is completed and equipment sizing is finalised.

6. References

Agriculture and Agri-Food Canada. (2025, July 10). *Drought analysis*. Retrieved from Agriculture and Agri-Food Canada: https://agriculture.canada.ca/en/agricultural-production/weather/canadian-drought-monitor/drought-analysis#dro

Canadian Climate Institute. (n.d.). *Extremem Heat in Canada*. Retrieved July 03, 2025, from Heat waves and extreme heat in Canada: https://climateinstitute.ca/reports/extreme-heat-in-canada/

City of Ottawa. (n.d.). *Ottawa in 2050: More rainy days and heavy rain events*. Retrieved July 11, 2025, from City of Ottawa: https://engage.ottawa.ca/climate-resiliency/news_feed/rainandsnow

Climate Change Team at LAMPS, York University. (n.d.). *Ontario Climate Data Portal*. Retrieved July 14, 2025, from Ontario Climate Data Portal: https://lamps.math.yorku.ca/OntarioClimate/total_precipitation.htm#/

ECCC. (2024, July 11). *Climate Trends and Variations Bulletin - Winter 2023/2024*. Retrieved from Canada.ca: https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/climate-trends-variability/trends-variations/winter-2024-bulletin.html#toc0

ECCC. (2024, March 28). *Snow cover*. Retrieved from Goverment of Canada: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/snow-cover.html

ECCC. (2025, February 27). *Extreme heat events*. Retrieved from Canada.ca: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/extreme-heat-events.html

ECCC. (n.d.). *Climate data extraction tool*. Retrieved July 08, 2025, from Government of Canada: https://climate-change.canada.ca/climate-data/#/

Eggleston, S., Buendia, L., Miwa, K., Ngara, T., & K. Tanabe, E. (2006). *2006 IPCC guidelines for national greenhouse gas inventories: Volume 5—Waste.* Institute for Global Environmental Strategies. Intergovernmental Panel on Climate Change. Retrieved from https://www.ipcc-nggip.iges.or.jp/public/2006gl/

Fiat, J. (2019). *Analyse and modelling of nitrous oxide emissions from full-scale tertiary nitrifying.* INSA de Toulouse, Chemical and Process Engineering. Toulouse: INSA de Toulouse.

Government of Canada. (2025, July 3). *Moose Creek Wells, Ontario*. Retrieved from Weather- Provincial summary: https://weather.gc.ca/past_conditions/index_e.html?station=tck&unit=imperial&view=graph

Government of Canada. (n.d.). *Climate data viewer*. Retrieved July 14, 2025, from Government of Canada: https://climate-viewer.canada.ca/climate-maps.html?t=annual&v=tmean&d=dcs_u6&s=ssp245&cp=1569373,-173274&z=9&ts=2&sl=CDD

IPCC. (2018). *Global warming of 1.5°C: An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways.* Intergovernmental Panel on Climate Change. Retrieved from https://www.ipcc.ch/sr15/

Mattson, R., Wildman, M., & Just, C. (2018). Submerged attached-growth reactors as lagoon retrofits for cold-weather ammonia removal: performance and sizing. *Water Sci Technol, 78*(8), 1625-1632.

MECP. (2024, September 04). *Biological Treatment and Secondary sedimentation*. Retrieved from Design Guidelines For Sewage Works: https://www.ontario.ca/document/design-guidelines-sewage-works/biological-treatment-and-secondary-sedimentation

Ministry of Natural Resources. (n.d.). *Ontario Low Water Response*. Retrieved June 30, 2025, from Ontario Low Water Response: https://www.lioapplications.lrc.gov.on.ca/Low_Water_Response/Index.html?viewer=Low_Water_Response.Historical

MNR. (n.d.). *Ontario Fire Info Map*. Retrieved August 18, 2025, from Government of Canada: https://www.lioapplications.lrc.gov.on.ca/ForestFireInformationMap/index.html?viewer=FFIM.FFIM

Natural Resources Canada. (n.d.). *Canadian National Fire Database (CNFDB)*. Retrieved August 18, 2025, from CWFIS: https://cwfis.cfs.nrcan.gc.ca/ha/nfdb

Natural Resources Canada. (n.d.). *Fire Weather Normals*. Retrieved August 18, 2025, from CWFIS: Fire Weather Normals

Nexom. (n.d.). *SAGR*. Retrieved July 03, 2025, from Nexom: https://nexom.com/sagr/

Ribeiro, R. P., Kligerman, D. C., & Oliveira, J. L. (2024). Nitrogen removal and nitrous oxide emission from moving bed biofilm reactor (MBBR) under different loads and airflow,. *Journal of Environmental Chemical Engineering,, 12*(3), 112574.

Sabba, F. T., & et al. (2018). Nitrous oxide emissions from biofilm processes for wastewater treatment. *Appl Microbiol Biotechnol, 102*, 9815–9829.

Township of North Stormont. (2023, March 17). *Water Safety Statement issued by South Nation Conservation*. Retrieved from Township of North Stormont: https://www.northstormont.ca/living-stormont/news-notices/water-safety-statement-issued-south-nation-conservation

Zhou, X., Yang, F., Yang, F., Feng, D., Pan, T., & Liao, H. (2022). Analyzing greenhouse gas emissions from municipal wastewater treatment plants using pollutants parameter normalizing method: a case study of Beijing. *Journal of Cleaner Production, 376*(134093).

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